EUROPEAN FUTURES

The Politics and Practice of Research Policies in the European Union

Submitted by Marco Liverani to the University of Exeter
as a thesis for the degree of
Doctor of Philosophy in Sociology
In April 2011

This thesis is available for Library use on the understanding that it is copyright material and that no quotation from the thesis may be published without proper acknowledgement.

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature: .....

A Michaela e al suo futuro

ABSTRACT

Over the past decades, research policies have gained an increasing importance in the overall strategy of the European Union. Early programmes date back to the late 1970s, but in recent years the promotion and funding of scientific research have become a central field of European governance within the wider policy drive towards the making of a 'knowledge-economy' in Europe. These developments are not only relevant to better understanding the process of European integration, but they also constitute an important chapter in the history of modern science. Today, EU framework programmes, the main instrument for research support at the European level, are arguably the biggest research funding scheme in the world. Moreover, European policies have introduced innovative practices of scientific collaboration and a new culture of research, which has contributed to key changes in the social and organisational dimension of science.

This sociological work examines these issues at two interrelated levels of analysis. First, it explores the emergence and development of Community research policies, in the changing political, cultural and economic context from the 1970s to the present, with a focus on the main narratives that have sustained and legitimised policy choices. Particular attention is paid to the life sciences and biotechnology as a research area where important issues of European governance and political culture emerged and were negotiated. Second, it aims to gain an understanding of the ways in which policy strategies have worked out in the actual practice of scientific cooperation. To do so, the second part of the thesis discusses the results of a micro-sociological study of two transnational networks in stem cell research, funded by the European Union under the Sixth Framework Programme (2002-2006).

ACKNOWLEDGMENTS

This thesis has been possible through the support, advice and collaboration of many people. First, I wish to thank my two supervisors, Christine Hauskeller and Massimo Mazzotti, who have been very supportive and helpful throughout my research journey. Then, I am very grateful to Peter Andrews for hosting me at his laboratory at the University of Sheffield during my early stage of research. Fieldwork in Sheffield was funded by a grant of the UK Social Science Stem Cell Initiative, which I gratefully acknowledge. I also wish to thank all scientists and other professionals who offered me their time, knowledge and insights, and especially Elena Cattaneo, Anders Björklund, Austin Smith, Claire Blackburne, Andrew Smith, Christian Desaintes, Giuseppe Testa, and Simon Thomlinson. Also, I am indebted to many staff and graduate students of EGENIS, the research centre for the study of genomics in society at the University of Exeter, who have provided inspiration and helpful comments at various stages of this work. The College of Social Sciences and International Studies of the University of Exeter, with extensive expertise in the social studies of science, European governance and integration has been an ideal research environment to carry out this study. Finally, this work owes much to the support of my partner Alexandra, who has shared with me the joys and hardships of this hectic period of our life, in which we changed homes four times, became parents, found new jobs, and moved to another country.

TABLE OF CONTENTS

ABBREVIATIONS

BAP	Biotechnology Action Programme
BEP	Biomolecular Engineering Programme
BRIDGE	Biotechnology Research for Innovation, Development and Growth in Europe
BSC	Biotechnology Steering Committee
CABAG	Competitiveness in Biotechnology Advisory Group
CAP	Common Agricultural Policy
CERN	European Organisation for Nuclear Research
CORDIS	Community Research and Development Information Service
COST	Cooperation in Science and Technology
CUBE	Concertation Unit for Biotechnology in Europe
DG	Directorate-General of the European Commission
EC	European Community
ECSC	European Coal and Steel Community
ECU	European Currency Unit
EEC	European Economic Community
EGE	European Group on Ethics in Science and New Technologies
ELSA	Ethical, Legal, and Social Aspect
EMBL	European Molecular Biology Laboratory
EMBO	European Molecular Biology Organization
EMU	European Monetary Union
ERA	European Research Area
ESA	European Space Agency
EU	European Union
Euratom	European Atomic Energy Community
FAST	Forecasting and Assessment in Science and Technology
FP	Framework Programme for Research and Development
GMO	Genetically Modified Organism
hESC	human Embryonic Stem Cell
IT	Information Technology
IVF	In Vitro Fertilisation
MP	Member of Parliament
OECD	Organisation for European Cooperation and Development
OTA	US Office of Technology Assessment
SEA	Single European Act
SME	Small and Medium Enterprise

INTRODUCTION

Research is essential to meet the threats of the future and to hold the hope of a second renaissance in Europe.[1]
The FAST team, European Commission (1981)

Even more so than the century that has just finished the XXIst century we are now entering will be the century of science and technology. More than ever, investing in research and technological development offers the most promise for the future.
European Commission (2000)

To govern is more than ever to fore-see, in other words, to go faster, to see before.[2]
Paul Virilio

Over the years, the promotion and funding of scientific research have gained an increasing importance in the development of the European Union. Early interventions date back to the 1970s, when the European Commission initiated a number of experimental programmes to foster scientific collaboration and knowledge sharing across national borders, with the ultimate goal of boosting economic growth through innovation. In the past decade, this policy drive has received further impulse in the wider context of the Lisbon Strategy (2000), a broad set of guidelines which set the ambitious target of making 'Europe the most competitive knowledge-based economy in the world'. Recent policy documents, such as the paper *Innovation Union* (2010a), have reasserted the central role of science and innovation in the overall framework of European governance and strategic planning.

European research policies and initiatives are not only relevant to an understanding of the process of European integration, but they also constitute an important chapter in the history of modern science. Today, EU framework programmes, the main instrument for research support at the European level, are arguably the biggest research funding scheme in the world. Moreover, EU policies have introduced innovative practices of scientific collaboration and a new culture of research, which has contributed to key changes in the social and organisational dimension of science, including a higher degree of accountability in the conduct of research and the transnational network as a distinctive mode of collective action in the production of scientific knowledge.

[1] Godet M. and O. Ruyssen (1981: 101).
[2] Quoted in Michael Fortun (1998), 'The Human Genome Project and the Acceleration of Biotechnology', in Arnold Thackray (ed.), *Private Science: The Biotechnology Industry and the Rise of Contemporary Molecular Biology*, University of Pennsylvania Press, p. 192.

Yet, the study of these developments has been relatively neglected. While there is a vast and diverse body of academic work on various institutional, economic, social and cultural aspects of European integration, the field of research policies has been given much less attention. What is more, little is known on the ways in which research policies work in practice, as well as their effect on the culture of science and their significance for the wider process of European integration.

To explore these questions, this thesis involves two interrelated levels of analysis: the study of the wider context of Community research policies and the ways in which policy strategies work out in the practice of scientific cooperation. Specifically, the first level of analysis examines the emergence and development of Community research policies in the changing political, cultural and economic context from the 1970s to the present, with a focus on the main narratives that have sustained and legitimised policy choices. Particular attention has been paid to the life sciences and biotechnology. This area of scientific research and applications has long been identified as a priority sector for European planning and interventions. At many points in time, science policy makers in the European Commission have embraced with enthusiasm the innovative potential of biotechnology, due to the economic prospects of its commercial applications and the promises to provide technical solutions to major social concerns, from energy supply to waste management, healthcare and unemployment. In many ways, biotechnology and the life sciences have been elected as key resources for the *future of Europe*.

The practical realization of this techno-political vision for the European future, however, has not been straightforward. First, the European Commission has had to face considerable difficulties in 'europeanising' a sector that has been shaped by national and global dynamics, alliances and networks. Second, transnational cooperation in the life sciences has been hampered by the fragmentation of the regulatory landscape at the national level. In some contentious research areas such as stem cell research, marked differences between national regulations have counteracted the establishment of a uniform European platform for the circulation of researchers, scientific knowledge and biological substances. In this situation, the European Union has had to find a difficult balance between the promotion of scientific research, the principle of subsidiarity, and the protection of common 'European values' in the domain of

human rights. The critical study of these issues, therefore, can shed light not only on the ways in which scientific knowledge is circulating and being produced in a 'postnational' context, but also on the wider process of European integration. As Sheila Jasanoff argued, 'biotechnology policy became a site of interpretative politics, in which important elements of European identity were debated along with the goals and strategies of European research' (2005: 92).

The second level of analysis aims to gain an understanding of the ways in which policy strategies have worked out in the actual practice of scientific cooperation. To do so, the second part of the thesis discusses the results of a micro-sociological study of two transnational networks in stem cell research, funded by the European Union under the Sixth Framework Programme (2002-2006). The transnational network or 'consortium' has been a distinctive configuration of European science cooperation since the late 1970s. While it has provided a flexible and efficient structure to organise research activities at the European level, it has also entailed problems of standardisation of experimental practices and, especially, regulations. This problem has been particularly thorny in stem cell research. Despite its widely advertised therapeutic promises, stem cell science has become the *bête noire* of Pro-Life campaigners in several parts of the world, due to the ethical implications of related practices such as cloning, the production of chimeras and hybrids, and the manipulation of human embryos. In the European Union, the promotion of transnational research in this field been has been highly problematic. Discrepancies between national attitudes have jeopardized the approval of recent funding programmes and highlighted once again the long standing problem of the harmonization of research policies and, more broadly, of European unity and cultural identity. In my micro-sociological work, I have tried to understand how this fragmented landscape has impacted on the practical work of scientists.

Research questions and roadmap

More specifically, this study has been designed around the following research questions:

1. What is the political and cultural background for the emergence and development of European research policies on biotechnology and biomedical research?
2. How do these policies work in practice?
3. What is their influence on the organisation and culture of science?
4. What are their implications for the wider process of European integration?

To answer these questions, the structure of the thesis proceeds from the general to the particular. The first chapter outlines the main trends that have characterized academic work on European integration in the past two decades. After a preliminary overview of EU history and the debate in political sciences, the remaining pages discuss themes and approaches that emerged in sociological and anthropological studies. This chapter is not meant to offer a comprehensive overview of the field, but it rather provides some insights on the ways in which the question of Europe has been framed, conceptualised, and explored according to different disciplinary perspectives.

The second chapter provides a discussion on the methodological foundations of my research approach, and revolves around two main issues. The first is the quandary of case study research, and related methodological problems of generalisation. The second issue concerns the ethnographic component of this work. How can one make sense of transnational networks? Former approaches will be considered, as well as specific problems associated with the study of scientific networks.

The third chapter introduces the 'macro' aspect of my research by providing an historical account of the emergence and development of European biotechnology programmes, in the wider context of Community science policy. This chapter attempts to pinpoint the most relevant arguments in the European discourses about science and technology and to place them in the changing political and economic context from the 1970s to the present. Research has involved the critical reading of various sources and documentation, including European programmes, directives and 'white papers', as well as conversations with policy makers.

The following two chapters narrow down the discussion to the specific field of stem cell research. The fourth chapter prepares the stage for the case study

analysis. After a brief overview of the field, it outlines the main issues in the bioethical debate both at the national and European level. Chapter five presents and analyses results from the micro-sociological study of two EU-funded networks in stem cell science, through interviews and observations conducted in laboratories in the UK, Italy, and Sweden, and at public events and scientific meetings.

Chapter six offers a more analytical discussion of the issues and materials presented. It draws some conclusions and addresses more directly the initial research questions, including the wider implications of research policies on European integration and their influence on the organisation and culture of science.

In sum, this thesis sheds light on European scientific integration both as a development that is shaped by policy makers and institutional dynamics, and a process that is enacted in social practices and behaviours by scientists and other professionals who are involved in EU-funded projects. As my research findings document, at least in the field of biomedical research, the creation of a European community of scientists still faces important challenges, due to technical problems of standardization, the fragmentation of the regulatory landscape, and epistemic issues in distributing experiments across laboratories. Moreover, the policy drive towards the growth of the knowledge-economy in Europe is counteracted by global dynamics, as well as the difficulty of creating partnerships in the long term beyond the multi-annual duration of research projects. Despite these challenges, however, the europeanisation of science is a tangible social and cultural phenomenon, which is illustrated by many examples, such as European societies, conferences, journals, summer schools, and the use of 'Europe' as a unit of analysis in a range of studies and statistical surveys. In many ways, this process has contributed to de-nationalising the contexts for the organization and conduct of research projects and knowledge production. At the same time, however, the shaping of the European Research Area has been and is still underpinned by discourses and narratives that are reminiscent of national ideologies and policy strategies, namely the constant framing of science as a means to boost European 'competitiveness' vis-à-vis international players. This contradiction touches on one of the key questions concerning the future of European integration. The notion of Fortress Europe - open inside its borders but closed to the outside world - has been debated in

relation to EU migration policies, but to some extent can also be used to challenge research programmes. The creation of a European Research Area can be as much exclusive as inclusive. Likewise, the establishment of 'networks of excellence' can create self-perpetuating elites and marginalisation. To avoid such undesirable implications, it is argued, discourses and narratives on European science should be more inspired by values of cosmopolitanism and global solidarity.

1. MAKING SENSE OF EUROPE

The question of Europe became the focus of systematic academic interest after the end of Second World War, in concomitance with the beginning of the process of economic and political integration. Over the years, as the European project has grown and evolved, the field of European studies has also expanded and attracted scholars from different disciplines. While political scientists have been mainly concerned with institutional processes and 'top-level' dynamics, sociological contributions have begun to examine Europe as a social and cultural project. In social theory, some attempts have been made to conceive new critical tools in order to make sense of social phenomena that increasingly transcend national boundaries. In empirical research, recent works have focused on transnational or 'postnational' identities, collective action and political mobilisation at the European level, and the 'europeanisation' of social fields such as sport and education. Also, *Europe* has become the unit of analysis of large-scale comparative studies on different issues, such as governance, health care, religion, criminality, and education.

This chapter reviews the main critical arguments that have emerged from this body of works in order to provide a theoretical background and rationale to my project. After a preliminary overview of the history of the European Union and the debate on European integration in political sciences, it discusses themes and approaches that emerged in sociological and anthropological works. It is not meant to offer a comprehensive overview of the field, but it rather provides some insights on the ways in which European integration has been framed and conceptualized according to different disciplinary perspectives.[3]

[3] The review considers only works in the English language. It would have been fruitful to analyse in a comparative fashion the ways in which particular issues – such as the debate on European identity – have been discussed in different academic contexts. However, this task would go well beyond the aims of my research project. Also, the focus on Anglo-American literature reflects the cultural and academic context in which this work was developed.

1.1 Towards the EU

European integration, at least in its most tangible and visible form, is a series of institutional developments consisting of formal agreements, which are aimed to create some degree of cooperation or federation between national governments. From the postwar to the present, there have been several such efforts, including the Council of Europe, the Organisation for European Economic Cooperation (OEEC), the Western European Union (WEA), the European Free Trade Association (EFTA), and the European Union. However, the historical development that led to the establishment of the European Union in 1992 has introduced the most radical innovations in governance and political practice.[4] The beginning of this process can be dated to 1951, when six countries (France, Germany, Italy, Belgium, Netherlands, and Luxembourg) agreed to establish an international organisation in order to create a common market for the coal and steel sector: the European Coal and Steel Community (ECSC). This initiative, according to its promoters, was aimed to help postwar economic reconstruction, but also to forge deeper bonds between former enemies and to mark a first step towards the constitution of a European federation. As the French foreign minister Robert Schumann claimed in 1950 in a famous declaration to the French National Assembly, 'by pooling basic production and by instituting a new High Authority, whose decisions will bind France, Germany and other member countries, this proposal will lead to the realization of the first concrete foundation of a European federation indispensable to the preservation of peace' (Salmon & Nicoll 1997: 45).

Some years later, the 'Six' decided to further consolidate their economic relationships by launching two other organisations: the European Community for Atomic Energy (Euratom) and the European Economic Community (EEC). The former included provisions on industrial policy and scientific research on the peaceful use of the atom. The latter was given a wide range of economic competences, such as the power to establish a customs union with internal free trade and a common external tariff; common policies for particular sectors, notably agriculture; and more general co-operation on macroeconomic

[4] The literature on the history of European Union is vast and diverse. To write this section, I mainly relied on Urwin's classic work on *The Community of Europe* (1995) and Dinan's *Europe Recast* (2004), which provides a more recent overview. Also, Pinder's (2001) short introduction is a valuable guide to understand the intricate working of EU institutions. Finally, Salmon & Nicoll (1997) edited a useful collection of historical documents on European integration.

strategies (Pinder 2001: 13). The institutional structure of the EEC was based on the interplay between a Commission, which represented common European interest and had a monopoly in initiating legislation, and a Council, composed of national ministers and vested with decision-making powers.[5]

Both organisations were inspired by the mission of bringing 'peace' and 'prosperity' to Europe, as the founding treaties specified; but the EEC Treaty also envisaged the ultimate goal of achieving an 'ever closer union' between European countries. Indeed, the architects of these agreements were convinced federalists and, like Schumann, were committed to realize political unification by means of economic integration. Few years later, the first President of the EEC Commission, Walter Hallstein, remarked: 'We are not integrating economies, we are integrating politics. We are not just sharing our furniture, we are jointly building a new and bigger house' (in Urwin 1995: 75).

During the 1960s, however, this initial drive towards an ever closer union was considerably weakened as a result of the changing context of European politics. For example, since his election as French president in 1959, Charles de Gaulle had pursued a foreign policy marked by aggressive nationalism. In the European arena, he firmly opposed any projects for political integration and, in contrast, sought to use the EEC as a means to serve national interests. To this aim, he twice vetoed Britain's application to join the Community, fearful that her membership could challenge French leadership in Europe. Besides, he boycotted plans to grant more power to the EEC Commission, to the extent that he withdrew France's representative at the Council of Ministers in Brussels.[6]

With de Gaulle's resignations in 1969, the political climate for international negotiations became more relaxed and, in 1973, Britain could finally join the Community, along with Ireland and Denmark. The accession of Britain introduced an important player in the game of European bargaining, yet the institutional landscape did not change significantly. Like France, Britain was unwilling to surrender national sovereignty to European institutions; besides, the economic crisis following the Yom Kippur war in 1973 forced most European

[5] The Treaty establishing the EEC also provided for the constitution of a Parliamentary Assembly (the forerunner of the current European Parliament), which originally had only an advisory role and its members were not elected by direct universal suffrage. The Treaty also established the Court of Justice in order to enforce Community law.
[6] This crisis ended with the so called 'Luxembourg Compromise', where the French insisted on having a right of veto in the Commission whenever important national interests were at stake.

countries to restrict the scope of the free market and shelter again behind protectionism.[7]

A resurgence of interest in the European project occurred only in the 1980s, under the leadership of the new Commission's president Jacques Delors, within a global trend towards deregulation and liberalisation of economic markets. In particular, the Single European Act (1986) introduced a number of measures in order to remove non-tariff trade barriers such as state subsidies, and to reduce discrepancies in taxation systems across member states.[8] On the other hand, a renewed emphasis on the link between economic growth and technological innovation urged European policy makers to boost cooperation in industrial research, until then a minor concern of the Community.[9] Notably, in 1984 the Commission launched the first Framework Programme for research and development, a multi-annual funding scheme to support transnational research projects in thematic priority areas.

In the same period, the accession of Greece (1981), Spain and Portugal (1986) added a Mediterranean dimension to the Community, but it also introduced new problems of cohesion due to their relatively poor economies in comparison with the other member states. On this issue, there were different views. The British Prime Minister Margaret Thatcher - who by that time had become a convinced advocate of economic liberalism - regarded any form of financial help as a distortion of the 'proper' working of the free market economy. By contrast, Delors endorsed Community interventions and proposed to allocate structural funds in order to redress regional inequalities. Delors' views were backed by a report drafted by the Italian economist Tommaso Padoa-Schioppa, who later became one of the main architects of monetary union. In a rebuke of neoliberal doctrine, he stressed that 'any easy extrapolation of "invisible hand" ideas into the real world of regional economics in the process of market opening would be unwarranted in the light of economic history and theory' (in Dinan 2004: 226).

[7] This pronounced shift towards 'intergovernmentalism' was also marked by the increasing influence of the European Council, a high-level summit of the heads of member states which had been established in 1961 to define broad political guidelines on Community actions.
[8] While the EEC Treaty had successfully worked for the removal of tariffs and quotas, the abolishment of non-tariff barriers was hindered by the requirement of unanimous voting in most legislative domains. As a result, trade exchange between member states was still very modest. The SEA set a long list of measures to remove non-tariff barriers and extended the principle of majority voting in all areas concerning economic integration.
[9] Limited provisions on research policy were included in the ECSC, Euratom and EEC Treaty.

Delors' plans were eventually approved. They also included provisions on social policy and occupational health and safety, as well as the draft of a common charter on the Fundamental Rights of Workers, which was adopted by most national leaders in 1989. Following these early successes, Delors made some efforts to push forward one of his most ambitious goals: the establishment of the single currency. Proposals about a European currency had been around at least since the inter-war period, but they were never carried out for lack of feasibility or national resistance.[10] By the end of the 1980s, however, the idea of monetary union gained a new sense of urgency for two main reasons. First, it was regarded as a vital requirement in order to realize a truly unified economy. Second, radical changes in the global order created favourable conditions for closer economic integration. After the collapse of the Soviet system, which opened up the prospect of enlarging the Community to the East, German unification also became possible. Consequently, it became an imperative to strengthen economic and political ties between Germany and the rest of the continent in order to ward off any potential resurgence of German imperialism. As Pinder pointed out, the French president Mitterrand 'saw the single currency as the way to anchor Germany irrevocably in the Community system, and hence as a condition for German unification' (2001: 27). Conversely, this ensured the German chancellor Helmut Kohl the necessary support in Germany to proceed with the project.

The result of this bargaining was the Maastricht Treaty, signed in February 1992, which made provisions not only for the euro and the European Central Bank but also in a large number of areas including infrastructure, technology, research, education, environment, immigration, justice and police. The political meaning of the treaty was emphasised by the new name *European Union*. At the institutional level, the most relevant innovation was the increased weight of the Parliament,[11] which previously had a merely advisory role, and the introduction of two new 'pillars' alongside the Community: 'common foreign and security policy' and 'co-operation in justice and home affairs'.

[10] For instance, as early as 1929, German Chancellor Gustav Stresemann proposed to establish a European currency at a meeting of the League of Nations.

[11] This occurred through the establishment of the so called 'co-decision' procedure, which gave the European Parliament the power to adopt legislation jointly with the Council of the European Union, requiring the two bodies to agree on an identical text before any proposal can become law.

In the past decade, the basic structure of Maastricht has been substantially revised, mainly as a result of the dramatic process of enlargement which raised to 27 the number of EU member states. In 1998, the Amsterdam Treaty introduced important innovations in the areas of democracy and human rights, in order to reassert fundamental 'European values' as a necessary requirement to join the EU. Namely, the Amsterdam Treaty affirmed that the Union 'is founded on the principles of liberty, democracy, respect for human rights and fundamental freedoms, the rule of law, principles which are common to the member states' (in Dinan 2004: 291). In 2001, the Nice Treaty made some amendments to the majority voting system to redress the imbalances brought about by the enlargement process.[12] Finally, the Lisbon Treaty, signed in December 2007, introduced structural reforms after the failed plans for a European Constitution (rejected by the French and Dutch electorates in 2005), including the establishment of a EU sitting president and a 'foreign policy chief', the simplification of the overarching institutional framework, and the introduction of the Charter of Fundamental Rights as a legally binding document. After a complicated political process, including the initial rejection by Irish voters in June 2008 (a decision that was reversed in a second referendum in 2009), the Lisbon Treaty was eventually ratified by all member states and entered into force in December 2009.

Despite the impressive expansion of the European Union, repeated rejections of EU politics in popular referenda have brought to the fore one of the biggest problems of European integration. As some commentators highlighted, the Community, to some extent, can be regarded as a technocratic machine that is orchestrated by an elite of functionaries and is not legitimised by normal democratic procedures.[13] Over the past two decades, to increase the accountability of Community institutions and counteract 'democratic deficit', EU policy makers have implemented several reforms to increase the power of the European Parliament and established various forms of public consultation. Besides, the Commission has launched a number of cultural initiatives aimed to promote a sense of belonging to the common 'European home', including a

[12] The geopolitical boundaries of the European Union have greatly expanded as a result of three waves of enlargement: in 1995 (Austria, Finland, and Sweden), in 2004 (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia), and in 2007 (Bulgaria and Romania).

[13] For an overview of the issue of democratic legitimacy in the EU, see Banchoff and Smith (1999).

Europe's Day, the European flag and the European anthem (Shore 2000).[14] All these efforts, however, do not seem to have enlivened the feeble enthusiasm for the EU in a large part of its population. Citizens' attitudes range from lukewarm interest to open rejection, as the French, Dutch, and Irish referenda demonstrated.

Nevertheless, despite the apparent disconnection from ordinary people, the process of European integration has contributed to radical changes in traditional governance and social practices. The degree of this change, however, is a matter of controversy among intellectuals and scholars. Is the European Union a new form of super-state? Is there such a thing as a European social model? What is the impact of European integration on the wider society? I will continue the discussion in the following section, by reviewing a number of academic works that have addressed these issues.

1.2 Institutional Studies

In the field of political sciences and international relations, research on European integration has largely focused on institutional processes and 'top-level' dynamics. After the first modest initiatives of economic integration, the establishment of the European Economic Community in 1957 marked a significant step towards closer integration between European countries and posed a more serious challenge to traditional forms of governance. As a result, scholars in political sciences began to examine the reasons why some states had chosen to surrender part of their sovereignty to supranational institutions. In his pioneering work on the uniting of Europe, Ernst Haas (1958) provided a thorough empirical account of the political, social and economic grounds which underpinned the establishment of the European Coal and Steel Community, emphasizing the utilitarian benefit of the actors involved rather than the ideological commitment to a new political order. Further, he elaborated a broad theoretical model to understand the ways in which 'political communities are formed among sovereign States' (1958: xii). Drawing on functionalist

[14] In this respect, European policy makers had to find a difficult balance between the promotion of 'Europeanness' and the respect of national and regional identities. This tension is well epitomized in the EU motto 'unity in diversity' (see Schlesinger 1993).

approaches in political theory,[15] Haas argued that the initial decision by national governments to place a certain sector of the economy (such as the steel and coal industry) under a central authority inevitably creates the conditions to foster integration in other areas such as currency exchange rates, taxation and wages (Pollack 2005). As he put it, integration is a dynamic process driven by a *spill over* effect from one sector to another.[16] For Haas, this course of actions would ultimately lead to political integration, which he defined as 'the process whereby political actors in several distinct national settings are persuaded to shift their loyalties, expectations and political activities to a new centre, whose institutions possess or demand jurisdiction over pre-existing national states' (1958: 16).

During the 1960s, however, the functionalist approach was challenged by a renewed emphasis on the *raison d'état*. While Haas had argued that political (and social) integration would follow automatically from technical and economic cooperation, a new wave of historical studies stressed the primacy of nation states in the making of European politics. This turn was largely dictated by historical developments in the 1960s and 1970s. As mentioned, at that time negotiations within the Community were driven by an 'intergovernmental' logic. To many commentators, this development illustrated some profound truths about the continued dominance of national interests in Europe (Hoffmann 1966).[17] As a result, political scientists shied away from the functionalist paradigm and reconsidered the issue in more conservative terms. Haas himself, in an article published in 1975, reformulated his initial thesis and pronounced the 'obsolescence of regional integration theory' (in Pollack 2000: 360).

In the following decade, the state-centred approach became the leading paradigm for the study of European integration. In an influential work on the origin of the European Community, the British historian Alan Milward (1992) argued that European integration had begun, as it was the only way for nation

[15] In international relations theory, functionalism emerged in the inter-war period mainly from the work of the Romanian scholar David Mitrany. In particular, Mitrany rejected the belief that the nation-state is the best instrument to fulfil human needs and devised a future in which governments would be replaced by networks of functional committees (see Rosamond 2000: 33-35).

[16] Thus, as Lindberg summarized, functional spill over refers to 'a situation in which a given action, related to a specific goal, creates a situation in which the original goal can be assured only by taking further actions, which in turn create a further condition and a need for more action, and so forth' (in Laursen 1999: 72).

[17] During the 1970s, symptoms of the persistence of intergovernmentalism were the increasing authority of the European Council (a regular summit meeting of EU heads of state and governments); the rise of new barriers to trade among EC member states due to the economic recession; the failed attempts to monetary integration.

states to save their central role after the disasters of the war. To Milward, after 1945 'the European nation-state rescued itself from collapse, created a new political consensus as the basis of its legitimacy and through changes in its responses to its citizens which meant a sweeping extension of its functions and ambitions, reasserted itself as a fundamental unit of political organization' (1992: 3). In his revisionist fervour, Milward also challenged the federalist commitment of the founding fathers of the Community - the 'European saints', as he called them. For example, he noted that Schumann took 'the general ideas of his officials, the specific version of them suggested by Monnet, the increasing desperation of the Americans to find a way of binding Germany to the west, the extreme need of the first government of the Federal Republic to obtain a measure of equality of rights with the other nations, the wave of vague sentiment in favour of European unification, and from the combination of all these elements produced a foreign policy coup which turned out to be a major contribution to French national security' (1992: 325).

In tune with this perspective, the political sociologist Michael Mann argued that nation-states in Europe are hardly withering away. Although he acknowledged that, alongside strong national loyalties, there is 'a diffuse cultural sense of being "European" which is widespread across the member countries', he also stressed that 'Europe is not moving toward a single state or even toward a federal state' (1993: 127). 'In controversial areas', he observed, 'the EC works not according to supranational principles, but according to geopolitical ones - agreements and alliances between powers (...) Largely toothless, the EC regulates only the capitalist activity of a region. It provides a genuinely 'European' regulation - but only for areas agreed on by traditional geopolitics. It is not yet a state, nor is it replacing states' (128).[18]

Similar arguments can be found also in a celebrated work by Andrew Moravcsik, whose central thesis is that 'European integration can be best explained as a series of rational choices made by national leaders' (1998: 18). In particular, Moravcsik provided a detailed political analysis of five important negotiations in the history of the European Community, from the international

[18] In his book *The European Sisyphus* (1995), Stanley Hoffman claimed that, apart from the lack of a coherent and appealing project, the main obstacles to European unity were and are the resilience of the nation state. He argued, like Milward, that European integration has tended to strengthen, rather than weaken, the nation state, the persistence of national identities and diversities, and the divergence of EU member state interests, especially in response to outside pressure and crises.

conference in Messina, Italy, which laid down the basis of the EEC to the negotiations for the Maastricht Treaty. To do so, he developed a theoretical framework based on three stages of international negotiations. In the first stage, he argued, national preferences are defined by each state based on their economic interests. The second step consists of negotiations between national governments to reach substantive agreements, in which the outcome depends on the relative power of each state. Finally, the last phase involves the establishment of common institutions that ensure credibility for the achieved commitments. Like Milward, Moravcsik concluded that conventional accounts of European integration had given too much credit to the rhetoric of an 'ever closer union', as well as to the initiative of supranational actors. European integration, by contrast, emerged as the result of rational decisions made by the three largest member states (France, Germany, and Britain) and is grounded on core economic interests.

Moravcsik's thesis has been much debated and is still one of the leading theories of European integration. However, theorists have challenged his underlying assumptions and especially his methodological rationalism. For instance, the 'constructivist' school maintained that national preferences and identities are reshaped by the process of European integration itself (Pollack 2005: 362-365). Drawing from concomitant developments in social theory, constructivists argue that interests and identities are not absolute values, but are produced by the constant interaction of social actors.[19] While rationalists focused on material benefits and power, constructivists argue that the most important aspect of international relations is social, rather than material. As Alexander Wendt pointed out, it is the very interaction with others that 'create and instantiate one structure of identities and interests rather than another; structure has no existence or causal powers apart from process' (in Jackson & Sorensen 2006: 168).

1.3 The Sociology of Europe

[19] In social theory, Barry Barnes (1988, 1995) has developed a similar theoretical framework, which emphasises the importance of interactions over rational choices and normative values in explaining social order.

While scholars in the field of international relations have been mainly concerned with institutional aspects, a growing body of sociological works have begun to look at Europe as a social and cultural project. These studies have focused on different issues and have been underpinned by a variety of approaches; however, it is possible to single out some common concerns and trends. Notably, in many works, 'Europe' has become a new unit of analysis for sociological investigations. Works in this category have often addressed the question whether there is a distinctive European model of society, or a peculiar historical development that distinguishes Europe as a whole from other regions of the world. For example, in his social history of *European Modernity*, Göran Therborn (1995) argued that postwar Europe, 'from the Atlantic to the Urals', experienced a reorientation from an outward thrust, represented by centuries of overseas expansion and colonialism, to an inward thrust, characterized by 'two of the world's greatest attempts at large-scale social steering: building socialism in the East and uniting the nation-states of the West' (Therborn 1995: 334). Moreover, he maintained that this reversal was associated with a process of modernisation, documented by consumption patterns, rise of women and children's rights, working class politics, industrialisation, and reduction of mortality. From the 1970s onwards, however, the European dimension of such developments faded away, mainly as a result of deindustrialisation and the overwhelming dominance of the United States in the cultural industry. Nevertheless, to Therborn, a new kind of uniqueness emerged: Europe became the 'sceptical continent of the world', at least in regard to religion and, more loosely, nationalism (ibid.)

The sociologist Colin Crouch (1999) raised similar issues in his broad sociological survey of social change in Western Europe from the 1960s to the 1990s. The book is part of a series of academic studies on 'European societies', edited by Crouch himself, which also includes essays on religion (Davie 2000), the European cities (Le Galès 2002), and migration (Schierup et al. 2006). In his own contribution, Crouch verified the existence of a supposed European 'social form' and social 'convergence', by comparing a broad range of statistical data in socio-economic areas such as the organization of labour and capitalism, as well as in political life, the family and religion. According to Crouch, this research question was legitimised by recent political developments such as the arrival of the single currency, increasing European integration in many other

areas, and 'the frequent reference in much political and economic discussion to a "European model" of society' (1999: xi).[20] The whole book articulates around the thesis of what Crouch calls the 'mid-century social compromise', in which economic liberalism and welfare state achieved a distinctive European balance after World War II. In contrast to Therborn, however, Crouch is more sceptical about the emergence of a common pan-European model. Despite relative homogeneity in some geopolitical areas, he observed, Europe can be regarded as an entity with 'variable geometry', characterised by important regional differences both in social and political structure. Further, he argued that a distinctive Western European culture - in the sense of 'a mass of interactions that involve large numbers of people in social rather than political relationships at levels transcending individual nation-state boundaries' (1999: 395) - can be identified only in three domains: classical art, classical music and association football. In sum, he concludes, 'to search for a European society being shaped by the formal process of European integration is therefore either a too easy negative task or a premature one. It is too easy to point to all the ways in which the construction of an economic union has not yet produced much social integration; given how slow and deeply rooted social processes are, no one should expect anything to have happened yet' (ibid.).

In a number of works, the 'European model' has been studied by means of comparative analyses with other highly industrialised regions of the world, and, particularly, the United States.[21] Crouch himself measured social indicators in Europe against the yardstick of the US and Japan.[22] Likewise, Jeremy Rifkin attempted to grasp the essence of Europeanness by contrast with the American way of life. In particular, Rifkin argued that a new 'European dream' is emerging and replacing the 'slow death of the American dream'. In sharp contrast with American individualism, according to Rifkin, Europeans have a more inclusive conception of freedom, based on 'embeddedness', community life, and 'the

[20] Likewise, in the introduction to a collection of works on the 'anthropology of Europe', the authors claim: 'At present there are two main reasons which suggest that Europe can be treated as a unit: increased economic interdependence between the different European states, and increased information exchange through the mass media as well as personal contact through tourism, study and work (...). Perhaps the most significant factor to apply to Europe specifically is the increasing integration at a political level through agreements and treaties, and increasingly vigorous drives towards legislative ad institutional standardization, particularly within the European Union (EU)' (Goddard et al: 24).

[21] Conversely, individual countries are often assessed against the EU as a whole (e.g. 'the UK has the lower rate in the EU of car-related accidents').

[22] Rodríguez-Pose (2002) adopts a similar approach in a book on 'economy, society, and polity' in the European Union.

access to a myriad of different relationship' (2004: 13). Thus, 'the European Dream emphasizes community relationships over individual autonomy, cultural diversity over assimilation, quality of life over the accumulation of wealth, sustainable development over unlimited material growth, deep play over unrelenting toil, universal human rights and the rights of nature over property rights, and global cooperation over the unilateral exercise of power' (2004: 3).

While these works have different concerns and approaches, they all face a common methodological issue. What are the boundaries of 'Europe'? How can we conceptualise Europe for research purposes? In the face of these questions, Crouch adopted a strictly quantitative approach and framed Europe as an aggregate of national statistics. With respect to the research sample, he decided not to include any countries that had a population smaller than one million. As he specifies in the preface, 'this leaves us with 16 cases: the 15 current Member States of the European Union, less Luxembourg but plus Norway and Switzerland' (1999: xii). These specifications cast much light on the inherent ambiguity of a general sociology of Europe: on the one hand, the European framework has allowed scholars to make far-reaching comparisons and bold socio-cultural syntheses; on the other, it has implied generalisations and methodological choices which inevitably 'construct' the research object rather than simply examine it. This problem is apparent when comparing the different definitions of 'Europe' in the works by Therborn and Crouch: while Crouch focused on 'Western Europe', Therborn's geopolitical frame spans from the 'the Atlantic to the Urals'. In this respect, a general sociology of the 'European Union' is also problematic, if we consider the ongoing remaking of its borders and the variable level of integration among member states. Moreover, the framing of Europe as a uniform context of social and cultural practices can easily lead to distortions, oversimplifications and essentialist conceptions, as in Rifkin's analysis. This is also the case of the sociological commonplace of 'secular Europe' or, conversely, the exclusive identification of European values and cultural identity with the Christian heritage.[23]

1.3.1 European Identity

[23] For a critical rereading of both concepts, see Davie (2000).

Since the mid-1990s, the question of identity has become a key topic in the sociological and political debate on the European Union. The point of departure is the idea that European integration needs a common set of values and cultural references to ensure its coherence and to endow its actions with legitimacy and meaningfulness. As early as 1989, Jacques Delors reportedly said that 'we need a soul for Europe' (in Cerutti 2001). This need has become more pressing after the Maastricht Treaty, which entrusts the Community with new and stronger competences in a wide range of areas such as foreign policies, security and defence.[24] Besides, the prospect of Turkey's accession, with her predominantly Muslim population, and general issues of globalisation and immigration, have further added to the identity debates (see Macdonald 1997).[25]

So far, the identity of the European Union has been primarily defined in economic and political terms. As we have seen before, the founding treaties state that the EU is based 'on the principles of liberty, democracy, respect for human rights and fundamental freedoms, and the rule of law'. However, it shall also promote the diversity of its cultures, while 'bringing the common cultural heritage to the fore'.[26] To this aim, in the past two decades the Commission has designed a number of initiatives aimed to foster a sense of belonging to the common 'European home', including a European flag, the anthem, and the Europe's Day on the 9th of May, the date of the Schuman declaration (see Shore 1993, 2000).

In the academic arena, these issues have been examined in numerous studies and critical debates. For instance, Anthony Smith, a prominent scholar of nationalism and a convinced advocate of the ethnic origin of nations, argued that Europe needs 'sentiment' (1992a, 1993). The integration project, he observed, will remain shaky until the great majority of Europeans will be able to discover shared cultural values. However, he noted, 'Europe lacks a pre-modern past, a "prehistory" which can provide it with emotional sustenance and historical depth' (1992a: 62). It is possible, in Smith's view, to single out major cultural traditions that have shaped and contributed to the European history

[24] In a speech to the European Parliament, German Chancellor Angela Merkel said: 'we must give a soul to Europe; we have to find Europe's soul. Any failure could be a historic failure' (*Der Spiegel* January 17, 2007; available at: http://www.spiegel.de/international/0,1518,460369,00.html). This and all other web links in this thesis were checked in March 2011.
[25] See, for instance, Mandel, Ruth, 'Fortress Europe and the foreigners within. Germany's Turks', in Goddard et al (1994).
[26] Treaty on the European Union (1992), *Official Journal*, C 191 of 29 July 1992.

along the centuries, such as 'Roman law, Greek philosophy and science, Hebraic ethics and Christian theology, as well as their Renaissance and Enlightenment successors', but it is rather unclear whether this 'family of cultures' could compete, or even coexist, with much more accessible, well established, vivid and long popularized national identities (1993: 133).

The anthropologist Chris Shore has framed the issue in a different perspective. Rather than attempting to detect or refute a putative European identity by considering the cultural history of Europe and its diversity, Shore went right to the heart of the institutions which are supposed to construct this sense of Europeanness, namely the Directorate General for Information, Culture, and Communication (or 'DG X') of the European Commission. Drawing on ethnographic fieldwork amongst civil servants and politicians in Brussels, Shore explored the ways in which 'EU elites have attempted to further the integration process by forging and diffusing their vision of "European consciousness" and "European culture" among the peoples of Europe' (2000: 1). In particular, he critically examined the policy moves to create symbols of identification with the European project, from the common currency and its cultural (rather than merely economic) implications to the 'People's Europe' campaign.[27] Ultimately, Shore aimed to unmask the doctrine of European integration by unravelling the cultural discourse and the political motives of its engineers. Two assumptions underpin this approach. First, the idea that European integration, namely the neofunctionalist 'transfer of loyalties from the nation-state to European institutions' (2000: 224), has had little impact at the level of popular consciousness and only involved a restricted circle of functionaries and political elites in Brussels. Second, the belief that their cultural project is perilously close to nationalistic ideologies: '(...) just as the nation-state was forged by intellectuals and elites whose goal was to inject nationalist consciousness into the masses, so EU officials, politicians and advertising experts are attempting to instil "European consciousness" among the peoples of Europe. From this perspective, *construction europeénne* appears not only as a teleological grand narrative about "destiny" and "progress" but also as a project of social engineering reminiscent of Leninism. In either case,

[27] Other symbols are the European flag, the Europe's Day, the standardized European passport (introduced between 1987 and 1989), the European driving licence and number plate, and the European anthem taken from Beethoven's *Ode to Joy*. See also Shore (1993).

"culture" has provided the idiom through which elites try to galvanise and mould public opinion' (2000: 221-222).

Shore's work is sustained by a sound methodological approach and provides an original contribution to the debate on European integration. However, recent works in social theory have questioned his basic assumptions. In particular, Gerard Delanty and Chris Rumford (2005a) argued that the European Union is not seeking and should not aspire to replicate the model of the nation-state, as Shore implies, but should rather develop a cosmopolitan identity. To them, 'being European' cannot be defined through distinctive European values or a European history. Instead, Europe should become a transnational polity based on a model of civilization engaged with the realization of cosmopolitan values all over the world (2005b). Also, the cosmopolitan vision has found an elaborated endorsement in the work of Ulrich Beck, who devoted an entire trilogy to the implications of this concept for the social sciences, including *Power in the Global Age* (2005), *Cosmopolitan Vision* (2006) and *Cosmopolitan Europe* (co-authored with Edgar Grande 2007). According to Beck, the perspective that politics and society can only be organized along the lines of the nation-state is inherently mistaken. This belief, he argues, can lead to two different biases. 'The national outlook' refers to the standpoint of political actors who accept the nation as the unique horizon of their activities. 'Methodological nationalism', instead, refers to the viewpoint of social scientists that implicitly adopt the nation-state as the dominant framework of their investigations (2007: 18). Specifically, methodological nationalism equates the nation state with society and assumes that 'humanity is naturally divided into a limited number of nations, which organize themselves internally as nation-states and externally set boundaries to distinguish themselves from other nation-states' (2006: 3). With regard to Europe, Beck and Grande maintain that this historically unique form of international community cannot be understood and conceptualized in terms of the traditional concepts of politics and the state: 'Europe in movement – Europe *as* a movement – escapes our understanding because this permanent process of transformation contradicts the conception within which Europe hitherto seemed to be self-evidently situated, namely the conceptual horizon of national societies and states' (2007: 2). By contrast, they argue, we must rethink the conventional categories of social and political analysis, and theorize a Europe in which 'the supranational level is not equated with loss of power at the

national level', but co-exist and complement traditional forms of governance (2007: 18). From this stance, the actual process of European integration appears as an example of 'deformed cosmopolitanism', caused by 'the egoism of member states, economic self-interest and the asymmetries in influence on political decisions in the EU, the technocratic policy approach of the supranational institutions and the weakness of actors from civil society' (2007: 20).

Finally, also Jürgen Habermas has endorsed the cosmopolitan ideal and refuted a conception of Europe based on cultural sameness. In particular, he argued, a nation of citizens must not be confused with a community of fate shaped by common descent, language and history: 'this confusion fails to capture the voluntaristic character of a civic nation, the collective identity of which exists neither independent of nor prior to the democratic process from which it springs' (2001a: 12). According to Habermas, such a civic (as opposed to ethnic), conception of the nation reflects both the actual historical trajectory of the European nation-states and the fact that 'democratic citizenship establishes an abstract, legally mediated solidarity between strangers' (ibid.). Ultimately, Habermas envisages a sort 'cosmopolitan solidarity', based on the moral universalism of human rights, rather than being rooted in particular collective identities (2001b: 108).

1.3.2 Empirical Works

The debate on European integration in social theory has brought new questions and insights into a field that has long been dominated by the narrow perspective of institutional, legal, or economic studies. Indeed, the notion of cosmopolitan Europe is a powerful criticism of current policy discourses and touches on one of the most crucial issues for the future of European integration. Besides, the debate has prompted some authors, like Beck, to rethinking longstanding assumptions on methods and data collection in the social sciences. However, the call for a radically new, 'transnational' or 'postnational', sociology has not been followed by empirically informed works. By contrast, most contributions have been merely prescriptive. Social theorists have been committed to tell what European integration *ought to be*, but they did not shed much light on what it actually *is*. Conversely, Shore's ethnography is based on solid empirical

research, but, once again, it is confined within the boundaries of institutional dynamics and does not say anything about the impact of European integration on wider society.

In a recent overview of the literature, Adrian Favell has well summarized the terms of this issue, and urged sociologists working on European integration to study 'real people' and not only the elites who are working in Brussels or 'Europeans reified as ethnic or national groups and collective identities'. In his view, studies should focus on 'the very real individuals experiencing and living out the micro-level consequences of macro-level regional integration on an everyday, social level, and whose actions and embodiments of Europe as an everyday practice aggregate somehow into the familiar political, institutional and pan-European societal structures we know' (Favell 2007).

But where are these people? Who is actually experiencing on a daily basis the effects of regional integration? Favell himself opened up a promising area of investigation with a qualitative wok on 'free moving' professionals across European cities. This is a relevant issue, as the free movement of people, along with goods, capital and services, is one of the four pillars of the common market. Favell's analysis indicates that mobility within the EU – even among highly qualified professionals – is still hindered by hurdles such as discrimination in the housing market, education, welfare institutions, consumer services and political representation. Thus, Favell concludes that 'the limited cross-national mobility of professionals in Europe suggests that the dominantly national organization of access to "quality of life" benefits might still constitute the major barrier to intra-European migration, despite the growing economic and cultural opportunities of such movement' (2003: 33).

The comparative study of different attitudes towards the European Union has been another subject of recent investigations. In this area, Juan Diéz-Medrano (2003a, 2003b) has provided a robust qualitative work that examines beliefs of ordinary citizens, intellectuals and members of the local elites about European integration. In particular, Diéz-Medrano aimed to understand the reasons why public support to the EU is characterised by marked national differences. Methodologically, he relied on interviews in three countries (Spain, Britain and Germany) and the analysis of newspapers and other printed sources such as school textbooks and novels. Then, he contextualized his findings within respective national histories and cultures. This is a well documented and

articulated work, which enrich the dry statistical figures of 'Eurobarometers' with thick qualitative data, theoretically underpinned by the use of Goffmann's frame analysis.[28] However, it is limited to the ambiguous domain of 'attitudes' and 'beliefs' and does not say anything about social practices.

In a recent article, Diéz-Medrano himself has recognized the need to study the social impact of economic and political integration in empirical terms, assuming that 'the new European Union has a tremendous impact on the European citizens' lives, whether they know it or not' (2008: 4). In particular, he distinguished between two different levels of Europeanization which are worth of specific sociological investigations. The first is the Europeanization of the national societies, understood as a 'widening of the scope of the national citizens' economic and political activities that directly or indirectly result from the economic and political institutions of the European Union'. The second is a 'European society proper', namely 'the emergence of European social groups, that is, transnational groups of European citizens whose consciousness and behaviour denote solidarities that transcend national and subnational affiliations' (2008: 5).

The few empirical works on transnational groups and identities, however, have come to contrasting conclusions. For example, a collection of essays on *Contentious Europeans* argued that many social categories - including farmers, labour movements, and trade unions - are increasingly protesting against EU policies, 'but on domestic soil and not against the institutions that produce them' (Imig & Tarrow 2001: 3). What is more, with few exceptions, social protests appear to be overtly competitive, 'supporting the view that the European single market has created more incentives for competition than for cooperation' (Imig & Tarrow 2001: 235). In contrast with these findings, research on migrant experiences has documented the emergence of 'postnational' identities and new forms of participation at the European level (Soysal 1994; Kastoryano 2003). For example, a comparative study by Yasemin Soysal on guest worker associations in six European countries suggests that traditional notions of citizenship, anchored in territorialized notions of cultural belonging, is being replaced by a more universalistic model based on the protection of human rights (1994: 159). Thus, to Soysal, 'the incorporation into

[28] Eurobarometers are social surveys on public opinion, conducted by the European Commission since 1973 in support to decision-making and evaluation of its work.

a regime of membership rights no longer inevitably requires incorporation into the national collectivity' (1994: 3).

Sport, and particularly football, has also been the subject of fruitful investigations. Football is a social form where collective identities are enacted and performed, and has long been a prominent expression of national ethos and loyalties. In his book on *The European Ritual* (2003), however, Anthony King has effectively articulated the thesis that football is now becoming a transnational phenomenon.[29] While until the 1990s European football was dominated by the overwhelming influence of national federations, in the past fifteen years association clubs have become nodes of economic power in a pan-European network where national affiliations are almost irrelevant. Furthermore, King's ethnography of British fan clubs demonstrates that new forms of localism or post-national identities are emerging. Although his findings stem from the ethnographic study of a small group of Manchester United supporters, his approach proves to be more revealing than abstract theorizations on European integration. As he argues, 'statements about the nature of European identity become more than mere assertions, only by engaging in detailed ethnographies, which illuminate the way individuals are actually re-negotiating their identities and social relations in specific circumstances' (2000: 421).

1.4 The Politics of Science

This sparse group of empirical works on Europe indicates a promising research direction, but there are still many avenues open to further investigation. For several reasons, science represents a fertile terrain to explore the dynamics of European integration 'at work'. First, along with the economy, politics and sport, scientific research is one of the few fields that have been most visibly europeanised. Although the individual states remain the main actors for the organisation and funding of research activities, the emergence of a European

[29] In recent years, football and sport in general have been at the centre of several studies on transnational processes and globalization. See, for instance, Giulianotti, Richard and Robertson, Roland (2007), 'The Globalization of Football: A Study in the Glocalization of the "Serious Life"', *British Journal of Sociology* 55(4), pp. 545–68; Giulianotti, Richard and Robertson, Roland (2007), 'Sport and Globalization: Transnational Dimensions', *Global Networks*, 7 (2), pp. 107-116.

dimension of science has been illustrated by various examples, including the establishment of 'big science' centres such as the European Centre for Nuclear Research (CERN) and the European Molecular Biology Laboratory (EMBL), European societies and academic journals, and transnational research networks. Also, the organisation and management of research activities has gained a crucial importance in the overall strategy of the European Union. Since the late 1970s, the promotion and funding of science has been a central part of governance and political culture of the European Community. In recent years, the emphasis on science and innovation has been increasingly prominent. In early 2000, a communication of the Commission announced plans for the establishment of a European Research Area (ERA), namely a broad initiative aimed to enhance cooperation among European scientific institutions and the mobility of researchers across national borders. Not only were science and technology seen as crucial means for economic and technological advancement, but they were also celebrated as inherently positive social values: as the communication remarked, 'science and particularly technology is what makes society thick'.[30] Few months later, this strategy was reasserted by the heads of member states at the European Council with the adoption of the Lisbon Agenda, a broad policy guideline that set the ambitious goal to make 'Europe the most competitive knowledge-based economy in the world'.[31]

However, the practical accomplishment of this grand vision has not always been straightforward. As we will see, scientific cooperation across national borders has raised issues of standardisation of laboratory practices and measurement systems. Moreover, despite the supposed 'neutrality' of basic science, the creation of a common European research platform has been hindered by marked differences between national attitudes and regulations. This issue has been particularly problematic in the life sciences and biotechnology. While this sector has long been identified as a key target for planning and interventions, public concerns about the ethical implications of controversial research practices in human genetics and stem cell research have jeopardized the approval of recent funding programmes. In this situation, the European Union has had to find a difficult balance between the promotion of science, the respect of national regulations, and the safeguard (or the definition)

[30] Commission of the European Communities (2000), 'Making a Reality of the European Research Area (ERA)', COM 2000 (612), p. 7.
[31] Lisbon European Council, Presidency Conclusions (23 and 24 March 2000), available at: http://ue.eu.int/ueDocs/cms_Data/docs/pressData/en/ec/00100-r1.en0.htm

of common 'European values'. The study of European policies and programmes in the life sciences and biotechnology, therefore, can add to an understanding both of the integration process and the politics of European identity.

With a few notable exceptions (Guzzetti 1995; Krige 2006), these issues have been overlooked by former studies on European integration. In line with policy discourses, a number of works have measured the 'competitiveness' of European science through quantitative indicators, often by comparison with the United States or emerging Asian economies.[32] In one of the few ethnographic studies, the anthropologist Stacia Zabusky (1995) provided a detailed analysis of the collaborative work of scientists and engineers at the European Space Agency. However, this study is more concerned with the social nature of technical cooperation, than the process of European integration.

Surprisingly, also scholars in the field of social studies of science (STS) have showed scarce interest in European research policy. One of the reasons is probably that the field has been dominated by detailed ethnographies of local practices, scientific disciplines or specific technologies, with little attention to the overarching political and institutional frameworks. This point has been highlighted some years ago by Andrew Barry, who argued that 'science and technology studies have tended to be dominated by the study of "cases" which become the objects of theoretical arguments about the character of the scientific and the technical, but whose significance for the study of politics is obscure' (2001: 12). Likewise, broad analyses of the changing nature of knowledge production have framed scientific research in universalistic terms, disregarding the influence of concomitant political developments (e.g. Gibbons et al. 1994). It is no surprise, thus, that 'writers in international relations, cultural studies and politics have been inclined to see studies of science and technology as of rather marginal interest' (Barry 2003: 12).

The following pages address this gap in the literature by exploring the interplay between ongoing political developments in the European Community and the production of scientific knowledge. While they consider and analyse key aspects in the history of European research policies, particular attention will be paid to the field of the life sciences and biotechnology as a locus where important elements of European political culture and identity emerged and were negotiated. Finally, the micro-sociological study of two European networks

[32] See, for instance, a special issue of *Research Policy* 27 (6), published in 1998.

in stem cell research will shift the focus from the institutional setting to the 'very real individuals' who experience and live out the 'micro-level consequences of macro-level regional integration'. In following Favell's advice, therefore, this work aims to connect the overarching institutional framework with social practices and the actual behaviour of people. In addition, it aims to shed some light on the ways in which the changing political context is reshaping the production of scientific knowledge. In the next chapter, I will provide a more detailed discussion of my research approach and related methodological issues.

2. METHODOLOGY

> Only by moving grandly on the macroscopic level can we satisfy our intellectual and human curiosities. But only by moving minutely on the molecular level can our observations and explanations be adequately connected. So, if we would have our cake and eat it too, we must shuttle between macroscopic and molecular levels in instituting the problem *and* in explaining it
>
> Charles Wright Mills (1953: 273)

2.1 Policy Narratives

This work focuses on science cooperation in the European Union and is organised around two interrelated levels of analysis: the institutional context of policy making and the ways in which policies work out in the actual practice of European scientific cooperation. The first 'macro' level of analysis mainly involved the collection and critical reading of documentation pertaining to Community research policy, including communications, reports, white papers, directives and regulations. Official documents of European institutions are largely available in public libraries and online digital archives. In 2009, the Publications Office of the European Union launched the EU Bookshop Digital Library, an online service giving access to documents edited by the Publications Office on behalf of the EU institutions, agencies and other bodies since 1952. In addition, there are other valuable online sources of historical materials, such as the archive on European integration maintained by the Centre for European Studies of the University of Pittsburgh.[33]

In analysing the institutional context, I aimed to identify and explore the main discourses that have underpinned and legitimised Community research policies and programmes, with a focus on biotechnology. In doing so, I found inspiration in former critical studies that have analysed biotechnology policies as *narratives*. In his book *Governing Molecules* (1998), for example, Herbert Gottweis argued that narratives are 'ordering devices' into the messy world of policy making. As he explains, 'This power to create order is an attractive quality that makes narratives essential for the shaping of policies, the settling of

[33] http://aei.pitt.edu

conflicts, or the securing of legitimacy for political action' (1998:32). Thus, according to Gottweis, it is crucial to highlight 'the importance of discourses and narratives for the construction of political reality, the constructed nature of actors in politics and society, and the phenomenon of the competing, conflicting, and often contradictory structures of meaning and expression in social and political life' (1998:12). Likewise, Sheila Jasanoff has shed light on the ways in which the regulation of biotechnology has been *framed* according to different political cultures. In her work *Designs on Nature* (2005), she described the historical and social origins of 'controlling narratives' that have framed the course of policy development in three different countries and examined the reasons why they were differently institutionalized within each political system. Both works include an overview of European biotechnology policy, but there is wide room for further research and insights. In particular, I aimed to gain an understanding of the background of political culture that sustained the emergence and development of interventions at the EU level, with a focus on the increasing use of the *future* and *long-term planning* as the key principles in policy discourses and governance from the 1970s to the present days. Secondly, I have paid particular attention to the gap between the policy vision of a *biosocial future* and the many hurdles to its implementation. In the analysis of the early history of Community research policies, Luca Guzzetti's (1995) pioneering work has provided an important source of knowledge and critical insights.

Finally, I am aware that in my work I have not simply analysed narratives, but I have also *produced narratives* on the history of EU research policies, and other aspects that are related to my research object, such as biotechnology, stem cell research and European studies. As Shore pointed out (2006), ever since the so-called reflexive turn of the 1980s, social scientists have recognised that historiography, ethnography and critical analysis are themselves reifications. In other words, we shape and construct social worlds in the very act of writing about them, as we single out particular elements and developments out of the messy complexity of social life to produce a coherent text. As mentioned, this can be applied to fabrications of 'Europe' in academic studies, but, *lato sensu*, can be extended to any interpretations of social and cultural worlds, including this work. This does not mean that we shall discard any effort of writing culture, politics and society as mystifications, but nevertheless it is important to reflect

on the contingent nature of our investigations, and stress the fact that alternative narratives are possible.

2.2 The Case Studies

The second level of analysis involved the study of European research policies 'at work' through the in-depth analysis of two cases. In particular, I followed the activities of two transnational networks in stem cell science, which were funded by the European Union under the Sixth Framework Programme for research and development (2002-2006) and were closely linked through shared activities and projects: Eurostemcell and Estools. I decided to focus on this research area, as it can provide a revealing perspective to make sense of wider issues of European integration. Due to public concerns about related laboratory practices such as embryo manipulation and cloning, stem cell science has become a controversial cultural field, in which divergent understandings of life, morality and 'values' emerged and were reflected. For this reason, stem cell research has been at the centre of many works in the humanities and social sciences, including comparative studies of ethical debates and regulations (Bender et al. 2005), critical re-reading of scientific discourses (Hauskeller 2005), and broad analyses of wider issues of political economy (Salter 2007; Cooper 2008). At the EU level, stem cell research has been identified as a priority area in recent funding programmes due to its therapeutic promises and the economic prospects. However, discrepancies between national views and regulations jeopardized the approval of the two latest framework programmes and highlighted once again the long standing problem of the harmonization of research policies in Europe and, more broadly, of European unity and cultural identity. In my research, I was interested in understanding the ways in which these issues, among others, played out in the practice of transnational cooperation.

Finally, there are also more practical reasons. Before embarking in my doctoral studies, I had previous knowledge on stem cell science, as I had studied the Italian debate on embryo research for my Masters dissertation in social anthropology at University College London (Liverani 2006). Moreover, from 2007 to 2009, I had the opportunity to work in close association with the

project ‘Stem Cell Research in Context’ at EGENIS, the ESRC Centre for the Study of Genomics in Society at the University of Exeter. This project aimed to investigate how public governance and regulations influence everyday laboratory activity in stem cell research. Specifically, it examined the ways in which the infrastructure of stem cell science, its research questions, objects and routines are shaped by different regulatory frameworks, ethical discourses, science policies and professional backgrounds. In turn, the research group at EGENIS was part of a wider initiative involving other centres in British universities (the UK Social Science Stem Cell Initiative), which included various meetings and workshops. Thus, the links with these initiatives allowed me to deepen and discuss my research project with a large community of social scientists.

2.3 Case Studies and Generalisation

These considerations seem to provide a sound justification for the choice of the case study in stem cell research. However, it might be objected that the focus on a single case is a weak methodological strategy to answer my research questions. Specifically, to what extent can the study of two research networks cast light on wider issues of European science cooperation, let alone the process of European integration?

The problem of generalization is a crucial issue in case study research and has been discussed in several methodological works (Stake 1995; Flyvbjerg 2006). In general, *inductive reasoning* has been at the centre of methodological debates since the time of the philosopher David Hume, who was highly sceptical of the inference of general truths from the observation of particular phenomena. Some theorists, however, have argued that *strategic sampling* can offer a substantial basis for generalization. For example, Robert Yin (1994) has pointed out that the choice of a *critical case* is a valid method to test a theoretical proposition or examine specific social issues. As social phenomena and practices never occur in a cultural vacuum, but are always embedded in a wider context of meaning, the detailed analysis of specific instances can illuminate wider social and cultural phenomena from a given viewpoint. Moreover, it is well recognised that the ‘thick description’ of a significant case can provide a wealth of insights

that are inaccessible to quantitative research, such as statistical surveys. Similar considerations can be applied to many pivotal works in the social sciences, from the pioneering studies of the Chicago School of urban sociology to Goffman's ethnographies. In *Asylums* (1961), Erving Goffman provided revealing insights on the social condition of mental patients by drawing on participant observation in a psychiatric hospital in Washington D.C. Despite focusing on a single case, his work illuminate key aspects of social dynamics in a 'total institution'. Likewise, in their classic study on *Laboratory Life* (1986), Bruno Latour and Steve Woolgar challenged some fundamental assumptions about the nature of knowledge production through the detailed description of routine scientific work. Their arguments were not based on observations in many laboratories, but on a single case. Besides, the choice of a specific case was haphazard rather than 'strategic'. As they explained, 'The choice of laboratory was determined mainly by the generosity of one of the senior members of the institute in providing office space, free access to most discussions and to all the archives, papers and other documents in the laboratory' (39).[34] Yet again, the study of this 'random' case produced an impressive account of knowledge production, which is highly relevant well beyond the contingent arrangements of that particular research setting.

In my research, the choice of two particular networks (Eurostemcell and Estools) was partly dictated by information that I had collected in earlier studies. In researching the topic of my Masters dissertation, I had met (and interviewed) some Italian participants in the consortium Eurostemcell, who became subsequently involved also in Estools. Thus, I could rely on a small network of existing connections and a familiarity with the case study. More importantly, in the initial stages of my research, the network Eurostemcell was the largest EU-funded consortium on stem cell science and applications, with a budget of 11.9 million euros and involving more than 100 researchers across 27 research groups in 16 partner institutions. On the other hand, the consortium Estools was the only European network entirely focused on the controversial field of embryonic stem cells. Due to the involvement of partners from countries

[34] Or it was strategic precisely because it was haphazard. In this respect, Latour and Woolgar write: 'It is perhaps relatively easy to show the intrusion of social factors in cases of borderline, controversial science, or where secrecy and competition are evident (...) The work of our laboratory, however, constitutes "normal" science which is relatively free from obvious sociological events. We are less tempted, therefore, to try to tease out instance of gossip and scandal; no sociological muckraking is intended, nor do we claim that science devoid of such intrigue is unworthy of sociological attention' (1986 31-32).

with different regulatory regimes, it constituted a 'critical' case to examine the ways in which the fragmented nature of the *moral landscape* around scientific research (Pàlsson and Hardardóttir 2002) affects the practical working of transnational consortia in the European Union.

2.4 Studying Research Networks

The case study component involved another important methodological issue. How could I make sense of transnational research networks? What is the best approach to study such an elusive social configuration? During my research, I evaluated several options and walked more than one route. In the initial stages, I identified social network analysis as a potentially suitable analytical tool. This approach has become a popular method to evaluate relational data in a broad range of contexts, including industrial organisations, kinship and friendship ties, corporate interlocking patterns, and virtual communities. Its origins are rooted in early anthropological works on social structures, especially in Radcliffe-Browne's structural functionalism, but it was systematically developed only during the 1960s and the 1970s through the insights of theorists such as Harrison White and Ronald Burt (Scott 2006). While there are different schools and approaches, the central point of network analysis is the emphasis on relational ties over normative values in shaping the structural properties of a network. As Barry Wellman explains, network analysis concentrates on studying 'how the pattern of ties in a network provides significant opportunities and constraints because it affects the access of people and institutions to such resources as information, wealth, and power'. Thus, network analysts treat social systems as networks of dependency relationships resulting from 'the differential possession of scarce resources at the nodes and the structured allocation of these resources at the ties' (Wellman 1983:157).[35]

Over the years, theorists in this area of research have elaborated an increasingly codified and formalized language to describe social dynamics

[35] A similar view is held by Barry Barnes in his *The Nature of Power*. In particular, Barnes rejects the Parsonian 'normative determinism' in which social structure is maintained through the individual internalization of norms. By contrast, Barnes stresses the importance of 'ongoing interaction and mutual sanctioning' (1988: 138).

within a network environment, including concepts of density, centrality and centralization, clustering and cliques, and asymmetrical ties. Moreover, a range of computer programmes have been designed to handle vast amounts of relational data and produce visual representations of network structures. In the field of science studies, this approach has gained popularity as a tool to examine broad patterns of collaboration and co-authorship, often through bibliometric analyses of co-authored publications.[36] For example, the sociologist Alberto Cambrosio and his colleagues at McGill University have used computer-based network analysis to make sense of relational data in large biomedical research projects (Cambrosio et al. 2004). Such methods can be very effective in providing a bird's-eye view of the social geography of collaborative research and in highlighting emergent properties in large-scale networks. However, they are not suitable for the study of qualitative aspects of networking, as they reduce the richness and complexity of social relations to a few quantitative indicators, disregarding both social practices and the Weberian 'subjective motivations' of social actors.[37] In short, I eventually discarded network analysis as a heuristic tool for my research and decided to rely on ethnographic methods such as interviews, observations and content analysis, partly because bibliometric works on international cooperation in stem cell science already exist (Rüdiger 2006). But more importantly I was interested in a micro-sociological account of the ways in which participants experience and enact the aspects of European research networking, rather than providing a static picture of European patterns in stem cell cooperation.

The choice of ethnographic methods, however, posed other challenges. In particular, traditional ethnography is not well equipped to study transnational networks involving many participants in different countries. It would take a very long time, require considerable funding and still it is highly uncertain how fieldwork should be organised and divided up between twenty or more different locations. As an alternative strategy, fieldwork can be limited to one or few

[36] See, for instance, Glänzel et al (1999) for a bibliometric analysis of scientific cooperation in the European Union.

[37] Indeed, Cambrosio and his colleagues have strengthened their methodology with interviews and content analysis: 'Sociological analyses of this kind of large-scale collaborative research usually adopt one of two equally unsatisfactory alternatives: either they provide thick descriptions of selected sites, thus missing the figurational dimension of the collaborative network, or they attempt to account for figurational complexity by reducing it to a few quantitative indicators, thus destroying for all practical purposes the very phenomena under investigation. To avoid these two alternatives, we opted for a combination of ethnographic methods (interviews, content analysis) and a computer-based analysis' (2004: 326).

nodes of the network. For instance, in his study of anti-corporate globalization networks, Jeffrey Juris conducted long-term participant observations within an individual local group, and followed their activities across a range of other sites. Juris writes that 'it was only by remaining situated within a concrete node that I was able to appreciate the complete imbrications of local, regional and local scales' (2008:298). In focusing on one site, however, this approach overlooks the perspective of other 'nodes' in the network. The salient feature of a research network is precisely its decentred configuration and the emphasis on a single point does not make justice to its intrinsic multiplicity and complexity.

In many ways, the problem of studying research networks ethnographically recalls the many other situations where local contexts are interconnected with much wider systems and relations. These situations require the rethinking of the anthropological method of intensive participant observation in a single bounded location. In the 1980s, George Marcus and Michael Fischer argued that the traditional 'single-sited' ethnography is inadequate to make sense of phenomena that increasingly transcend the boundaries of the small group or community. As a solution, they proposed 'multi-sited ethnography' (Fischer & Marcus 1986/1999). However, as Kaushik Sunder Rajan pointed out (2006), the notion of multi-sited ethnography does not mean 'a simple multiplication of the number of field sites, a quantitative "adding on" to single-sited ethnography'. Rather, 'multi-sited ethnography is a *conceptual topology*, a different way of thinking about field sites in relation to analytic and theoretical questions about the world we live in' (2006:31). This change of perspective might require different methodological strategies, as well as the access to a different range of sources and field locations, such as websites, visual material, face-to-face and phone interviews.

In keeping with these suggestions, my case study research aimed to confront the complexity of European stem cell networks by using a variety of sources and empirical material, including websites, scientific articles, visits to laboratories, participation in scientific conferences and public engagements events. In the process, I travelled to a number of sites in the United Kingdom, Sweden, Germany, and Italy over a two-year period from early 2007 to the end of 2009 (Table 1). In 2007, I had the chance to visit for ten days a stem cell laboratory in Sheffield, whose director, Professor Peter Andrews, was the coordinator of Estools, one of the two European consortia I had chosen as core case studies.

Access to this laboratory was gained through the brokerage of my first supervisor, who had previously collaborated with Professor Andrews on other research projects. This was a crucial experience that helped me gain a feel for the practical aspects of scientific work in this area. Not only did I have the chance to talk to scientists about their work, but I could observe them doing various tasks such as pipetting, slicing animal tissue, operating chromatography and PCR machines, and culturing cell lines. My engagement with 'laboratory ethnography', however, was limited to this single experience, as I did not aim to explore routine scientific work beyond a general understanding of the basics of stem cell research. My main interest laid in the practice and subjective experience of networking, a phenomenon that can be hardly observed in long sessions of participant observations at laboratory benches. Networking practices can be more profitably observed at international meetings, workshops and conferences where participants meet and interact. In this respect, I had the chance to participate in a variety of events that were organised by the European stem cell networks, including a public engagement conference and a public workshop on ethical issues of stem cell research. The first meeting on 'Ethical Aspects of Stem Cell Research in Europe' took place in Berlin in April 2007, and was aimed to discuss controversial aspects of legislation on stem cell research at the European level, to evaluate the feasibility of stem cell-based therapies, and to define potential milestones for a road map toward clinical application. The second meeting was held in Lund, Sweden, in October 2008, and focused on ethical and regulatory aspects of interspecies embryo research and IPS research – two new stem cell research areas that emerged at the time of my fieldwork (see section 4.2). I was particularly interested in these meetings, as they provided an opportunity to examine the ways in which participating scientists engaged with the public on the ethical implications of their work (see section 5.4).

In addition to these key research sites, I attended other public meetings and conferences on stem cell science, including the opening conference for the new Wellcome Trust Stem Cell Centre in Cambridge and several workshops that were organised by the UK National Stem Cell Network, an independent body established in 2006 as the national focal point for the promotion of stem cell research and the dissemination of knowledge about UK stem cell research to overseas researchers, the general public and the media. Although these

meetings were not strictly related to my case study, they helped me gain a better understanding of stem cell science in a different context of institutionalisation (see, for example, section 4.1.2).

Research Site	Date	Research Activity
University of Cambridge (UK), Meeting on '25 years of embryonic stem cell research in Cambridge' and Official Opening of the Wellcome Trust Centre for Stem Cell Research	18-19 December 2006	Observations
University of Sheffield (UK), Centre for Stem Cell Biology	9-18 April 2007	Observations and interviews
ESTOOLS/EUROSTEMCELLS second ethics public workshop on 'Ethical Aspects of Stem Cell Research in Europe', Berlin, Germany	19-20 April 2007	Observations and interviews
Heriot-Watt University, Edinburgh (UK), UKNSCN Inaugural Annual Meeting	9-11 April 2008	Observations
ESTOOLS/EUROSTEMCELLS first ethics public workshop on 'Ethical aspects of research on interspecies embryos and IPS cells', Lund (Sweden)	2-3 October 2008	Observations and interviews
University of Milan (Italy), Centre for Stem Cell Research	11 November 2008	Interviews
University of Cambridge, Wellcome T\rust Centre for Stem Cell Research	21 November 2008	Interviews
University of Edinburgh, Institute for Stem Cell Research	11 December 2008	Interviews

Table 1. Research Sites

Finally, a crucial component of my collection of empirical material consisted of interviews with scientists and other professionals that were involved at various levels in the research consortia Eurostemcell and Estools, as well as informal conversations in laboratory settings and at scientific meetings. Given the large number of partners in the two research consortia I had chosen to investigate, however, I was initially confronted with further methodological issues. From the outset, I discarded the option of a large-scale survey of the entire cohort of participating scientists. While this approach may be valuable in broad opinion polls such as the Eurobarometers, my aim was to elicit information at a deeper level of understanding that is virtually inaccessible to surveys, and can be better

achieved through semi-structured interviews in which researcher and informant engage in a process of *dialogue* and mutual understanding. It might be contested that interviews are a misleading approach to study the *practice* of research collaboration, as they offer a rhetoric formulation of actual social behaviour. However, in doing interviews, I was precisely interested in the kinds of rhetorical devices participants use to make sense of their experience with European networks. Thus, I did not regard the interview process as a 'false' representation of practice, but rather as a key ritual where participants had the opportunity to negotiate meanings and subjective experiences in a self-reflexive way. Indeed, during some interviews, informants expressed complex views that could not have been elicited through survey questionnaires (see, for example, the lengthy extract in section 5.3.1).

The choice of in-depth interviews, then, required the strategic selection of a manageable number of informants that were best positioned to shed light on specific issues I was interested in, such as (1) patterns of network formation; (2) the flow of biological material and scientific knowledge across laboratories; (3) the effect of regulations on the division of scientific labour and the mobility of scientists across laboratories; (4) economic implications; (5) administrative and organisational aspects; (6) the interface between the conosortia and the wider society.[38] To this aim, during the initial stages of my research, I identified key categories of informants according to their position in the networks. Details regarding partners and their roles in the networks were available on the project websites. Once I had collected and organised this information, I approached selected informants by e-mail contact and agreed on time and date for the interview. Prior to each meeting, I drafted a list of indicative questions that were tailored to the position of the interviewee and her/his area of expertise. The following section gives further details about this operational strategy:

Coordinators. This category includes senior scientists with a leading role in the organisation and overall structuring of the consortia, including the design of scientific projects, the recruitment of partners, the direction of the Steering Committee and liaisons with the Commission on contractual agreements.

[38] These 'sub-topics' were partly identified in the initial research stages, after preliminary literature reviews and the analysis of available documentation, but they became more focused and refined as research progressed. For example, I decided to explore more thoroughly the notion of 'accountable science' (see section 5.2), as this issue recurrently emerged in interviews with senior scientists and administrators.

Interview questions/topics: What is your background? Why and how did you get involved in a EU-funded consortium? Do you feel part of a European community of scientists? What is the difference between a EU-funded project and a 'standard' research grant? Do you have former experiences with EU grants? How did you involve participants?

Principal Investigators. Both consortia had a large number of principal investigators, working in many different countries. While I had conversations (or interviews) with several PIs at research sites in the UK, Italy and Sweden, I was particularly interested in hearing the experiences of senior researchers who were working in countries with 'strict' regulatory regimes on embryo research such as Italy and Germany.[39]

Interview questions/topics: What is your background? How did you get involved into the European network? How are regulations in your country affecting your work and collaborations with other partners?

Project Managers. Due to the administrative complexity of EU grants, both networks had a project manager who was responsible for budgetary aspects, the delivery of periodic reports, and other administrative issues.

Interview questions/topics: What is your background? What is your role in the network? How is the research grant shaped? How is the relationship with the European Commission?

Training/outreach Directors. The scientific programme of Eurostemcell and Estools included outreach and training activities to promote the exchange of expertise between partners, and to ensure the wider dissemination of knowledge to other stem cell scientists, clinicians and the public. In both networks, a dedicated professional was responsible for the organisation of such activities.

Interview questions/topics: What is your background? What kind of activities did you organise? How did you engage with the wide public of non-specialists?

Biotech Entrepreneurs: As many other EU-funded consortia, Eurostemcell and Estools involved private companies (often spin-out of academic departments), which focused on the development and commercialisation of stem cell technologies for research, drug discovery, and therapeutic treatments.

Interview questions/topics: What is your role in the network? What are the arrangements on intellectual property and patenting? Is stem cell science a profitable research field? Who is going to benefit of the results of collective research involving many partners across Europe?

[39] While I managed to meet and interview two key informants in Italy, I eventually failed to interview partners in Germany for lack of time and resources.

Bioethicists: Due to the sensitivity of the research field, bioethics was a key component in the research programme of both networks. Göran Hermerén, professor of bioethics at Lund University, was the coordinator of the work-package on bioethics in both networks.

Indicative interview questions: What is your role in the consortium? Did you come across any ethical issues? Are there 'European values' in bioethics?

This taxonomy reflects the self-definition of professional roles by the actors themselves, and provided an outline map in identifying key informants out of the complex architecture of the two research networks. In addition to these categories, I interviewed other professionals who had a particular role in (or outside) the network, such as the curator of the bioinformatics database and the EC scientific officer, as well as junior scientists who were not directly involved in European projects but nonetheless provided important insights on scientific collaboration and the ethics of stem cell science.

Overall I conducted 23 semi-structured interviews, all taped and then transcribed on paper (see details in Appendix 1), including one interview by e-mail exchange. Interviews were all conducted in English, except the interviews with Italian scientists, which were conducted in Italian. The vast majority of contacts agreed to be interviewed, and often engaged in highly informative and long-lasting conversations (up to two hours). At times, informants provided long and detailed explanations on technical aspects of their research work and the focus of the interview shifted away from my research concerns - a situation that occurred more frequently in interviews with junior scientists, who were usually more interested in the science of stem cells, rather than organisational aspects of collaboration and research funding, at least in comparison with their senior colleagues. Finally, it is important to note that a few contacts declined the interview, either by not responding to email requests or by re-directing me to other informants or sources of knowledge (such as technical documentation or scientific articles on stem cell research). Due to the small sample and lack of further information, I could not explore the reasons for these refusals.[40]

[40] To some extent, however, a number of these refusals put important constraints on my research plans. In particular, three scientists from private companies involved in the two networks never responded to my requests for an interview, thus the pool of informants in this key area of investigation was significantly reduced.

2.5 Ethical Issues

From the postwar years to the present, there has been increasing awareness of ethical issues concerning research involving human subjects. In the medical sciences, bioethics emerged in the 1960s and the 1970s as a specific area of expertise in response to Nazi atrocities committed in the name of science and the Tuskegee experiment where African Americans were deliberately denied effective treatment for syphilis. In the past decade, as I will further discuss in section 3.4 and chapter 4, there has been an enormous expansion of bioethics as a result of controversial practices in biomedicine and reproductive technologies, such as embryo research, genetic testing, cloning, and the commoditisation of human tissues.

In the social sciences, the ethical debate has been much less articulated. This can be explained, perhaps, by the wrong assumption that potential harms associated with social research are less detrimental to human subjects than those associated with clinical research. In recent years, however, there has been more awareness of the ethical implications of social research, especially in studies involving vulnerable groups such as children or people with disabilities, the study of sensitive topics and documentation, and the general need to protect participants at various stages of the research process. Moreover, a number of notable cases of highly unethical practices, such as the infamous controversy in anthropology over Napoleon Chagnon's field methods, have contributed to a deeper reflection on the ethics of ethnographic research.[41]

Driven by an increased awareness of these issues, professional associations and funding bodies in the social sciences have made some efforts to strengthen ethical standards and codes of conduct. For example, the British Sociological Association, the American Anthropological Association, and the Economic and Social Research Council in the UK have all developed ethical guidelines (Parker 2007). Also, most university departments have established their own ethics committees in order to provide guidance on ethical issues and evaluate research projects involving human subjects.

[41] In 2000, the journalist Patrick Tierney in his book *Darkness in El Dorado* accused Chagnon of highly unethical practices, including the introduction of a measles epidemic among the Yanomamö people for experimental purposes and the deliberate incitement of violence. Although the worst allegations have been partly rejected, Chagnon remains a controversial figure and his case has generated a huge debate on the ethical implication of anthropological fieldwork (see Gregor and Gross 2004).

Although my research did not involve vulnerable groups, it has nevertheless required careful ethical scrutiny. Due to associated laboratory practices such as embryo manipulation and cloning, stem cell science has become one of the most contentious fields of scientific research. In some countries, such as Italy and Germany, scientists work in a cultural minefield and social investigations on their activities could disclose sensitive information. Therefore, I prioritized informed consent and obtained ethical approval from the research ethics committee of the School of Social Sciences and International Studies at the University of Exeter, also relying on the expertise of my supervisor in researching the ethics of stem cell research. I treated with confidentiality any sensitive information which could potentially be harmful to the professional or personal life of participants. Despite the sensitivity of the issue, however, concerns with confidentiality and/or anonymity did not arise with any informants.

3. BIOSOCIAL FUTURES

This chapter focuses on the 'macro' aspect of my research by providing a critical account of the emergence and development of Community research policies, with a focus on the life sciences and biotechnology. It aims to identify and analyse the most relevant arguments in policy narratives on science and technology and to place them in the changing political and economic context from the 1970s to the present. It is organised and divided into four sections, which follow institutional developments in a chronological order. The first section ('The Making of the Bio-Society') examines the context of political economy and technology culture that provided the background for the development of Community research policy in the early 1980s. In particular, it focuses on the increasing importance of *future* and *long term planning* as key concepts in governance and policy making, as well as the historical roots of the 'biotech vision' as a peculiar form of manipulation of the natural order. The second section ('Networking Scientists') moves from policy discourses to the actual implementation of the early biotechnology programmes, with a focus on the network approach and related problems of harmonisation. The third part ('A Strategy for Europe') analyses the development of strategies and interventions over the past fifteen years, in the wider context of the policy drive towards the making of a 'knowledge society/economy' and the emergence of health as an increasingly important area of EU governance. Finally, the last section ('European Values') focuses on the difficult issue of creating a common European framework on the ethics of biomedical research.

3.1 The Making of the Bio-Society

In chapter 1, we have seen that the process of European integration initially unfolded through the working of three different 'communities' with specific sectoral competences: the European Coal and Steel Community, the European Economic Community and Euratom. Although their founding treaties included some provisions on research and development, these organisations were primarily concerned with industrial and economic policies. During the 1960s,

scientific research at the European level was carried out by intergovernmental organisations, such as the European Centre for Nuclear Research (CERN), which were independent from these institutions. At the Community level, research was mainly limited to the activities of the Joint Research Centre (JRC), a scientific institution that was established under the Euratom Treaty in order to provide *ad hoc* technologies and solutions on nuclear safety issues and nuclear waste management.

From the early 1970s, however, the promotion and planning of scientific research became more important within the overall strategy of the European Community. In 1973, during his short stint in the European Commission, Ralf Dahrendorf laid out the first proposals for the establishment of a European Research Area, a broad policy initiative that was aimed to foster the mobility of researchers and to encourage cooperation between institutions across national borders. For Dahrendorf, research activities should focus on two main objectives: improving the quality of life and regenerating European industry. Following this input, in 1974 the Council adopted a number of pioneering resolutions on the integration of national research programmes, the definition of areas of Community interest, the establishment of a European Science Foundation to support basic research, and the possibility to set a permanent forum for science and technology forecasting (Guzzetti 1995).

Early proposals for a common European research policy were partly the outcome of the 'Merger Treaty', which in 1967 joined the three communities into one European Community. This institutional change resulted in a single European Commission, with a Directorate-General for Science, Research, and Development (DG XII).[42] On the other hand, there were important issues of political economy. After almost three decades of steady growth and prosperity, the economic boom was over. The oil crisis following the Yom Kippur war in 1973, the decline of the European manufacturing sector and the instability of financial markets had plunged European societies into economic stagnation, soaring inflation and unemployment (Judt 2006). The economic recession had a negative impact also on the process of European integration. Despite the

[42] The European Commission has always been divided into administrative departments known as Directorate-Generals (or DGs). Each DG covers a specific policy area or service. Initially, however, responsibility for research policies was shared across different DGs - for instance, DG III Industry was responsible for information technology.

political success of the Hague Summit in 1969,[43] the European project suffered from the consequences of the economic downturn, to the extent that many commentators began to announce the 'death' of Europe.[44] As Dinan pointed out, 'recession and spiralling inflation hastened economic divergence among member states, put an end to EMU, and threatened to roll back existing levels of market integration, notably through the proliferation of nontariff barriers to trade' (Dinan 2004:145).

In this difficult situation, science and technology became a priority on the agenda of European integration. In the midst of the economic recession, policy makers argued that the promotion of research activities could help economic growth and revitalize European industry. This belief was further reinforced by the widespread idea that advanced industrial societies were becoming 'knowledge economies'. In an influential book published in 1974, the sociologist Daniel Bell had argued that the economic recession was not necessarily a sign of decline, but a result of the transition towards a different social system, characterised by the replacement of industrialism with a new service economy. To Bell, this change would inevitably strengthen the leading role of highly-skilled workers and the 'crucial function of science and cognitive values as a basic institutional necessity of the society' (1974:43). Besides, he predicted that invention would no longer be an individualised activity, left to chance and personal initiative, but the object of planned management. 'The development of new forecasting and "mapping techniques"', he wrote, 'makes possible a novel phase in economic history – the conscious, planned advance of technological change, and therefore the reduction of indeterminacy about the economic future' (1974:26).

Along with the postindustrial narrative, the profile of research policies in Europe was also raised by the increasing perception of a 'technological gap' with the United States and Japan. Especially in France, this argument had gained wide currency after the publication of *The American Challenge* (1967), a best-seller essay by the French journalist Jean-Jacques Servan-Schreiber that

[43] The summit followed de Gaulle's exit from the political stage. Political leaders committed to develop new forms of political and economic cooperation, including financial and monetary union.

[44] In France, this perception was particularly vivid, as a cursory glance at titles of publications of the period well illustrates, including *L'Europe, c'esi fini* (J. Fralon), *L'Europe saboiêe* (Yann de l'Ecotais), *Pavanne pour une Europe défunte* (J.M. Benoit), *Plaidoyer pour une Europe décadente* (R. Aron), *L'Europe truquée* (Cl. Bourdel), *L'Europe interdite* (J.F. Deniau), *L'enlèvement d'Europe* (Ceres), *L'Europe suite ou fin* (Visine); quoted in Godet and Ruissen (1981).

portrayed European industries as backward vis-à-vis the organisational talent and entrepreneurial skills of American companies. In Servan-Schreiber's view, despite the economic boom of the 1960s, European industries were doomed to failure. Without radical changes, he argued, Europe would become a colony of American industry: 'fifteen years from now it is quite possible that the world's third greatest industrial power, after the United States and Russia, will not be Europe, but American industry in Europe' (1968: 3). With the onset of the economic recession, this motive became central to policy discourses on European science cooperation, as many people believed that Western Europe could survive only if it were to engage in the high-tech race and compete against the United States and Japan.

Finally, the promotion and organisation of scientific research became a critical policy field for the political survival of European institutions. At a time of growing scepticism about the process of European integration, the need for a common research policy could provide the Community with a new sense of purpose and legitimacy. In 1977, a document of the Commission stressed that 'it is essential to pursue energetically the further development of the common research policy. Scientists, politicians, industrialists, and the public must all contribute, in the awareness that research and technology policy constitutes a driving force for European unity' (European Commission 1977: 38). In this context of political concerns, the emphasis on the technological gap with the US, and the resulting need for enhanced cooperation, became an expedient rationale for interventions at the European level. Given the scale of the American (and Japanese) challenge, it was deemed crucial to pool and coordinate resources. During the 1970s, in fact, the global recession severely affected also the United States, a situation that was worsened by the financial consequences of the Vietnam War. Nonetheless, the American challenge remained a powerful rhetorical argument to shape science policies and, concurrently, provide a new sense of purpose to the process of European integration. Interestingly, this new approach marked a sharp departure from former political discourses. While postwar European reconstruction had been animated by a spirit of solidarity in transatlantic relations, the new politics of European integration came to be characterised by a more aggressive posture in terms of global competition. Indeed, from the early 1980s onwards, *competitiveness* became the ubiquitous

buzzword in nearly all statements, white papers and directives on European research policy.[45]

3.1.1 Chasing the Future

The drive for the creation of a European research policy, however, left many open questions. First and foremost, policy makers had to identify research areas for policy intervention. At that time, this choice was far from being simple. While research planning raised hopes of regeneration, the whole scientific enterprise had become a highly contested domain. With the rise of the environmental movement, the very notion of 'scientific progress' was challenged on many accounts. Science and technology were no longer seen as inherently good endeavours. In *Silent Spring* (1962), the cornerstone of the new environmental consciousness, the biologist and activist Rachel Carson had painted an alarming picture of the dangers associated with technological and industrial development: 'The most alarming of all man's assault upon the environment is the contamination of air, earth, rivers, and sea with dangerous and even lethal materials (...) In this now universal contamination of the environment, chemicals are the sinister and little-recognized partners of radiation in changing the very nature of the world - the very nature of its life' (1962/2002: 6). During the 1970s, this sense of impending disaster was further exacerbated by the circulation of Malthusian predictions about the fate of human societies, which cast a dark shadow on the notions of 'economic growth' and technological progress. In 1968, the American biologist Paul R. Ehrlich published the results of a scientific study proving that population growth was greater than the capacity of the earth to produce subsistence for man. In his view, the battle to feed all of humanity was over and nothing could be done to prevent the imminent disaster: 'In the 1970s and 1980s hundreds of millions of people will starve to death in spite of any crash programs embarked upon now. At this late date nothing can prevent a substantial increase in the world death rate' (1968:xi). In the following years, the publication of other 'doom reports' further contributed to this sense of incumbent apocalypses. In the international best-seller *Limits to Growth* (1972), a group of scientists at the Massachusetts

[45] For an early statement on the link between research and economic competitiveness, see European Commission (1983a).

Institute of Technology predicted mass starvation, political chaos and general catastrophe by the middle of the next century, as a result of the depletion of non-renewable resources (Meadows et al. 1972).

In popular culture, the environmental movement and the doom reports determined a shift in the perception of technological risk. As Andrew Ross pointed out, the Cold War threat of nuclear annihilation was still alive, but it was gradually replaced by a 'slow' notion of gradual deterioration. In the wake of the oil crisis, 'eco-dystopian images of the world became the official look at the future' (Ross 1991:144). In political life, the emergence of this new consciousness brought about important changes to traditional modes of governance. Based on sophisticated computer modelling and simulations, reports such as *Limits to Growth* were an authoritative source of prospective knowledge and drew the attention of political leaders to the need for 'long-term' planning. In 1977, the US President Jimmy Carter requested 'appropriate agencies to make a one year study of probable changes in the world's population, natural resources, and environment through the end of the century', in order to provide 'the foundation of our longer-term planning' (Barney 1980:vii). The resulting 800-page study, released in 1980 by the US Department of State, concluded that 'unless nations collectively and individually take bold and imaginative steps (...) the world must expect a troubled entry into the 21st century' (Barney 1980). In the same period, the OECD published another lengthy report, called *Interfutures: Mastering the Probable and Managing the Predictable* (OECD 1979), in order to foresee 'the future development of advanced industrial societies in harmony with that of developing countries' (1979: 5). Recognizing the need for long-term planning, the report was 'an investigation of the range of possible scenarios, which by giving some insights into potential problems, will hopefully improve our ability to master the future and adapt to the unpredictable' (1979: 405). The expert committee of advisers included Daniel Bell, who had honed his skills as futurologist since his work as chairman of the 'Commission on the Year 2000' in 1965, a research programme of the American Academy of Arts and Science that was aimed 'to anticipate social patterns, to design new institutions, and to propose alternative programs' (Bell and Graubard 1965/1997).

In this period of great uncertainties, science and technology forecasting became a critical area of policy making. On the one hand, it was increasingly

important to foresee and assess the social and environmental impact of new technologies at a time of increasing public concerns about science. On the other, it was necessary to identify the most suitable research areas for policy interventions and funding programmes. As Bell himself had argued, 'the conscious, planned advance of technological change' could reduce uncertainties about the economic future. To these aims, some governments and international authorities decided to establish dedicated offices and committees. In Sweden, for instance, these issues were strongly debated in the early 1970s, and in 1973 the Swedish government instituted a department for 'future studies' that was also responsible for science and technology forecasting. According to the Cabinet Office, technology was to be evaluated within the wider social and economic context: 'Technology assessment should form a natural ingredient of all those decision-making processes in society which decisively affect technical systems; it can therefore not be seen as an isolated or highly specialized activity' (in Dylander 1980: 219). Unlike the Swedish approach, the US government set up an Office of Technology Assesment (OTA), which was designed 'as an aid in the identification and consideration of existing and probable impacts of technological application'.[46] In introducing the bill establishing the OTA in 1970, a US Congressman well summarized the ambivalent meaning of science and technology in this age of looming uncertainties: 'Probably the greatest single force for both good and evil which is abroad in the land today is technology. In large part the destiny of the human race depends on what use we choose to make of science and its handmaiden, technology. There is scarcely a major existing ill which cannot in some manner be traced to technological application - nor is there one whose solution does not lie, at least in part, with better managed and better used technology' (in Kundle 1995).

3.1.2 Going FAST

In tune with mainstream policy orientations, in early 1970s, the commissioner Dahrendorf proposed the setting of a research programme for long-term scientific and technological forecasting in the European Community, called *Europe +30*. In his intentions, this programme should address the possibility to

[46] Available at: http://www.princeton.edu/~ota/ns20/act_f.html

establish a permanent forecasting instrument and whether the European Commission should have its own technology assessment office, along the lines of the OTA. In a report presented in 1975, and later published with the title *The Futures of Europe*, the research team led by the British politician Wayland Kennet concluded that 'models of the future should be worked out: possible scenarios the feasibility of which would depend on the objectives and the means chosen' (Guzzetti 1995: 98). Also, the report advised the Commission on the need to establish a forecasting office which would deal with science and technology, as well as with all areas of social and economic concern, in consideration of the 'potential and unintended social, environmental and other effects of the application of existing or foreseen technologies' (ibid: 99).

Following these debates, in 1978 the Commission decided to set up a preliminary forecasting programme, with a staff of ten people and over a period of five years. This initiative, called Forecasting and Assessment in Science and Technology (FAST), was supposed to 'contribute to the setting of long-term objectives and priorities for Community research and development, and thus to a coherent long-term policy in the field of science and technology' (ibid: 100). The results of the first phase of FAST were presented in the report *The Old World and the New Technologies* (1980), which aimed to outline 'future prospects and problems that could affect the long-term development of the Community', with particular attention to the social and economic implications of new technologies. In a dramatic tone, the report emphasised the crucial role of long-term planning in an increasingly 'hostile' world plagued by economic recession, financial instability, energy crisis, environmental concerns, and the 'big threat from the United States and Japan'. In this gloomy scenario, scientific innovation was identified as the only hope for European regeneration: 'research is essential to meet the threats of the future and to hold the hope of a second renaissance in Europe' (Godet and Ruyssen 1980: 101). Moreover, the report gave precise indications on the 'major technological changes in the next few decades'. Similar to other forecasting exercises, such as Bell's post-industrial society, social change was seen as being driven by the self-sustaining agency of particular technologies and fields of applications: computer sciences, over the next few years, and biotechnology, in a more distant future.[47] With a dash of

[47] Bell himself had placed computers at the centre of his post-industrial narrative: 'A pre-industrial sector is primarily extractive, its economy based on agriculture, mining, fishing, timber, and other resources such as natural gas or oil. An industrial sector is primarily

technological determinism, the report confidently concluded that 'biotechnology could establish itself as the driving force of a new found economic growth over the coming decades', a force which would bring a revolution of traditional modes of industrial production, as well as social practices and behaviours. In a document released in the same year, the FAST group boldly predicted the coming a new 'bio-society', in which 'whole areas of human activity will be transformed through recourse to biotechnology', including the possibility to change human behaviour and manipulate embryonic development:

> Within the relatively near future, bio-technology could be used in a number of sectors such as human health and behaviour. We could control the development of the human embryo and - perhaps within twenty years - determine its sex. We could prevent certain malfunctions. We should be able to create new vaccines and inoffensive drugs to counter addiction to alcohol or tobacco, even to regulate moods and emotions. We could also improve the quality of life for the elderly, improve techniques for transplants and even create artificial organs and biochemical (European Commission 1980:2).

In the following years, as we will see, this optimism was tempered by growing concerns about the safety and ethical implications of innovations in the life sciences and biotechnology, as well as the many gaps between the promises of biotechnology and the actual results. It is however noteworthy that, at this early stage of Community research policy, there was a blind trust in the ability of science to fulfil any social needs simply 'on demand'. In an article published in 1982 on the journal *Long Range Planning*, Mark Cantley, one of the most 'avant-garde' experts in the FAST group, wrote: 'There is little exaggeration in stating that *in biotechnology one can now "invent to order"* – subject to some uncertainties on price and delivery time' (Cantley 1982: 111).

3.1.3 Biotech Visions

The biotech vision has a long history. In the late nineteenth century, new developments in genetics, embryology and physiology gave rise to a new interest

---

fabricating, using energy and machine technology, for the manufacture of goods. A post-industrial sector is one of processing in which telecommunications and computers are strategic for the exchange of information and knowledge' (1976: xii).

in controlling nature, which marked a sharp turn from former approaches. While traditional biology was based on the observation, description and classification of natural forms and phenomena, a new generation of experimental scientists began to tamper with fundamental processes of generation and reproduction, with the deliberate intention of transforming them. This change of attitude is well epitomized by the work and ideas of the physiologist Jacques Loeb. Since his early studies in Germany, Loeb vigorously embraced the 'engineering standpoint' to the life sciences (Pauly 1987). In a letter of 1890 to his mentor Ernst Mach, he wrote that 'man himself can act as a creator even in living nature, forming it eventually according to his will' (in Pauly 1987: 51). Few years later, Loeb reported the results of an experiment on the eggs of sea urchin that contributed to radical changes in the culture of scientific practice. By treating the eggs with a hypertonic medium, he was able to induce their embryonic development into larvae without sperm, a method that he called artificial parthenogenesis. In 1907, talking to an audience of scientists, he declared that 'nothing indicates at present that the artificial production of living matter is beyond the possibilities of science' (1987: 5).

Loeb's achievements were widely covered in newspapers and magazines of his time, and sparked public and academic debate. Most importantly, they opened up a new range of possibilities and profoundly influenced the course of the life sciences, especially in the United States. As early as 1910, the zoologist and geneticist Edmund Beecher Wilson, the scientist who discovered the system XY for sex determination, declared that Loeb paved the road to create 'wholly new organic forms by varying slightly the conditions of development' (in Pauly 1987:101). During the 1920s and the 1930s, Loeb's 'engineering standpoint' inspired the work of other scientists who made various efforts to manipulate and control human behaviour or reproduction, including John B. Watson, Hermann Joseph Muller, and Gregory Pincus, one of the inventors of the birth control pill. On occasions, such efforts inspired grand visions for the future of human societies. In his book *Out of the Night* (1935) – 'a biologist's view on the future' - the Nobel laureate Hermann Joseph Muller outlined various means for controlling and improving human evolution in new eugenic terms. In Muller's views, which were informed by a combination of eugenic ideals and socialist beliefs (and thus in contrast with the old eugenics based on race and class), the perfection of human artificial parthenogenesis would 'greatly extend the

reproductive potencies of females possessing characters particularly excellent, without thereby necessarily interfering with their personal lives' (in Paul 1984: 577). In 1939, Muller was one of the main signatories of a *Geneticists' Manifesto*, stressing that 'the most important genetic objectives, from a social point of view, are the improvement of those genetic characteristics which make (a) for health, (b) for the complex called intelligence, and (c) for those temperamental qualities which favour fellow-feeling and social behaviour' (1984: 583). It is worth mentioning that in these same years the involvement of the Rockefeller Foundation in the promotion and funding of molecular biology was largely driven by an agenda of social control.[48] As Lily Kay pointed out, 'greatly influenced by Jacques Loeb's vision, the Rockefeller Foundation officers and their scientific advisers sought to develop a mechanistic biology as the central element of a new science of man whose goal was social engineering' (Kay 1996: 17).

After the end of World War II, biological programmes of social reformation were largely dismissed, especially as a result of Nazi racial policies and their connection with eugenics. Nevertheless, the biotech vision did not lose its attraction in social imagery.[49] The discovery of the DNA structure by Watson and Crick in 1953 gave further impulse to the whole field of the life sciences and, at the same time, rekindled dreams of transforming nature and society. In 1958 Edward Tatum, Nobel laureate for his one gene-one enzyme model, used his Nobel lecture to urge preparation for the 'biological engineering of people': 'Perhaps within the lifetime of some of us here, the code of life processes tied up in the molecular structure of proteins and nucleic acids will be broken. This may permit the improvement of all living organisms by processes which we might call biological engineering' (in Wright 1986: 306).

A decade later, these dreams came closer to reality as a result of advances in a new field of applications that came to be known as *genetic engineering*. In 1971, a research team led by Paul Berg, a biochemist at Stanford Medical School, completed a groundbreaking experiment in which they successfully managed to

[48] The Rockefeller Foundation is one of the most influential philanthropic organisations in the world. Established in 1913 by the American oil magnate John D. Rockefeller, the foundation pioneered the development of biomedicine and contributed to setting research directions and priorities through the politics of funding.

[49] However, as Nicolas Rose pointed out, there is a crucial difference between early twentieth-century eugenics and postwar biopolitics, at least in the field of biomedicine: while eugenics was concerned with the control of population groups en masse, contemporary biomedical technologies are concerned with the treatment (or identification) of specific individuals (see Rose 2007, chapter 8).

isolate and join the genetic material of a bacterial virus with the DNA of a monkey tumour virus, using a technique called restriction endonucleases.[50] Two years later, Herbert Boyer, Stanley Cohen, Robert Helling and Annie Chang perfected that first attempt of gene splicing and showed that DNA from the toad, which normally codes for a specific type of RNA, could be introduced and replicated in the bacterium *E. coli* (Wright 1986). These two experiments opened up new research frontiers in the life sciences, as well as a promising area of industrial applications. The new field of biotechnology rapidly expanded in the United States, also due to a number of favourable legal and economic conditions. In 1980, a landmark decision of the US Supreme Court paved the way to the protection of intellectual property rights on genetically modified organisms.[51] In the same year, the Bayh-Dohle Act granted universities and small businesses intellectual property rights on inventions that were derived from public funding, and thus facilitated the commercialisation of basic research problems. Also, in early 1980s, the US Congress allowed pension, insurance, and endowment funds to invest up to 10 percent of their capital in venture deals. As a result, risky business sectors, such as biotechnology, received huge capital flows.

Despite initial concerns about the hazards associated with the creation of hybrids and the genetic modification of living organisms, biotechnology rapidly became a fast growing business sector. In this context, the new figure of the scientist-entrepreneur was born: Boyer himself became rich, through the outstanding profits of Genentech, the company he had founded in 1976 to capitalise on his inventions (see Shapin 2008, chapter 8). The first industrial applications initially centred on biomedical products. Bacteria were engineered to produce important pharmaceutical proteins, including insulin, human growth hormone, hepatitis B vaccine, several types of human interferon, and human blood clotting factor VIII. In the agricultural sector, genetic manipulation allowed scientists to create traits which could not be generated by traditional methods of selective breeding, such as increased nutritional qualities, resistance to drought and freeze, and improved texture and taste. Also, a number of other

[50] A restriction endonuclease is an enzyme that cuts double-stranded or single stranded DNA at specific recognition nucleotide sequences known as restriction sites. This technique was developed by Werner Arber, Daniel Nathans, and Hamilton Smith in 1970.
[51] In the case Diamond vs Chakrabarty, the US Supreme Court ruled that a live organism is patentable.

industrial applications were envisaged in the energy sector and industrial waste management.

As Gottweis pointed out, these developments in US biotechnology were soon to attain a 'mythical status' in the European policy discourse (Gottweis 1998: 159). In the midst of economic recession, the promises of the biotech industry raised hopes of economic regeneration, as several official reports of that period emphasised. Besides, in an age obsessed with high-technology competition, biotechnology became essential to national status and prestige. For example, a report of DECHEMA, a German forum for cooperation between science and industry, concluded that 'this field absolutely needs directed support and only in this way can the necessary level of economic and technical development be reached which is crucial for an industrial nation' (ibid.: 187). Likewise, a British report emphasised the crucial importance of the new sector for the future of national industry: 'biotechnology is an area of high technology with large potential growth offering opportunities for the renewal of various existing industries and the creation of new ones' (ibid.:197).[52] At the same time, however, there was a large consensus among science administrators and policy makers that in Europe, unlike the United States, the development of the biotech industry was hampered by many hurdles, including the shortage of human resources and skilled staff, a legal environment overwhelmed by regulations, and the lack of venture capital for risky business sectors. In the UK, Sir Alfred Spinks, the chairman of the British report on biotechnology, lamented the 'lack of gambling money' in UK research grants. At the European level, the relative weakness of national profiles in biotechnology and the 'technological gap' with the United States provided another compelling rationale to justify large-scale planning and coordination. Beside, the inherent 'complexity' of the new field further justified institutional coordination and interventions:

> The fragmentation, isolation and even dispersion of national efforts were acceptable as long as the traditional applications of biology and industry and agriculture could develop separately, slowly and within isolated disciplines. This situation no longer holds because modern biotechnology is in essence multidisciplinary in its approach, complex in its solutions, and is being advanced with great rapidity (European Commission 1983b).

[52] See also the French report *Science de la vie et société* (Paris:Seuil 1979), by François Gros, François Jacob et Pierre Royer.

In late 1970s, thus, biotechnology was identified as a crucial field of decision-making in the wider policy drive towards the creation of a European dimension for research. At a time of economic recession and widespread scepticism about the European project, the 'technology of living substances', as Loeb called it at the beginning of the century, offered promises of regeneration and social progress. Science advisers in the European Commission embraced with enthusiasm its innovative potential and foresaw the dawn of a 'biosocial' revolution, characterised by new wealth and prosperity, as well as radical changes in social practices and traditional modes of industrial production. In their view, biotechnology held the key to the *future* of Europe and thus required institutional strategies and planning. As a result, discourses of global challenges, economic growth, technical complexity, political identity, and biosocial regeneration were conflated and mediated into a single vision which made biotechnology and the life sciences the object of European coordination and policy interventions.

3.2 Networking Scientists

After a decade of intense speculations about the future of Europe, in the early 1980s the European Community launched the first important initiatives towards a common research policy. In 1984, the Commission established the first Framework Programme (FP) for research and development, a multi-annual funding scheme that encompassed all Community research activities and thus provided an instrument to embed and restructure the individual programmes into a comprehensive master plan. Within this broad structure, industrial technology, information science, and biotechnology were identified as priority areas for funding and planned management (Guzzetti 1995).

In biotechnology, the task of coordinating the 'bio-society' was distributed across a range of institutional bodies: the Biotechnology Steering Committee (BSC) and its secretariat, the Concertation Unit for Biotechnology in Europe (CUBE), formed in 1984, and the Biotechnology Regulatory Interservice Committee, in operation from 1985 to 1989. Mark Cantley, former member of the FAST group, was appointed as CUBE's director.

Early research programmes were based on a two-pronged strategy. On the one hand, they involved horizontal actions that were aimed to expand the

knowledge base, foster a collaboration habitus, and facilitate professional exchanges across national borders by the allocation of training contracts and mobility grants. On the other, they promoted vertical actions in a number of designated areas through the funding of transnational networks, an approach that had been experimented at the European level since the early 1970s. In biotechnology, this trend was initiated by the Biomolecular Engineering Programme (1982-1986), a small research scheme with a budget of 15 million ECUs, which was mainly focused on industrial and agricultural research. In the following years, this initiative was followed by a more ambitious programme, the Biotechnology Action Plan (BAP), which ran from 1985 to 1989 with an overall budget of 75 million ECUs. In addition to training contracts and collaborative research grants, BAP funded studies on potential environmental risks and their regulation, as a result of increased public concerns about the deliberate release of genetically modified organisms into the environment.[53]

In addition to long-term prospects, the first action plans in biotechnology aimed to address some pressing concerns of Community economic policy. During the 1970s, the problem of agricultural surplus had become an unbearable burden for both the EEC and the member states (Dinan 2004). As a result of national subsidies and price support policies, European countries were producing food far beyond their needs. Despite the provisions of the Common Agricultural Policy (CAP), which in 1962 had established a unified market for the free movement of agricultural products in the Community, farm output vastly exceeded demand, especially in livestock and cereals. As part of this trend, storage for superfluous production had become too expensive, and EC member states began to 'dump' their excess products at below world prices. In this unsustainable situation, science administrators believed that biotechnology could help find new outlets for agricultural surplus by *transforming* agricultural products into other commodities that were in increasing demand, such as liquid fuel. Robert van der Meer, chairman of the Management and Advisory Committee of the BAP programme, noted that European research programmes in biotechnology could have a key role 'by developing other outputs for

[53] Specifically, the BAP programme aimed 'to allow the continuation, under the same basic principles and implementation mechanisms, of BEP and its extension to new areas considered as essential for the development of biotechnology in the Community. The new domains include contextual measures for the pooling and improvement of existing facilities for R&D in protein design, application of genetic engineering to industrial microorganisms, and the development of new in vitro systems for the assessment of the pharmacological and toxicological properties of molecules' (van der Meer 1986:278).

agricultural feedstock, by increasing the added value of agricultural processes and by developing new products and application areas' (1986: 279). Likewise, science administrators at CUBE firmly believed in the transformative power of the new technology – the power to change the economy through manipulations of the natural order. In an article published in 1981, Mark Cantley and his colleague Ken Sargeant argued that the 'new biology' and biotechnology were at the centre of a profound qualitative change in the relationship between man and the nature, that is: 'the shift from largely unconscious or traditional ways of coping with nature's complexity, to *the conscious management of sustainable systems*, based on a new understanding of biological mechanisms and their relationships with their environment' (1981:323). Ultimately, for Cantley and Sargeant, biotechnology could dispense farming of the need for land and thus lead to the accomplishment of rural autarchy in the European Community: 'In crowded Europe, it is to this "landless agriculture" of intensive units and microbial fermentation that we must look to enhance our self-sufficiency' (331).

3.2.1 Industrial Science

The participation of industry in EC-funded research networks was another important aspect of early biotechnology programmes. As mentioned, science administrators in the Commission believed that planned research could help economic growth and boost European industrial competitiveness. Funding schemes, thus, encouraged the participation of private companies that could capitalise on findings of basic research and translate them into industrial applications. For example, the BRIDGE programme (Biotechnology Research for Innovation, Development and Growth in Europe), the biotechnology module of the Second Framework Programme (1987-1991), was designed to 'mark the properties of living cells and secure their exploitation by agriculture and industry'. To this aim, the programme included a number of 'concertation' activities that were aimed to monitor the development of the bio-industry in Europe and enhance the participation of small firms. Likewise, ÉCLAIR (European Collaborative Linkage of Agriculture and Industry through Research) was designed to bring innovation to agriculture and promote the use of agricultural products as raw materials in industry. An official assessment

published in 2000, however, concluded that 'the program has not had the impact on the CAP, rural economies, employment or agro-industry that was hoped for', due to the challenges of translating basic research into tangible agricultural benefits.[54]

The inclusion of industrial partners, moreover, opened up important issues of benefit sharing, especially when research networks involved many companies and focused on technology that could potentially be highly profitable. Given this problem, policy makers introduced the new concept of 'precompetitive' research in the lexicon of research funding.[55] While the legal and epistemic boundaries of this 'no-man's land between basic research and industrial research' (Guzzetti 1995: 79) were not always clear, it was an effective semantic strategy to construct an ideal space for European science cooperation, close enough to the market to attract SMEs, but far enough from it so as to prevent issues of ownership and intellectual property.

3.2.2 The Network Model

Beside the redefinition of industrial research strategies, European science policies brought about important changes in the organisation of knowledge production. One of the most innovative aspects of early biotechnology programmes was the creation of the European Laboratories Without Walls (ELWW). This 'open' reconfiguration of scientific work was aimed to encourage the establishment of European networks between universities and private laboratories, which were centred on the resolution of a specific research problem (van der Meer et al. 1987).[56] At the same time, the ELWW could foster the creation of a European space for research and development with far reaching connections across national borders.

Over the years, the transnational network or 'consortium' became the dominant model of science cooperation in all Community research programmes. The beginning of this approach dates back to the launch of COST (Cooperation

[54] Available at: http://cordis.europa.eu/euroabstracts/en/november00/life2.htm
[55] The term 'pre-competitive' science was first introduced with ESPRIT, the research programme which was designed to boost the information technology sector at the European level.
[56] In 1987, there were 11 European Laboratories Without Walls; at the beginning of the 1990s, the number had grown to 35. As a rule, the teams met every six months in one of the involved laboratories to exchange experiences. In addition, the academics visited one of the associated partner laboratories for a few weeks (Nollert 2000)

in Science and Technology), an intergovernmental initiative that was set up in 1970 by the research ministries of fifteen European countries (Brickman 1977). Unlike 'big science' centres such as the European Centre for Nuclear Research (CERN) or the European Molecular Biology Laboratory (EMBL), which gathered a critical mass of scientists within a large structure dedicated to a single type of research, COST provided a platform to *coordinate* national scientific projects in different thematic areas of common interest to participant countries. The transnational nature of this initiative was insured by the involvement of at least two member countries in each individual project. During the 1980s, this organisational model was also adopted by Eureka, another intergovernmental organisation aimed to create a European hub for industrial innovation (Guzzetti 1995).

At the Community level, the network model gained increasing momentum since the mid-1980s, in coincidence with the consolidation of the framework programmes for research and development. As Andrew Barry (2001) pointed out, the Commission became a facilitator of synergies and connections between professionals across the member states - a sort of big 'marriage agency' that matches international partners in academia and industry. Moreover, European networking was supported through a range of different arrangements, including 'thematic' and 'concertation' networks, 'integrated projects' and 'networks of excellence'. The latter were introduced with the Sixth Framework Programme in order to 'strengthen scientific and technological excellence on a particular research topic' and 'to gather the expertise needed to provide European leadership' (Luukkonen et al. 2006:239-240).

The choice of linking local centres and institutions, rather than building new centralised facilities such as CERN or EMBL, was partly dictated by the development of scientific practice. While until the 1960s 'big science' was predicted to become a key feature in most research areas, during the 1970s and the 1980s there was a comeback to the traditional laboratory. On the one hand, the increasing availability of cheap and ready-made kits, especially in biotechnology, reduced the need for big facilities (Morange 1997). On the other, the development of computer networks (and the increasing digitisation of scientific knowledge) facilitated the flow of data and information across wide geographic areas. In general, the network provided a flexible and efficient structure to organise and foster knowledge production at the European level. As

Luca Guzzetti pointed out, it became a *collective actor* that could benefit of different expertise, shared equipment and data collections, and so prevent the duplication of scientific labour and resources (Guzzetti 1995:133).

The success of the network model, however, can also be explained in the light of political considerations. During the 1980s, the network model provided the ideal instrument to implement a policy intervention that was aimed to 'animate' socio-technical connections, rather than to establish a relationship of patronage between the central authority and the clients. In the view of some policy makers, this approach was a compromise between social democracy and the laissez-faire doctrine of neoliberal economy (Barry 2001). Second, the network concept was part of the broader techno-political vision of a 'network society'. This notion, popularised by the sociologist Manuel Castells (2000), posed the IT revolution as the foundation of a new social system characterised by communications and interactions across borders.[57] The network society narrative was particularly appealing to European policy makers as it enabled the creation of a virtual European space that was alternative to traditional geopolitical divisions. To quote Barry again, 'by becoming part of a network an entity (firm, device, person, region) might, in principle, become "European" without first having to locate themselves in a national context' (Barry 2001:90).

3.2.3 Harmonization

The practical working of transnational networks, however, has not always been straightforward. The wide circulation of scientific data and information requires a uniform *epistemic culture*.[58] But the attainment of this ideal condition implies considerable efforts. Despite claims to universalism, scientific practice has increasingly been nationalized over the past two centuries. This process not only resulted in the establishment of national institutions and organisations, but also 'national styles' of scientific research, exemplified by different professional

[57] Castells argued that the European Union exemplifies the 'network state': 'it is a state made up of institutional links between EU institutions (...), national governments, regional governments, local governments, and NGOs, and extending internationally through multiple links on such important decision-making institutions as NATO, the IMF, the UN, the European Conference on Security, and a myriad of international agreements that bind the EU in trade, the environment, security, human rights, etc' (Castells & Ince 2003).

[58] Karin Knorr-Cetina points out that 'the notion [of epistemic culture] foregrounds not only a "relatedness" and "clustering" of various parts, but also a "disunity" of science in regard to epistemic practice'(1991:107).

environments, measurement systems, and organisational models.[59] Besides, science has always been shaped by *tacit knowledge* and practices that are peculiar to local contexts, and cannot be easily codified into written theories and methods.[60]

Given these considerations, it is no surprise that the collaboration between research centres has often been challenging, especially when European projects involve thirty or more teams. Scientists need to know and trust each other. Also, their data, protocols and procedures must be comparable. In this respect, the case of the yeast genome project is illustrative. In basic research, BAP's most remarkable achievement was the first sequence of an entire chromosome, the chromosome III of yeast (Guzzetti 1995). Moreover, the scientific output of this project was a notable case of transnational collective action in the production of scientific knowledge: the resulting article in the journal *Nature* was signed by 147 researchers from more than thirty different laboratories located in several European countries (Olivier et al 1992).[61] As these figures show, the project was highly successful in pooling together a wide range of human and technological resources, across a wide geographic area. Also, it produced a landmark scientific breakthrough which proved the added value of European science cooperation. Nevertheless, the accomplishment of this feat entailed important problems of standardisation. The use of different sequencing techniques led at first to unreliable results, whose accuracy could be confirmed only after a painstaking work of cross-checking between all laboratories involved.

As this case exemplifies, *harmonisation* has become a key issue in the process of European integration (Barry 2001). In many contexts, it requires considerable efforts to smooth out discrepancies and local idioms, so as to create a homogeneous space where information bits can circulate freely and be integrated into a coherent 'European' product. This process can take several years and be a major impediment to the actual working of European integration, not only in science but also in many other policy domains such as education, taxation or public health.

---

[59] There is a rich literature on national styles of scientific research. See, for instance, Harwood (1993).

[60] On the concept of 'tacit knowledge' see Collins (1974).

[61] Borrowing again a concept from the sociologist Karin Knorr-Cetina (1991, 1999), we can say that this mode of knowledge production is characterized by the reduction of the 'epistemic subject' and the emergence of a collective author (see also Galison 2003). Besides, the discovery is no longer associated with a specific laboratory, but it is the outcome of the collective action of an 'epistemic community' which transcends national borders.

3.3 A Strategy for Europe

As we have seen in the first section of this chapter, in the 1970s and the 1980s research and innovation became crucial concerns of European policy makers. Along with the booming IT sector, the prospects of the emerging biotech industry were seen as a unique opportunity to boost European economy and provide technical solutions to economic and environmental problems, from energy supply to industrial waste management. During the 1990s, however, early enthusiasm for biotechnology was tempered by a more cautious approach. As the first commercial products came out from the laboratories and hit the market, the optimism of the biotech visionaries in the Commission had to reckon with strong oppositions from member states and the public over issues of environmental risks and potential harm to human health.

Genetic engineering had raised serious safety issues since its early developments in the 1970s. In the aftermath of the first successful experiments on recombinant DNA, some scientists expressed great concerns about the potential biohazards that may result from the uncontrolled spread of undesired genes. In 1974 the American biologist Robert Louis Sinsheimer noted that 'The invention and introduction of new self-reproducing, living forms may well be irreversible. How do we prevent grievous missteps, inherently unretraceable? Can we in truth foresee the consequences, near- and long-term, of our interventions?' (in Wright 1986: 316). The following year a group of prominent American scientists, including Paul Berg, organised a conference at Asilomar, California, 'to review scientific progress in research on recombinant DNA molecules and to discuss appropriate ways to deal with the potential biohazards of this work' (Berg 1975: 1981). Participating scientists were concerned with the introduction of dangerous traits into molecules that might be hard to contain within the walls of the laboratory, or within the altered organism (Jasanoff 2005: 47). In the conference proceedings, the promoters of the initiative urged colleagues to continue experimental research in this area, but they also warned that 'little is known about the survival of laboratory strains of bacteria and bacteriophages in different ecological niches in the outside world. Even less is

known about whether recombinant DNA molecules will enhance or depress the survival of their vectors and hosts in nature' (Berg et al 1975: 1984).

During the 1980s, the issue of biohazards was partly defused by the drafting of more stringent laboratory protocols (Gottweis 1998: 109). However, the question of risk assessment and management re-emerged as a crucial debate in early 1990s, as it became clear that the rapid development of genetic engineering and the large scale industrial production of biotechnology products could not easily be controlled through existing regulatory practices.

Driven by the need to 'establish harmonized procedures and criteria' for the production and circulation of the new technologies, in 1990 the Council of the European Community adopted the first two legally binding directives on genetically modified organisms. The first Directive (90/219) was aimed at regulating the use of genetically modified micro-organisms in contained facilities (e.g. laboratories, animal houses, greenhouses). It set basic safety principles and demanded anyone carrying out such work to obtain permission from the authorities. The second Directive (90/220) focused on the deliberate release of genetically modified organisms into the environment, and required the manufacturer or importer seeking to market or release GMOs into the environment to apply for approval and provide the competent national authority with an extensive risk assessment. For EU-wide commercial authorization, moreover, the procedure allowed member states to raise objections or to request additional evidence. If one of the member states raised an objection, a decision was taken at the EU level. However, the Directive included a 'safeguard clause', which allowed member states to limit or prohibit the use of a GM organism in their territory on the basis of scientific evidence of potential threats on human health or the environment (Pollack e Shaffer 2005: 337-338).

The setting of standards in this area was a fundamental premise to ensure the circulation of GM products in the European market and thus to boost the European bio-economy. At the same time, the transnational nature of the environmental risk further justified the need for common regulations. As the Directive noted, 'living organisms, whether released into the environment in large or small amounts for experimental purposes or as commercial products, may reproduce in the environment and cross national frontiers thereby affecting other Member States' (Council of the European Community 1990).

These early efforts to 'normalize' biohazards, however, proved inadequate as the first products entered the market. First, the Directive 90/220 was criticised by many agro-business companies that were investing in plant biotechnology, especially as it put a heavy regulatory burden on an entire category of products for which there was no prior evidence of harm (Levidow 2001: 850). Also, supporters of biotechnology in the Commission believed that European policy had taken a wrong turn in targeting the technology of genetic manipulation rather than its actual risk.[62] According to Cantley and Sargeant, the Directive induced biotech companies to divert investments towards more favourable business environments outside the Community (Jasanoff 2005: 82). Second, the Directive was highly ineffective in dealing with the increasing hostility in the European public towards the new technologies, as the case of Bt-maize and GM food in general well exemplify. Bt-maize is a variant of maize that was genetically modified so as to express a toxin from *Bacillus thuringiensis* (Bt), a micro-organism that protects the maize from an insect pest which eats and destroys corn stems (the European corn borer). While the first commercial plantings of Bt-maize in the US and Canada raised no objections, the export of this product to Europe was highly controversial. In 1997, the corporation Ciba-Geigy submitted an application to commercialize Bt-maize all over Europe. Despite the strong opposition of most member states, the European Union approved the application, in accordance with the procedure of Directive 220/90. However, member governments did not accept this decision. In particular, they objected that GM crop might disrupt the ecosystem and lead to the emergence of insect pests that are resistant to the Bt toxin.[63] Moreover, many experts believed that Bt-maize could constitute a significant risk to the health of consumers because it was not tested thoroughly enough to assure that it did not contain unanticipated allergens or pathogens. As a result, Austria and Luxembourg banned the product on the bases of the precautionary principle and the 'safeguard clause' of the directive on deliberate release. Other governments followed suit and the importation of Bt-maize, as well as other GM crops, was de facto discontinued.

By the end of the decade, public hostility in Europe against genetically modified crops was further exacerbated by new scientific evidence on their

[62] Unlike US regulations, which focused on the *product* of genetic manipulation, the directive 90/219 targeted the *process* of genetic manipulation
[63] See: http://www.netlink.de/gen/BTCorn.htm

potential hazards to human health. In the UK, public protests escalated after the publication of an experiment on the effects of GM food on metabolism. In 1998, Dr Arpad Pusztai, a senior researcher at Scotland's Rowett Research Institute, announced on Granada Television's *World in Action*, that rats fed with pest-resistant transgenic potatoes experienced significant damages to their immune systems, as well as reduced organ growth. As a result, GM crops were labelled as 'Frankenstein Food' in many news reports and green activists organised spectacular protests in crop fields and government sites. The British public became increasingly hostile to the new products and retail chains removed all GM ingredients from their own brand foods. In commenting on these developments, a spokesperson from the British retail giant Sainsbury's declared that 'our customers have indicated to us very clearly that they do not want genetically-modified ingredients in their food and we are taking steps to offer that guarantee'.[64] Given the hostile reception of GM foods in the UK and other EU member states, in 1998 the European Commission declared a moratorium on the import of any GM products, which was lifted only in 2003, also due to increasing political pressure of the United States (which were losing a vital market for the sale of their own GM products) and on conditions of clear traceability of any genetically modified ingredient.

3.3.1 Towards the Knowledge-Society

Despite heated controversies over GM organisms, the promotion of research and development in biotechnology and the life sciences remained a critical component of the overall strategy of the European Union throughout the 1990s, as well as the wider policy drive to strengthen the European research system. In many ways, research activities became increasingly locked into the institutional structure and governance of the European Union. First, after the provisions in the Single European Act (1986), the Maastricht Treaty (1992) reasserted, at the highest juridical and political level, the formal commitment of the Union to support research activities and to work on the coordination of national programmes (Guzzetti 1995). Specifically, the Treaty stated that 'the Community and the Member States shall co-ordinate their research and

[64] http://news.bbc.co.uk/1/hi/uk/298229.stm

technological development activities so as to ensure that national policies and Community policy are mutually consistent'. Second, the link between high technologies and competitiveness remained a dominant narrative in European policy discourses. In the White Paper *Growth, Competitiveness, Employment* (European Commission 1993), the last major initiative by Jacques Delors as president of the European Commission, much emphasis was placed on the crucial role of research and technological development as vectors of economic growth, and the challenges of international competition. In line with former analyses, the White Paper concluded that European competitiveness was hampered by three main shortcomings in its research base: the lack of adequate financial investments, especially in frontier research; the lack of coordination between national programmes; and the inability to 'convert scientific breakthroughs and technological achievements into industrial and commercial successes' (1993: 87). Moreover, the White Paper emphasised the need for stronger links between universities and businesses and 'coordinated strategies between businesses, universities and the public authorities' – a recommendation that came with no reflections on the implications that such policy might have on both higher-education and the nature of academic research. Third, the profile of research programmes was further enhanced as the result of the wider policy drive towards the making of a 'knowledge-economy' in the European Union. As we have seen earlier in this chapter, the idea that advanced liberal democracies were becoming 'knowledge societies' can be dated back as far back as the early 1970s. In his post-industrial narrative, Daniel Bell had argued that an economy of knowledge and creativity was replacing traditional modes of production and commercial strategies. During the 1990s, in concomitance with the diffusion of the Internet, notions of 'knowledge society', 'information society', and 'learning society' became increasingly popular both in policy worlds and academia. At the European level, these ideas were central to Delors' policy vision in the White Paper on *Growth, Competitiveness, Employment*, which stated that: 'In a society based far more on the production, transfer and sharing of knowledge than on trade in goods, access to theoretical and practical knowledge must necessarily play a major role'. Thus, the White Paper emphasised the need for 'life-long learning', 'continuous training', and a

'European system for education', as key measures to reduce unemployment and boost European growth (European Commission 1993:122).[65]

In the following years, the knowledge-society narrative gained further momentum in EU policy making. Most notably, the White Paper *Towards a Learning Society*, issued in 1995 by DG Research as part of the initiatives for the 'European Year of Lifelong Learning', was aimed to 'prepare Europeans to pass smoothly to a society based upon the acquisition of skills, where one continues to learn and to teach throughout life - in other words, a learning society' (European Commission 1995: 6). To this aim, the White Paper reasserted the importance of a 'broad knowledge base', along with specific skills for employability, continuing training, 'flexibility', and closer links between universities and industries. Moreover, it advocated the need to form an 'enlightened public', able to make decisions on increasingly complicated issues that were deemed to require scientific and technical knowledge, rather than 'emotional' or 'subjective' criteria:

> Democracy functions by majority decision on major issues which, because of their complexity, require an increasing amount of background knowledge. For example, environmental and ethical issues cannot be the subject of informed debate unless young people possess a certain scientific awareness. At the moment, decisions in this area are all too often based on subjective and emotional criteria, the majority lacking the general knowledge to make an informed choice. Clearly this does not mean turning everyone into a scientific expert, but enabling them to fulfil an enlightened role in making choices which affect their environment and to understand in broad terms the social implications of debates between experts (European Commission 1995: 28).

In sum, the promotion of a 'scientific and technical culture', as it was called in the White Paper, was driven by two main concerns. First, policy makers wanted to spark interest in science, especially among the young generations, in order to enhance the bases of the knowledge-economy in terms of human resources. To this aim, the Commission organized several initiatives, such as a European Week of Scientific Culture including visits to laboratories, seminars, games and

[65] After he left office in 1994, Jacques Delors reasserted these policy goals in his new role as chairman of the 'International Commission on Education for the Twenty-first Century', an expert committee which was set up by UNESCO to provide guidelines on the use of education for international development. In the final report *Learning: the Treasure Within* (1996), the committee argued that education was the principal means to foster human development and 'to reduce poverty, exclusion, ignorance, oppression and war' (13). In his introductory remarks, Delors advocated the actualization of a 'utopian idea': 'a learning society founded on the acquisition, renewal and use of knowledge' (1996: 23-24).

exhibitions. Second, these policies were aimed to foster a more positive reception of the new technologies among the general public. Indeed, it was deemed that public rejection of GM foods was largely irrational, due to lack of understanding and 'scientific illiteracy'. Thus, a proper background in scientific and technical knowledge could enable the public to make 'enlightened' choices, as the White Paper pointed out. To this purpose, from the 1990s, EU-funded research programmes increasingly included dissemination activities for the lay public. However, as we will see, increasing pressures from the public and the emergence of new controversial issues around biomedical research, led the policy world to change the tone and reconsider the 'subjective' and 'emotional' criteria of the public in a more constructive way.

3.3.2 Biotechnology in the Knowledge-Economy

With the beginning of the new millennium, the notion of 'knowledge-society' not only remained crucial to the overall policy agenda of the EU, but also became a sort of master narrative, which was able to influence decisions at the highest level of policy making. In January 2000, a communication of the Commission announced plans for the establishment of a European Research Area (ERA), thus reviving Dahrendorf's old idea of a European space for research equivalent to the common market. Similar to its forerunner, the new ERA concept was aimed to foster the movement of researchers and scientific knowledge across the European space, increase connections and networking between research centres in different locations, and to establish a common regulatory platform and intellectual property regime. In proposing the initiative, the Commission emphasised once again the promises of science and technology for the *future* of Europe: 'even more so than the century that has just finished the XXIst century we are now entering will be the century of science and technology. More than ever, investing in research and technological development offers the most promise for the future' (European Commission 2000). Furthermore, not only were science and technology regarded as crucial means for economic and technological advancement, but also as inherently positive social values. As the communication remarked, 'In the final years of the XXth century we entered a knowledge-based society. Economic and social

development will depend essentially on knowledge in its different forms, on the production, acquisition and use of knowledge. Science and particularly technology is what makes society thick [sic]' (ibid.). Finally, the document reasserted the connection between innovation, economic growth and employment: 'by creating new products, processes and markets research and technology provide one of the principal driving forces of economic growth, competitiveness and employment'.[66]

Some months later, this strategy was confirmed by the heads of member states at the European Council with the adoption of the Lisbon Agenda, a broad policy guideline which set the ambitious goal to make 'Europe the most competitive knowledge-based economy in the world' (European Council 2000). The context of the Lisbon Agenda was not very different from the social and economic background of Delors' White Paper at the beginning of the 1990s: relatively high unemployment, but now with the complicating circumstance that European population was declining, while people lived longer. As a result, those in the workforce had to support through taxes larger numbers of unemployed and retirees, who received generous welfare and other benefits (Dinan 2004: 388-389). In order to sustain its welfare programmes, European countries would have to boost their productivity and get more people into the workforce. In line with former approaches, the Lisbon Agenda stressed that these issues should be addressed by enhancing European competitiveness. To this aim, more investments in research and development, the establishment of the European Research Area, and the fostering of a culture of innovation in European companies were needed.[67]

Within this broad policy programme, life sciences and biotechnology were identified again as a key area for economic growth. In revising the strategy of the Lisbon Agenda at the Stockholm Summit in 2001, the European Council recommended to 'examine measures required to utilise the full potential of biotechnology and strengthen the European biotechnology sector's competitiveness in order to match leading competitors' (European Council

[66] It is important to mention that these statements, once again, reflect the wider international context of high-level policy making. In 2005, UNESCO published a lengthy report titled *Towards Knowledge Societies*, which stressed similar concerns with life-long learning and knowledge economy. Unlike EU policy strategy, however, UNESCO paid more attention to persistent imbalances between the North and South of the world in access to knowledge and resources (Bindé et al 2005).

[67] The Lisbon Agenda set the goal of increasing European R&D expenditure to 3% of GDP by 2010.

2001). This advice was followed by an action plan of the Commission, called *Life Sciences and Biotechnology: A Strategy for Europe*, which was designed to harness the benefits of biotechnology for healthcare and agriculture, as well as its potential as 'a growing source of wealth in the future, leading to the creation of jobs, many of which will be highly skilled, and new opportunities for investment in further research' (European Commission 2002a). As a result, life sciences and biotechnologies were given 'first priority' in the range of research fields funded by the Sixth Framework Programme for research and development (2002–06).

In keeping with the interventionist tradition of 'action plans', the programmatic document identified thirty specific actions which were aimed to strengthen European biotechnology, including the training of skilled workforce, the implementation of measures to attract and retain scientists in Europe, the establishment of a bioinformatics infrastructure, the creation of networks of biotechnology company managers, the development of a European web portal on biotechnology, the improvement of societal scrutiny and dialogue, the definition of new regulations on genetically modified organism and an harmonised system of intellectual property protection, the fostering of bioethical debate, and an increased commitment for the developing world. Also, the document proposed to set up a Competitiveness in Biotechnology Advisory Group (CABAG), in order to advise the Commission on industrial strategies and policies. The group was appointed in 2003 and involved entrepreneurial academics and representatives from industrial companies. Finally, the Commission decided to monitor the implementation of the strategy on a regular basis through the drafting of annual progress reports and reviews. To this aim, in 2007 the Commission carried out a mid-term review of the strategy, based on evaluations of the progress made since 2002 and on a lengthy report by the Joint Research Centre to examine the social and environmental effects of biotechnology applications, as well as the state of EU competitiveness. According to the JRC report, the number of relevant scientific publications in the EU had considerably increased over the previous ten years, but the share of EU patent applications was still modest in comparison with the US and Japan. Thus, the report concluded, the EU still faced the challenge identified by the CABAG, namely 'promoting biotechnology entrepreneurship based on the knowledge created by scientific research' (JRC 2002: 121)

3.3.3 Biomedicine and the Making of the European Citizen

If we consider the development of EU biotechnology policy in historical perspective, we can see a remarkable continuity with the past. Not only has the biotech vision been a cornerstone of Community research programmes from the 1970s to the present, but similar discourses and themes have sustained its implementation: the great promises for agriculture and industrial development, the potential in terms of economic growth, the imperative to catch up and compete in the high-tech race with the United States, Japan and the emerging Asian economies. However, in recent years, there have been some notable changes. As already mentioned, widespread mistrust of the European public and governments towards biotechnology products, especially GM food, has led to reconsider regulatory practices and to pay more attention to the social reception of new technologies. Another major shift has been the growing support to biomedical research.[68] In the overall budget of the Fourth Framework Programme (1994-1998), which amounted to 13,215 million ECU, a relatively small share was allocated to the 'Biomedicine and Health' thematic area (358 million ECU). However, the Fifth Framework Programme (1998-2002) earmarked a staggering figure of 2.4 billion euros to the 'Quality of Life and Management of Living Resources' programme, the biggest part of which was dedicated to health research. Also, the Sixth Framework Programme (2002-2006) assigned more than 2.2 billion euros to the priority area 'Life Sciences, Genomics and Biotechnology for Health', while an additional 555 million euros funded research projects under the thematic area 'Research for Policy Support', including studies on public health policy and infectious diseases such as influenza and severe acute respiratory syndrome.

The emergence of biomedicine as a priority area can be partly explained by important advances in the life sciences and their well-advertised promises to revolutionize medical care, especially in the new fields of genomics and regenerative medicine. Perhaps more importantly, Community support to biomedical research has increased in concomitance with the gradual formation of a European public health policy. While the Treaty of Amsterdam stated that

[68] http://ec.europa.eu/research/health/previous-framework_en.html#

'the European Union shall fully respect the responsibilities of the Member States for the organisation and delivery of health services and medical care', the legal bases for Community planning and interventions in this area have been considerably strengthened, although in a rather unsystematic way and mainly through case law (McKee and Mossialos 2006; Greer 2008; Lamping and Steffen 2009). This shift has been well exemplified by the changing role of the DG for Health and Consumers, also known as DG-Sanco. The Directorate for Health and Consumers was initially instituted to monitor the safety of food and other goods that are traded in the European common market, but in recent years it has addressed many other public health issues and shifted its main focus on the 'health of European citizens': 'our job is to help make Europe's citizens healthier, safer and more confident', specifies the front page of DG-Sanco's website.[69] In observance of the principle of subsidiarity, the EU cannot replace national authorities, but shall complement them in areas where monitoring and coordination at the European level are needed. Yet, DG-Sanco – in combination with other EU bodies such as the European Medicines Evaluation Agency, the European Food Safety Authority, the European Monitoring Centre for Drugs, and the recent European Centre for Disease Prevention and Control – has addressed a growing number of public health areas, including prevention and control of infectious diseases, the mobility of patients across the European space, the safety of pharmaceutical products, and the reduction of healthcare inequalities across member countries. In this context, the promotion and improvement of health has become a priority also in the funding schemes of the latest framework programmes. Specifically, 'the objective of health research under FP7 is to improve the health of European citizens and boost the competitiveness of health-related industries and businesses, as well as address global health issues'.[70]

References to the 'European citizen' in these programmatic statements deserve critical attention and a brief historical detour. In a section of his *History of Sexuality* (1984), Michel Foucault argued that for a long time the privileges of sovereign power was the right to decide over life and death. However, Foucault noted, since the classical age power has been rather exercised at the level of life: after the eighteenth century modern states became increasingly concerned with the biological fitness of their populations; they became 'managers of life and

[69] http://ec.europa.eu/dgs/health_consumer/index_en.htm
[70] http://cordis.europa.eu/fp7/health/

survival', as the centralised control of population health emerged as a crucial component in national projects. From the postwar period to the present, health care, as well as other welfare services such as pensions or unemployment benefits, have been a key area of governance and a basic human right. In 1948, the Universal Declaration of Human Rights of the United Nations proclaimed that 'Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control'. While in many parts of the world this basic principle is neglected, either for lack of resources or political will, medical care is today recognised as a fundamental right of citizens, as well as a critical source of legitimacy of national governments.

Given these premises, the insistence on the notion of 'European citizen' in EU policy documents on public health and biomedical research is significant. In the transition of the European Union from a primarily economic to a more political organisation with ambitions as global power, the issue of citizenship is becoming increasingly important. In 1992, the Treaty of Maastricht institutionalised the status of 'citizenship of the Union', in order to strengthen and enhance European identity and enable citizens to participate more actively in the political life of the Community. However, the political contours of this new legal subject are still rather ambiguous and have been questioned on many occasions. In particular, recent debates on democratic deficit, the bureaucratic and technocratic bias of the EC system, and the lack of a European public sphere have highlighted the shortcomings of these efforts in terms of democratic participation and public involvement (see Hix 2005, chapter 6).

In this difficult and controversial process of polity building, the emergence of a European public health policy, as well as the increasing support to biomedical research, has not only broadened the scope of the EU institutions to a crucial area of governance, but has also contributed to the social construction of a new subject - the EU citizen - who is otherwise still very fragile in the actual practice of political life and deliberative democracy.

3.4 European Values

In the previous section we have seen that biomedical research has become a priority in the latest EU framework programmes. However, as in plant biotechnology, the promotion of this sector has faced many challenges. While recent advances in the life sciences and biomedical research have opened up new pathways towards the understanding of fundamental biological processes, as well as the finding of revolutionary therapies, controversies over related practices such as cloning, the manipulation of human embryos and the production of hybrids and chimeras have raised important moral concerns, with the very notions of human life and natural order at the centre of divergent interpretations and beliefs.

At the EU level, the governance of biomedical research has been particularly thorny, as European institutions has had to find a difficult balance between the promotion of cutting-edge scientific research, the respect of national attitudes and regulations, and the definition of common principles in bioethics. In many ways, the bioethical debate has been an important locus where questions of European identity and political culture emerged and were negotiated. The final section of this chapter provides a critical appraisal of these issues. After a brief overview of early debates and developments, the remaining sections will examine the various approaches by which European institutions have sought to regulate this difficult field of policy making, including the quest for 'European values', the establishment of expert committees, and the recent debate on public engagement.

3.4.1 Early Troubles and the Role of the Parliament

The bioethical question came to the forefront of European research policies at the end of the 1980s, as soon as the Community became involved in the Human Genome Project. In July 1988, the European Commission submitted a decision proposal to promote a European participation in the international effort to map the human genome, and thus 'to set a basis for support of European research

activities in future wide-ranging medical applications' (European Commission 1988).[71]

This plan well combined with other European initiatives in the same scientific area. As mentioned, the Commission had already funded a number of projects that aimed to map the whole genome of model organisms, including the flagship consortium on the yeast genome (see section 3.2.3), and other projects on *Arabidopsis*, the fruit fly, mouse, and porcine genomics. Due to the routine nature of genome research, collaboration between centres was feasible and to some extent desirable, as it enabled to break down the painstaking work of gene sequencing across many laboratories.[72] Moreover, it could show the added value of transnational cooperation at the European level in a prestigious scientific endeavour.

The European participation in the international Human Genome Project, however, was slow to start due to concerns about its social and ethical implications. The emphasis in the Commission's proposal on 'predictive medicine', reflected in the original title of the programme, was fiercely contested in the ensuing parliamentary debate, as some MPs argued that this approach conjured up the shadows of eugenics and racial hygiene. Driven by these concerns, in 1989 the European Parliament issued a Resolution on the Ethical and Legal Problems of Genetic Engineering, which warned about 'the risk of applying genetic analysis for the purposes of social control and the segregation of whole social strata, of selecting embryos and foetuses on the basis of their genetic characteristics alone, of producing fundamental changes in our society' (European Parliament 1989). Moreover, the document stated that genomic science ought to be designed 'exclusively for the well-being of those concerned' and not for 'the unacceptable purpose of 'positively improving' the population's gene pool', or the selection of workers on the basis of genetic criteria.

As a result of political pressure from the Parliament, and its enhanced legislative influence through the co-decision procedure with the Council, the Commission was forced to make several changes to the initial proposal,

[71] Specifically, it focused on four research areas: improvement of the human genetic map; physical mapping (including ordered clone libraries); data handling and databases; improvement of the methods and basis for the study of the human genome. The implementation of the programme was through resource centres, transnational research projects, training and studies on the ethical, social and legal aspects of human genome research.
[72] On the evolution of sequencing methods, see Hall (2007).

including the omission of the phrase 'predictive medicine' from the original title, as well as a commitment to introduce bioethics as an integral part of the research programme. In 1991 the funding scheme was eventually approved. Nevertheless, the political debate highlighted the importance of ethical issues in research policies and the need for new regulatory practices to address them at the EU level. Moreover, it brought to the fore the new role of the Parliament in the institutional dynamics of EU politics as the advocate of research ethics and a humanistic approach, often in contrast with the technocratic vision of the 'biosocial revolution'. The Resolution of 1989 stated that 'the development of genetic strategies for the solution of social problems must not be allowed since it would undermine our ability to understand human life as a complex entity which can never be encompassed entirely by any single scientific approach' (ibid.). In the following years, the Parliament expressed such concerns on many other occasions, including Resolutions on cloning (1993, 1997, 2000), the trade in human egg cells (2005), and organ donation and transplantation (2008).

3.4.2 ELSA

One of the most important outcomes of the early debate on bioethics was the establishment of research into Ethical, Social, and Legal Aspect (ELSA) as a regular component of scientific programmes. As the final Council Decision of 29 June 1990 on the human genome programme clearly stated, 'the Commission will ensure that during the execution of the programme there will be wide-ranging and in-depth discussion of the ethical, social and legal aspects of human genome analysis and that possible misuses will be identified regarding applications of the results obtained or of future development of that research' (European Council 1990). The first batches of ELSA projects focused on the human genome programme. However, the ELSA component was later extended to all research in the life sciences and biotechnology, including studies on intellectual property and the social implications of agricultural technology (European Commission 1998).[73]

In addition to the social and ethical *implications* of new technologies, part of the ELSA funding was allocated to research on *fundamental European values*

[73] Besides, ethical review became mandatory for all projects in the life sciences and biotechnology.

that could guide the regulation of research in the life sciences and biotechnology, as the project on 'Basic Bioethical and Biolegal Principles in Europe' illustrates. This project was coordinated by the philosopher Peter Kemp, director of the Centre for Ethics and Law in Copenhagen, and involved 22 principal investigators from other European countries through the usual network approach. After three years of work, the network produced a detailed report that identified and elaborated on four basic 'European principles' or 'articulations' (i.e. autonomy, dignity, integrity and vulnerability). These findings were later advertised in the *Barcelona Declaration*, a 'manifesto' of European bioethics (Kemp and Rendtorff 2008).

According to the final report, the four basic principles reflected a European tradition of legal and moral culture, as well as the European model of economic development. The principle of autonomy, for example, was associated with the humanistic tradition of giving high value to individuals and their development in society – a tradition whose cultural roots were traced back to the classic texts of Western thought, from Stoicism to Kantian philosophy. Moreover, the report stressed that the relation between basic principles, rights and protection of person and body shall be seen as 'a consequence of the development of the welfare state and risk society into a caring and protectioning state of care and protection', in contrast with the mainstream American approach, mainly centred on autonomy and self-determination.[74]

Over the years, the idea of 'European bioethics' has gained wide currency in the academic debate (see Saas 2001). For example, the recent project Gleube, funded by the Commission under the Seventh Framework Programme (2007-2013), and involving several European universities, aims to showcase European bioethics to a broad international audience, in response to 'the emergence of distinct European model of bioethics, and the perception that current education, clinical and policy activity is dominated by American approaches'.[75] It is worth mentioning that these formulations imply a shift from a universalistic conception of bioethics and human rights to the emphasis of a particular cultural perspective (i.e. European), which can be understood along the same lines of the narrative of the 'American challenge' in technological and

[74] This model emerged in the late 1970s, with the so called 'Georgetown mantra', a set of other four principles (autonomy, non-maleficence, beneficence and justice) that were codified in the widely read book *Principles of Biomedical Ethics* by Beauchamp and Childress (1979).
[75] www.gleube.eu

industrial development – a further evidence of the deep correlation between knowledge production and the wider context of political economy across different fields of expertise.

3.4.3 The Oviedo Convention

Beyond the academic debate, the European Convention on Human rights and Biomedicine of the Council of Europe (1997) - also known as 'Oviedo Convention' – has been a more influential effort to define basic European values. Similar to the Barcelona Declaration, this legal document combines the tradition of protecting individual freedom and legal rights ('the interests and welfare of the human being shall prevail over the sole interest of society or science'),[76] with an emphasis on social solidarity and the defence of the weakest subjects. Moreover, its legal framework was designed as an open instrument, with basic principles that could be complemented by additional protocols on specific issues of biomedical research or clinical practice. Since its adoption, additional protocols have been issued on the prohibition of human cloning; organ transplantation; biomedical research; and genetic testing for health purposes.

As Roberto Andorno observed, the Convention is a remarkable achievement in international law, especially if we consider profound discrepancies among European countries on key bioethical issues. Indeed, the Convention is the first multilateral *binding* instrument entirely devoted to biomedicine; besides, it constitutes a comprehensive effort to frame a broad and complicated issue, unlike other international instruments that aim to regulate only specific aspects such as the UNESCO Declaration on Human Cloning (Andorno 2005: 143).

However, critics have identified important limitations. As in other international legal instruments, consensus was sought through minimalist claims that could meet the needs of all parties involved.[77] For example, crucial issues for harmonisation such as euthanasia, palliative care, and European

[76] This principle was reasserted on the Universal Declaration on Bioethics and Human Rights of UNESCO (2005): 'the interests and welfare of the individual should have priority over the sole interest of science or society'.

[77] The criticism of David Benatar (2005) to the *Universal Declaration on Bioethics and Human Rights* can also be applied to the *Oviedo Convention*: 'To the extent that a declaration is characterized by minimalism and vagueness it does not say anything we do not already know. It presents us with the uncontested and remains silent about the contested. It gives guidance where none is needed and it fails to give guidance where it is needed' (2005:221).

citizens' rights to health care were not addressed (Saas 2001), although additional protocols might be adopted in the future. Despite its vagueness, moreover, the Convention has failed to create a truly supranational framework, as many countries have not ratified the document, including the UK and Germany.[78] Finally, observers have challenged its cultural biases. According to Demetrio Neri and Maurizio Mori, for example, the Convention does not reflect cultural diversity in Europe, as 'no procedure guarantees that within the Council the different schools of thought are fairly represented' (Mori and Neri 2001:325).

3.4.5 The Expert Committee and Moral Diplomacy

The setting of expert groups has been another important development towards the shaping of a European framework on bioethics. In 1991, recognising the need for further input in the regulatory process, the Commission decided to set up an independent Group of Advisers on the Ethical Implications of Biotechnology, which was later renamed as European Group on Ethics in Science and New Technologies (EGE). This initiative was in keeping with concomitant developments at the national level. Since the late 1980s, many governments in both Europe and North America have established national bodies of professional advisers on the ethics of biomedical research and practice. As early as 1983, the French government set up the National Consultative Ethics Committee in order to 'foster an active moral attitude in its field of expertise: ethical and societal issues raised by the advancement of knowledge in the health and life sciences'.[79] In the UK, the first official body was the Nuffield Council on Bioethics, established in 1991 with the mandate 'to identify, examine and report on the ethical questions raised by recent advances in biological and medical research'.[80] Likewise, since 1991 the Italian Bioethics Committee has provided guidance to the Italian government and the public on 'ethical implications of the advancement of scientific research and new

[78] Interestingly, these two countries rejected the Convention on opposite grounds. To the Germans, it was too permissive and imprecise, especially on the informed consent of incapacitated persons. Conversely, the British government has not ratified it, due to its limitations to all forms of cloning, including 'therapeutic' cloning.
[79] www.ccne-ethique.fr/brochure.php
[80] http://www.nuffieldfoundation.org/nuffield-council-bioethics

technologies in the life sciences and health care'.[81] In all these cases, bioethics has gradually emerged as an intellectual framework to assist policy-making and governance. As Sheila Jasanoff pointed out, it became 'a new language of deliberation, geared to the analysis of human values rather than the benefits of the market, the facts of science, or the norms of law' (Jasanoff 2005:172).

Similar to the procedure of most national bioethics committees, the European Group on Ethics issues periodical statements (called 'Opinions') on topical questions concerning science and technology, either in response to a request from the President or on its own initiative. In the past two decades, the EGE group has produced opinions on a broad range of topics, including gene therapy (1994), prenatal genetic diagnosis (1995), the patenting of inventions involving elements of human origin (1996), the genetic modification of animals (1996), cloning (1997), human tissue banking (1998) and stem cell research (1998). In comparison with national committees, however, EGE's task has been more challenging, given the fragmented regulatory landscape across EU member states. Indeed, EGE's mission has often been one of *moral diplomacy*, as the group has had to find a difficult balance between the respect of discrepant national regulations, the overarching framework of international regulations such as the Oviedo Convention, and the definition of common European values. Despite these challenges, however, the EGE Group has played a key role in the process of EU policy making, also due to a general lack of confidence in the credibility of scientific assessments (as the GM controversy exemplifies). In this situation, as Brian Salter and Mavis Jones pointed out, the group has become an important 'policy broker', complementing scientific analyses with ethical reviews that address social concerns and, at the same time, might fend off potential political problems (Salter and Jones 2002a, 2002b).

3.4.6 Democratic Legitimacy and Public Engagement

Institutional bioethics has become essential in the regulation of biotechnology, not only in Europe. However, important issues have been raised. Some commentators argued that decisions on science and technology have been entrusted to expert committees, and thus removed from democratic processes of

[81] http://www.governo.it/bioetica/

deliberation involving the wider public. As Sheila Jasanoff argued, 'democratic governments are presumed to be capable of discerning their citizens' needs and wants, and of deploying science and technology effectively to meet these needs. Citizens, once they have elected representative governments, are not entitled to steer science; nor are they thought to need an autonomous position from which to oversee the partnership of science with the state' (2006:247).

In the EU context, this criticism has been applied not only to science policy but to the whole system of European governance. Especially from the late 1990s, there have been many debates about the so-called *democratic deficit* in the EU and the wide gap that separates bureaucrats in Brussels and the general population. As a result, the European Commission has recognized that civil society needs to be more actively engaged in EU policies if they are to be regarded as legitimate. To this aim, various efforts have been made to adopt a more inclusive approach to policy making. The increased use of surveys to capture the attitudes and perceptions of EU citizens has been an initial effort towards this direction, including reports on 'Europeans and biotechnology' (Gaskell 2001). In 2005, moreover, DG Research commissioned a broad survey on 'Social values, science and technology' to assess Europeans' views and perceptions of the ethical implications of the new technologies (European Commission 2005).

Beyond the survey approach, the Commission has sought a more active *public engagement* with science, which departs from the former model of *public understanding* (see section 3.3). In 2001, the *White Paper on European Governance* emphasised the need for 'better involvement and openness', as well as 'a stronger interaction with regional and local governments and civil society'. In research policy, this view was reflected in the consultation document *Towards a Strategic Vision of Life Sciences and Biotechnology*, which stated that:

> Democracy depends on people being able to take part in public debate. To do this, they must have access to reliable information on European issues and be able to scrutinize the policy process in its various stages. Hence, the need for institutions to communicate more actively with the general public on European issues, in particular if they are of such a sensitive nature as life sciences and biotechnology (European Commission 2001: 4).

This change also applied to the EGE. In 2001, the expert group reconceptualised its mission as 'the guardian of the rights of civil society by enabling the

Community authorities, which are responsible for regulating the market, to take better account of the aspirations of the public in the various aspects of their lives: as consumers, workers, parents, patients etc' (EGE 2001:12).

Over the past few years, these commitments have been followed by some practical actions, as the EU institutions have engaged in closer interactions both with the public at large and the expanding numbers of NGOs in the biomedical arena, including patient associations. Interactions have occurred through various forms of consultation, public events, stakeholders meetings, and other initiatives. It is however questionable to what extent EU institutions have been and will be able to involve the 'European public', considering the sheer dimension and diversity of the European Union, especially after the latest rounds of enlargement. Moreover, further research should reflect on the degree to which public engagement has actually moved beyond merely rhetorical postures to become an integral part of the policy making process.

4. THE POLITICS OF STEM CELLS

In the previous chapter I have examined policy narratives that have underpinned the emergence and development of biotechnology policy in the European Union. Then, I have explored the ways in which the biotech vision of the European Commission has been hindered by unanticipated issues such public perceptions of environmental risk and ethical concerns with laboratory practices in biomedical research. In the second part of this work, I will narrow down the analysis to the specific case of stem cell research. This is a critical case to make sense of the politics of science cooperation in the EU. Despite its widely advertised therapeutic and commercial promises, stem cell science has been at the centre of heated debates in several countries, due to the ethical implications of related practices such as cloning, the production of chimeras and hybrids, and especially the manipulation of human embryos. As a result, European cooperation in this field has been particularly problematic. Discrepancies between national attitudes have jeopardised the approval of recent funding programmes and highlighted once again the long standing problem of the harmonisation of research policies and, more broadly, of European unity and cultural identity.

This chapter focuses on the emergence of stem cell research and the resulting regulatory debate both at the national and EU level. It is divided into three main sections: the first part (‘Regenerating Life’) provides an introduction to stem cell science and its institutionalisation as a field of biomedical research, applications and financial investments; the second section (‘The Policy Shaping of a Controversial Field’) analyses the ethical and regulatory debate on stem cells in three European countries - the UK, Germany, and Italy - which epitomise the diversity of ‘national attitudes’ towards controversial biomedical research; the last part (‘The Debate in the EU’) moves from national debates to EU governance, and examines the stem cell question within the process of approval of the latest framework programmes for research and development.

4.1 Regenerating Life

As most scientific endeavours, the shaping of stem cell science into a distinctive 'field' of research has not followed a straight path, but has often been marked by serendipitous findings, radical changes of directions and the contributions of various disciplinary approaches, including embryology, anatomy, cancer research, molecular biology and genetics, as well as the influence of ethical debates. As Michele Morange documented (2006), the prehistory of stem cell science can be dated back to research on teratomas (see also Cooper 2004; Solter 2006). Teratoma is a Greek word that literally means 'monster tumour', and in medical language indicates a malformation containing a mixture of random tissue, such as teeth, hair, pieces of bone, and muscle. In a seminal article published in 1954, cancer researcher Leroy Stevens suggested that such malformations were likely to result from the anomalous development of 'pluripotent embryonic-type cells', thus they were able to form a variety of different tissues (Stevens & Little 1954). In the following years, researchers began to use teratoma as a model to understand embryogenesis and early cellular development in mammalians. Teratomas allowed the isolation of embryonic-type cell lines at different stages of commitment and differentiation, as well as the observation *in vitro* of processes of cellular differentiation. Scientists demonstrated that these cell lines were multi-potential and could be maintained in an undifferentiated state by cellular culture.

In the late 1970s, the molecular resemblance between teratocarcinoma cells and pluripotent stem cells forming the inner cell mass of early embryos became increasingly clear (Martin et al. 1978). At the same time, two groups of scientists developed techniques for isolating and establishing cultures of pluripotent cell lines directly from normal mouse embryos - an achievement that marked the emergence of stem cell science as we now understand it (Morange 2006). In 1981, Gail Martin at the University of California and Martin Evans and Matt Kauffman at the University of Cambridge both reported the first successful attempts to isolate and establish Embryonic Stem (ES) cell cultures from a mouse blastocyst, the structure formed in early embryogenesis after five or six days from the first division of the zygote (Martin 1981; Evans & Kauffman 1981).

Two aspects of the early history of stem cell research deserve further attention. First, early experiments on embryonic stem cells were not primarily

aimed at developing new biomedical applications, but were driven by the desire to better understand processes of cellular development. On the isolation of embryonic stem cells, Gail Martin wrote that 'this method should be useful not only for further elucidating the relationship between teratocarcinoma stem cells and their normal embryonic progenitors but also for generating new, genetically marked pluripotent cell lines that can be used for studying various aspects of early mammalian development' (Martin 1981: 7637). There is no emphasis here on future therapies and biomedical applications. The idea of systematically exploring the therapeutic possibilities of ES cells emerged later, following the successful transplantations of bone marrow and related studies on the regenerative capacities of hematopoietic stem cells. It was only then that the properties of the ES cell were 'rediscovered' as being essentially benign and thereby distinguishable from those of carcinoma cells, although the precise nature of this difference is yet to be defined (Andrews 2005). Second, since the very beginning, laboratory practices in stem cell research moved away from purely observational science. From the experiments of Leroy Stevens to the first isolation of mouse ES cells, advances in the field were defined by techniques that were aimed to manipulate, relocate and 'direct' natural processes of cellular development and differentiation – an approach that bears the hallmark of Loeb's 'engineering standpoint' in the life sciences (see section 3.1.3) and would become the distinctive feature of stem cell research for the coming years (Landecker 2007).

4.1.1 Hope and Hype

Despite growing scientific interest, until the late 1990, stem cell science was a small research area, highly specialised and known mainly by professionals in the field (Solter 2006). This changed in 1998, when a research group at the Wisconsin Regional Primate Research Center, led by the biologist James Thomson, used the technique developed for mice to isolate and grow stem cells derived from human blastocysts (Thomson et al. 1998). Almost simultaneously, another research group at the Johns Hopkins University, led by John Gearhart, reported the derivation of pluripotent human stem cells from primordial germ cells in human foetal tissue (Shamblot et al. 1998).

These two experiments were celebrated as achievements of paramount importance. Scientists soon realized that human embryonic stem cells (hESCs) had a huge therapeutic potential as they hold the capacity to produce every tissue of the human body. This unique property, along with the capacity of self-renewal, raised the hopes to find treatments for many incurable diseases through the regeneration of dead or dysfunctional human tissues. As Thompson and his colleagues emphasised in their seminal article, 'the standardized production of large, purified populations of euploid human cells such as cardiomyocytes and neurons will provide a potentially limitless source of cells for drug discovery and transplantation therapies. Many diseases, such as Parkinson's disease and juvenile-onset diabetes mellitus, result from the death or dysfunction of just one or a few cell types. The replacement of those cells could offer lifelong treatment' (Thompson et al. 1998: 1146). At the same time, the cloning of Dolly the sheep in 1996 through somatic nuclear transfer opened up the way to the generation of ES cells with the same genetic profile of any adult organism (thereby avoiding the problem of immunological rejection).

These therapeutic promises immediately raised the profile of the new technology. In 1999, the prestigious scientific journal *Science* elected stem cell research as 'breakthrough of the year', due to 'new hopes of dazzling medical applications'. In a similar tone, Lee M. Silver, professor of molecular biology at Princeton University, stressed that 'gene and genomes represent only one of two pillars of likely twenty-first century progress in biomedicine. The second is stem-cell biology' (Silver 2004). Popular media contributed to amplifying the hype about stem cells and their therapeutic promises amongst the audience of non-professionals. In 2001, *Time* magazine nominated James Thompson 'America's Best in science and medicine' and placed his picture on the front cover of the December issue, under the heading 'the man who brought you stem cells'.[82]

But the excitement for stem cells went far beyond its therapeutic value. The new technology was celebrated as a potential source of youthfulness, if not immortality. In an article titled 'Capturing the Promise of Youth', published in 1999 on the journal *Science*, stem cell research inspired visions of rejuvenation: 'If it lives up to its early promise, it may one day restore vigour to aged and diseased muscles, hearts, and brains - perhaps even allowing humans to

[82] http://www.time.com/time/magazine/article/0,9171,1000602,00.html

combine the wisdom of old age with the potential of youth' (Vogel 1999). Likewise, a columnist of the New York Times imagined the future of stem cell medicine as a world of recycled generations: 'For one thing, every place in the developed world might look a lot more like Florida. Although the maximum attainable human life span is now approximately 120 years, only about 65,000 Americans have currently reached the age of 100. But a century from now, with new medical technologies in place, the Census Bureau predicts there will be 5.3million people living to the age of 100 and perhaps much longer' (Hall 2000). Given these prospects, stem cell research attracted huge investments from venture capitalists, governments, and pharmaceutical companies. Ahead of times, the US biotech company Geron, specialised in developing and marketing products to fight ageing, had funded the two derivations of human embryonic stem cell lines of 1998.

4.1.2 Institutionalisation

Over the past decade, stem cell science has rapidly grown not only qualitatively, but also quantitatively. A simple search on the PubMed service of the US National Library of Medicine for the keyword 'stem cells' yields about 11,000 articles in 2009, four times more than 1998 and eighteen times as many articles as in 1981. As expected, the greatest increase has been in papers that are related to embryonic stem cells. A search of papers that were published in 1981 with the keyword 'embryonic stem cells' retrieved only one paper, the seminal report on the first isolation of pluripotent cell line from early mouse embryos, described by Gail Martin. However, after the publication of the two 1998 landmark papers, the number of publications increased exponentially: from 269 papers in 2001 to 1762 papers in 2007.[83] Likewise, the number of dedicated scientific journals has grown significantly, including *Stem Cells* (1993), *Stem Cells Reviews* (2005), *Stem Cells and Development* (2004), *Cloning & Stem Cells* (2002), *Cytotherapy* (1999), *Cell Tissues Organs* (1999), and *Stem Cell Research* (2007).[84] In higher

[83] Source: PubMed, US National Library of Medicine National Institutes of Health (http://www.ncbi.nlm.nih.gov/pubmed). I carried out this search in February 2010.
[84] The publishing history of some of these publications, interestingly, provides indications on the rapidly changing trends and approaches in biomedical research. For instance, the journal *Hematotherapy* was founded in 1992 following the first successful bone marrow

education, modules or entire programmes in stem cell science and technologies have been set up in many universities. In the UK, for example, the University of Sheffield (UK) offers a new postgraduate programme in 'Stem Cell and Regenerative Medicine'. On the promotional website, it is noted that: 'this is a rapidly emerging area of biomedical research with enormous therapeutic potential. As the academic research base broadens and industry begins to adopt the new technologies, the demand for skills in this area is increasing rapidly, resulting in excellent employment opportunities for graduates with training in this area'.[85] Similar programmes have been established at the universities of Nottingham, Bristol, Bath, and Cardiff. Finally, the institutionalisation of stem cell science as a distinctive field of research has been further illustrated by the proliferation of new sites for knowledge production, ranging from small laboratories within university department of molecular biology to large specialised units, such as the I-Stem centre in Evry, near Paris. In general, the growth of stem cell centres over the past five years has been impressive, especially in North America, Western Europe and East Asia.[86] In Europe, the United Kingdom has led this trend with the establishment of almost twenty specialised centres, including the Centre for Stem Cell Research at the University of Cambridge, set up in 2007 with the support of a generous grant from the Wellcome Trust, a UK-based charitable foundation dedicated to achieving improvements in human health. In December 2006, I had the chance to attend the inaugural conference. In a crowded lecture room at the University of Cambridge, the event was presented as a pivotal moment for scientific progress with much emphasis on the historical continuity between early British achievements in stem cell science (such as the first derivation of mouse embryonic stem cells) and the foundation of the new centre. The conference booklet stressed that the new institution aimed to 'become the leading research centre in Europe and to compete with leading institutes in Japan, Singapore and North America'. In the opening lecture, the chairman of the Wellcome Trust Sir William Castell claimed that the centre would forge new leaders in the context of 'global competition in science'. A couple of years later, significantly, an image of stem cells taken in a laboratory of the new centre was projected onto the

---

transplantations; in the wake of Dolly, however, it was first renamed as *Cloning*, then *Cloning and Stem Cell Research* and, finally, *Stem Cells and Development* in 2004.

[85] http://www.shef.ac.uk/bms/prospective_pg/masters

[86] see map at http://www.mbbnet.umn.edu/scmap/scresearchmap.html

screen-wall of the King's College in Cambridge, as part of the celebrations for the 800th anniversary of the University of Cambridge - an iconic demonstration of the prestige and recognition of stem cell science in the academic establishment.

4.2 The Policy Shaping of a Controversial Field

While the achievements of stem cell research have been celebrated as outstanding scientific breakthroughs and great promises for human health, they have also raised profound ethical concerns. Concerns are not about the substance of research, but they are associated with the ethical implications of related laboratory practices. First, stem cell science is still partly dependent on the manipulation and destruction of human embryos, although the new technology of 'induced pluripotent stem cells' (or iPS cells) might dispense with the use of embryonic cells in the future.[87] Second, stem cell research is associated with cloning, as scientists believe that the generation of cell lines that are genetically identical to recipient patients in therapeutic treatments could solve the problem of immunorejection. Finally, shortage of human eggs has led scientists to propose using animals as the source of the significant quantities of egg needed to create cytoplasmic hybrid embryos (or 'cybrids') from which human embryonic stem cell lines might be produced. However, many people have questioned the ethical, legal and biological consequences of mixing human and animal DNA.

Due to these controversial practices, national and international authorities have made several efforts to regulate stem cell research with new policy frameworks and ad hoc legal instruments. However, the diversity of national regulations is striking and is thus 'another prominent reminder of the ways in which the "hard" sciences are powerfully shaped by social and cultural factors' (Franklin 2006: 71). Before moving to the EU level, I shall briefly review the

[87] iPS cells are a type of pluripotent stem cell artificially derived from a non-pluripotent cell, typically an adult somatic cell, by inducing a 'forced' expression of specific genes. Induced Pluripotent Stem Cells are similar to natural pluripotent stem cells, such as embryonic stem (ES) cells, in many respects, such as the expression of certain stem cell genes and proteins, potency and differentiability, but the full extent of their relation to natural pluripotent stem cells is still being assessed. iPS cells were first produced for human cells in 2007 by a team at Kyoto university, led by Shinya Yamanaka (see Takahashi et al 2007).

regulatory debate in three European countries - the United Kingdom, Germany, and Italy – as these cases well illustrate the range of different attitudes and approaches across Europe.

4.2.1 United Kingdom

In the United Kingdom, the legal bases of current governance of biomedical research were laid down in the early 1990s, when the British Parliament passed the Human Embryology and Fertilisation Act in order to regulate In-Vitro Fertilisation (IVF) and research on 'spared embryos' from IVF treatments. In line with the British tradition of practical ethical reasoning (Hauskeller 2004), this document was not primarily concerned with the moral status of the embryo, but it rather created a space for deliberation on a case by case approach. The law provided for the setting of an ad hoc statutory body, the Human Embryology and Fertilisation Authority (HFEA), with the mandate to license and monitor IVF clinics and to approve any research projects involving human embryos through a peer-review procedure. While adopting a pragmatic approach, the document identified five criteria by which embryo research could be permitted: (1) to promote advances in the treatment of infertility, (2) to increase knowledge about the causes of congenital disease, (3) to increase knowledge about causes of miscarriages, (4) to develop more effective techniques of contraception, and (5) to develop methods for detecting the presence of gene or chromosome abnormalities in embryos before implantation.[88] Moreover, the law established the threshold of 14 days as the point beyond which research should no longer be permitted on human embryos.

Towards the end of the decade, however, the introduction of new experimental practices challenged this regulatory framework. First, in 1996 the cloning of Dolly the sheep by somatic nuclear transfer, and the resulting prospect to apply the same method to human embryos, became the focus of new debates and policy moves. To address this issue, in 1998 the HFEA and the newly created Human Genetics Commission (HGC) published a joint advisory document on *Cloning Issues in Reproduction, Science and Medicine* (1998), which banned any forms of cloning for reproductive purposes, but approved

[88] http://www.legislation.gov.uk/ukpga/1990/37/schedule/2

'scientific and therapeutic applications of nuclear replacement technology, which do not involve the creation of genetically identical individuals' (HFEA and HGC 1998). Second, after the derivations of human embryonic stem cells in 1998, the prospects of this emerging field of biomedical research and applications required further policy input. In April 2000, the Nuffield Council on Bioethics, an independent advisory body funded in 1991, suggested that 'research involving human embryos be permitted for the purpose of developing tissues to treat diseases from derived embryonic stem (ES) cells' (Nuffield Council 2000). Few months later, this advice was confirmed by an official government report on *Stem Cell Research: Medical Progress with Responsibility* (also known as the Donaldson report), which recommended 'research using embryos (whether created by in vitro fertilisation or cell nuclear replacement) to increase understanding about human disease and disorders and their cell based treatments should be permitted, subject to the controls in the Human Fertilisation and Embryology Act 1990' (UK Department of Health 2000). Following these consultations, in 2001 the Human Fertilisation and Embryology Act 1990 was amended with a revision of the purposes for which embryo research may be authorised, now including the development of treatments for serious diseases. The HFEA, moreover, was given powers to issue licenses for human embryonic stem cell research.[89] For example, in 2004 the HFEA granted scientists from Newcastle University a licence to produce cloned human cells – the first such case in any European country.[90]

After a few years, however, this framework became obsolete again due to the introduction of new controversial practices, as scientists proposed to harvest stem cells from hybrid or admix embryos, where the nuclei of human cells are inserted into animal eggs. Unlike former bioethical issues, the 'animal-human embryo' was more difficult to be normalised through existing regulatory practices. After many debates (including a public consultation), policy documents and the failure of a new Bill on Human Tissue & Embryo, the British government eventually decided to 'upgrade' the HFE Act 1990 with provisions that, in substance, permit the creation of admixed embryos for research purposes, in addition to other key changes such as the recognition of same-sex couples as legal parents of children conceived through assisted reproduction technologies.

[89] http://www.opsi.gov.uk/SI/si2001/20010188.htm
[90] http://news.bbc.co.uk/1/hi/health/3554474.stm

As a result of these policy efforts, today the UK has one of the most articulated regulatory frameworks for biomedical research, which also includes the promotion of studies on the social implications of new medical technologies (see Hauskeller 2004). For example, the ESRC Social Science Stem Cell Initiative (SCI) was set up in the autumn of 2005 with the broad aim of supporting a range of sociological work and dissemination activities, 'to build research capacity and raise awareness within the UK social science community, in regard to the emerging field of stem cell science'.[91]

As many commentators (Brownsword 2005) noted, British regulations are rather liberal in comparison with other European countries as they permit the creation of embryos for research purposes (in contravention of the Oviedo Convention), as well as the production of hybrid embryos and therapeutic cloning. This Pro-Science attitude has been explained in relation to the historical legacy of 'British' breakthroughs in the life sciences and biomedical research, including the discovery of the double helix by James Watson and Francis Crick in 1953, the first derivation of mouse embryonic stem cells, the first successful clinical application of IVF, and the first cloning of a mammalian. As Jasanoff pointed out, 'Britain's scientific community saw bioethics first and foremost as a device for safeguarding a space for research' (2005:187). By contrast, as we will see in the following pages, the shaping of stem cell regulations in countries such as Germany and Italy was driven by different priorities.

4.2.2 Germany

In Germany, stem cell research became an important field of deliberation in which the recently unified nation had to reflect on its political culture and identity at a critical historical juncture (Sperling 2004; Nehrlich 2005). In the realm of high culture, the debate was sparked in 1999 by a controversial publication by the German philosopher Peter Sloterdijk. In his essay *Rules for the Human Park* (*Regeln für den Menschenpark*, 1999), Sloterdijk lamented the growing decline of human civilization and imagined a new age in which the techniques of genetic engineering and selection might lead to a better breed of

[91] http://www.york.ac.uk/res/sci/introduction.htm

humans – a standpoint that is reminiscent of earlier statements by European policy makers about the coming of a 'bio-society' (see section 3.1). The implications of these claims for German history and identity did not pass unnoticed. Sloterdijik's apparent support for eugenics, as well as his references to contentious philosophers such as Martin Heidegger, conjured up the shadows of Nazi practices and provoked a flurry of criticisms by public intellectuals, including Jürgen Habermas (Jasanoff 2006: 183).

In this context of public debates about the social implications of biotechnology, the regulation of stem cell research became an important field of deliberation in which post-unification Germany had to reflect on its political culture and identity at a critical historical juncture. The initial trigger of the regulatory debate was in 1999, when Oliver Brüstle, a neurologist from the University of Bonn, submitted a request to the German Science Foundation to import human embryonic stem cell lines for research purposes. The issue was contentious from the outset. The Embryo Protection Law, enforced in January 1991, required that no more embryos should be produced during in-vitro fertilisation (IVF) than will be implanted in the woman whose eggs have been used. Thus, IVF clinics had no spare embryos from which researchers could derive human embryonic stem cells. Further, the law categorically prohibited any experiments on human embryos. However, the law did not provide any indications about the possibility to import embryonic cells from other countries in which such practice is allowed. Forced to decide on the legitimacy of human embryo research, the German Bundestag asked its internal commission on bioethics (*Enquete Kommission Recht und Ethik der modernen Medizin*) to produce a comprehensive report. Concurrently, the Chancellor Gerhard Schröder appointed a National Ethics Council (*Nationaler Ethikrat*), which began to work on the same issue. While the internal commission recommended a total ban on the import of hESC lines, the National Ethics Council allowed for some exceptions: 'Provided that imports are restricted to embryonic stem cells derived from embryos independently of research projects in Germany and prior to the time when these projects are requested, the existence of an incentive for the "consumption" of embryos can be ruled out, so that the level of protection corresponds to that provided by the German Embryo Protection Law'.[92]

[92] German National Ethics Council, Opinion on 'The Import of Human Embryonic Stem Cell'; available at: http://www.ethikrat.org/_english/publications/stem_cells/Opinion_Import-HESC.pdf

On 30 January 2002, after a long parliamentary debate, the Bundestag decided to permit such imports, but only within strict limits. The Stem Cell Law, passed the same year, prohibited the import and use of human embryonic stem cells as a matter of principle, but then listed a number of cases under which certain kinds of stem cells may be brought into the country. Most notably, the cell lines should have been produced before 1 January 2002, and should no longer be suitable for implantation in fertility treatment. Moreover, cell lines must be derived from embryos that have been discarded, but for reasons that are unrelated to the state of the embryo – a legal clause that reflects widespread concerns with the burdensome past of Nazi eugenics.

In July 2007, however, the German National Ethics Council presented a position statement on possible amendments of the Stem Cell Act 2002. In keeping with the British approach, the Council proposed abolishing the cut-off date and replace it with 'a practicable and reliable case-by-case consideration as a part of the approval procedure for the import and use of embryonic stem cells'. Also, it demanded an end to the penalties for scientists involved in international projects using stem cells.[93] The basic principles of the Stem Cell Law 2002 have so far remained unchanged. In 2008, however, the German Parliament decided by a 346-228 vote to move the cut-off date to May 2007 and not to prosecute scientists for work conducted outside Germany.

4.2.3 Italy

In Italian political life, the debate on stem cell research was also highly contentious (Liverani 2006, Metzler 2009). One of the first official statements on stem cell science is a document drafted in December 2000 by an advisory commission headed by the Nobel laureate Renato Dulbecco. The advisory group was established by the Ministry of Health in order to clarify the Italian position after the publication of the Donaldson Report in the UK, especially with regards to 'therapeutic cloning'. In its recommendations, the advisory group stated that 'the nuclear transfer of autologous stem cells is the most promising technology for the treatment of many incurable diseases, which affect millions of Italians'.[94]

[93] http://www.ethikrat.org/_english/press/PR_2007_08_English.pdf
[94] In biology, autologous refers to cells, tissues or even proteins that are reimplanted in the same individual as they come from.

Moreover, the commission approved in large majority research on supernumerary embryos from IVF for the reason that it could be 'highly beneficial to humankind' and 'it does not imply either an instrumental conception of the embryo or an act of disrespect towards human life, especially if we consider that the alternative is to let these embryos perish as they would be no longer available for their initial destination'.[95] Other political actors, however, did not share these views. A few weeks before the Dulbecco Commission began its works, the Pontifical Academy for Life, a highly influential Vatican congregation for the promotion of Catholic values in relation to biomedicine, issued a Declaration on the Production and the Scientific and Therapeutic Use of Human Embryonic Stem Cells, which stated that 'the ablation of the inner cell mass (ICM) of the blastocyst, which critically and irremediably damages the human embryo, curtailing its development, is a gravely immoral act' (Pontifical Academy for Life 2000). Notably, the document sustained this position with biological (and not theological) arguments: 'On the basis of a complete biological analysis, the living human embryo is - from the moment of the union of the gametes - a human subject with a well defined identity, which from that point begins its own coordinated, continuous and gradual development, such that at no later stage can it be considered as a simple mass of cells. From this it follows that as a human individual it has the right to its own life; and therefore every intervention which is not in favour of the embryo is an act which violates that right'. [96]

Soon afterwards, conservative parties close to the Vatican translated this standpoint into a new law Bill on assisted reproductive technologies, which banned any manipulation of the human embryo for other purposes than procreation, on the basis of similar biological essentialism: 'The embryo is a human subject from the fecundation of the maternal egg. This is a scientific truth that cannot be contested by any free intellect. Since his very beginning (i.e. his status of zygote), the embryo has no need to add anything external to carry out his developmental process that he will accomplish in complete autonomy (...), for the zygote possesses (as gene pool) the tens of thousand regulatory genes (e.g. positional, selector, structural), destined to control the whole

[95] The document is available at: http://www.lucacoscioni.it/node/2349 (accessed July 2008).
[96] Pontifical Academy for Life, 'Declaration on the Production and the Scientific and Therapeutic Use of Human Embryonic Stem Cells', Vatican City, August 25, 2000. Text available at: http://www.vatican.va/roman_curia/pontifical_academies/acdlife/documents/ (accessed July 2008)

ontogenetic process which is highly coordinated, continuous and gradual' (XIV legislature, law bill n. 47).

After nearly three years of heated political debates, the Bill was eventually passed by the Italian Senate and approved by the Chamber of Deputies on 19 February 2004 (Law 40/2004) with few modifications on the initial proposal.[97] While the prohibition of IVF was abolished, though regulated with several restrictions, any kind of research on human embryos was banned as well as therapeutic cloning and the production of chimeras. However, the governmental decision escalated the political tension that had already emerged during the parliamentary debate. Soon after the approval of the law, the Radical Party, traditionally on the front line of liberal struggles such as the battles over divorce and abortion in the 1970s, proposed to call a popular referendum in order to repeal the most controversial articles of the law. The referendum was held in June 2005.

In the three months preceding the consultation, the political climate around science became highly polarised between two opposed alignments. Pro-Life groups were largely of Catholic inspiration and supported the legitimacy of the law as key legal instrument to prevent unethical practices in science and medicine. For example, the political manifesto of the newly established Committee 'Science & Life' (*Scienza & Vita*) emphasised 'the primacy of life' and human rights over science, and depicted the human embryo as a 'citizen' who needs solidarity.[98] By contrast, Pro-Science groups demanded a radical revision of the regulatory framework and supported the referendum. A few weeks before the ballot day, more than a hundred researchers and clinicians formed a political committee named 'Research & Health' (*Ricerca & Salute*) and signed an appeal to urge the Italians to vote against the most contested articles of the law. Members of the committee highlighted the importance of human embryonic stem cells and advocated the autonomy of scientific research from religious belief and personal convictions. Along with the majority of scientists, embryo research was also endorsed by the renowned Accademia dei Lincei, the official scientific academy of Italy founded in 1603 as a pillar of the early scientific revolution. In an official document, the Academia stated that 'the prohibition to use frozen embryos does not seem justifiable since the concerned embryos are destined to be eliminated anyway, and their aim would be to

[97] http://www.ministerosalute.it/imgs/C_17_normativa_454_allegato.pdf
[98] http://www.comitatoscienzaevita.it/comitato/documenti/manifesto.doc

alleviate diseases, i.e. to diminish human sufferance'.[99] Moreover, the Academia pointed out the contradiction inherent in Italian law, which on the one hand protects the human embryo but on the other legalizes practices such as abortion and the 'morning-after' pill.

Pro-Science groups eventually lost their battle. Although the large majority of Italians voted for the abrogation of the contested articles of the law, the referendum was invalidated as only 29.9% of the overall population eligible to vote went to the polls.[100] However, the stem cell controversy opened up an unprecedented debate in contemporary Italy on the ethical implications of science, which is still ongoing. The *Scienza & Vita* committee has become a reference point for Catholic scientists and clinicians, whereas pro-science activists, including some patient associations, continue their battles on the freedom of scientific research. Unlike the German case, however, where precise boundaries were established, the situation of Italian researchers is more ambiguous: the current law is rather vague and does not account for cases such as the import of embryonic cell lines from abroad. In this situation, there has been room for further claims and controversies over the legitimacy of embryonic stem cell research. In 2008, for example, a group of three Italian scientists challenged their government's decision to exclude embryonic stem cell research from a major funding call by contending that the minister that opens such calls has no rights and competence to exclude a type of research that is legal. However, this appeal was rejected by a first court ruling (Tribunal of Latium) in July 2009, on the grounds that the dean of a hospital or the rector of a university (and not the scientists) had the right to appeal. In December 2009, a second court ruling (State Council) questioned the legitimacy of the appeal as it was 'defective of [the demonstration that] a research proposal [on hES cells] was prepared and submitted', notwithstanding that the call for proposals itself had excluded such a submission.[101]

***

Rapid advances in biomedical research have raised unprecedented moral issues that challenged existing legal frameworks and required the creation of ad hoc

[99] Agenzia Nazionale Stampa Associata (Ansa), 25 April 2005.
[100] According to the Italian law, a vote is valid only if the number of the ballot papers reaches the quorum of 50% plus one of the overall population eligible to vote.
[101] http://news.sciencemag.org/scienceinsider/2009/07/italian-court-r.html

regulatory instruments, such as statutory bodies, advisory committees, public consultations, and new laws. However, as we have seen, regulatory processes can follow very different pathways according to the wider context of political culture and institutionalisatio. In the UK, the regulation of stem cell research centred on the establishment of a new institution, the HFEA, which was given the mandate to deliberate on biomedical research and reproductive technologies on a case-by-case basis. By contrast, in Germany and Italy the process was driven by the quest for ultimate values. To some extent, the pragmatic approach of the UK government has been more effective, as it provided a flexible regulatory environment that can more easily incorporate and adapt to rapid changes in biomedical practices.

Important differences can also be seen in the level of public involvement and democratic participation. In Germany, the process of policy making was mainly sustained by a top-down logic, whereby advice and decisions were entrusted to expert committees and an *internal* commission of the government. In the UK, especially in recent years, efforts have been made to involve the public in broad consultations. Moreover, the Stem Cell Social Science Initiative bears witness to an ongoing commitment of the government to widen the range of disciplinary expertise and views on questions concerning science and technology. In Italy, the political debate has been characterised by the highest level of democratic participation, as decisions over the legitimacy of the Law 2004/40 on assisted reproduction and embryo research were submitted to a popular referendum. Yet, the low turnout of eligible voters and the resulting invalidation of the referendum raise important issues of public awareness and 'engagement' with science in this country. Finally, the three regulatory processes produced very distinct outcomes, underpinned by different understandings of human rights, moral integrity, and life itself.

How can we account for these discrepancies? A number of studies have examined the ways in which wider issues of national identity and culture have contributed to the shaping of regulations on stem cell science and biotechnology in general. As already mentioned, Sheila Jasanoff has explained the liberal attitude of the UK government by reference to the historical legacy of past 'British' achievements in science and their importance as a token of national pride and identity. According to Jasanoff, British regulations primarily aimed to create and protect a legal space for science, in a context of new moral dilemmas

that could potentially jeopardise scientific advances in a key sector for biomedicine as well as national prestige. The German case has also been the focus of critical studies that stressed the key role of national identity and culture. For example, Stephan Sperling argued that the regulatory debate on 'imported' embryonic stem cells was framed in a way that reflects the ongoing shift of national self-conception from people (*Volk*) to population (*Bevölkerung*), and the changing perception of immigrants within this wider transition. As he put it, 'In its effort to regenerate and preserve the social body and also maintain its moral integrity, the German state classifies foreigners according to their potential, and stem cell lines according to the ethical circumstances of their production' (2004: 143). Likewise, a recent analysis of the 'nationalization' of embryos in the Italian debate on stem cell research and assisted reproduction has pointed to the centrality of the family in Italian society (Metzler 2007).

As these examples illustrate, the critical study of stem cell debates has often involved the analysis of wider cultural issues, both in Europe and beyond, including works on debates in Israel (Prainsack 2006), China (Döring 2004), Japan (Sleebon-Faulkner 2010) and intercultural perspectives (Walters 2004). Due to the ethical implications of embryo research and the increasing importance of biopolitics in governance practices, the regulation of this field of biomedicine has been a particularly revealing vantage point in recent years to explore issues of national identity and political culture. Yet, the selection of distinctive cultural and social motives to explain the *outcomes* of regulatory debates remains problematic.

First, regulatory processes are often shaped by a contingent combination of different drivers, so that linear causations between discrete cultural factors and policies are inevitably biased. The analysis of the complex set of dynamics that contributed to peculiar developments in the UK, Germany and Italy goes well beyond the scope of this work, although further general issues can be mentioned such as institutional mechanisms of path-dependency, the balance of powers in parliamentary debates, and - last but not least - the influence of the European framework on political debate and contention at the national level, as I will further explore later on (see section 5.4.2). Due to this inherent complexity, the prediction of future developments and their influence on scientific research is

very difficult, even in countries that are traditionally 'pro-science' such as the UK.

Second, processes of policy making undeniably reflect cultural contexts in which they take place; however, cultural contexts are almost invariably heterogeneous, especially at the level of nation-states. It is true that trends and dominant patterns can be identified, but the outcomes of political debates do not necessarily epitomise such trends or the essence of 'national attitudes'; indeed, they can be the mere expression of a powerful minority that was able to impose its stance over other stakeholders, as the analysis of the Italian case well exemplifies. Once again, it might be worth noting that the use of broad analytical categories such as 'Europe' or 'Asia' in comparative analyses of country cases can reinforce such essentialist views on national attitudes and values. As the analytical gaze shifts the focus to increasingly larger units of analysis, important details on cultural diversity at smaller scales of social action and cultural practice might be obscured.

4.3 The EU Debate

The analysis of the regulatory debate in the UK, Germany, and Italy illustrate the diversity of standpoints, debates and regulations on stem cell research in Europe, both at the national and sub-national level. In 2007, the European Group on Ethics (EGE) group produced a comprehensive review of the situation in all EU member states, which identified four clusters of countries, according to their different attitudes (EGE 2007):

Permissive Position: A few EU Member States have specific legislation for hESC research, covering the procurement of stem cells and their use for research. In Belgium, Spain, Sweden and the UK, for example, embryo creation is allowed for research purposes.

*Permissive position with restrictions***:** In other EU Member States such as the Czech Republic, Denmark, Finland, France, Greece, Netherlands and Portugal, regulations allow the derivation of new hESCs from embryos created as a result of assisted reproduction technology (ART) and *in vitro* fertilisation to induce pregnancy, but only when they can no longer be used for that purpose.

Restrictive position: Germany and Italy have stricter hESC research regulations. Scientists in these countries cannot derive new hES cell lines, but can import them. The Italian legislation covers Artificial Reproduction Technology and the production of new hESC (research involving the destruction of embryo is not allowed). Italy has therefore no legal provision as regards the use of imported hESC or existing hESC.

No specific legislation or indirect legislation only: In many Member States, hESC research has still no specific legislation (Bulgaria, Cyprus, Estonia, Ireland, Luxembourg, Latvia and Romania). Ireland, for instance, currently has no specific legislation dealing with embryonic stem cell research and furthermore does not have a legislative basis for the practice of IVF. Some other EU Member States have no 'specific' regulation on hESC research, but explicitly indicated that they are against it (Austria, Lithuania, Malta, Poland and Slovakia) by voting against hESC research during the Council decision for FP7. Lastly, in some countries hESC is at present regulated only by indirect legislation for embryo research (Hungary, Slovenia), but without specific reference to hESC.

Given these discrepancies, the establishment of a working platform for European cooperation in this research area has been particularly challenging. As we will see in the following section, the European Union has had to find a difficult balance between the promotion of transnational cooperation in this promising field of biomedical research, the respect of national regulations, and the definition of a common European approach.

4.3.1 Early Developments

At the European level, early debates about embryo research date back to the preparatory works of the Oviedo Convention of the Council of Europe. In the final document, Article 18 states that (1) 'where the law allows research on embryos in vitro, it shall ensure adequate protection of the embryo' and (2) 'the creation of human embryos for research purposes is prohibited'. By the end of the 1990s, however, the derivation of human embryonic cell lines and the prospect of funding this type of research within the EU framework programmes forced EU policy makers to reflect more directly on the bioethical implications of the new technology. The debate began in the late 1990s, during the institutional negotiations on the Fifth Framework Programme, when the European Parliament voted to exclude from Community funding any research projects that might result 'in the destruction of human embryos'. In response to

this objection, the Commission asked for advice to the European Group on Ethics (EGE), which issued an 'opinion' on the Ethical Aspects of Research involving the Use of Human Embryos. While recognising the imperative to respect national regulations and attitudes, the EGE group concluded that 'funding should not a priori exclude human embryo research which is the object of different ethical choices in different countries' (EGE 1998). After many consultations, the European Parliament and the Council eventually approved the FP5 (1998-2002) in co-decision procedure. Funding was excluded for cloning and any research intended to modify 'the genetic heritage of human beings by alteration of germ cells or by acting at any other stage in embryonic development and which can make such alteration heritable' (European Parliament and the Council 1998). However, the thorny issue of embryo research remained unsettled.

In this context of moral uncertainties, DG-Research set up a European Group on the Life Sciences (EGLS), to inform the Commission on the current situation in this field of research and on imminent or foreseeable developments. Another objective was to establish a broad discussion forum, in order to provide scientists with a platform to discuss the new technologies with the public and various stakeholders. In December 2001, for example, the Group organised a meeting in Brussels to discuss stem cells and their possible use in future therapies. The meeting gathered scientists and a wide range of stakeholders, including bioethicists, lawyers, patients' associations, interest groups, students and teachers, educators and media, physicians, and representatives of various public authorities. In his opening address, the Research Commissioner Philippe Busquin claimed that 'today's conference aims to give science back to society; it is intended as more than just a conference; it should be a real discussion platform' (European Commission 2002). For the occasion, the Commission produced a catalogue of stem cell projects that were funded under the FP5. As the catalogue reported, at that time the EU was supporting 15 research projects on stem cells, involving 117 laboratories, with a total contribution of almost 30 million euro. Stem cell projects were classified into four main categories: 'neural stem cells, from basic research to clinical application'; 'stem cells, from differentiation to tissue engineering'; 'haematopoietic stem cells, from bench to bedside', and 'ethical, legal, and social issues'. Significantly, the document stressed that 'the human stem-cell sources used in these projects include cord

blood and foetal and adult tissues' and the Commission 'does not fund any research that involves creating a human embryo for research purposes alone'.[102]

4.3.2 The Debate in the Sixth Framework Programme

In the following years, however, the fragile compromise on stem cells in FP5 was threatened by further developments. First, in 2000 the European Parliament issued a new Resolution on Cloning in response to the publication of the Donaldson report in the UK, which had explicitly sanctioned therapeutic cloning (European Parliament 2000). The Resolution condemned any form of cloning, including therapeutic cloning, and urged the UK Government to review its liberal approach on the grounds that 'human rights and respect for human dignity and human life must be the constant aim of political legislative activity' (European Parliament 2000). At the same time, the EGE issued a second Opinion on the ethics of stem cell research, which regarded as 'premature' the creation of embryos by somatic cell nuclear transfer, 'since there is a wide field of research to be carried out with alternative sources of human stem cell (from spare embryos, foetal tissues and adult stem cells)' (EGE 2000). Second, the institutional debate on the Sixth Framework Programme (2002-2006) brought again to the surface unsettled issues concerning embryo research. The draft proposal of the new programme, presented by the Commission in 2001, included a priority thematic area on Genomics and Biotechnology for Health, in which the use of embryonic stem cells was explicitly supported (European Commission 2004: 7). The final decision of the European Parliament and the Council on the programme was relatively straightforward, with a few amendments on the original proposal of the Commission. In its subsequent decision on the specific programme which included stem cell research, the Council permitted the funding of research activities involving the use of human embryos and human embryonic stem cells, with three exceptions: (1) human

[102] However, during a presentation for the EGE meeting of 17.1.07, Health Director Octavi Quintana Trias reported the following updated figures on FP5: (1) 50 projects with at least one component of SC research with an overall contribution of 86 million euro (2) over 95% of projects only involved somatic SC and (3) 2 projects also involved hESC.
http://ec.europa.eu/european_group_ethics/activities/docs/quintana_trias_en.pdf
Proceedings of the conference are available at:
http://ec.europa.eu/research/quality-of-life/stemcells.html
Projects Catalogue available at:
http://ec.europa.eu/research/quality-of-life/stemcells/pdf/projects_en.pdf

cloning for reproductive purposes, (2) modifications of the genetic heritage of human beings which could make such changes heritable and (3) research activities intended to create human embryos solely for the purpose of research or for the purpose of stem cell procurement, including cloning by somatic nuclear transfert (i.e. therapeutic cloning) (European Council 2002).[103] In September of the same year, however, a parliamentary group formed by Austria, Italy, Germany and Ireland questioned the legitimacy of the programme and forced the Council to adopt a package of measures in response to its ethical concerns with embryo research, including a new ban on therapeutic cloning and a moratorium on EU funding of human embryo and hESC research until December 2003. By that time, the Commission was given the mandate to produce a detailed report on hESC research as the basis for an inter-institutional seminar on bioethics, and, taking into account the seminar's outcome, to provide further guidelines on the principles that should guide Community funding of such research.[104] Despite this new policy input and sustained efforts of the Commission, Parliament and the Council eventually failed to reach an agreement on the conditions for funding embryo research (specifically, the Council did not accept Parliament's proposition to eliminate of a cut-off date for embryo procurement). Thus, the moratorium expired at the end of 2003 and the criteria contained in former decision of the Parliament and the Council remained in place: therapeutic cloning could not be funded, research on supernumerary embryo could be funded and the issue of research using donated and aborted embryos as the source of stem cells was unsolved.

4.3.3 The Debate in the Seventh Framework Programme

In the past few years, the lack of EU regulations on embryo research has given rise to more controversies and political debates. Following investigations into a fertilisation clinic in Romania that was allegedly selling oocytes for profit, in 2004 the European Parliament issued a new Resolution that condemned 'all trafficking in the human body and its parts', and required member states to

[103] While the European Parliament and the Council approve the overall framework programmes in co-decision procedure, the 'specific programmes' are approved by the Council alone.
[104] 2451st meeting of the Council of the European Union held in Brussels on 30 September 2002;
http://register.consilium.europa.eu/pdf/en/02/st12/12523-zzen2.pdf

ensure 'voluntary and unpaid donations of tissues and cells'. Further, the Resolution required the Commission 'to apply the subsidiarity principle in connection with other forms of embryo research and embryonic stem cell research so that Member States in which this kind of research is legal fund it from their national budgets'. By contrast, 'EU funding should concentrate on alternatives like somatic stem cell and umbilical cord stem cell research, which are accepted in all Member States and have already led to successful treatment of patients' (European Parliament 2005b). Soon afterwards, a coalition of 73 Members of the Parliament, led by the European People's Party, wrote a formal letter to the President of the European Commission José Manuel Barroso to urge the Commission to respect Parliament's position of the Resolution on the trade of human eggs and, thus, not to fund any research projects that involved human cloning, embryo research and human embryonic stem cell research.[105] Likewise, the German research minister Annette Schavan sent a formal request to the Finnish EU presidency asking that 'The European Union science programme should not be used to give financial incentives to kill embryos', and stressing that 'the current proposal from the European Commission and the European Parliament does not rule this out'.[106] Despite these oppositions, in 2006 the Parliament backed the Commission's proposal for the Seventh Framework Programme (2007-2013): it agreed that embryonic stem cell research may continue to be financed under the case-by-case approach used in FP6, and confirmed the ban on (1) research activities aiming at human cloning for reproductive purposes, (2) research activities intended to modify the genetic heritage of human beings which could make such changes heritable, (3) research activities intended to create human embryos solely for the purpose of research or for the purpose of stem cell procurement, including by means of somatic cell nuclear transfer (European Parliament 2005a). At the end of the month, the Council adopted its final decision on the programme by a small majority, as the Austrian, Lithuanian, Maltese, Polish and Slovakian delegations voted against. The agreement was successful because Germany and other countries changed their former position, after assurances that no funding would be granted to research activities that involve the destruction of human embryos or are aimed at procurement of embryonic stem cells. At present, the funding for embryonic stem cell research is thus permitted and continues to be regulated

[105] http://www.epp-ed.org/Press/pdoc05/050920letter-barroso.pdf
[106] http://www.guardian.co.uk/germany/article/0,,1825412,00.html

under the case-by-case practice that had already been adopted in FP6, while research into human cloning and research that would result in hereditable changes is forbidden. Moreover, the EU cannot fund any activities that are forbidden in all member states and research projects will only be considered for funding from member states where the research is legal.[107]

Following a request from President Barroso, in 2007 the EGE group issued another opinion on the guidelines for the ethics review of EU projects involving human embryonic stem cells (EGE 2007). The opinion aimed to assure that ethical rules and requirements were fully met, and suggested that: (1) hESC lines shall result from non-implanted IVF embryos, (2) if alternatives to hESC with the same scientific potential as embryo-derived stem cells will be found in the future, their use should be maximised, and (3) donors' rights in terms of health, informed consent, data protection and free donation have to be protected and safeguarded. Moreover, EGE stressed the need to maximise the use of hESC lines banked in the European Registry and to take concrete actions to stimulate public debate on hESC research.

As mentioned earlier, this document also included a detailed survey of embryo research regulation in all EU countries, which was compiled with information provided by EU27 National Ethics Councils (updated May 2007). In commenting the situation, the expert group significantly observed that 'the ethical dilemma regarding the moral status of the human embryo and its use in research still persists. The EGE therefore stresses that the ethical differences of opinion concerning hESC research have not been resolved' (EGE 2007).

4.4 Unity and Diversity

While the EU is obliged to respect the cultural diversity of its member states, as is reflected in the motto *unity in diversity*, in the past decade the search for 'European' values has gained increasing relevance for EU policy makers. As the EU evolves from a merely economic organisation to a more political form of union, the quest for common principles has underpinned recent debates and institutional developments. The Amsterdam Treaty (1998), notably, affirmed

[107] Council of the European Union, Press release of 24 July 2006 meeting; http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/intm/90654.pdf

that the Union ‘is founded on the principles of liberty, democracy, respect for human rights and fundamental freedoms, the rule of law, principles which are common to the member states’ (in Dinan 2004: 291). Also, documents such as the Charter of the Fundamental Rights of the European Union, which was proclaimed in December 2000 and became binding in December 2009 when the Lisbon Treaty came into force, bears witness to the increasing relevance of these issues.

The stem cell debate has occurred in parallel to this key transition in the process of European integration. Due to the ethical implications of related practices such as embryo research, the regulation of this controversial field has reflected wider issues of political culture and European identity. In many ways, the whole regulatory process has shown that the quest for common European values is highly problematic, as soon as it shifts from simple rhetorical formulations to the actual practice of supranational governance. All EU member states in principle endorse fundamental values such as human dignity and are constitutionally committed to the protection of human rights. However, the introduction of new biomedical practices has challenged traditional understandings of these concepts and the very notion of ‘human person’. Where does personhood begin? In the embryo, the foetus, or the newborn? And who is the legitimate authority to deliberate on these issues? In the ambiguous space left open by these difficult questions, there has been room for different ethical concerns, which inevitably reflect the diversity of cultures and interests in the Union. As a result, it has been particularly difficult to reach a European consensus, despite years of debates and negotiations. It is significant that the only legally binding directive that potentially could have regulated stem cell research, the EU Directive on Human Tissues (2003), eventually set standards of quality and safety for the circulation of human tissues in clinical settings, but did not address the most controversial ethical questions concerning research practice (Faulkner et al. 2008). In the first reading of the Commission’s proposal, the Parliament tried to establish bans on (1) research on human cloning for reproductive purposes, (2) research designed to create human embryos solely for research purposes or to supply stem cells, including by means of the transfer of somatic cell nuclei. Also, it added that ‘cloned human embryos, and human-animal hybrid embryos produced by cloning, aggregation or any other procedure, and tissues and cells derived from them, shall be

excluded as sources of material for transplantation' (European Parliament 2003). These amendments, however, were later rejected, as the Commission noted that provisions on human embryos fall outside the scope of the Treaty establishing the European Community, which is limited to public health protection and 'not to the implementation of ethical objectives' (European Parliament and the Council 2004; Article 152).

5. INSIDE THE NETWORK

In the previous chapters I have examined various aspects of the 'politics' of research at the European level, with a focus on biomedical research and stem cell science in particular. In this chapter I shift the attention from the institutional debate and the process of policy making to the people that actually live out the effects of EU policies: scientists and other professionals involved in EU-funded research networks. In doing so, I aim to offer an account of European integration 'at work'. At the same time, I shall pay critical attention to an important new mode of knowledge production – the European consortium – that has been scarcely studied by former works in the sociology of science.

In particular, the chapter reports and analyses research findings from the study of European cooperation in stem cell research. As we have seen, this burgeoning field of biomedicine was identified as a priority area in the latest framework programmes, due to its therapeutic promises and the potential for economic growth. However, controversies around the morality of related practices such as the manipulation of human embryos and cloning have jeopardised the approval of funding schemes. The institutional debate, additionally, has brought to the fore wider issues of European identity and political culture. How do these issues play out in the practice of scientific cooperation? How do scientists manage to collaborate, given the fragmented nature of the regulatory landscape? What is their contribution to European 'competitiveness'? Why do scientists decide to participate in such large research collaborations?

I explored these questions by following two EU-funded stem cell consortia, which were closely linked to one another through shared activities and projects: Eurostemcell and Estools. Eurostemcell was a broad network, which combined the expertise of more than 100 researchers across 27 research groups in 16 partner institutions. It was funded under the FP6 with a budget of 11.9 million euros to study and develop cell lines of therapeutic potential, derived from stem cells of embryonic, neural, and epithelial origin. Estools was also funded under the FP6 with a budget of 12 million euros; it ran from 2006 to July 2010 and provides an interesting case study as it was entirely focused on the controversial

field of human embryonic stem cells. In reporting the results of my study, I organised the material around six core themes or issues that emerged during fieldwork and interviews with participants: the first section ('Coming Together') focuses on the process of network formation; the second ('Accountable Science') examines the contractual form of the funding agreement between the Commission and the research consortium and its implications for the production of scientific knowledge; the third part ('Flows') reports on findings regarding the circulation of information, scientific 'facts' and biological material across the nodes of the network; the fourth part ('Bioethics in Practice') analyses how the fragmentation of the regulatory landscape affects the practice of scientific cooperation; the fifth section ('Added Biovalue') addresses the involvement of private companies in research consortia and their contribution to European 'competitiveness' and economic growth; finally, the sixth part ('Branching Out') turns to the fate of European networks after the completion of their multi-annual mandate.[108]

5.1 Coming Together

To some extent, large European research networks are distributed variants of 'big science', as they can be supported by multi-million budgets and involve a hundred of scientists or more from many EU member states or third-countries that are part of the European Research Area, such as Switzerland, Norway or Israel. How do such large collaborations begin? In a study of multi-organisation research projects, Joel Genuth and colleagues identified five types of formations on the basis of the initial driver, including the quest for additional resources, the need to learn new skills or broaden research horizons, the need to revive a scientific career, and the brokerage of an external agency that encourage cooperation through the politics of funding (Genuth et al. 2000). In European networks, as in many other cases, the role of the external funding body is essential. Nonetheless, scientists might decide to get involved for different motivations or strategic interests.

[108] Detailed information on both projects are reported in Annexes 2 and 3, including a brief history of each project, the full list of participants and their roles in the two networks, a list of work packages and how they were distributed, and a list of key publications.

In my interviews I found that project leaders believe that the joint action of research centres can be comparatively more effective than the efforts of individual laboratories. Especially in emerging fields such as stem cell science, the creation of a critical mass of experts can contribute to the institutional recognition of the field and, simultaneously, speed up the translation of basic research into applications. Professor Anders Björklund, a prominent Swedish biologist and co-founder of the consortium Eurostemcell with his British colleague Professor Austin Smith, explained to me during our interview at Lund University that 'we wanted to put to fruition stem cell science and we realised this could not be done by individual groups only'. Likewise, Smith noted that research efforts in Europe were highly dispersed and isolated, and the main idea behind Eurostemcell was to stimulate cooperation and exchanges across laboratories: 'I thought there were people in Europe that were good and I thought that we should bring them together'. In line with EU policy discourses, moreover, Smith stressed that the project was partly driven by the will to boost European science vis-à-vis international competitors: 'part of the drive was to make sure that European science in this area is competitive with what is being done in the States, in Singapore, in China, in Japan'. When they decided to set up the consortium, he noted, US laboratories had much more resources than European centres, and many young researchers had moved to the US, attracted by a more favourable professional environment. As a result, the project also aimed to prevent the 'brain drain' of young researchers from Europe to the US: 'we wanted to show them that the only future is not only in the States, but it is possible to do very good research here in Europe'.

Other participants, however, were more sceptical about the political vision of 'European science' and regarded EU projects mainly as a financial support for their research work. A senior British biologist, for example, openly said he was sceptical of 'grand political funding schemes': 'In the end I am much more interested in securing a salary for staff working in my lab rather than money for networking and flitting around'. While recognising to some extent the value of European networking, he believed that 'people talk to each other anyway (...) you don't' really need politicians to get you in'. Moreover, in contrast with the narrative of the American challenge, he endorsed a more cosmopolitan notion of scientific cooperation: 'One of the nice things in doing science is that, compared to many other activities, there is quite a lot of cooperation across the world, not

just competition (...) personally, one of the things I enjoy in science is that I know people in the States, I know people in Europe, I know people in Japan which I can regard as friends to do things with (...) Personally I find the thing of competing with the US a funny way, I don't like sort of thinking like that'.

Beyond personal beliefs and commitments, however, scientists might decide to get involved in European consortia for other reasons that depend on the local context of knowledge production. The Italian biologist Elena Cattaneo, for example, has been able to carry out research on embryonic stem cells mainly through her solid connections with international partners in EU-funded networks. The participation in EU-funded consortia has been a way of securing financial support for research that otherwise would remain unfunded by the Italian government. Also, the collaboration with renowned scientists such as Smith and Björklund has allowed her laboratory to keep abreast with the state of the art in stem cell science.

5.1.1 Making the Network

Once an individual scientist or a group of scientists decides to apply, they need to bring people in the project. EU-funded consortia must include at least three groups from three different countries, but large networks often involve dozens of research centres from many countries, in both public and private institutes. For example, the consortium Eurostemcell combined the expertise of more than 100 researchers across 27 research groups in 16 partner institutions. The recruitment of partners deserves critical attention. As the sociologist Andrew Barry pointed out, the Commission has become a facilitator of synergies and connections between local actors in the member states - a sort of big 'marriage agency' that matches international partners in academia and industry (Barry 2001). In the field of research, this function is mainly carried out through the online database of the CORDIS service (Community Research and Development Information Service). As the CORDIS website explains: 'Building international partnerships is part of taking part in EU research programmes. CORDIS has an established Partners Service and a specialised service for FP7, fostering public-private partnerships to design, propose and launch new projects'. Similar to some dating websites, CORDIS provide search facilities to find international

partners with the 'expertise, profile or technology that you are looking for'.[109] In addition, the DG-Research of the European Commission has organised various 'interest meetings' to discuss prospects of collaborations and create new partnerships.

However, my research has documented a fundamental tension between this approach and the views of project coordinators, as the experience of Peter Andrews, Professor of Biomedical Science at the University of Sheffield and coordinator of the European consortium Estools, well illustrates:

> When the Sixth Framework Programme was going to come out I had been to a meeting in Italy at the Joint Research Centre at Ispra with groups who were interested in developing tools for toxicology and they wanted to talk about stem cells as a sort of tool (...) sometime later I got an invitation with this group in Brussels, so I went there and we put together a project (...) my immediate reaction was that this was a complete disaster (...) basically what they did was to collect a lot of people in a room who were vaguely connected or not even connected to each other and asked: what should we do? They said you'll do this, you'll do that (...) actually this was a waste of time and we withdrew from that.

As this quotation suggests, scientists - and especially senior scientists - don't like 'blind dates' or the imposition of partners by the external funder. Indeed, they are more likely to engage in European cooperation if they can rely on a network of trusted professional contacts. After this initial failure, Professor Andrews became involved in another project, but this time he was given the chance to choose his partners: 'we then decided who should be doing that, and essentially it was based on people we knew (...) they had to be people we knew, we felt we could work with and who had something that fitted in obviously'.

Other project leaders stressed the importance of gaining 'control' of the composition of the research consortium. Austin Smith, for example, noted that 'the key thing is that we selected the people and that gives you control to start and we were really clear about what we wanted to do and try to achieve'. Likewise, Anders Björklund said that the existence of a core group of established collaborations was essential to the effective working of the project:

> We brought in groups that already had established collaborations into a wider network. And then there were groups that had no collaborations with others (...) so it was a mix. But this would be my advice (...) if one would ask how to construct a European consortium I would

[109] http://cordis.europa.eu/fp7/partners_en.html

> advise them to make sure they have the core of established collaborations to build on because the collaborative spirit would depend very much on whether or not people were interested and able to collaborate.

It is worth noting that networks that are formed through personal connections are most likely to be initiated by senior scientists with established international reputations, who know well the professional landscape in their research area and are able to 'buy in' the European project partners and stakeholders. As we will see later, however, this pattern of network formation can have some undesirable implications, such as the perpetuation of elite groups.

5.1.2 Organic Solidarity

The insights of Émile Durkheim can contribute to further explore the process of network formation. In his work on *The Division of Labour on Society* (1893/1984), Durkheim made a distinction between 'mechanical' and 'organic' solidarity. Mechanical solidarity, he argued, is social cohesion that results from homogeneity and likeness of individuals, who have a similar occupation, lifestyle, educational or religious background for example. To Durkheim, this pattern normally occurs in small-scale, traditional societies, based on kinship ties of familial networks. By contrast, organic solidarity is social cohesion and integration that arises from specialization and complementarities between people, most commonly in modern societies. From this distinction, Durkheim identified two patterns of cooperation: 'To co-operate, in short, is to participate in a common task. If this is divided into tasks qualitatively similar, but mutually indispensable, there is a simple division of labour of the first degree. If they are of a different character, there is a compound division of labour, specialization properly called' (1893/1984: 124).

In EU research consortia, and science cooperation in general, organic solidarity is the most common principle of collaboration. Scientists are most likely to cooperate with colleagues that work in the same research area, but with different specialisations. This pattern is reflected in the structure of European research networks, usually organised around a number of *work packages* with

specific aims and tasks.[110] For example, the consortium Eurostemcell was sub-divided into eight work packages and each of them looked at a specific area of stem cell research or technology, from the conditions required to culture stem cells, to key technologies for their identification and isolation, to the control of differentiation and ethical issues. Moreover, three work packages were focused on the testing and application of stem cell therapies, namely for neurological diseases, muscle repair and neuromuscular disease, and skin regeneration. The network, therefore, constituted an organic ensemble, in which each research group played a specific role and integrated in the wholeness of the system with complementary expertise: 'this network was composed by senior scientists, who have a long standing record of authority in their own fields of expertise; thus, the main point was to create synergic links between each individual laboratory', a participant in Eurostemcell told me.

In addition to functional benefits, however, the quest for complementary expertise in consortia is also related to strategic calculations that depart from Durkheim's understanding of organic solidarity. In Durkheim's view, organic solidarity was not only a purely 'economic' phenomenon, but also responded to a moral vision of society in which all parts harmoniously work together towards the collective good of the whole, as it occurs in organisms: 'This solidarity resembles that which we observe among the higher animals. Each organ, in effect, has its special physiognomy, its autonomy. And, moreover, the unity of the organism is as great as the individuation of the parts if more marked. Because of this analogy, we propose to call the solidarity which is due to the division of labor organic' (1893/1984:131). However, organic solidarity in research collaborations partly results from the struggle for personal success and recognition. Indeed, scientists are reluctant to cooperate with other colleagues with similar expertise also because they see them as competitors. As Professor Andrews noted, 'if there is someone down the hall who is doing the same thing you don't want to collaborate with him (...) but if there is someone on the other side of the street who is doing something complementary, then you might want to collaborate as we are not doing the same thing'.

[110] The full list of work packages in the research consortia Eurostemcell and Estools is included in Annexes 2 and 3.

5.2 Accountable Science

In many ways, the participation in EU grants is a complicated process. After the enrolment of potential partners, the project coordinator can submit a formal application to the European Commission, in line with the criteria of the call for proposals. If the grant application has positive evaluation from the Commission, there is a process of 'negotiation' between the project coordinator and the Commission, in which the terms of the funding agreement are discussed on the basis of an Evaluation Summary Report. To this purpose, the Commission usually appoints a Project Officer who represents the Commission in the negotiation process and might demand substantial changes to the initial proposal. If an accord is reached, the project is funded for the first year. Funding, however, comes under strict conditions. First, the consortium is obliged to provide 'concrete output and evidence of the work' (European Commission 2005) through detailed periodical reports. Second, as part of the agreement, it must produce a number of *milestones* and *deliverables* at various stages of the project. In the framework programme specifications, milestones are 'points where major results have successfully been achieved as the basis for the next phase of work, or are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project' (ibid.). Deliverables are finished products, such as 'a report, or an action such as the construction of a prototype, the holding of a conference or demonstration, the publication of a book, or the completion of a specification' (ibid).

In addition to these obligations, funded projects are subject to a strict regime of financial monitoring. Especially after the 1999 corruption scandal involving the then research commissioner Edith Cresson, every item in a research budget has to be justified in all details. The documentation provided in the approved project application must be updated at the end of each year, with meticulous explanations for any changes in expenses and for any delays in the production of deliverables, as well as their modification or transfer between partners. Funding for the following year's money will not be released until this documentation is submitted and approved (Nature 2010).

Due to this tight system of accountability, EU-funded consortia usually have an administrative office that manages the research budget, and also ensures that

both milestones and deliverables are ready on time. Andrew Smith, the project manager of the consortium Estools, explained to me that:

> The contract is structured effectively in terms of research services. It is almost like a business contract, which makes it quite different from the way in which research is funded when a grant is given. Usually there is little monitoring by the funder and maybe at the end there is a report, whereas this project has tangible deliverables, which are in effects reports. The specification of what these deliverables are is very lengthy (...) part of what the project management do is operate a system so that the progress towards those eventual publications seems to be on track.

To carry out these cumbersome administrative tasks, project managers can rely on the support of external companies that are specialised in the management of EU grants. Indeed, a profitable business of consulting companies that provide services to applicants or administrators has flourished. For example, the Irish company Hyperion offers consultancies and training courses on the whole process of EU framework programmes, from the initial grant application to the negotiation stage and the administration.[111] Likewise, the Italian company Innova has gained 'extensive expertise in accessing, managing, implementing and monitoring EU funded projects, acting as partner and supporting companies in accessing EU-funded schemes for R&D'.[112]

5.2.1 Trust Researchers

What do participating scientists think of the 'Brussels style' of research funding? In my interviews, I found that some researchers regard the strict regime of European grants as a good exercise in discipline: 'I personally quite like it as it reminds me that you should have obligations and keep things on track', explained a researcher from the University of Edinburgh. The vast majority, however, complained that the bureaucratic style and business-like approach of EU grants is overwhelming, counterproductive or even at odds with the 'true spirit' of science. For example, a senior partner bemoaned the bureaucracy of the grant application and challenged the contractual form of the agreement:

[111] See http://www.hyperion.ie
[112] See http://www.innova-eu.net/projects-and-events/eu-funded-projects

> I am not very eager to do European projects, basically because of all the bureaucracy and the structure of the application – it is written very bureaucratic and heavy-handed (...) and the amount of effort that goes into getting money is a lot more than to get the same amount of money from a national [UK] agency. At this point I am reasonably happy with it as a useful exercise that is quite different to what I have done before. The downside of it is the amount of work that has to go into (...) if you write the grant (...) technically it's not a grant (...) it's a 'contract' and it's not how most people do science (...) the way you normally write a grant is that I've got my idea and I want to do this, so you go to a funding body and you say I've got this idea and that's the amount of money I need to do it. Then commonly the project becomes something different (...) but you don't have to measure it with milestones (...) tick this box, tick that box...

Another senior scientist who had been involved in more than ten European projects, noted that 'there are good reasons to criticise European funding and the most obvious reason is the bureaucratic style (...) the process is absurdly focused on little details (...) and you cannot see the reasons why this attention to details and this idea of control and accountability has to be brought to that point'. At times, the sheer size of the project and all the administrative duties can put off scientists from the outset. A molecular biologist, for example, said he was reluctant to get involved in European projects, as he only enjoyed 'being in a lab' and did not want to take on all the management burdens that come with a big European project: 'scientists aren't always very good at managing', he said, 'often good scientists do not have the personality to do that'.

These views are echoed in an expert report that was conducted in March 2009 by an independent group of academics from across Europe and the United States, on behalf of the European Commission (Rietschel 2009). The report went as far as saying that the bureaucratic process of applying for and winning funding from the Sixth Framework Programme was a 'stain' on its reputation and 'a significant barrier to participation'. As a solution, the report proposed moving towards a trust-based system in which a price is agreed for a project, and the researchers are then left to get on with their work. The report said such a system would remove the need for the 'fussy bureaucracy' of the existing system, in which the cost of the research is audited as the project progresses, and thus encourage a wider participation of public and private researchers (see also Gilbert 2009).

Driven by these concerns, in February 2010 a group of researchers and science administrators launched an initiative called 'Trust Researchers' to

change the way research and innovation is funded in Europe.[113] Specifically, the petition argued that the current approach is unsatisfactory both for researchers and the European Community, as it 'treats research in a similar way as procurement processes for any goods'. By contrast, the group proposed a new system in which European funding should be based on a relationship of 'mutual trust and responsible partnering', avoiding all kinds of unnecessary technical and administrative details and promoting key funding principles based on an 'appropriate level of accountability'. In a few months, the declaration was signed by almost 14,000 researchers and other stakeholders, from all EU member states and associated countries.

5.2.2 Safe Science

Due to increasing pressure and complaints, the European Commission has made some efforts to simplify procedures and the application process. Notably, the recently appointed research commissioner Máire Geoghegan-Quinn noted that 'Simplifying FP7 financial and administrative procedures must be addressed. We need a proper use of funds, proportionate controls and professional management. We must maximise simplicity without compromising on audit or evaluation quality. For our vital Public Private Partnerships this means more innovation-friendly operating rules and conditions' (Geoghegan-Quinn 2010). To this aim, in April 2010 the European Commission issued a Communication suggesting viable directions for simplifying the implementation of framework programmes, including a number of measures to streamline proposal and grant management (European Commission 2010).

At present, EU grants are still framed in a quasi-procurement model whereby knowledge production is treated as a commodity that can and must be delivered according to the detailed specifications and timeframe of initial agreements. This approach is in line with the ultimate goals of EU research policies. As we have seen in chapter 3, the European Commission is not particularly interested in 'blue skies' or 'pure' research, but the promotion of science is instrumental to other policy aims such as the imperative to boost

[113] http://www.trust-researchers.eu

European competitiveness or, more recently, 'the health of Europe's citizens'.[114] Moreover, fussy bureaucracy and red tape result from the commitment of EU institutions to ensure transparency and a high level of accountability, also given the large amount of money involved – almost 50 billion euros in FP7.

However, there are important limitations. An approach based on rules and procedures is appropriate enough for projects whose final results can be precisely defined in advance, but can be misguided for research endeavours with highly uncertain outcomes. As the campaigners of the initiative 'Trust Researchers' pointed out, 'research and innovation are risk taking activities' and 'an appropriate level of tolerable risks is vital for success and should be supported by European research programmes'. Especially in a frontier-research area, such as stem cell science, the possibility that an investment might return fewer results than hoped must become part of the EU funding culture. In this respect, a partner of the consortium Estools made a distinction between the procurement of a technical artefact, such as a nuclear power station, and the production of new scientific knowledge: 'I can understand if you order a new nuclear power station, you have to be very careful with how you write the contract to make sure that you get what you want (...) and the consortium whose producing the power station should be accountable for everything (...) the quality, what they deliver (...) but that's a different thing from research projects where you cannot define a research outcome in a way that you can define a nuclear power station'.

Given this situation, participants in EU-funded projects tend to commit to a peculiar research strategy that guarantees maybe modest, but 'safe' returns. For example, a scientist working at the University of Edinburgh pointed out that 'you never want to fail to deliver a milestone (...) so you don't take any risk but only very safe options (...) so you can absolutely guarantee that 100% of that milestone will be finished'. Another partner conveyed a similar view, explaining the strategy that is induced by the regime of deliverables and milestones:

> If you had to build a rocket, the deliverable wouldn't be the rocket, but a report on how to build a rocket. And the milestones? That might be making the tail of the rocket, some bits along the way... The important thing in this is that you are not becoming hostage to fortune (...) you do things in a way that you have a good chance of meeting what you said you could

[114] Specifically, the aims of 'Integrated Projects' in FP6 were: (1) increasing Europe's competitiveness and (2) addressing major needs in society.

> do. If you actually try to build a rocket and it actually doesn't work, you've got a problem as you said you were going to deliver a rocket. But if you said I am going to write a report on how to build a rocket, you actually don't have to hand over a rocket which actually works. You just have to hand over the blueprints.

This statement not only sheds much light on the ways in which a rigid system of accountability might influence the conduct of EU-funded projects; it also provides some insights on the wider implications of contractual agreements on knowledge production. In one of the studies collected in his book *Studies on Ethnomethodology* (1984), Harold Garfinkel aimed to understand why clinical records in a psychiatric hospital were almost invariably incomplete, with missing or very poor information. To Garfinkel, lack of time or motivation were plausible reasons influencing the reporting behaviours of clinical staff. Yet there was another important factor. On the one hand, clinical records are written documentation of medical and biographical facts; on the other, they can be read as 'the record of a therapeutic contract between the clinic as a medico-legal enterprise and the patient' (1984:198). Since issues of medico-legal responsibility have priority over other possible procedures for the maintenance of records, the lack of information was due to the fact that any reporting system had to be reconciled with the legal, social and practical ways in which the clinic operated. Garfinkel's study was part of his wider interest in 'accountability' of social action. Living at the dawn of what has been called the 'audit society' (Power 1997), Garfinkel argued that everyday activities are 'methods' for making those same activities rational, reportable and accountable in a socially organized system. While this insight can be generalised to the entire spectrum of social behaviours, it is most clearly visible in social practices that are regulated by contractual agreements and legal obligations. For better or worse, science is no exception.

5.3 Flows

EU-funded research networks are distributed systems of knowledge production. Unlike the conventional 'centralised' model of the individual laboratory, the scientific output of a European consortium ideally should result from the joint efforts of researchers that are located in different institutions. This approach

has many functional advantages. For example, wide research networks can combine a broad range of expertise, skills, and insights that is unlikely to be found in a single research institution. Also, participants can share material resources and costly laboratory equipment, with obvious benefits for researchers working in less well resourced countries or institutions. At the same time, as mentioned in chapter 3, the network approach is instrumental to the policy drive of the European Union towards the creation of a European Research Area, in which local resources are valorised but at the same time can contribute to a collective 'European' product.

The practical accomplishment of this vision, however, can be challenging, as briefly discussed in section 3.2.2. First, scientific data and information must *flow* rapidly and effectively across all the 'nodes' of the network. In this respect, the rapid development of electronic communications and the increasing availability of scientific 'facts' in digital format have facilitated the mobility of data across wide geographic spaces. Although in Europe there is still differential access to IT and communication resources, over the years the DG Information Society of the European Commission and other authorities have made several efforts to bridge the 'digital divide' and ensure fast Internet coverage throughout the European space. Second, there is a need for a uniform *epistemic space*, where data and information that are produced in local settings can be integrated in different contexts of knowledge production.[115] Indeed, the feasibility of a European Research Area depends on the assumption that scientific data are neutral and can easily circulate across laboratories. In a recent article on data exchange through biological databases, Sabina Leonelli has effectively elaborated on this issue: 'When researchers pass their data to one another, data are taken to speak for themselves. The results of measurements and observation are relied upon as incontrovertible facts, independent of their "local" origins. The quality and reliability of data, and thus the conditions under which they were produced, are critically scrutinised and eventually disputed only when data have already been appropriated by a new research context: that is, when they are used as evidence for new claims about phenomena. When data travel across scientific communities, it is their neutral value as "records" of phenomena that counts (and that makes them travel widely, so to speak)' (Leonelli 2010:59). As

[115] Here I follow Staffan Müller-Wille and Hans-Jörg Rheinberger's definition of 'epistemic space' as 'a domain of research to be mapped out by taxonomies and regularities, rather than an individual object of research to be identified by determining its properties and functions' (2007:7).

many social studies of science documented, however, scientific data are never completely value-free. For example, in her pioneering ethnography of the world of high-energy physicists, the anthropologist Sharon Traweek (1992) argued that some of the fundamental beliefs about time, space, and matter that give meaning to the world of high-energy physics can take different forms in the United States and Japan, resulting in divergent methods and experimental practices within the same discipline. In general, the comparability of data coming from different sources can be affected by local idiosyncrasies in data collection practices, laboratory protocols, and measurement systems.[116]

In the life sciences and biotechnology, the problem of data integration is becoming particularly challenging. In the wake of the various 'omics' revolutions (e.g. genomics, proteomics, transcriptomics), the collation and interpretation of huge amounts of data from different sources has become a common pattern of biological research, for example in high-throughput techniques such as microarray expression profiling (Hess et al. 2001).[117] However, microarray data do not always travel well across research centres due to the lack of standards in platform fabrication, assay protocols, and analysis methods. Likewise, large-scale analyses of genomic sequences face major issues of standardization and data sharing (Blankenberg et al 2007). For this reason, bioinformatics has become a key component of biological research (Leonelli 2010). Bioinformatics not only involves the creation of computational tools that can help scientists store and manage huge amounts of data, but also the difficult task of producing a uniform archive out of heterogeneous data collections. In research networks, biological databases are crucial as they can provide a sort of *epistemic centre* wherein experimental data that are produced by individual laboratories converge and can be analysed as a coherent whole. As Simon Thomlinson explained me, the work of bioinformatics fits very nicely into a large European consortium. His research group at the University of Edinburgh has built a database on stem cell related information, 'StemDB', which has been used to store data from various partners in a EU-funded stem cell consortium: 'our work is to integrate a lot of different data sets from multiple sources together (...) we find common patterns and a pool of data so as to inform individual experiments'. However, he is aware that the work of database curators can be

[116] For a philosophical discussion on the disunity of biological sciences, see Dupré 1993.
[117] DNA microarrays are devices that measure the expression of many thousands of genes in parallel.

daunting, as data often come in different formats, standards, and packaging systems.

At the European level, institutions such as the European Molecular Biology Organisation (EMBO), the European Molecular Biology Laboratory (EMBL) or the European Bioinformatics Institute (EBI) have long contributed to the setting of 'European' standards in experimental protocols, classification and measurement systems. Giuseppe Testa, a molecular biologist who had conducted his doctoral research at the EMBL and was associated principal investigator in the consortium Eurostemcell, pointed out that:

> Especially today, as the amount of scientific data has become huge because it is much easier to generate them, you could not make any comparisons without standard measures and grids. EMBO and EMBL, for example, organise every year advanced training courses precisely to form the technical expertise of the new generations of life scientists, including the standardisation of protocols and experiments. Moreover, if I develop a particularly good protocol in my laboratory, I can ask EMBO to organise a training course and disseminate my technology to many other laboratories.

However, important differences in data collection might still obscure the comparability of data from multiple sources. Driven by this concern, the European Commission has supported several projects to foster the standardisation of measures and the creation of a 'European' grid for data collection and analysis. For example, the EMBRACE project (European Models for Bioinformatics Research and Community Education) was launched in 2005 to address the incompatibility of biological databases in Europe.[118] In particular, the project addresses 'the need for unified bioinformatics approach in Europe' and thus aims to 'exploit state-of-the-art computational and e-science methods to devise database interfaces that conform to certain standards, so that out of the numerous existing databases will emerge an overarching data grid – the EMBRACE grid – through which users can access information dispersed through the various resources, as seamlessly as possible'. Likewise, the European project BioSapiens aims to provide 'a concerted effort to annotate genome data by laboratories distributed around Europe', using both informatics tools and input from experimentalists.[119]

[118] See http://www.embracegrid.info
[119] See http://www.biosapiens.info

5.3.1 Flow of Substances

Another problem concerns the flow of biological substances. In the life sciences and biotechnology, the practice of science cooperation entails a busy traffic of cell cultures, reagents, samples, and other biological substances. Indeed, the circulation of biological samples and material is the lifeblood of transnational research networks. Yet, similar to data flow, important hurdles can interrupt or slow down the movement of substances across the European space. As we have seen in chapter 4, the regulatory landscape on human embryo research is marked by prominent differences between national laws and regulations. While some countries allow the derivation of embryonic stem cell lines, other countries prohibit this practice. In the latter category, regulations are further fragmented between countries that have banned the derivation of new cell lines but permit their import with restrictions and countries that have banned any form of embryo research. At the EU level, the only document that regulates the circulation of human substances across member states is the Tissues and Cells Directive (European Council and the Parliament 2004). This Directive aims to ensure a safer and easier exchange of tissues and cells (including human eggs and sperm) across EU member states and to improve safety standards for European citizens (see section 4.4). In particular, it includes provisions on licensing of authorised tissue establishments, traceability of cells and tissues, the obligation to notify serious adverse events and reactions, data protection and confidentiality, processing, storage and shipment procedures. However, the Directive does not affect 'the decisions of the Member States prohibiting the donation, procurement, testing, processing, preservation, storage, distribution or use of any specific type of human tissues of cells from any specified sources, including where those decisions also concern imports of the same type of human tissues or cells' (European Parliament and the Council 2004). Thus, no supranational framework presently regulates the flow of embryonic stem cell across European laboratories. As a result, partners in EU-funded consortia are mandated to carry out research in compliance with the regulations of the member states in which they work. This situation affects the spatial trajectories of cell cultures and the actual conduct of collaborative research, giving rise to a peculiar division of labour whereby the allocation of tasks responds to

regulatory constraints, rather than the mere distribution of complementary expertise:

> [A colleague] works in Switzerland both on skin adult stem cells and human embryonic stem cells. He tries, *as he can*, to elicit information from human embryonic cells which can be useful to improve the regenerative capacities of adult skin cells. Then, what does he do? He passes this information to [another colleague], who works in the UK, and together they work on the regeneration of human skin. How does this contribute to my work? By studying the differentiation of human embryonic stem cells into skin cells, they can understand a molecular mechanism which can be useful to better understand the neural differentiation I am interested in. Indeed, that's what happened some time ago. Then, what do I do? I use this knowledge to carry out experiments on the imported cell lines, just like the German colleague, *as we are just allowed to do so*.[120]

This excerpt from my interview with Elena Cattaneo sheds much light on the effect of regulations on the actual working of European research consortia. In addition to broad regulatory issues, legal problems may also arise as current legal frameworks are not always well equipped to keep abreast with the complexity of biological research, including the increasing atomisation of 'life' well beyond the scale of the cell. For example, as a senior biologist pointed out, it is rather unclear whether RNA derived from embryonic cell lines should be subject to the same legal constraints that regulate the use and circulation of stem 'cells': 'what happens if someone is working with RNA that comes from another country (...) for example if we were sending RNA of one of our cell lines to all of them, I don't know whether this could cause a problem or not (...) I think we assumed that no one called us up on it, but it's one of those things it is difficult to pin down'.[121] Finally, issues of research practice might limit the circulation of biological substance across laboratories also for other reasons. As many other scientific areas, stem cell research is undergoing a process of increasing digitisation and reliance on computational tools. For example, the EU-funded consortium Eurosystem aims to link complementary biological and computational expertise to understand cellular patterns of self-renewal, commitment and differentiation. Nevertheless, in many ways, stem cell science

[120] The emphasis is mine.

[121] In passing, we might note that these problems of scale are not only telling about the difficulty to regulate a sector which is characterised by ontological ambiguity, but they also shed light on the increasing molecularisation of the 'politics of life itself'. As Nicholas Rose suggested, 'natural life can no longer serve as the ground or norm against which a politics of life may be judged (...) biopolitics now addresses human existence at the molecular level: it is waged about molecules, amongst molecules, and where the molecules themselves are at stake' (Rose, 2001:17).

resists 'portability' and the distribution of knowledge production across laboratories for reasons that have to do with the ontological status of stem cells and resulting experimental practices. When scientists study the differentiation of stem cells into specialised tissues, they are not interested in a static snapshot of living matter, frozen in time and cut off from the temporal continuum of its developmental process. Rather, they are interested in the *process* itself - a process that can be studied and analysed only after weeks of painstaking observations of the same cell line under the microscope. To some extent, stem cell science can be regarded as a 'qualitative' rather than 'quantitative' science, as it requires a familiarity and 'feel' of the individual scientist for her/his experimental material. Indeed, in informal conversations on their work, stem cell specialists often talked about their 'own' *living* cells with a sense of parental affection and intimate knowledge.

As a result of these implications, the distribution of experiments and observations across different sites is particularly challenging. In this respect, it is worth reporting a lengthy extract from an interview with Professor Elena Cattaneo, conducted at her laboratory in Milan in October 2008:

ML: What do you think about distributed systems of knowledge production in stem cell research, based on different specialisations of research centres in Europe? Do you think the laboratory can be replaced as the fundamental unit of knowledge production?

EC: This is unlikely, because we are dealing with *living matter*. You can definitely rely on external transcriptome sequencing services (...) you send them your RNA sample and they send you back the results. They are very good at that and the service works very well. But the biology of stem cells is different, as they are living matter. Moreover, while transcriptome services use a standard procedure, in stem cell biology scientists constantly put their hands on cell cultures as they try to grow cells with a cheaper medium, a new growth factor or feeder layer. You get to know very well your cell cultures, and from time to time you can go back to them and produce new knowledge and technology. So, distributed research is difficult with cell cultures. In addition, many scientists do not trust their colleagues, especially when it come to cells biology (...) I would say that cooperation is more likely to occur in molecular technologies, but it is harder in biology.

ML: Don't you think it is also an issue of standardisation, especially in a relatively young research area as stem cell science...

EC: Possibly. However, when it comes to *living matter* it is always difficult to imagine collaborative work at a distance – I will never be trustful enough to base my work on cell lines

that come from outside. I am happy to import the cell lines at the outset, but then I want to have total control on them (...) *every day something might happen* (...) *it is living matter*. You see, it is very difficult to have a cellular product that fits all needs: one research group might be interested in one specific event, but another group might be interested in a cellular event that occurred earlier and yet another group might be interested in a differentiation event that occurred even earlier... We might get there, but for the moment a network strategy is still very limited in this respect (...) That's why you need a in-house facility for cellular culture. Moreover, you have the problem of shipment. How can you guarantee that embryonic cell cultures and especially their derivatives will always arrive in perfect conditions? Now they are trying to develop freezing system to ship embryonic cell cultures. However, it is still very expensive and does not guarantee that, once defrosted, cells will exactly be as they were before they had been frozen.[122]

This long excerpt sheds light on the importance of *temporality* for scientists working on living matter, and the resulting problem of distributing experiments across different sites of knowledge production. As early as the 1940s, the French biologist Alexis Carrel (1873-1944), a pioneer of organ transplants and a central figure in the field of tissue culture, had noted this fundamental aspect of modern biological research: 'A tissue is evidently an enduring thing. Its functional and structural conditions become modified from moment to moment. Time is really the fourth dimension of living organisms. It enters as a part into the constitution of a tissue. Cell colonies, or organs, are events which progressively unfold themselves. They must be studied like history' (in Landecker 2007: 87).[123]

5.4 Bioethics in Practice

Over the past decade, EU research policy has been committed to ensure a high standard of ethical scrutiny and conduct in scientific projects. As we have seen in chapter 3, in the communication *Life Science and Biotechnology: a Strategy for Europe*, the European Commission identified this area of research and innovation as the first priority for the upcoming funding programme, but also emphasised the need for responsible policies, based on 'transparency,

[122] The emphasis is mine.
[123] This analysis owes much to Hannah Landacker's insightful history of tissue culture and her discussion of the importance of temporality in the new cytology: 'the old cytology had placed the emphasis on the static building block of nature of cells and tissues, whereas the new cytology studied them as active agents' (2007:86)

accountability and participatory approaches'. In further policy documents, effective societal scrutiny, public dialogue, and the integration of ethical and social aspects have been identified as essential parts of the European strategy on biotechnology.

As a result of this commitment, from the Sixth Framework Programme (2002-2006), the European Commission has implemented several measures to make sure that ethical, legal, social, and wider cultural aspects are taken into account at the earliest possible stage of EU-funded research projects. Specifically, each research proposal submitted for funding is subject to ethical review from a panel of independent advisers. In sensitive research areas, such as embryonic stem cell research, there are additional procedural requirements, including the request of approval from the national or local authority in each country in which the research project will be carried out and further evaluation criteria (European Commission 2008b).

Beyond monitoring procedures, the Commission has encouraged the integration of ethical, legal, and social analyses as part of the scientific culture of European networks. While in earlier funding programmes ELSA research was funded in separate projects, from FP6 'reflexivity' on ethical, legal, and social issues has been embedded into the work programmes of many research consortia, especially in contentious areas such as stem cells. For example, one of the work packages of Estools, the European consortium for research into human embryonic stem cells, was entirely focused on ethical issues and included workshops and public engagement events, as well as the production of reports on the ethics of stem cell research and applications.[124] Specifically, the ethical component of Estools aimed to 'examine ethical aspects of stem cell research and use to alert politicians and scientists to ethical aspects of stem cell research, and to discuss how they could or should be handled. The fundamental values at stake and the value conflicts raised by research will be analysed, including options and their consequences, which are in part linked to aspects of comparative law and data protection, public attitudes to information and consent procedures, risk-benefit assessment, confidentiality and privacy, fair access to research results, and application and implementation of the proportionality principle'.[125] As part of this programme, in April 2007 the

[124] Details on the bioethical component of the consortium Estools are provided in Annex 3, including a list of workshops and related activities.
[125] See http://www.estools.eu/estools/ethics/ethics

consortium organized a meeting in Berlin on 'Ethical aspects of stem cell research in Europe', in collaboration with the partner consortium Eurostemcell. The meeting aimed to discuss controversial aspects of legislation on stem cell research, to evaluate the feasibility of stem cell-based therapies, and to define potential milestones for a road map toward clinical application. At the same time, it was a 'high-profile' event which provided participating scientists with an opportunity to engage with a broad range of stakeholders, including ethicists, clinicians, biotech entrepreneurs, EC representatives, and politicians from all over Europe. As the project leader Austin Smith pointed out in the opening remarks, 'public engagement is a crucial mission of the consortium'. Significantly, the event was held in Germany, one the countries with the most restrictive legislation on stem cell research, so as to introduce a 'European' (liberal) voice in the national regulatory debate.

In addition to conferences, the two stem cell consortia organized other public events that aimed to deepen ethical reflection, engage with a wider public of non-specialist, but also provide a positive or at least complex understanding of stem cell science amid controversies that could jeopardize the future of the research field, as well as international cooperation. For example, the consortium Estools organized a photo exhibition with pictures of adult and embryonic stem cells, produced by scientists working in partner laboratories in seven different countries. In the exhibition each picture was given an evocative name – such as 'asteroids' or 'butterfly' – which was inspired by its shape and thus conjured up an object or a situation familiar to the non-specialist audience. With the positive title 'Smile of a Stem Cell', the exhibition was displayed in many schools throughout Europe, in combination with educational activities on stem cell biology and ethics. In addition, the consortium Estool and other partners commissioned a theatre piéce on stem cell science, which dramatized the ethical dilemmas concerning embryo research. Written by the Italian play writer Valeria Patera, the work *Staminalia: a Dream and a Trial* was inspired by an eponymous book by the Italian philosophers Armando Massarenti (2008). While the book is a polemic pamphlet and a vigorous defense of the freedom of scientific research, the theatre piece aims to represent ethical tensions without coming to a moral standpoint. To do this, the piece tells the story of a stem cell scientist and mother who is plunged into an existential crisis, as her daughter challenges her research work on fundamental moral questions. Specifically,

Staminalia portrays 'the complex palette of emotion and human feelings of a scientist, depicting the inextricable link between science, philosophy, politics and aspects of every day social life that characterise stem cell research'.[126]

5.4.1 Backstage

Borrowing a concept from the sociologist Erving Goffman (1959), meetings and other public engagement can be regarded as the 'front' region of the bioethical debate, namely they are outlets or stages on which European consortia interface and communicate with the wider society.[127] In doing so, they tend to present an orderly framing of bioethical dilemmas, as the neat order of presentations at conferences and workshops illustrate. To some extent, a work of art as *Staminalia* presents a more nuanced understanding of the ethical tensions in contemporary biomedical research. But what happens in the 'backstage' of the laboratory? What are the actual implications of the bioethical and regulatory dimension on the practice of scientific work? In the sociological literature, a number of works have begun to explore the implications of bioethics and regulations in laboratory settings. For example, Steven Wainwright and colleagues examined scientists' perception of human embryonic stem cells and the effect of regulations in the actual research practice (Wainwright et al 2006). In the conclusions, they argued that scientists tend to occupy a positive 'ethical space' which signals both ethical reflection and rectitude: 'The rectitude is largely underpinned by reference to the formal legal and ethical framework that defines and allows "ethical science", but it is also signalled by the reflection itself, by preparedness – at least in many cases – to venture into ethical argumentation' (2006:744). In a more nuanced analysis, a recent comparative study on stem cell research in the UK and Germany pointed out that the implementation of regulations is not as straightforward and unproblematic as former studies seem to suggest, but often involves a complex set of 'interpretive practices' that are associated with questions of professional interests and

[126] http://www.estools.eu/estools/events/staminalia-a-dream-and-a-trial; see also Testa (2010).
[127] According to Goffman's dramaturgical sociology, the front region refers to a place where a particular social performance is given. On the other hand, the backstage is the social space in which facts that were suppressed in the neat order of the front region appears. For example, inside the house, the living room is the front region, while the bedroom and bathroom is the backstage.

legitimisation of a novel biomedical field (Wilson-Kovacs, Weber and Hauskeller 2010).

In my research, I have tried to understand the ways in which bioethical dilemmas and regulations affect transnational research consortia and the general working of the European Research Area. In section 5.3 I have already explored these issues with respect to the flow of biological substances; here I will focus on the mobility of scientists. Due to staff exchanges in EU-funded consortia, as well as Marie Curie scholarships and other mobility grants, there is an increasing circulation of scientific workers across the Union. However, in contentious areas such as stem cell research, their mobility patterns and/or research strategies may be affected by the fragmentation of the regulatory landscape. For example, I met a PhD student who had started his doctoral work in a German university. From there, he moved to a laboratory in Britain, where at the time of my fieldwork he was finishing his doctoral work on carcinoma stem cells. Although he was no longer affiliated with German academia, he decided to stay clear of new embryonic stem cell lines that were derived in the UK, in compliance with the German law that said that scientists must not work on embryonic lines that have been derived after 2001: 'should I decide to go back to Germany, I don't want this to affect my career', he noted. Moreover, he explained to me that his personal views on the ethics of stem cell research were influenced by his religious faith in Islam, which teaches that we should seek a cure for all diseases, but we will never be able to cure aging and prolong our life indefinitely - a prominent reminder that 'European values' in biomedical ethics reveal a variety of standpoints that is rarely accounted for in mainstream debates. During my fieldwork, I met another German researcher working in the same laboratory. As soon as she came to the UK, however, she was confronted with the bureaucratic hurdles of a German stem cell scientist willing to work in the UK:

> When I came here for the interview they said I should enquire Germany about the law – whether I am allowed to work with [embryonic] stem cells here. And I did this at the DFG [Deutsche Forschungsgemeinschaft], as you might know, they write petitions to the BMBF [Bundesministerium für Bildung und Forschung] (...) they want to get to the point that scientists working abroad don't need to be scared about working with stem cells. However, there is no specific regulation on this, so they pointed to expert opinions, and I had to go through a lot of paper. The responsible eventually told me, directly after a press conference, that if you are not sent over here by a German institution you might be allowed to work with

> embryonic stem cell, as long as you are only investigating them and not deriving them by yourself. That's the point.

Despite these reassurances, she wanted to 'avoid any troubles', given the prospect that, like her colleague, she might go back to Germany one day. Thus, she decided not to share any information on her work on embryonic stem cells in the UK with colleagues working in Germany.

5.4.2 United Scientists of Europe

Recent changes in the German law on stem cell research have partly loosened former restrictions (see chapter 4). However, these two accounts shed light on some important gaps between the policy vision and the reality of the European Research Area. As their stories suggest, the mosaic of regulatory arrangements can affect professional mobility across Europe and hinders transnational cooperation. As a result, principal investigators in stem cell consortia have lobbied to ask governments of EU member states with strict regulations to remove or at least lower political and legal barriers. In 2007, before the recent changes to the law in Germany, a review of the bioethics conference in Berlin noted that 'Projects that are perfectly legal in Sweden and the UK can draw a 3 year prison sentence in Germany. This incongruence creates a plethora of problems for international collaboration. Despite common funding by the sixth and seventh frameworks of the EC, scientists within Europe cannot freely exchange personnel and cell lines. Researchers from countries with very restrictive legislation, such as Germany, might even become liable by taking on coordinating positions within European networks comprising institutions that generate their own hESC lines' (Testa et al. 2007). In line with the mainstream narrative of EU research policy, the review stressed that 'European heterogeneity in stem cell politics is about to slow the development of stem cell based biomedical applications and further impede the competitiveness of Europe in global stem cell science' (Testa et al. 2007:156). Most notably, in 2007 the leaders and a group of principal investigators from the same networks issued a joint statement on 'The Impact of Legislation in Europe on Our Ability to Perform Research Using Stem Cells', in which they expressed concerns about the personal consequences of 'normal scientific activities', including punitive

legal action in Germany, and provided a list of actual cases in which legal constraints in both Italy and Germany had jeopardised scientific cooperation.[128] Given these problems, the document urged 'Europe's legislators and administrators, who have the power to change the situation, especially in Germany and Italy, to act to enable all European scientists to work freely together in the pursuit of knowledge without fear of legal action or loss of research funding'. Finally, the joint statement included a number of specific requests to the Italian and the German governments to recognize stem cell science as a cutting edge field of modern biotechnology and to act accordingly to support scientists 'to thrive alongside the best of their European colleagues in both human embryonic and adult stem cell research'.

The premises of this statement can be challenged. The fact that most EU member states have endorsed a relatively liberal regulation on stem cell research does not automatically imply that their standpoint ought to become the European norm. Especially when it comes to moral and cultural issues, the challenge of European integration is not necessarily to create a uniform and flat regulatory platform that fits everyone, but to achieve cooperation and integration despite differences - in keeping with the overarching principle of 'unity in diversity'. Moreover, there are complex cultural and institutional reasons that underpin legal constraints in countries such as Italy or Germany (see section 4.2), which cannot simply be offset by claims to scientific freedom and the need for cross-border cooperation. Regardless of its legitimacy, however, the joint statement has an important meaning for the wider process of European integration, as it suggests the emergence of a European form of collective action, which can mobilise and speak as a single supranational voice to leverage against national governments over unwanted domestic policies and regulations. In a collection of essays on *Contentious Europeans*, published in 2001, a group of scholars explored ways in which social movements have been influenced by growing Europeanisation, with a focus on the efforts of European citizens to make demands on EU institutions (see chapter 1). In short, the book argued that a truly supranational layer of collective action has hitherto been very weak and elusive, as many social categories - such as labour movements, trade unions, and environmentalists - are increasingly protesting against EU policies, 'but on domestic soil and not against the institutions that produce

[128] http://archive.eurostemcell.org/Documents/press_releases/27.07.07-JointStatement-estools-eurostemcell.pdf

them' (Imig and Tarrow 2001:3). The case of the stem cell debate, however, suggests the emergence of another form of collective action and contention at the European level, which is directed against national policies and not against EU policies, but exploits its European dimension as enhanced political status in the struggle for domestic change.

5.5 Added Biovalue

As we have seen in chapter 3, the establishment of closer links between academic and business partners has been a crucial objective of Community research policies since the 1980s. Over the past decade, this goal has gained further importance within the wider framework of the Lisbon Agenda and its drive towards the consolidation of a knowledge-based economy in Europe. In the communication *Life Sciences and Biotechnology - A Strategy for Europe*, for example, the Commission stressed that 'excellence in the science base is not enough: it is essential to have the capacity to translate knowledge into new products, processes and services, that in turn will generate benefits to society, skilled jobs and prosperity' (European Commission 2002a). In this context of policy making, the European Commission has implemented specific actions to facilitate knowledge transfer and the mobility of researchers across academia and industry, such as the recent programme Marie Curie Industry-Academia Partnerships and Pathways, a broad funding scheme to 'boost skills exchange between the commercial and non-commercial sectors'.[129] Notably, the latest framework programmes have substantially increased the share of their overall budget to support and encourage the participation of Small and Medium Enterprises (SMEs) in transnational research consortia.[130] As a result, private companies have become an integral part of the European culture of research and innovation. For example, the consortium Estools included as commercial partners Stem Cell Sciences Ltd and Axordia, two biotech companies focused on the development and marketing of human embryonic stem cell technologies for research, drug discovery, and therapeutic treatments.

[129] See http://cordis.europa.eu/fp7/mariecurieactions/iapp_en.html
[130] From 10% in FP5 to 15% in FP6 and FP7.

5.5.1 Promissory Capitalism

The participation of SMEs in the activities of European consortia has helped companies to internationalise their business outlook and access new knowledge produced in a stimulating context of innovation. However, the making of a knowledge-based economy in Europe has been very challenging, especially in a high-risk sector such as medical biotechnology. The problem is that financial investments have been sustained by a regime of high expectations, both in terms of therapeutic benefits and financial returns, since the bioscience community realised that 'merely producing truth will be insufficient to move the venture capitalists, patent offices, and science writers on whom the biosciences are increasingly dependent for their newfound wealth' (Rabinow 1996: 137). While the growth of the whole sector has been driven by a distinctive brand of *promissory capitalism*, the actual returns of frontier biomedical research have hardly matched the initial promises.[131] Despite some spectacular achievements such as the cloning of the sheep 'Dolly' and the derivation of the first embryonic stem cell lines, the translation of these technologies into biomedical therapies and commercial products has been much slower than expected. Therefore, many investors have become impatient and decided to bet on safer sectors, such as information technology – a situation that has been exacerbated by the ongoing economic crisis (Ledford 2009).

Stem cell research, again, is a good case in point. The rise of stem cell science as a 'high-profile' sector of biomedical research has been sustained by claims about miraculous therapeutic promises, claims that have often been amplified by optimistic media coverage. However, after a decade of massive investments amid controversies and moral debates, the translation of stem cell research into practical applications has been very modest. Jim Walsh, director of stem cell research at Axordia, a spin-out of the University of Sheffield and former partner in the European consortium Estools, explained to me during our interview in Sheffield that the production of stem cell lines for research purposes is not a very profitable business, although added value might result from the development of 'satellite technology', such as a complete package of tools to work with the cell lines:

[131] Promissory capitalism has been defined in relation to the biosciences as 'capital raised for speculative venture on the strength of promised future returns' (Franklin and Lock 2003:6-7). See also Michael Fortun (2001).

> I think that simply selling embryonic stem cells is never going to make a huge amount of money. It's only when you put in place a technology which allows these cells to be used for particular applications that they start to acquire value. So arguably it is the satellite technology that has the real value. Or selling a complete package where you have got the embryonic stem cells plus the tools to do something useful with. So that full package would be valuable. But just a stand-alone research grade embryonic stem cell lines I don't think it is a high value product.

The simple extraction of 'biovalue' from bare life, therefore, is not a lucrative activity in the current business of stem cells, but things are likely to change if basic research will be translated into actual medical therapies.[132] At the time of my fieldwork, Axordia was collaborating with the University of Sheffield and the consortium Estools to produce GMP (Good Manufacturing Practice) grade embryonic stem cell lines, which could be used in clinical trials. However, as Walsh noted, it is difficult to predict when (embryonic) stem cells will take off as a standard therapeutic practice, also due to high costs of commercialisation. EU funding can provide a financial incentive, but can hardly match the budget that is required to develop, test, market, and distribute a novel biomedical product. As the Chief Scientific Officer of Stem Cell Sciences Ltd, Tim Allsopp, noted in an interview with the journal *Nature*, the participation in European projects is a means of expanding the research horizons of a company, rather than an important source of money (Gilbert 2006).

The fragmented nature of regulations on intellectual property rights across member states is another important hurdle. In 1998, the European Parliament and the Council adopted a Directive on Biotechnological Inventions to establish a uniform legal environment and thus encourage international investments in Europe (European Parliament and the Council 2008). However, the formulation of this document is ambiguous. The Directive states that 'inventions shall be considered unpatentable where their commercial exploitation would be contrary to ordre public or morality', including processes for cloning human beings, modifying the germ line of human beings, and, significantly, 'uses of human

[132] The term 'biovalue' was developed by Catherin Waldby and has gained currency in the sociological debate on biotechnologies and stem cell research. In particular, Waldby argued that 'Biovalue refers to the yield of vitality produced by the biotechnical reformulation of living processes. Biotechnology tries to gain traction in living processes, to induce them to increase or change their productivity along specified lines, intensify their self-reproducing and self-maintaining capacities. This intensification or leveraging of living process typically takes place not at the level of the body as a macro-anatomical system but at the level of the cellular or molecular fragment, the mRNA, the bacterium, the oöcyte, the stem cell' (2002:30).

embryos for industrial or commercial purposes'. As expected, the latter prohibition has given rise to divergent interpretations, notably by the UK patent office, the Swedish Patent Office, the European Patent Office (EPO), and the European Group on Ethics (EGE). Therefore, there is uncertainty over the patentability of human embryonic stem cells in Europe, with different jurisdictions adopting different policies on the scope of moral exclusions on hESC patents in the Directive (Plomer and Torremans 2010). In the context of European consortia, these discrepancies might create further hurdles to open cooperation, as they would provide an unfair advantage to commercial or academic partners that can exploit the more liberal regimes of intellectual property protection.

5.5.2 Globalisation

In addition to regulatory and legal issues, the growth of the European bio-economy has had to face another challenge, namely the difficulty to europeanise a sector whose development has been marked by global dynamics, alliances and transactions. Despite many efforts to promote European competitiveness, biotechnology is a global industry. Many European companies have made business agreements with North American partners. Back in the late 1990s, for example, the French corporation Genset, one of the flagship European companies in the field of genomics, had subsidiaries in the US, Japan, Singapore, and Australia. Significantly, in 1997 Genset started the first pharmacogenomics research program in the world in collaboration with the US-based Abbott Laboratories (Marshall 1997). More recently, Roslin Cells Ltd., a spin-out of the Roslin Institute, the research centre where the sheep 'Dolly' was cloned, has initiated a collaboration with the US company Lonza to develop customized cell culture media and processes for the production of pluripotent stem cells.[133] Also, European managers have found employment outside Europe - attracted by higher salaries and lower income tax levels - and many European companies have been sold out to foreign owners in the United States or East Asia.[134]

[133] http://www.roslincells.com/news.asp
[134] http://www.sciencemag.org/site/products/euro2.xhtml

The story of Stem Cell Science Ltd provides a striking example of these dynamics. The company was co-founded in 1994 by Austin Smith and Peter Mountford to develop stem cell as therapies. At that time, Smith was a rising star in the field of stem cell science, working as group leader at the Centre for Genome Research of the University of Edinburgh. Mountford was a junior Australian scientist who had come to Edinburgh in the early 1990s on a postdoctoral fellowship to work with Smith on stem cell biology. After the end of the two-year fellowship, Mountford decided to go back to Australia and the head office of the company was established in Melbourne, at Monash University. In 2004, however, the company 'returned' to Scotland, where Smith was directing the newly founded Stem Cell Centre of the University of Edinburgh. 'We feel that a base in Edinburgh allows us to be close to our academic colleagues and also the heart of the European pharmaceutical markets. Also, so many breakthroughs in this area have been the product of Scotland. It's only right that SCS should be here and that this country should benefit', reportedly said Mountford in an article featured in a special issue on 'the best of Scottish science and technology', published in the magazine *Science Scotland* by the Scottish Royal Society.[135] The company was soon celebrated as a jewel of the Scottish biotech industry. At the same time, it became a flagship 'European' company, with participations in large EU-funded consortia such as Eurostemcell and Estools. In 2008, however, the company relocated its offices and laboratories in Cambridge, where Smith had become the director of the new Wellcome Trust Centre for Stem Cell research. The move, which also involved a number of redundancies among the staff in Edinburgh, was regarded as 'a major blow to Scotland's life sciences industry', as Stem Cell Sciences had been 'one of Scotland's big hopes in the pioneering world of stem cells'.[136] But the final blow came in February 2009, when the company was eventually sold to Stem Cell Inc, an American company based in California. Alistair Riddell, the new CEO of Stem Cell Sciences, declared that Stem Cell Sciences had no funding and could not raise any more money from bank or from its shareholders.[137]

---

[135] *Science Scotland*, Issue 2 (Spring 2004), available at http://www.sciencescotland.org/issue.php?id=2

[136] 'Stem cell Sciences to quit Scotland', *Herald Scotland* (16 February 2008)

[137] See *Compute Scotland* (March 2009), available at: http://www.computescotland.com/edinburgh-university-stem-cell-spin-out-sold-to-us-2123.php; see also http://www.inpharm.com/print/3131

The story of Stem Cell Sciences Ltd. is not exceptional. Despite the support of regional funds and EU money, many biotech companies in Europe find it hard to survive after the hype around regenerative medicine has faded away. The company Axordia, one of the commercial partners in the European consortium Estool, has met a similar fate. Established in 2001 by Professor Peter Andrews and Professor Harry Moore to capitalize on their innovations in stem cell research, in 2008 the company was taken over by the tissue therapy specialist Intercytex. After the deal, Intercytex gained exclusive rights to commercialise research from the Centre for Stem Cell Biology (CSCB) at the University of Sheffield, where both Andrews and Moore work.[138] However, its future is now in doubt as Intercytex is struggling to survive and has initiated discussions with a number of interested parties about a potential trade sale.

5.6 Branching Out

The consortium Eurostemcell, one of the two research networks I have followed during my fieldwork, has completed its activities in early 2008. In the previous section, we have seen that contributions of commercial partners to the European 'bio-economy' have been poor. In many other ways, however, the project was very successful. During its four-year duration, more than 100 researchers from 27 laboratories in Europe tackled the basic, applied, clinical and ethical research needed to build the foundations for regenerative medicine. In doing so, they developed new methodologies, media, tools and laboratory protocols, producing more than a hundred publications in peer-reviewed scientific journals (see the publication list in Annex 2).

In the eyes of the Commission, the project was a good working example of European integration. In a speech at the European Parliament, the then European Commissioner for Research Janez Potočnik stressed that 'This project brings clear European added value to this area of research, it is an example of the successful integration of science, communication, ethics and training. And it demonstrates how European science can become a world-wide reference in a particular field' (Potočnik 2007). Many participants, moreover, noted that the

[138] *Yorkshire Post* (23 December 2008), available at: http://www.yorkshirepost.co.uk/businessnews/Intercytex-takeover-prepares-Axordia-for.4817372.jp

project contributed to the creation of mutual trust amongst partners and a sense of community. According to Austin Smith, the consortium leader, 'one of the things people really valued in Eurostemcell is that you could talk about things that weren't published and get feedback and comments from your colleagues, which is very important in science and it is increasingly difficult to do because you can only do it if you have some basis of mutual trust'. Other participants emphasised the value of the project as a social platform to expand the network of professional contacts. Elena Cattaneo, for example, pointed out that the participation in Eurostemcell provided a unique opportunity to create bridges and connections with other scientists working in the same field, as well as a sense of community, common identity and values.

5.6.1 Fragile Communities

But what happens when EU-funded projects end? What is the future of these peculiar 'European communities of scientists'? Over the past decade, the development of lasting relationships between partners has been a key objective of EU funding programmes. 'Integrated Projects' and especially 'Networks of Excellence' explicitly aim at establishing substantial and long-term integration of research activities in Europe, in keeping with the overarching policy vision of a strong European Research Area. The main idea was to form a new layer of cooperation - a European framework – that would be juxtaposed to existing contexts of knowledge production through the network approach.

However, this goal was scarcely met. In 2008, an official assessment on the impact of Networks of Excellence in FP6 concluded that the creation of integrated and sustainable networks was poorly achieved. In particular, the reviewers argued that research consortia were not sustainable once EU funding was over, given the lack of continued financial support from other agencies, such as national or other European organisations (European Commission 2008a). Likewise, in 2009 the European Court of Auditors, an independent group of advisers that monitors EU finances, issued an interview-based review of EU-funded consortia that documented the lack of sustainability. The auditors noted that most research partnerships do not secure further funding from other sources as was hoped, and thus disintegrate as soon as European funding runs

out: 'Self-sustainable long-term research activities and partnerships were not achieved for any of the audited networks, thus making future collaboration subject to continued public support' (European Court of Auditors 2009).

As Bruno Latour explained in *Science in Action*, however, technoscientific projects are never 'self-sustainable', but require constant efforts to keep the interested groups in line. The initial success of a project depends on the enrolment of a wide range of actors and 'allies' (including funding agencies, institutional bodies, colleagues, and non-human actors such as technical objects), but the conversion of a temporary ensemble of interests and stakeholders into a durable whole also demands considerable efforts to prevent that all the elements will be *disbanded* as easily as they have been assembled (1987:122). The same line of reasoning can be applied to make sense of the fate of European consortia. As discussed earlier, project coordinators assemble the consortium by relying on personal contacts. At this stage, the quest for complementary expertise is crucial, but people are more likely to get involved as they need additional financial support, especially in countries where research is underfunded. Once projects end, however, European cooperation lacks support to continue and develop. In addition, the conversion of temporary arrangements into durable partnerships is particularly challenging due to their peculiar social configuration. In comparison with conventional units of scientific work, such as public or private laboratories or big science centres, European networks are more 'fragile' assemblages, as they join the efforts of many centres that are scattered over a vast and diverse geopolitical space. It is no coincidence that the actual work of EU-funded networks is regulated by a tight system of accountability (see section 5.2). On the one hand, the Commission is committed to ensure transparency and integrity in the use of large sums of public money, as well as high ethical standards. On the other hand, without a 'Fordist' regime of knowledge production, managed by a rigorous schedule of milestones and deliverables, the focus of research collaboration could easily drift away due to lack of frequent interactions. The very notion of 'virtual research community' - a concept that is often used to define transnational research consortia, based mainly on electronic communications - has important limitations. While the development of computer networks has greatly facilitated collaborations across a wide geopolitical space, face-to-face interaction is likely to remain a key component in the making of scientific communities. In general, several studies

have stressed that members of virtual communities are less attached and obligated than in social groups that are based on face-to-face interactions (Blanchard 2004). To be sure, European consortia are not merely 'virtual' assemblages. As part of the research programme, participants are expected to attend workshops, conferences, and joint training courses. These events are particularly important as they gather all the network participants in one place and thus have a key role in strengthening a sense of community and participation among partners, both in formal and informal contexts. As Elena Cattaneo noted, 'informal conversations at a pub after a meeting were just as important as the meeting to form and reinforce a common sense of identity'. However, once EU funding is over, the chances to meet up with former collaborators inevitably recede and the sense of 'European stem cell community' can rapidly vanish. Scientists may get involved in other projects, which may be supported by other agencies that are not necessarily interested in strengthening the European Research Area, as their *political* mandate may be different. For example, the UK National Stem Cell Network aims to encourage exchanges and cooperation at the *national* level, while a regional initiative such as the East of England Stem Cell Network focuses on the *regional* level.

5.6.2 Euroelites

The situation is very different, of course, when participating scientists receive continued funding from the EU to be involved in other European research consortia. This development is well illustrated by the story of Eurostemcell. As mentioned, this network completed its four-year activities in 2008. Soon after the end of the programme, the consortium 'branched out' into three new stem cell consortia, also funded by the European Union, which involved many partners that had participated in the original network. While Eurostemcell joined laboratories with different expertise, the three new consortia are more specialised: the first consortium, EuroSyStem, combines biological and computational expertise to understand fundamental processes of stem cell differentiation and self-renewal; the second, Optistem, focuses on stem cell applications for muscular and epithelial disease; the third, Neurostemcell, aims to develop stem cell based therapies for Parkinson's disease and Huntington's disease. Moreover, the project Eurostemcell is still alive, but with a different

concept and goals. The original website has become a permanent 'European stem cell portal', with specialised content both for researchers and the lay public, and the network has recently received additional funding from the European Union to organise dissemination activities.[139]

These examples indicate that scientists are willing to engage in lasting partnerships at the European level, at least as long as EU funding is available. In many ways, this is crucial not only to the policy vision of a strong European Research Area, based on enduring cross-national connections, but it can also ensure more effective collaboration, as scientists are already familiar with the complicated procedures of EU grants and can rely on existing ties of mutual trust and respect. Also, they can build on former experience in the *practice* of cross-border cooperation.

However, this development can have undesirable implications. One of the reasons why EU institutions aim to support sustainable networks is that funding is limited and can be allocated only to a small number of applicants in any priority research area.[140] In a context of scarce resources, institutions or individual scientists who are familiar with the intricacies of EU grants and the practice of transnational cooperation are in a better position than others to receive further support. This advantage can easily lead to the formation of self-perpetuating European elites, which are able to attract continued resources, drive the development of scientific fields, and even shape the process of policy making, following a pattern of *cumulative advantage*, which has long been documented by studies in the sociology of science (Merton 1973; Mulkay 1976; Zuckerman 1996).

Issues of scientific prestige and status can further contribute to this pattern.[141] As we have seen in section 5.1, leaders and organisers of large European consortia are usually senior scientists with international recognition, who are consequently able to 'buy in' the European project many partners and stakeholders. Understandably, they want to pursue scientific excellence and thus tend to adopt an exclusive approach to networking. In its website, the consortium Eurosystem claims to 'bring together elite European research teams to create a unique and world-leading programme in fundamental stem cell biology'. During our interview, Austin Smith, the former leader of Eurostemcell,

[139] The original website is still available online as archive site at: http://archive.eurostemcell.org
[140] In the last two framework programmes, about 15% of applicants received funding.
[141] On status groups and normative order in scientific collectives, see Barnes (2007).

emphasized the importance of selection criteria, in contrast to the more inclusive approach of EU policy makers:

> We cannot just open the door to everyone (...) we need to have criteria of selection (...) and that's one of the points we keep saying to Brussels (...) we are not accepting everyone that actually Brussels has [decided to involve] (...) you have to find the best (...) and I think they are more inclined to do that now than in the past.

At the same time, however, he is aware of the risk of self-perpetuating elite groups. In order to create mechanisms of wider participation, Eurosystem includes a work package to establish a broad European network of stem cell researchers, including an open call for forty new junior scientists to be involved in the consortium as associate principal investigators. As he explained to me, 'we don't have the resource to be able to give them any real money (...) but it will be a way of kind of recognizing them within the stem cell community (...) and they get to come and speak at the meeting'. This is an important initiative, which can help people to jump on the train of Euroscience. Nevertheless, the challenge might be daunting, especially in countries where research is underfunded for lack of resources or regulatory barriers. In this respect, again, Elena Cattaneo provided some enlightening observations:

> If you live in a place like Italy (where the government gives two cents for my line of research) [i.e embryonic stem cell research], it is very difficult to build the knowledge base and the reputation to get into European networks. Some people come to me and ask me: 'can we get into this consortium you are setting up?' And I often have to reply: 'I am sorry, but you have no credentials'. I mean, interested people first ought to demonstrate proven scientific productivity in these research areas. It is not necessarily the big work on Nature or Science, but at least a couple of articles in journals such as Developmental Biology (...). However, I realise that people have no funds and resources to build these credentials. As a result, they have a double disadvantage. First, they are out of the mainstream circuit of European cooperation. Second, they are penalised as they live in a country that does not invest in this kind of research (...) These factors, among others, can contribute to the creation of elite groups that eventually shape the pathways of science while penalising many other opportunities.

As this case exemplifies, problems of marginalisation are not only important at the level of individual scientists and institutions, but also at the macro level of EU member states. The lack of financial support at the national level, however,

might be an incentive to participate in EU grants. For example, if we look at the proportion of national participations in projects on human embryonic stem cell research within FP6, Italian laboratories were relatively well represented, following British and German institutes. On the other end, it is striking that many other countries such as Hungary, Portugal, and Ireland were almost entirely absent, not to mention the more recent member states of the European Union (Table 2).[142]

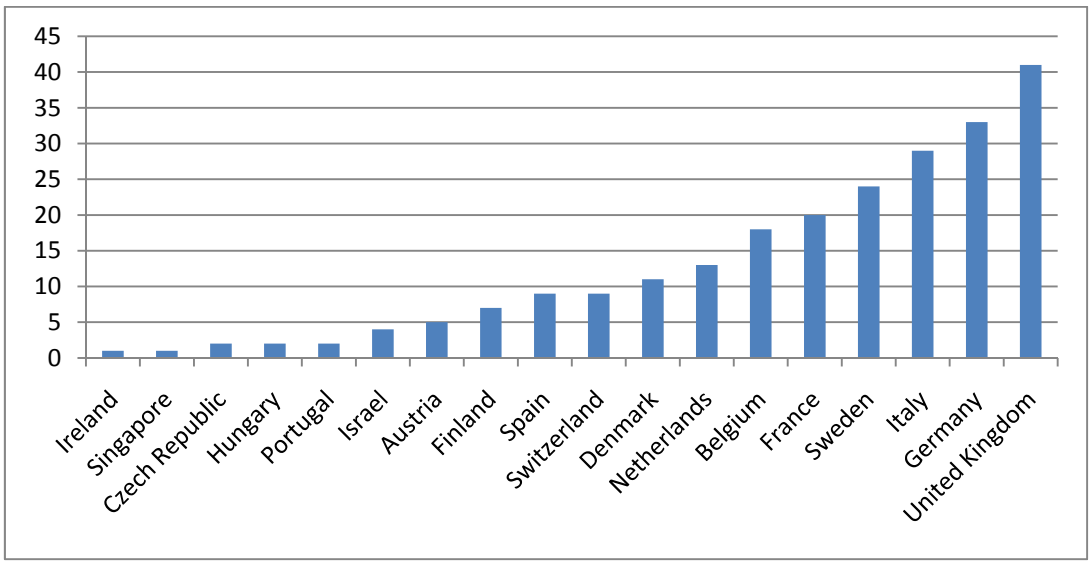

Table 2. National participations in EU-funded projects involving hESCs

The analysis of the overall data on stem cell research within FP6 is also revealing of clear imbalances in the Europe of science. According to a report by the European Commission, FP6 funded 111 projects that involved stem cell research, with an overall budget of 532 milltion euros (see full list in Annex 4). As Hogarth and Salter (2010) documented, the most common partners were Germany, UK, France and Italy. The second group of countries included Netherlands, Spain, Switzerland, and Sweden. In terms of leadership of projects, Germany, France, UK, Netherlands and Belgium were the leading countries (Table 3). Yet again, more than one-half of EU member states were barely represented in this key sector for European scientific cooperation.

[142] I produced these figures from data on participations in FP6, available on CORDIS.

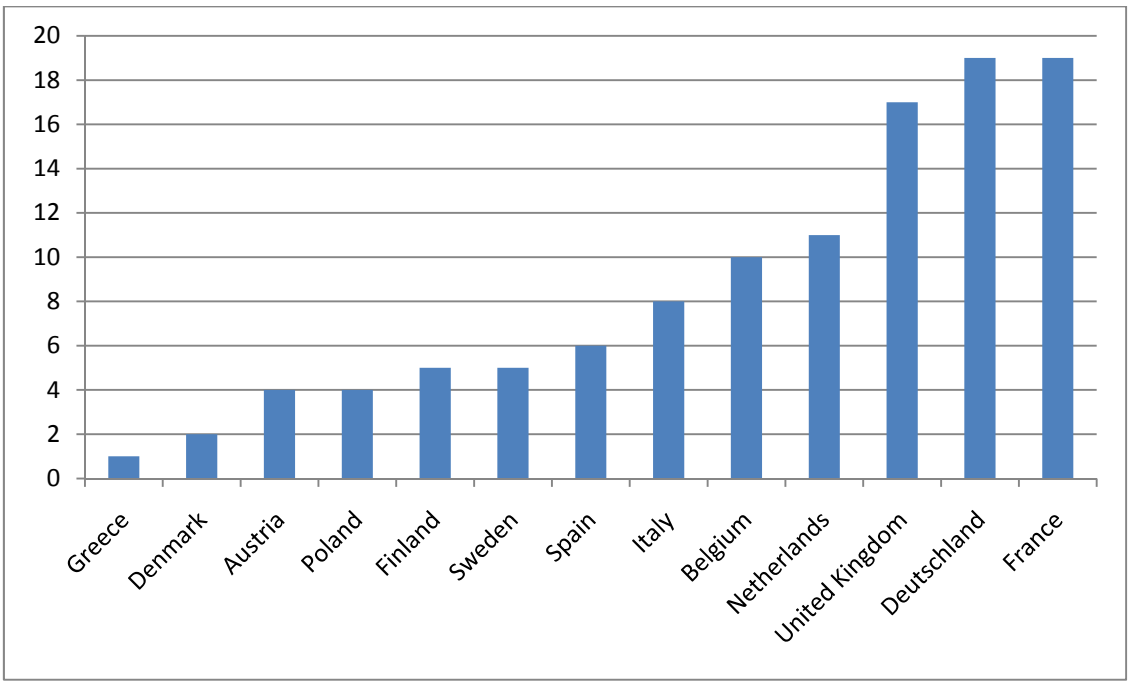

Table 3. Leadership of EU-funded projects involving stem cells by country

Low participation in European projects is not necessarily an indicator of poor performance at the national level, as the case of Finland illustrates. However, it is well documented that research and high-technology activities are highly concentrated in a few core regions of the Union. In 2007, the fourth report on European cohesion identified a large number of regions with an innovative performance level below the EU average, with at the bottom of the scale regions in Greece, Spain, Portugal, the Czech Republic and Poland, while data for Romania and Bulgaria were not available. On the other end of the spectrum, some European regions, particularly in Sweden, Germany and Finland, had higher levels of innovation than the United States or Japan. Given this situation, the European Union has designed a number of initiatives, such as the allocation of structural funds for research, to help all regions build research and innovation capacities corresponding to their situation and priorities. Over the past decade, cohesion policy funding has given substantial sums of money to redress imbalances between European regions and promote research and development in economically poorer countries. Nevertheless, the process of 'catching up' is slow and might require a long time, especially at a time of economic recession. In the meantime, a fundamental tension remains between the pursuit of scientific excellence and European 'competitiveness' on the one hand, and the need to redress imbalances across the European Research Area

on the other. This tension not only concerns EU research policy, but also reflects a key dilemma in the wider process of European integration.

6. SCIENCE AND THE BUILDING OF EUROPE

In chapter 3 I provided a critical account of the emergence and development of Community research policy. As we have seen, early statements on the need for a European Research Area date back to the late 1970s. In the wake of the oil crisis and economic downturn, science and innovation became a new field of European governance, with their promises to boost economic growth and find solutions to pressing social issues such as environmental degradation, the depletion of energy sources, and unemployment. Concurrently, the policy drive to build a stronger European platform for research and innovation became a new source of legitimacy and *raison d'être* for the European Community at a time of growing scepticism about the project of European integration. It was deemed that scientific progress held the keys to the future of Europe and could usher Europe as a whole into a new age of prosperity. In this visionary context of policy planning, the burgeoning field of biotechnology raised the highest hopes of regeneration. Due to its putative capacity to change and manipulate the natural (and social) order, biotechnology was identified as a revolutionary force, able to drive Europe towards brighter social and economic futures.

Over the years, further developments of policy discourses have seen substantial changes, reflecting wider transformations in the public perception of science. In many ways, the optimistic vision of a European 'bio-society' has had to come to terms with increasing anxieties over some undesirable implications of the new technologies. Initially, the enthusiasm for biotechnology was stifled by widespread concerns with the environmental risks associated with the release of genetically modified organisms into the environment. More recently, ethical issues of controversial technologies such as cloning and embryonic stem cell research have forced European institutions to reconsider the policy framework on research and innovation in a more responsible and cautious way. In this context of increasing contention, policy makers have had to find a difficult balance between the promotion of European science, the respect of divergent national regulations and the quest for fundamental European values.

Besides these adaptations, however, some overarching policy themes have largely remained unchanged, including the link between scientific innovation and European 'competitiveness', the knowledge society narrative and the vision of a European Research Area in which people and knowledge can freely move

across national borders. To some extent, the current policy debate is more articulated than the past, also because the Commission has recently benefited from critical contributions of external reviewers, including scholars in the field of science and technology studies. For example, in 2006 DG-Research organised a workshop 'to tackle the questions of the interrelationships of science and politics through various historical situations in order to enrich today's debates on science and society issues, the final aim being to give input to policy making at EU level about *science and/in society*'. In the final report, Dominique Pestre challenged some basic assumptions of EU policy discourse such as the linear model of scientific innovation whereby social and economic progress automatically follow from investments in knowledge, the exclusive identification of knowledge with science, and the instrumental use of science to boost economic growth (Pestre 2007). In the same year, a report of an expert group on the theme 'Science & Society' framed in problematic terms narratives and imaginaries that have driven EU research policies, such as the understanding of innovation as unconditional good: 'Problematic aspects – if at all recognised – are mainly externalised, into the ways that innovations are implemented or in the public's misperception of technology's achievements and benefits. What values are embedded in the very concept of progress, and for whom those values have meaning, are thus rarely addressed' (Felte 2007). While these contributions bear witness to the development of a more critical debate on science and technology policies, it is unclear to what extent they will be included in future planning and interventions.

Another important question is the extent to which EU research policies have been able to achieve their strategic objectives. As we have seen in the previous chapter, the making of a European Research Area still faces many challenges. First, the lack of an overarching regulatory framework is an important hurdle to the working of transnational consortia and the free movement of researchers across member states, especially in controversial fields such as stem cell research. Second, there are more 'technical' issues. While the establishment of European institutions such as EMBL has contributed to the setting of European standards in laboratory protocols, the circulation of scientific 'facts' across laboratories might still be hindered by discrepancies in data collection and measurement systems. Also, the peculiar nature of some experimental practices and substances makes it difficult to distribute experiments across laboratories

that are separated by long distances. Finally, globalisation has frustrated the policy drive to boost the growth of the high-technology sector in Europe, as the story of Stem Cell Science Ltd exemplifies.

Despite these challenges, however, European research policies have achieved some notable results. While in applied research the pressure of global dynamics has counteracted the growth of a European bio-economy, basic science has been more amenable to Europeanisation. Collaborations and exchanges between European researchers have significantly increased over the past decades - a development that is also documented by the exponential growth of co-authored papers involving research centres in different member states (Mattson 2008). According to some informants who worked both in Europe and the US, this is a peculiar European development. Elena Cattaneo, for example, noted that 'in Europe a truly cooperative spirit is emerging, which is very different from the individualism in the American scientific system'. Likewise, an American professor of molecular biology, who had been working in the UK for more than ten years, noted that in the United States scientists are more reluctant than in Europe to engage in international collaborations and partnerships.

In addition to a quantitative growth of scientific cooperation, documented by the increase of European research projects and co-authored papers, Community research policies have contributed to and are part of a wider process of Europeanisation of the *culture* of academic research (Liverani 2010). This process is illustrated by many examples, including the establishment of European big science centres such as CERN, EMBL, and ESA, European societies and academic journals, European conferences and European educational programmes. As a simple search on the online database of the British Library documents, the adjective *European* has today become a commonplace in the world of academic publishing, with 'European journals' in almost any area of expertise. Also, European societies have flourished in many disciplines, such as the European Society of Cardiology, the European Society of Human Genetics, the European Association of Social Anthropologists, and the European Society of Social Psychology, just to give a few examples. It would be difficult to account for all these initiatives, as different interests and motivations have underpinned their emergence. In any case, however, the process of European integration has acted as a powerful *idée -force* (Llobera 2003) or

master narrative, able to catalyse energies, people, and resources around a specific cultural concept.

This development deserves further critical attention. Not only is it a prominent reminder of the political and cultural nature of science and academic research, but it also signals an ongoing process of de-nationalisation or at least diversification of knowledge production. As many studies documented, the nation-states in Europe have played a key role in shaping the aims, contexts, and institutional profile of scientific and academic work (Greenfield 1987; Porter and Mikuláš 1992; Crawford et al. 1993). In the sixteenth and seventeenth centuries, universities were no longer shaped by the universalism of Christian scholarship, but they were deliberately used as 'instruments to secure national coherence and to increase the power of the country on the new international chess board' (Crawford et al. 1993: 10). Likewise, the growth of the new scientific academies depended on the close relationship between their members and the rising nations: exploration, scientific expeditions, and the purchase of costly technological equipment bear witness to 'a growing concern among royalty and governments that scientific activities should indeed provide concrete and tangible results in the form of either prestige or commercial benefits' (Crawford et al. 1993: 9). During the second half of the nineteenth century, scientific practice became even more interlocked with the institutional, cultural, political and financial systems of national states. The transition of science from hobby for wealthy gentlemen to institutionalised profession unfolded in clearly nationalistic terms, with the establishment of national research councils, national societies, and national academic journals. It is true that internationalism never ceased to be an important part of the scientific profession. In the late nineteenth century, international congresses became a normal routine of the scientific life; also, the offices that attended business between meetings were often converted into international disciplinary associations. Nevertheless, these events were characterised by a confrontational attitude that was more akin to a sort of 'Olympic internationalism', rather than a truly cooperative spirit (Forman 1973). In the 1950s, however, the new political order following the end of WWII brought about important changes also in the contexts of knowledge production. On the one hand, the onset of the Cold War did not help foster international cooperation - and science made no exception. As it is well documented, the Cold War was marked by an aggressive high-tech

competition between the US and the Soviet Union, especially in nuclear technologies and space exploration (Wang 1999). On the other hand, at least in Western Europe, the idea of 'European science' began to take shape within the wider context of initiatives that were sustaining European reconstruction and integration, such as the Organisation for European Economic Cooperation (1948), the Council of Europe (1949) and the European Coal and Steel Community (1951). In this context, in 1952 the delegates of twelve governments agreed to establish the European Centre for Nuclear Research (CERN), a foundational moment that was followed by similar initiatives in other fields such as the European Molecular Biology Laboratory, the European Southern Observatory and the European Space Agency (Krige 2006; Liverani 2010).

From the 1970s to the present, as I have discussed in chapter 3, the institutions of the European Communities have become increasingly involved in this process. Today, they have gained a prominent role, due to the breadth and coverage of framework programmes. While EU funding programmes currently contribute to a modest average of 5% of national spending on research, they are a key element in the overall research landscape. National governments and agencies are still the main institutional actors in the organisation and funding of research programmes, but the notion of *European science* has become deeply ingrained in both practice and social imagery. In doing so, it has partly eroded the long standing alliance between science and the modern state. At the same time, moreover, regional initiatives of networking and cooperation are emerging at the sub-national level such as the regional clusters on biotechnology and the life sciences in the UK and Germany. As a result, the cultural landscape of knowledge production is today increasingly diverse, reflecting wider changes of political systems towards *multi-level* forms of governance and policy making.[143] For example, a stem cell research centre might simultaneously be involved in or supported by a regional cluster such as the East of England Stem Cell Network, a national platform such and the UK National Stem Cell Initiative, a European agency such as the European Union, and partake in a 'global' initiative such as the International Society for Stem Cell Research.

In this patchwork of different arrangements, the European Union will have to maintain its identifiable role and functions. Significantly, in 2003 the European Parliament launched an initiative named 'Regions of Knowledge',

[143] On multi-level governance, see Hooghe and Marks (2001).

which aims to strengthen the research potential and 'competitiveness' of regional-driven clusters by supporting the creation of synergies between universities, research centres, enterprises and regional authorities (European Commission 2007b). While this policy strategy is underpinned by the recognition of the crucial role of European regions in the knowledge-economy, it also consolidates the role of the Union as overarching coordinator of new organisational configurations that are emerging within the space of its geopolitical borders.

It might be objected, that 'European', as well as 'national' and 'regional', are just superficial layers that do not affect the ultimate outcomes of scientific research. This thesis is not a work in the sociology of scientific knowledge, but a study on European integration; however, I shall briefly reflect on some relevant epistemological issues. Just like modern states have shaped and continue to shape knowledge production, the process of European integration has been a critical engine of cultural and scientific change. Although this phenomenon has involved the full range of academic specialities, its actual impact has to be evaluated on a case-by-case basis. In the social sciences and the humanities, as mentioned in chapter 1, European integration has led to new approaches and methods of data collection. 'Europe' (or the European Union) has become the unit of analysis in numerous social or economic surveys, in alternative to traditional frameworks such as the local community or the nation. In the 'hard' sciences, the effect is more difficult to discern. In my interviews with stem cell researchers, many participants were reluctant to recognize any influence of the funding context on the final scientific output, in keeping with the Mertonian ideal of scientific universalism.[144] According to a project leader, for example, 'good scientists would do good science anyway'. Nevertheless, I argue that the wider institutional, social, and political contexts *always* play a critical role in shaping the actual products of scientific research. In his study of the development of genetics in the interwar period, Jonathan Harwood pointed out that two distinctive 'national styles' emerged in the United States and Germany: while German geneticists were mainly interested in a broad theoretical issues related to heredity, their American colleagues addressed more restricted, specific problems. To Harwood, this divergence was a result of the wider

[144] 'The acceptance or rejection of claims entering the list of science is not to depend on the personal or social attributes of their protagonists; his race, nationality, religion, class, and personal qualities are as such irrelevant. Objectivity precludes particularism' (in Merton 1973:270)

institutional context: 'the organization of the German university, intensified and reinforced by stagnation and financial crisis between 1870 and 1933, hindered the institutionalization of new disciplines like genetics and thereby imposed upon them a broad theoretical scope'. By contrast, 'the rapid expansion of American research institutions from the late nineteenth century and a university system that encouraged specialization allowed new disciplines to be as narrowly conceived as practitioners wished' (1987: 391). Likewise, in EU-funded projects, the definition of priority areas, the focus on 'applied' rather than basic research, the contractual nature of collaborative grants, the division of scientific labour into work packages and the choice of the network model are important *upstream drivers*, which are able to shape not only the aims of science, but also methodologies, experimental practices and research directions. As the case of EU-funded networks in stem cell research illustrates, the recruitment of participants and the definition of research hypotheses is a complex *social* process that involves much more than purely epistemological considerations. For example, a proposed research project ought to 'fit in' the aims and requirements of the overarching funding programme, attract the interest of biotech companies, comply with regulations at the EU and national levels, combine the expertise of many participants into a coherent whole, frame research questions in a way that can safely meet the tight schedule of milestones and deliverables. The resulting output of this process is unique. It is unique because, in a different research environment, *research questions and methods* would be framed in a different way, in order to be aligned with other interests, regulations, and standards. In her work on cancer research, the sociologist Joan Fujimura argued that the plausibility and success of the oncogene theory in the 1990s were due to a great deal of work and the use of concepts and techniques that could reconcile multiple conflicting viewpoints and allow different groups or social worlds to cooperate, including researchers in different disciplines and medical specialties, funding agencies, political actors in the US Congress, cancer research institutes, university departments and administrations, and biological supply organizations (Fujimura 1992:177). In EU-funded projects, research questions and outputs are also shaped by a variety of interests and elements, such as moral controversies over embryo research, the organisational model of the consortium, the imperative to find new therapies, the fragmentation of the regulatory landscape, and the need to involve biotech companies. To some

extent, the endpoint of this process can be defined 'European', as long as we give up any essentialist formulation. Rather, European is the sum of arrangements and alignments that can make 'doable' the collective action of a wide range of stakeholders in different social worlds, including EU institutions, high-tech companies, bioethics committees, and universities.

6.1 Science and Identity

At the beginning of my research journey, I aimed to situate science cooperation in a broader cultural analysis of the process of European integration. As we have seen in chapter 1, over the past two decades, the question of European identity has gained prominence in the academic and policy debate. As the European Union is moving from an economic organization to a more political form of integration, many people argued that the European project needs a shared cultural identity or a 'soul' to substantiate the development of a truly supranational polity. Indeed, a provision of the Maastricht Treaty (Title IX, article 128) declared the EU would 'contribute to the flowering of the cultures of the Member States [...] bringing the common cultural heritage to the fore'. As a result, European policy makers have developed a range of initiatives that could reinforce this sense of cultural belonging. As Chris Shore documented (1992, 1993, 2000), after the Maastricht Treaty, the European Commission entered the cultural field with new programs for generating and disseminating knowledge about the common European heritage and proposing various initiatives to value the European dimension of the arts, history and literature. Moreover, this process has largely involved academic humanities, with the proliferation of European histories, memories and area studies.

In this context of cultural concerns, science has gained a more pronounced meaning as an important element of European identity and the 'common cultural heritage', both inside and outside the institutional sites of policy making. In the opening lines of his historical study on *The Birth of Modern Science* (2001), for example, the historian and philosopher Paolo Rossi stressed the distinctive European character of early modern science, as well as its capacity to link people beyond political and religious divides. 'That complex historical reality which we today call *modern science*', he wrote, 'was not born in

any one specific place in Europe. Its birthplace is all of Europe. We should remember that Copernicus was Polish; Bacon, Harvey, and Newton English; Descartes, Fermat and Pascal French; Tycho Brahe Danish; Paracelsus, Kepler, and Leibniz were Germans; Huygens Dutch, and Galileo, Torricelli, and Malpighi were Italians. The arguments of one were linked to those of another in an artificial or imaginary reality without borders; in a Republic of Science that worked itself, against the odds, into difficult, often dramatic, and sometimes even tragic social and political contexts' (2001:1). Significantly, Rossi's work is part of a broad editorial project coordinated by the medievalist Jacques Le Goff, which includes historical contributions on various aspects of European history, under the heading *The Making of Europe*. In the editor's preface, Le Goff did not conceal the proactive political role of this cultural operation: 'Europe is in the making. This is both a great challenge and one that can be met only by taking the past into account' (2001:ix). Engaged in a similar pursuit, in 2004 a number of prominent academics convened at the Collège de France, in Paris, to express their views on the topic *Science et Conscience Européenne*. In his contribution, the social historian and member of the European Parliament Bronislaw Geremek stressed the consubstantial tie between science and 'the essence of Europe' through a highly rhetorical passage in which Europe is personified and endowed with a quasi-human agency:

> It is the spirit of innovation that stands in intimate connection with Europe. She [Europe] was able to introduce new technologies in medieval agriculture, exploit wind power, develop military techniques, establish schools and universities, use coal, iron and steel, produce industrial revolutions, build knowledge societies and promote the sciences, take advantage of her inventiveness and of other civilizations' inventions. It is not a contingent link that ties Europe with the Promethean spirit – this desire for appropriation of all nature's secrets and forces, this courageous will to overcome what has been acquired: *this is the essence of Europe*.[145]
>
> C'est bien l'esprit d'innovation qui semble être intimement associé à l'Europe. Elle a su introduire des technologies nouvelles dans l'agriculture médiéval, utilise la force du vent, développer les techniques militaries, créer des écoles et des universités, utiliser le charbon, le fer et l'acier, générer des révolutions industrielles, former des sociétés savantes et promouvoir les sciences, profiter de son propre génie d'invention et des inventions des autres civilisations. Ce n'est point un lien conjuncturel qui lie l'Europe à l'esprit prométhéen, cette

[145] The emphasis is mine.

> soif de s'approprier tous les secrets divins, toutes les forces de la nature, cetter force téméraire de dépasser ce qui est acquis, pour aller en avant: c'est bien l'essence de l'Europe.

Therefore, he concluded, 'Europe will assert herself only if she can rise again to the Promethean challenge and is willing to place science at the heart of her future development' (Collége de France 2004).[146] On the same occasion, the former director of the *Académie française* Marc Fumaroli conjured up the historical legacy of the Republic of Letters as a model of European cooperation beyond cultural, political, and religious divides (ibid.).

In turn, references to the past virtues of enlightened Europe have been frequent in policy documents. In particular, the theme of the 'New Renaissance' has often been deployed as an effective rhetorical device to conflate into a single narrative a vision of political and social regeneration with the intellectual legacy of early modern science. In 1980, a strategic document of the FAST group stressed that, as 'the Renaissance was born of the Middle Ages', 'a new renaissance for Europe by the appropriate development of science and technology is possible' (FAST 1981). Almost forty years later, a communication of DG-Research reproduced the same narrative to inject 'new' drive into the making of the knowledge economy:

> In the European Renaissance of the 15th and 16th centuries, new ideas in agriculture, commerce and governance brought greater prosperity, which in turn fostered the arts. Trade with the Near and Far East opened minds. The very notion of scientific method emerged in this period, led by Copernicus, Keppler, Galileo, Vesalius and others. Likewise scientific libraries began appearing; and what we today recognize as scientific disciplines started to form in astronomy, anatomy, botany and mechanics. New technical skills emerged in architecture, printing, ship-building and farming. These new insights and skills shook the established order and laid the groundwork for the prosperity brought by the Industrial Revolution, and our own age of the Knowledge Economy. Today we see the need for a similar paradigm shift, which we call a 'new Renaissance' (European Commission 2009).

Such statements have been instrumental to substantiate policy choices with a sense of historical continuity and rootedness. However, the election of science as a token of European identity is highly problematic. First, as many studies documented, the emphasis on the uniquely European character of the Scientific Revolution is a biased cultural perspective that singles out some particular

[146] L'Europe ne peut s'affirmer que dans la reprise du défi prométhéen, dans la volonté de placer les sciences au cœur de ses projets d'avenir.

developments while neglecting the intellectual contribution of non-European civilizations such as the Chinese and Arab numerical and astronomic traditions (Raj 2007; Bala 2008). While the recent communication of DG-Research calls for a 'paradigm shift', it actually recycles a centuries-old assumption in the cultural history of 'the West' (see Daston 2006).

Second, as years of work in the sociology of science documented, science is not a neutral value that can be placed beyond social conflicts, but it is always embedded within wider cultural and moral contexts. While scientific work can indeed foster integration and international cooperation, at the same time the contextual nature of scientific knowledge and practice does reflect and, at times, *amplifies* wider cultural issues that can potentially be highly divisive. As discussed above, the stem cell debate has brought to the fore profound divergences amongst European countries on fundamental moral and cultural issues.

Third, and more importantly, the very notion of *European science* is profoundly at odds with ideals of scientific cosmopolitanism. In policy and academic discourses, the model of the Republic of Science has often been conjured up as an historical blueprint for the making of the European Research Area. However, there is a crucial difference. In the Enlightenment, as well as in subsequent reformulations, the intellectual and moral strength of this concept stemmed from a universalistic vision of scientific and intellectual work. In 1684, the philosopher Pierre Bayle observed that 'It is not a matter of religion, but of science: therefore one should put an end to all boundaries that divide men into different camps, and consider only that which unites them, namely their rank as noblemen in the Republic of Letters. In this sense all scholars should regard themselves as brothers, and consequently one another as family' (in Eskildsen 2005: 421).[147] In a similar vein, Thomas Sprat, the author of the first history of the Royal Society, in 1667 noted that new members were accepted regardless of 'different religions, countries, and professions of life', as the Society 'openly professed not to lay the foundation of an English, Scotch, Irish, Popish, or Protestant philosophy; but a philosophy of mankind' (in Rossi 2000: 25). In contrast with this cosmopolitan outlook, current policies and discourses on European science are first and foremost *European*. It is true that the European

[147] In his *Dictionnaire Historique et Critique*, published in 1696, Bayle added that: 'It is liberty that reigns in the Republic of Letters. This republic is a state which is entirely free. The only rule to be recognised there is that of truth and reason' (in Goodman 1994: 135).

Commission has launched programmes of external cooperation and engaged in many bilateral agreements; moreover, participation in framework programmes is open to research institutes and researchers in non-EU countries under specific conditions. However, far from having encouraged a cosmopolitan understanding of scientific practice, European policy discourses on research and innovation have invariably stressed the challenge of global competition and the need to boost European capabilities vis-à-vis international competitors such as the US and Japan, as discussed in chapter 3. This is no surprise: as Durkheim pointed out many years ago, the creation of an 'in-group' always entails its demarcation from 'out-groups', and that demarcation is an *active* part of identity formation (Durkheim 1893/1984). This pattern occurs in small social groups, in corporate strategies, in projects of nation building, and even in a wider political process such as European integration and the making of the European Research Area. Indeed, without the construction of 'competitors' and global challenges, the Republic of Science could never be European.[148]

6.2 European Scientists?

Beyond this level of analysis, however, a critical discussion on science and European identity should not overlook the views of scientists themselves, and particularly scientists who are involved in EU-funded projects. In his sociological work on European football, as mentioned in chapter 1, Anthony King pointed out that 'statements about the nature of European identity become more than mere assertions, only by engaging in detailed ethnographies, which illuminate the way individuals are actually re-negotiating their identities and social relations in specific circumstances' (2000: 421). Football fandom provides a more spectacular and 'visible' domain for sociological investigations on identity rituals; nonetheless, interviews with scientists can offer some revealing insights on this issue, especially given the tension between cosmopolitan values and Europeanisation. I have already stressed in chapter 5 that European consortia are 'fragile communities', as their existence is tied to the temporary mandate of the funding agreement - usually no longer than 4/5 years - with resulting problems of sustainability and capitalisation. However, it

[148] See the chapter 'Uses of the Other in World Politics', in Iver B. Neumann (1998), *Uses of The Other: 'The East' in European Identity Formation*, University of Minnesota Press.

might be worth asking whether the involvement in EU-funded projects contribute to reinforcing a sense of intellectual belonging to an *imagined community* (Anderson 1991) of European scientists.[149] During my conversations with participating scientists, different attitudes and approaches emerged, ranging from keen support for the notion of European science to more pragmatic or even sceptical attitudes. Professor Smith, for example, noted that 'It might seem unusual for a British person but I am very pro European. I think it's our only future (...) I think that economically, scientifically, we have to integrate and work together'. In line with this approach, he is currently the co-ordinator of a broad consortium (EuroSyStem) that aims to create a 'European federation' of elite laboratories and 'engage with and provide a focal point for the European stem cell research community'.[150] Likewise, Claire Blackburne, the former coordinator of the training and outreach programme of the consortium Eurostemcells, noted that 'I don't know whether there is a European scientific community (...) but there definitely is in stem cells (...) the contacts that were formed there were continued far after the breaking up of the consortium (...) I think it was very positive from that point of view (...) At least in my own perspective, this made me more aware of European science than before and that makes Europe much more a reality to me'. In contrast with these views, Professor Andrews endorsed a more cosmopolitan understanding of scientific work, explaining that 'one of the nice things in doing science is that, compared to many other activities, there is quite a lot of cooperation across the world (...) I know people in the States, I know people in Europe, I know people in Japan that I can regard as friends to do things with, to talk with. I think I am fairly open about what we do (...) Personally, I find the thing of competing with the US a funny way, I don't like sort of thinking that way'. Finally, another participant pointed out that the establishment of a European community of scientists does not necessarily rule out the possibility of wider cooperation beyond the EU borders: 'especially at a time when science is likely to become increasingly expensive and in need of a critical mass of experts (...) EU funding is certainly welcome'. However, he added, 'this process does not clash with the

[149] In a paper on this issue, Ricardo Gusmao hastily concluded that 'Beyond the reinforcement of collaborative networks, the European programs also have a strong impact on training and mobility activities within the continent. In this respect, it must be said that they contribute to the creation of a new generation of 'European-minded' scientists, whose role will be increasingly important in steering European scientific and technological activities in the near future' (2001: 389).

[150] http://www.eurosystemproject.eu/project-outline

idea, just as legitimate, that European scientists can also be involved in collaborations at the global level. These two dimensions should be complementary, rather than exclusive'.

These few examples are not representative of 'what European scientists think', but nonetheless illustrate the diversity of attitudes towards the notion of European science. Despite such differences, however, many participants openly admitted that they had never really reflected on this issue before the interview: 'it's not something I think about in my daily work', said a biologist from the University of Edinburgh. To some extent, this is quite understandable. Especially at a time of scarce resources, strategic considerations of funding are the main incentive for scientists to participate in European projects. On the other hand, the lack of reflexivity on this point in many participants may also suggests that 'European science' has become firmly ingrained in both practice and social imagery, and therefore tends to be accepted without much critical questioning.

7. CONCLUSIONS

In this study I have provided a critical assessment of Community research policies and their actual working in the activities of EU-funded transnational consortia. One of my aims was to shed new light on the ways knowledge is produced today. In recent years, some notable efforts have been made to capture the changing nature of contemporary research. In a landmark work published in 1994, Michael Gibbons and colleagues argued that a 'Mode-2' has replaced traditional patterns of knowledge production, characterized by the priority of 'applied' research over basic science, trans-disciplinarity, the use of the network as organizational model in broad collaborations, and a more responsible and reflexive approach to research practice (see also Nowotny et al. 2003). This pathbreaking work has been very influential and set the tone of the current debate in research policy studies. However, it failed to understand these changes within specific contexts of knowledge production. As Dominique Pestre (2003) pointed out, the authors framed the emergence of Mode-2 as a 'natural' and universal development and neglected the role of the underlying political drivers: 'the authors may have underestimated the extent to which these transformations have been the results of political and social *choices*. This would mean recognizing that the developments they describe are not cases of *natural* evolution, which have simply to be identified and acknowledged, but are, rather, articulated with *alternative and conflicting* social, economic, and political projects' (Pestre 2003: 246). In tune with this argument, my research aimed to situate the changing nature of contemporary research within a specific institutional and political framework. To be sure, some elements of the 'EU style' of research well exemplify the 'Mode-2' and can be found in many other contexts of science governance at the national level, including the emphasis on applied research, increased reflexivity, the link between scientific innovation and economic competitiveness, and the organization of research in broad collaborative networks. In any case, however, these patterns are neither natural nor universal, as Pestre noted, but are the direct or indirect outcome of deliberate policy choices. Thus, it is only by analysing the political, social and cultural contexts in which such choices have been made that we can better

understand the process of change, suggest indications for future developments, and identify alternative options.

At the same time, my work aimed to provide new insights on European integration, not only as a development that is shaped by policy makers and institutional dynamics, but also as a process that is enacted in social and cultural practices. As my research findings document, at least in the field of biomedical research, the creation of a European Research Area still faces many challenges, due to technical issues of standardization, the fragmentation of the regulatory landscape, and the distribution of experiments across laboratories. Moreover, the policy drive towards the creation of a European community of scientists is counteracted by global trends and dynamics, as well as the difficulty to create links and partnerships in the long term beyond the duration of research projects. Despite these challenges, however, the Europeanisation of science is a tangible social and cultural phenomenon, which is illustrated by many examples in addition to research networks, including European societies, conferences, journals, summer schools, and the increasing use of 'Europe' as a unit of analysis in a range of studies and statistical surveys.

Further clarifications are needed. While I provided a fairly comprehensive reading of the main themes and narratives that have emerged in the policy debate from the late 1970s to the present, the study of 'practice' was mainly based on the case of stem cell research. In many ways, as I have explained, this is a critical case study due to the bioethical debates, at the national and European level, and the implications in terms of political economy. It might be objected that I have not engaged with other research areas that are key components in past and present European programmes and have their peculiar problems and dynamics. This is true and empirical work on other priority areas, such as information technology, might provide further insights on the politics and practice of research policies in the European Union. However, in this work I was not interested in providing a comparative review across disciplines and technologies; rather, I aimed to focus on those developments that, at least in recent years, have most clearly epitomised wider issues of European integration and political culture.

There are other important issues that I did not explore and should be given further attention. Notably, my work has mainly focused on 'internal' dynamics of European research. However, future studies should reflect on the effects of

EU research policies in other contexts of knowledge production. While there is a rich literature in the political sciences on the impact of EU political and economic dynamics on the logics of national politics and policy-making (Featherstone and Radaelli 2003), little attention has been paid to research policies. Yet, the European model of research funding and organisation has had a discernible effect at the national level. The network approach - as well as terms such as 'milestones', 'deliverables' and 'work packages' - have become common language and practice in many research cultures beyond the context of EU framework programmes. To give an example, I have recently received a communication from my academic institution, the University of Exeter, advertising a workshop on effective PhD research, which was aimed 'to help identify and develop the key milestones in your research project'. Also, the European model of 'public engagement' has inspired the development of similar initiatives in national contexts. As Cattaneo explained in our interview, after her successful experience with the consortium Eurostemcell, she decided to initiate with other colleagues an Italian network for the promotion and sharing of information and insights on stem cell science. Specifically, the consortium Unistem organises lectures and educational activities in various sites of dissemination, including high schools, museums, and universities, as well as documentaries and other cultural events across science and the arts.[151]

Finally, the migration of the EU approach to other regions of the world is another important issue that deserves specific attention. In the past years, the European Union has supported various initiatives for the promotion of scientific research in economically poor regions, especially in Africa. This commitment has increased after the declaration of the UN Millennium Development Goals in 2001, and was given official recognition in a number of agreements and policy statements, such as the Lisbon Declaration after the EU-Africa Summit in 2007.[152] Within this policy agenda, the EU has funded a number of research consortia that involve partners in the EU and Africa. For example, the Poverty Related Diseases-College (PRD-College) is a cross-regional consortium, which is funded under FP7 and is aimed to train and connect young African and European biomedical scientists and their institutions. The consortium involves a wide range of scientific partners from both African (in Cameroon, South Africa, Uganda, Zambia and Tanzania) and European institutions (in Germany,

[151] See www.unistem.it
[152] See http://ec.europa.eu/development/geographical/regionscountries/euafrica_en.cfm

Sweden, the Netherlands and Italy), and a non-governmental organisation. The approach of the PRD-College reflects the wider shift of European development policies, from a 'traditional donor-recipient relationship' to the 'building of common values and goals in our pursuit of peace and stability, democracy and rule of law, progress and development' (Lisbon Declaration 2007). Indeed, the PRD-College is the first European development project in the biosciences to be coordinated by an African institution, the University of Yaoundé I in Cameroon. At the same time, however, the PRD-College bears the hallmarks of a distinctively European approach. First, its arrangement as a transnational network draws on a well-rehearsed mode of science cooperation in Europe. The export of this model overseas, and its implications on the politics of science cooperation in Africa, is a matter of great interest, which shall be analysed through detailed ethnographic studies. Second, along with theoretical and practical learning in the biosciences, the educational programme of the PRD-College includes course modules in business administration, intellectual property and knowledge management. Thus, the course aims to disseminate not only 'pure' scientific knowledge, but also a full package of skills that well epitomise the culture of biotechnology in neoliberal economies. The reception of this approach in the African context provides a fertile terrain for investigation, as well as the analysis of its wider implications for the political economy of African biosciences.

The Future of Europe

Initiatives such as the PDR-College bear witness to a change of direction in European research policy, characterised by a more cooperative attitude towards the 'external' world outside the boundaries of the Union. Yet narratives of competitiveness and a global race are still prominent in policy discourses, although the ideas of scientists and the actual practice of scientific work are often at odds with these. In line with former statements, for example, the recent paper of the Commission (2010a) *Innovation Union* emphasises once again the challenges of 'increasing global competition', the lack of resources and research funding in Europe vis-à-vis international competitors (US, Japan, and now China), and the resulting need to promote and coordinate research as a means

to boost economic growth in the European Union. Within this wider context of political culture, various initiatives have been launched to 'defend' European scientific identity and elite research. For example, the Foundation Louis Jeantet organises programmes and awards to foster scientific excellence in Europe, with the aims 'to give support to European biomedical research and to defend its role and identity vs. international competition; to encourage the development of a network of first class researchers covering all European Council member countries and to retain or to attract the best of the worldwide biomedical elite to the old continent'.[153]

To some extent, these themes reflect a contradictory tension in the process of European integration as it can be understood through the lenses of Community research policies. While EU research programmes have largely contributed to the ongoing de-nationalisation of science and to some extent have provided a model to national programmes, they have also been underpinned by arguments and discourses that are reminiscent of national ideologies and strategies. As mentioned, the instrumental use of science as a means to enhance national power and prestige has been a recurrent pattern in the history of the modern state. In recent years, the long-standing relation between science and state power has been reframed within the competitiveness paradigm. This is not the place to engage in a thorough analysis of this development, although at least one explanation can be cursorily noted. As the economist Paul Krugman pointed out, concerns of political leaders with international competitiveness emerged in the 1970s/1980s, as a by-product of the economic recession. While the analogy between countries and big companies is unwarranted in strictly economic terms (Krugman 1996), the competitiveness narrative served as a political device to legitimize policy choices and divert the attention from real social issues. As he explained, 'the productivity of the average American worker is determined by a complex array of factors, most of them unreachable by any government policy. So if you accept the reality that our "competitive" problem is really a domestic productivity problem pure and simple, you are unlikely to be optimistic about any dramatic turnaround. But if you can convince yourself that the problem is really one of failures in international competition (...) then the answers to economic malaise may seem to you to involve simple things like subsidizing high technology and being tough on Japan' (Krugman 1994). In the European

[153] www.jeantet.ch

context, likewise, the competitive metaphor became an expedient rationale to avoid risky political choices at a time of increasing unemployment and social discontent. In a somehow elusive way, problems were diverted to the quest for enhanced competitiveness and solutions were delegated to scientific innovation. From then to the present, these narratives have survived for path-dependency, but also lack of political imagination in rethinking current models of political economy, and a different role of science, technology and innovation in a more cooperative world order.

In conclusion, I shall stress the limitations of an agonistic understanding of science and the need for a more cosmopolitan culture of research. The notion of 'Fortress Europe' - open inside its borders but closed to the outside world - has often been debated in relation to EU migration policies, but to some extent can also be used to challenge research programmes. The creation of a European Research Area can be as much exclusive as inclusive. Concurrently, a *not-for-profit* notion of knowledge (Nussbaum 2010) should be given more value in policy statements on European science.[154]

The challenge to embrace openness and global solidarity as fundamental values of science is not only crucial to the field of research policy, but touches on one of the most important questions for the future development of European integration. As we have seen, the *future of Europe* has been at the centre of an intense debate amongst policy makers and academics. Since the very beginning, the experimental nature of European integration and the lack of any historical references have inspired various scenarios about what the new Europe ought to become. Moreover, science has always had a central role in such speculations and planning, due to its ability to innovate and contribute to social change.

Over the past decade, the debate on the future of Europe has received new impulse amidst a renewed sense of crisis. In particular, the repudiation of the proposed federal constitution in 2005 by French and Dutch citizens and the initial rejection of the Lisbon Treaty in Ireland have brought to the surface long standing issues of political legitimacy and democratic deficit in EU policy making. Further, the process of EU enlargement, the growing economic weight of Asian countries, the prospect of Turkey's accession, and the political and

[154] See also Bhola (1999): 'research and basic education can become a regressive idea if, instead of being a tool of personal growth and understanding of humankind, nature and society, it is reduced to a mere tool for the social reproduction of labour and to the professionalization of labour for greater productivity, and higher economic returns to the captains of the global economy' (216).

social pressure of the ongoing economic recession have stimulated further debates on the future of the EU and its political identity. As we have seen in chapter 1, some social theorists have criticised the model of a European 'super-state' and recognized the cosmopolitan potential of the Union. For example, Gerard Delanty and Chris Rumford (2005a) argued that Europe should become a 'transnational polity' engaged with the realization of cosmopolitan values all over the world and 'new kinds of connectivity through which the social is constituted beyond the limits of national societies' (2005b: 416). In a similar vein, Ulrich Beck claimed that Europe should be defined by a 'global sense, a sense of boundarylessness' (2006).

For the moment, it is difficult to predict whether the process of European integration will evolve into a (competition) super-state, characterised by an agonistic attitude towards external players, or will become a more experimental 'cosmopolitan polity' - although current developments indicate a trend towards the former model and a cosmopolitan turn might be particularly challenging, given the institutional mandate of the European Union. In any case, however, science and innovation will be critical policy fields in which important choices about the future of Europe will be both made and reflected.

BIBLIOGRAPHY

Andorno, Roberto (2005), 'The Oviedo Convention: A European Legal Framework at the Intersection of Human Rights and Health Law', *Journal of International Biotechnology Law*, 2: 133-143.

Andrews, Peter et al. (2005), 'Embryonic stem (ES) cells and embryonal carcinoma (EC) cells: opposite sides of the same coin', *Biochemical Society Transactions* 33(6): 1526-1530.

Bala, Arun (2008), *The Dialogue of Civilization in the Birth of Modern Science*, New York: Palgrave Macmillan.

Banchoff, Thomas and Mitchell Smith (eds.) (1999), *Legitimacy and the European Union*, London: Routledge.

Barnes, Barry (2007), 'Catching up with Robert Merton: Scientific Collectives as Status Groups', *Journal of Classical Sociology*, 7(2): 179-192.

Barnes, Barry (1995), *The Elements of Social Theory*, Princeton University Press.

Barnes, Barry (1988), *The Nature of Power*, Cambridge: Polity Press.

Barney, Gerald O. (1980), *The Global 2000. Report to the President. Vol II: The Technical Report*, US Council of Environmental Quality and the Department of State.

Barry, Andrew (2002), In the Middle of the Network, in Law, John and Mol Anne Marie (eds.), *Complexities. Social Studies of Knowledge Practices*, Duke University Press.

Barry, Andrew (2001), *Political Machines: Governing a Technological Society*, London, New York: The Athlone Press.

Beck, Ulrich and Edgar Grande (2007), *Cosmopolitan Europe*, Cambridge: Polity Press.

Beck, Ulrich (2006), *Cosmopolitan Vision*, Cambridge: Polity Press.

Beck, Ulrich (2005), *Power in the Global Age*, Cambridge: Polity Press.

Beck, Ulrich and Natan Szneider (2006), 'Unpacking cosmopolitanism for the social sciences: a research agenda', *British Journal of Sociology*, 57 (1): 1-23.

Bell, Daniel (1974), *The Coming of the Postindustrial Society*, New York: Harper Colophon Books.

Bell, Daniel and Stephen Grauber (1965/1997), *Toward the Year 2000*, The MIT Press.

Benatar, David (2005), 'The Trouble with Universal Declarations,' *Developing World Bioethics* 5(3): 220-224.

Bender, Wolfang, Christine Hauskeller, and Alexandra Manzei (eds) (2005), *Crossing Borders: Cultural, Religious and Political Differences Concerning Stem Cell Research: a Global Approach*, Muenster: Agenda Verlag.

Berezin, Mabel and Martin A Schain (eds.) (2003), *Europe without Borders: Remapping Territory, Citizenship, and Identity in a Transnational Age*, Johns Hopkins University Press.

Berg, Paul et al. (1975), Summary Statement of the Asilomar Conference on Recombinant DNA Molecule, *Proceedings of the National Academy of Sciences USA*, 72 (6): 1981-1984.

Bhola, H. S. (1997), 'Adult education policy projections in the Delors report', *Prospects* 27(2): 207-222.

Bindé, Jérôme and Kōichirō Matsuura (2005), *Towards Knowledge Societies*, UNESCO Publishing.

Blanchard, Anita (2004), The effects of dispersed virtual communities on face-to-face social capital, in Marleen Huysman and Volker Wulf, *Social Capital and Information Technology*, The MIT Press.

Blankenberg, Daniel, et al. (2007), 'A framework for collaborative analysis of ENCODE data: Making large-scale analyses biologist-friendly', *Genome Research*, 17(6): 960-964.

Brickman, Ronald (1977), 'National Science Policy Coordination in the European Community', *International Organization*, 31 (3).

Brownsword, Roger (2005), Regulating stem cell research in the United Kingdom: Filling in the cultural background, in Bender et al. (eds.) (2005).

Cambrosio, Alberto, Peter Keating, and Andrei Mogoutov (2004), 'Mapping Collaborative Work and Innovation in Biomedicine: A Computer-Assisted Analysis of Antibody Reagent Workshops', *Social Studies of Science* 34(3): 325-364.

Cantley, Mark (1982), 'Boning up on biotechnology', *Long Range Planning*, 15 (1): 110-114.

Cantley, Mark and Ken Sargeant (1981), 'Biotechnology : The challenge to Europe', *Revue d'économie industrielle*, 18(1): 319-334.

Carson, Rachel (1962/2002), *Silent Spring*, New York: Mariner Books.

Castells, Manuel (2000), *The Rise of the Network Society*, London: Wiley-Blackwell.

Castells, Manuel and Ince, Martin (2003), *Conversations with Manuel Castells*, Cambridge: Wiley-Blackwell.

Cerutti, Furio (2001), 'Towards the Political Identity of the Europeans. An Introduction', in Fulvio Cerutti and Rudolph Enno (eds), *A Soul for Europe: A Reader*, Leuven: Peeters Publishers.

Collège de France (2004), Colloque 'Science et conscience européennes' (25-27 November 2004).

Collins, Harry (1974), 'The TEA set: Tacit Knowledge and Scientific Networks', *Social Studies of Science*, 4 (2):165-185.

Cooper, Melinda (2008), *Life as Surplus*, University of Washington Press.

Cooper, Melinda (2004), 'Regenerative medicine: stem cells and the science of monstrosity', *Medical Humanities* 30(1): 12-22.

Council of the European Community (1990), Council Decision of 29 June 1990 adopting a specific research and technological development in the field of health: human genome analysis (1991-1994), *Official Journal of the European Communities* (L 196/8).

Council of the European Community (1990), Directive on the deliberate release of genetically modified organisms into the environment (90/220/EEC).

Crawford, Elisabeth, Terry Shinn and Sverker Sörlin (1993), The Nationalization and Denationalization of the Sciences: An Introductory Essay, in *Denationalising Science: the Context of International Scientific Practice*, Dordrecht: Kluwer Academic Publishers.

Crouch, Colin (1999), *Social Change in Western Europe*, Oxford University Press.

Daston, Lorraine (2006), 'The History of Science as European Self-Portraiture', *European Review* 14(4): 523-536.

Davie, Grace (2000), *Religion in Modern Europe*, Oxford University Press.

Delanty, Gerard and Chris Rumford (2005a), *Rethinking Europe. Social Theory and the Implications of Europeanization*, London: Routledge.

Delanty, Gerard (2005b), 'The Idea of a Cosmopolitan Europe: On the Cultural Significance of Europeanization', *International Review of Sociology*, 15 (3): 415-421.

Delanty, Gerard (1998), 'Social Theory and European Transformation: Is there a European Society?', *Sociological Research Online*, 3 (1).

Diéz-Medrano, Juan (2003a), *Framing Europe. Attitudes to European Integration in Germany, Spain and the United Kingdom*, Princeton University Press.

Diéz-Medrano, Juan (2003b), Ways of Seeing European Integration, in Berezin and Schein (2003).

Diéz-Medrano, Juan (2008), 'Europeanization and the Emergence of a European Society', IBEI Working Papers 2008/12.

Dinan, Desmond (2004), *Europe Recast: A History of European Union. Basingstoke,* Basingstoke: Palgrave Macmillan.

Döring, Ole (2004), 'Chinese Researchers Promote Biomedical Regulations: What Are the Motives of the Biopolitical Dawn in China and Where Are They Heading?, *Kennedy Institute of Ethics Journal*, 14 (1): 39-46.

Dupré, John (1993), *The Disorder of Things*, Cambridge University Press.

Durkheim, Émile (1893/1984), *The Division of Labour in Society*, Basingstoke: Macmillan.

Dylander, Benny (1980), 'Technology Assessment: As Science and as a Tool for Policy', *Acta Sociologica*, 23(4): 217-237.

Ehrlich, Paul (1968), *The Population Bomb*, New York: Ballantine Books.

European Commission (2010a), Europe 2020. Flagship Initiative 'InnovationUnion', COM(2010) 546 final.

European Commission (2010b), Simplifying the implementation of the research framework programmes, COM (2010) 187.

European Commission (2009), Preparing Europe for a New Renaissance. A Strategic View of the European Research Area, Luxembourg: Office for the Publications of the European Communities.

European Commission (2008a), Final Report of the Expert Group on the Future of Network of Excellence.

European Commission (2008b), Rules for submission of proposals, and the related evaluation, selection and award procedures, COM (2008) 4617, Brussels.

European Commision (2007a), The European Research Area: New Perspectives, COM (2007) 161 final, Brussels.

European Commission (2007b), Commission staff working document. Regions delivery innovation through cohesion policy, SEC (2007) 1547.

European Commision (2005), Negotiation guidance notes for coordinators of Integrated Projects (IP).

European Commission (2003), *Towards a knowledge-based Europe. The European Union and the Information Society*, Luxembourg: Office for Official Publications of the European Communities.

European Commission (2002a), Life Sciences and Biotechnology. A Strategy for Europe, COM (2002) 27, Luxembourg: Office for Official Publications of the European Communities.

European Commission (2002b), *Stem Cells: Therapies for the Future?*, Luxembourg: Office for Official Publications of the European Communities

European Commission (2001), Towards a Strategic Vision of the Life Sciences', COM(2001) 454 final, Brussels.

European Commission (2000), Making a Reality of the European Research Area, COM (2000) 612 final, Brussels.

European Commission (2000), Towards a European Research Area, COM (2000) 6, Brussels.

European Commission (1998), ELSA FP4 - Catalogue of Contracts (EUR 18309), Brussels.

European Commission (1995), *Towards the Learning Society. White Paper on Education and Training*, Luxembourg: Office for Official Publications of the European Communities.

European Commission (1993), *Growth, Competitiveness, Employment. The Challenges and Ways forward into the 21st Century*, Luxembourg: Office for Official Publications of the European Communities.

European Commission (1988), Proposal for a Council Decision of 2 February 1989 adopting a specific research programme in the fields of health - Predictive medicine: Human genome analysis, COM (88) 496, Brussels.

European Commission (1983a), Prospects for the Development of New Policies: Research and Development, Energy and New Technologies, Bulletin of the European Communities, Supplement 5/83, Luxembourg: Office for Official Publications of the European Communities.

European Commission (1983b), Biotechnology in the Community, COM (83) 672 final/2, Brussels.

European Commission (1980), Tomorrow's Bio-Society, 11/80, Brussels.

European Commission (1977), Common policy in the field of science and technology, COM (77) 283 final, Brussels.

European Council (2002), Council Decision 2002/834/EC, *Official Journal* L294 (29.10.2002).

European Council (2001), 'Presidency conclusions', Stockholm European Summit, 23–24 March..

European Council (2000), 'Presidency conclusions', Lisbon European Summit, 23–24 March, No. 100/1/00.

European Court of Auditors (2009), 'Networks of Excellence' and 'Integrated Projects' in Community research policy. Did they achieve their objectives?, Special Report n. 8, Luxembourg: Publications Office of the European Union.

European Group on Ethics in Science and New Technologies (2001), Citizens Rights and New Technologies: a European Challenge, Brussels.

European Group on Ethics in Science and New Technologies (2000), Ethical aspects of human stem cell research and use, Opinion n. 15 to the European Commission.

European Group on Ethics in Science and New Technologies (2007), Opinion n. 22, Recommendations on the ethical review of hESC FP7 research projects.

European Group on Ethics in Science and New Technologies (1998), Opinion n. 12, Ethical aspects of research involving the use of human embryos in the context of the Fifth Framework Programme, 23 November 1998.

European Parliament (2005a), European Parliament legislative resolution on the proposal for a decision of the European Parliament and of the Council concerning the seventh framework programme of the European Community for research, technological development and demonstration activities (2007 to 2013).

European Parliament (2005b), Resolution on the trade in human egg cells, P6_TA (2005) 0074
European Parliament and the Council (1998), Directive on the Legal Protection of Biotechnology Inventions, *Official Journal of the European Community*, L 213 (30/07/1998).

European Parliament (2003), Legislative resolution on the proposal for a European Parliament and Council directive on setting standards of quality and safety for the donation, procurement, testing, processing, storage, and distribution of human tissues and cells, P5_TA (2003) 0182.

European Parliament (2001), Sitting of 29 November 2001, *Official Journal* C 153 E (2002).

European Parliament (2000), Resolution on Human Cloning, *Official Journal of the European Community*.

European Parliament (1993), Resolution on the Cloning of the Human Embryo, *Official Journal of the European Community*, C 315/224.

European Parliament (1989), Resolution on the ethical and legal problems of genetic engineering, *Official Journal of the European Community*, 96/166.

European Parliament and the Council (2008), Directive on the legal protection of biotechnology invention, *Official Journal of the European Community*, L 213.

European Parliament and the Council (2004), Tissues and Cells Directive, *Official Journal of the European Union*, L 102/48.

European Parliament and the Council (1998), Decision N. 182/1999/EC of 22 December 1998 concerning the fifth framework programme of the European Community for research, technological development and demonstration activities (1998 to 2002)*Official Journal* L 026, 01/02/1999.

Evans, Martin and Matt Kaufman (1981), 'Establishment in culture of pluripotential cells from mouse embryos', *Nature* 292(5819): 154-156.

Faulkner, Alex et al. (2008), 'Tissue-Engineered Technologies: Scientific Biomedicine, Frames of Risk and Regulatory Regime-Building in Europe', *Science as Culture*, 17: 195-222.

Favell, Adrian (2006), The Sociology of EU politics, in Joergensen, K. E., Pollack, Mark A., Rosamond, Ben (eds.), *The Handbook of EU Politics*, London: SAGE.

Favell, Adrian (2003), Eurostars and Eurocities: Towards a Sociology of Free Moving Professionals in Western Europe, CCIS Working Paper (71), University of California, San Diego.

Favell, Adrian and Guiradon, Virginie (2007), 'The Sociology of European Integration', in European Union Studies Association (EUSA), Biennial Conference 2007 (10th), May 17-19, Montreal, Canada.

Featherstone, Kevin and Claudio Radaelli (eds) (2003), *The Politics of Europeanisation*, Oxford University Press.

Felte, Ulrike (ed.) (2007), *Taking European Knowledge Society Seriously*, Luxembourg: Office for Official Publications of the European Communities.

Ferguson-Smith, MA (1991), 'European approach to the Human Gene Project', *FASEB Journal* 5: 61-65.

Fischer, Michael M. J. and George Marcus (1999), *Anthropology as Cultural Critique: an Experimental Moment in the Human Sciences* second edn (University of Chicago Press).

Flyvbjerg, Bent (2006), 'Five Misunderstandings About Case-Study Research', *Qualitative Inquiry* 12(2): 219-245.

Forman, Paul (1973), 'Scientific Internationalism and the Weimar Physicists: The Ideology and Its Manipulation in Germany after World War I', *Isis* 64(2): 151-180.

Fortun, Michael (2001), 'Mediated speculations in the genomics futures markets', *New Genetics and Society*, 20(2): 139.

Foucault, Michel (1984), 'Right of Death and Power over Life', in Paul Rabinow (ed), *The Foucault Reader*, New York: Pantheon Books.

Franklin, Sarah (2006), 'Embryonic Economies: The Double Reproductive Value of Stem Cells', *BioSocieties*, 1(01): 71-90.

Franklin, Sarah and Margaret Lock (eds) (2003), *Remaking Life & Death: Toward an Anthropology of the Biosciences*, School of American Research Press.

Fujimura, Joan H. (1992), 'Crafting Science: Standardised Packages, Boundary Objects, and 'Translation', in Pickering, Andrew (ed.), *Science as Practice and Culture*, University of Chicago Press.

Galison, Peter (2003), The collective author, in Mario Biagioli and Peter Galison (eds.), *Scientific authorship: credit and intellectual property in science* London, New York: Routledge.

Garfinkel, Harold (1984), *Studies in Ethnomethodology*, London: Wiley-Blackwell.

Gaskell, George (2001), In the public eye: representations of biotechnology in Europe, in George Gaskell and Martin Bauer (eds.), *Biotechnology 1996-2000: the Years of Controversy*, London: Science Museum Press.

Genuth, Joel, Ivan Chompalov, and Wesley Shrum (2000), 'How Experiments Begin: The Formation of Scientific Collaborations', *Minerva* 38(3): 311-348.

Geoghegan-Quinn, Máire (2010), Opening remarks at the European Parliament, (January 13, 2010), available at: http://ec.europa.eu/commission_2010-2014/geoghegan-quinn/headlines/speeches/2010/documents/20100113_ep_opening_remarks_en.pdf

Gibbons, Michael et al. (1994), *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*, London: SAGE.

Gilbert, Natasha (2009), 'Red tape blights European Union research programme', *Nature* (6 March 2009).

Gilbert, Natasha (2006), 'How can the EU fund your company', *Nature Biotechnology* (17 November 2006).

Glänzel, W. Et al. (1999), 'A bibliometric analysis of international scientific cooperation of the European Union (1985–1995)', *Scientometrics* 45(2): 185-202.

Goddard, Victoria, Llobera, Jospep, and Shore, Chris (eds.) (1994), *The Anthropology of Europe. Identities and Boundaries in Conflict*, Oxford: Berg.

Godet M. and O. Ruyssen (1981), *The Old World and the New Technology. Challenges to Europe in a Hostile World*, Luxembourg: Office for Official Publications of the European Communities.

Goffman, Erving (1959/1990), *The Presentation of Self in Everyday Life*, London: Penguin.

Goffman, Erving (1961/1990), *Asylums: Essays on the Social Situation of Mental Patients and Other Inmates*, New York: Anchor Books.

Goodman, Dena (1994), *The Republic of Letters. A Cultural History of the French Enlightenment*, Ithaca: Cornell University Press.

Gottweis, Herbert (1998), *Governing Molecules. The Discursive Politics of Genetic Engineering in Europe and the United States*, Cambridge, Massachusetts: The MIT Press.

Greenfeld, Liah (1987), 'Science and National greatness in seventeenth-century England', *Minerva*, 25(1): 107-122.

Greer, Scott L. (2008), 'Choosing paths in European Union health services policy: a political analysis of a critical juncture', *Journal of European Social Policy*, 18(3): 219-231.

Gregor, Thomas A. And Daniel Gross (2004), 'Guilt by Association: The Culture of Accusation and the American Anthropological Association's Investigation of *Darkness in El Dorado*' *American Anthropologist*, 106(4): 687-698.

Gusmao, Ricardo (2001), 'Research networks as a means of European integration', *Technology in Society*, 23 (3): 383-393.

Guzzetti, Luca (1995), *A Brief History of European Union Research Policy*, Luxembourg: Office for Official Publications of the European Community.

Haas, Ernst (1958), *The Uniting of Europe. Political, Social, Economic Forces, 1950-1957*, London: Stevens.

Habermas, Jürgen (2003), 'Toward a Cosmopolitan Europe', *Journal of Democracy*. 14 (4): 86-100.

Habermas, Jürgen (2001a), 'Why Europe Needs a Constitution', *New Left Review*, 11: 5-26.

Habermas, Jürgen (2001b), *The Postnational Constellation*, The MIT Press.

Hall, Neil (2007), 'Advanced sequencing technologies and their wider impact in microbiology', *Journal of Experimental Biology*, 210(9): 1518-1525.

Hall, Stephen S. (2000), 'The Recycled Generation', *New York Times* (January 30, 2000).

Harwood, Jonathan (1993), *Styles of Scientific Thought*, Chicago University Press.

Hauskeller, Christine (2005), 'Science in Touch: Functions of Biomedical Terminology', *Biology and Philosophy*, 20(4): 815-835.

Hauskeller, Christine (2004), 'How traditions of ethical reasoning and institutional processes shape stem cell research in Britain', *Journal of Medicine and Philosophy*, 29 (5), 509-532.

Hess, K (2001), 'Microarrays: handling the deluge of data and extracting reliable information', *Trends in Biotechnology*, 19(11): 463-468.

Hix, Simon (2005), *The Political System of the European Union*, New York: Palgrave Macmillan.

Hoffmann, Stanley (1966), 'Obstinate or Obsolete? The Fate of the Nation State and the Case of Western Europe', *Daedalus*, 95: 892-908.

Hoghart, Stuart and Brian Salter (2010), 'Regenerative medicine in Europe: global competition and innovation governance', *Regenerative Medicine*, 5 (6): 971-985.

Hooghe, Liesbet and Gary Marks (2001), *Multi-level Governance and European Integration*, Oxford: Rowman & Littlefield.

Human Fertility and Embryology Authority and Human Genetics Commission (1998), *Cloning Issues in Reproduction, Science and Medicine*, December 1998.

Imig, Doug and Sidney Tarrow (eds.) (2001), *Contentious Europeans. Protest and Politics in an Emerging Polity*, Oxford: Rowman & Littlefield.

Jackson, Robert and Georg Sorensen (2006), *Introduction to International Relations Theories and Approaches*, Oxford University Press.

Jasanoff, Sheila (2005), *Designs on Nature. Science and Democracy in Europe and the United States*, Princeton University Press.

Judt, Tony (2006), *Postwar. A History of Europe since 1945*, London: Pimlico.

Juris, Jeffrey S. (2008), *Networking Futures: The Movements Against Corporate Globalization*, Duke University Press.

Kastoryano, Riva (2003), Transnational Networks and Political Participation, in Berezin and Schein (2003).

Kay, Lily (1996), *The Molecular Vision of Life. Caltech, the Rockfeller Foundation and the Rise of the New Biology*, Oxford University Press.

Kemp, Peter and Jacob Rendtorff (2008), 'The Barcelona Declaration. Towards an Integrated Approach to Basic Ethical Principles', *Synthesis Philosophica* (46).

King, Anthony (2003), *The European Ritual. Football in the New Europe*, Aldershot: Ashgate.

King, Anthony (2000), 'Football Fandom and Postnational Identity in the New Europe', *British Journal of Sociology*, 51 (3): 419-442.

Knorr-Cetina, Karin (1999), *Epistemic Cultures. How the Sciences Make Knowledge*, Harvard University Press.

Knorr-Cetina, Karin (1991) 'Epistemic Cultures: Forms of Reason in Science', *History of Political Economy*, 23(1):105-122.

Krige, John (2006), American Hegemony and the Reconstruction of European Science, The MIT Press.

Krugman (1996), 'Making sense of the competitiveness debate', *Oxford Review of Economic Policy*, 12: 17-25.

Krugman (1994), 'Competitiveness: A Dangerous Obsession', *Foreign Affairs*, 73(2): 28-44.

Kunkle, Gregory (1995), 'New Challenge or the Past Revisited? The Office of Technology Assessment in Historical Context', *Technology in Society*, 17 (2):175-196

Lamping, Wolfram and Monika Steffen (2009), 'European Union and Health Policy: The "Chaordic" Dynamics of Integration', *Social Science Quarterly* 90(5): 1361-1379.

Landecker, Hannah (2007), *Culturing Life: How Cells Became Technologies*, Harvard University Press.

Latour, Bruno (1987), *Science in Action. How to Follow Scientists and Engineers through Society*. Harvard University Press.

Latour, Bruno and Steve Woolgar (1986), *Laboratory Life*, Princeton University Press.

Laursen, Finn (1999), 'Civil Society and European Integration', *Annals of the American Academy of Political and Social Science*, Vol. 565: 66-78.

Le Galès, Patrick (2002), *European Cities. Social Conflict and Governance*, Oxford University Press.

Le Goff, Jacques (2005), *The Birth of Europe*, Oxford: Blackwell.

Ledford, Heidi (2009), 'Biotech feels the pain', *Nature* 457: 136-137.

Leonelli, Sabina (2010), 'Regulating Data Travel in the Life Sciences: The Impact of Commodification', in Radder, Hans (ed.), *The Commodification of Academic Research: Philosophical Perspectives*, University of Pittsburgh Press.

Levidow, Les (2001), 'Precautionary Uncertainty: Regulating GM Crops in Europe,' *Social Studies of Science*, 31(6): 842-874.

Lewis, Ricki (2000), 'A stem cell legacy: Leroy Stevens', *The Scientists*, 14 (5): 19.

Liverani, Marco (2010), Science and the Building of Europe, in Mazzotti, Massimo (ed.), *Impure Cultures: Interfacing Science, Technology, and the Humanities*, Bologna Studies in History of Science (vol. 12).

Liverani, Marco (2006), *The Quest for the Moral Cell. Science, Religion, Politics and the Making of Biomedicine in Contemporary Italy*, MSc Thesis, University College London.

Llobera, Josep R (2003), 'The Concept of Europe as an Idée-force', *Critique of Anthropology* 23(2): 155-174.

Luukkonen, Terttu et al. (2006), 'Understanding the dynamics of networks of excellence', *Science and Public Policy*, 33: 239-240.

Macdonald, Sharon (1993/1997), Identity Complexes in Western Europe, in Macdonald (ed.), *Inside European Identities*, Oxford: Berg.

Mann, Michael (1993), 'Nation-states in Europe and Other Continents: Diversifying, Developing, not Dying', *Daedalus: Journal of the American Academy of Arts and Sciences*, 122(3): 115-140.

Marshall, Andrew (1997), 'Genset–Abbott deal heralds pharmacogenomics era', *Nature Biotechnology*, 15: 829-830.

Martin Gail, Smith S and Epstein C J (1978), 'Protein synthetic patterns in teratocarcinoma stem cells and mouse embryos at early stages of development', *Developmental Biology*, (66): 8–16.

Martin, G R (1981), 'Isolation of a pluripotent cell line from early mouse embryos cultured in medium conditioned by teratocarcinoma stem cells', *Proceedings of the National Academy of Sciences of the United States of America*, 78(12): 7634-7638.

Massarenti, Armando (2008), *Staminalia: le cellule etiche e i nemici della ricerca*, Parma: Ugo Guanda Editore.

Mattsson, Pauline et al. (2008), 'Intra-EU vs. extra-EU scientific co-publication patterns in EU', *Scientometrics*, 75(3): 555-574.

McKee, Martin and Elias Mossialos (2006), 'Health policy and European law: Closing the gaps', *Public Health* 120 (Supplement 1): 16-21.

Meadows, Donella, Dennis Meadows, Jorgen Randers, and William W. Behrens III (1972), *The Limits to Growth*, New York: Universe Book.

Merton, Robert K. (1973), *The Sociology of Science*, University of Chicago Press.

Metzler, Ingrid (2007), 'Nationalizing Embryos: The Politics of Human Embryonic Stem Cell Research in Italy', *BioSocieties* 2(4): 413-427.

Milward, Alan (1992), *The European Rescue of the Nation-State*, Berkeley: University of California Press.

Morange, Michel (2006), 'What history tells us. Twenty-five years ago: The production of mouse embryonic stem cells,' *Journal of Biosciences* 31(5): 537-541.

Morange, Michel (1997), 'EMBO and EMBL', in Krige, John and Luca Guzzetti (eds) (1997), *A History of European Scientific and Technological Cooperation*, Brussels: Office of the European Commission.

Moravcsik, Andrew (1998), *The Choice for Europe. Social Purpose and State Power from Messina to Maastricht*, Ithaca, N.Y.: Cornell University Press.

Mori, Maurizio, and Demetrio Neri (2001), 'Perils and Deficiencies of the European Convention on Human Rights and Biomedicine', *Journal of Medicine and Philosophy: A Forum for Bioethics and Philosophy of Medicine*, 26:323-345.

Mulkay, Michael (1976), 'The Mediating Role of the Scientific Elite,' *Social Studies of Science* 6(3-4): 445 -470.

Müller-Wille, Staffan and Hans-Jörg Rheinberger (2007), Heredity—The Formation of an Epistemic Space, in *Heredity Produced: At the Crossroads of Biology, Politics, and Culture, 1500-1870*, The MIT Press.

Nature (2010), Editorial: 'Simplification is essential', *Nature* 463 (7284): 999.

Nehrlich, Brigitte (2005), 'A River Runs Through it. How the discourse metaphor crossing the Rubicon structured the debate about human embryonic stem cells in Germany and (not) the UK', available at: http://www.metaphorik.de/08/nerlich.htm

Nowotny, Helga, Peter Scott, and Michael Gibbons (2003), *Knowledge and the Public in an Age of Uncertainties*, Cambridge: Polity Press.

Nussbaum, Martha (2010), *Not for Profit. Why Democracy needs the Humanities*, Princeton University Press.

OECD (1979), *Interfutures: Mastering the Probable and Managing the Predictable*, Paris: OECD.

Oliver et al (1992), 'The complete DNA sequence of yeast chromosome III', in *Nature*, 357 (7): 38-46.

Pàlsson, Gisli and Kristin Hardardóttir (2002), 'For whom the cell tolls', *Current Anthropology*, 43 (2).

Parker, Michael (2007), 'Ethnography/ethics', *Social Science & Medicine* 65(11): 2248-2259.

Paul, Diane (1984), 'Eugenics and the Left', *Journal of the History of Ideas*, 45(4): 567-590.

Pauly, Philip J. (1987), *Controlling life. Jacques Loeb and the Engineering Ideal in Biology*, Oxford University Press.

Pestre, Dominque (2007), *Science, Society and Politics. Knowledge Societies from an Historical Perspective*, Luxembourg: Office for Publications of the European Communities.

Pestre, Dominique (2003), 'Regimes of Knowledge Production in Society: Towards a More Political and Social Reading', *Minerva* 41(3): 245-261.

Peterson, John and Margaret Sharp (1998), *Technology Policy in the European Union*, Basingstoke: Macmillan.

Pinder, John (2001), *The European Union. A Very Short Introduction*, Oxford University Press.

Plomer, Aurora and Paul Torremans (eds) (2010), *Embryonic Stem Cell Patents. European Patent Law and Ethics*, Oxford University Press.

Pollack, Mark (2005), 'Theorizing the European Union: International Organization, Domestic Polity or Experiment in New Governance?', *Annual Review of Political Sciences*, 8, pp. 357-98.

Pollack, Mark and Gregory C. Shaffer (2005), 'Biotechnology Policy: Between National Fears and Global Disciplines', in Helen Wallace, Mark A. Pollack and Alasdair Young (eds), *Policy-Making in the European Union*, 6th edition, New York: Oxford University Press.

Pontifical Academy for Life (2000), Declaration on the Production and the Scientific and Therapeutic Use of Human Embryonic Stem Cells, Vatican City, August 25, 2000, available at: http://www.vatican.va/roman_curia/pontifical_academies/acdlife/documents/

Porter, Roy and Teich, Mikuláš (eds.) (1992), *The Scientific Revolution in National Context*, Cambridge University Press.

Potočnik, Janez (2007), 'Research on Stem Cells in Europe', Speech at the European Parliament, Brussels, Altiero Spinelli Building, 19 December 2007.

Power, Michael (1997), *The Audit Society: Rituals of Verification*, Oxford University Press.

Prainsack, Barbara (2009), 'Negotiating Life': The Regulation of Human Cloning and Embryonic Stem Cell Research in Israel', *Social Studies of Science*, 36 (2): 173-205.

Rabinow, Paul (1996), *Essays in the Anthropology of Reason*, Princeton University Press.

Raj, Kapil (2007), *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650-1900*, New York: Palgrave Macmillan.

Rietschel, Thomas et al (2009), Evaluation of the Sixth Framework Programme for Research and Technological Development, available at: http://ec.europa.eu/research/reports/2009/pdf/fp6_evaluation_final_report_en.pdf

Rifkin, Jeremy (2004), *The European Dream. How Europe's Vision of the Future is Quietly Eclipsing the American Dream*, Cambridge: Polity Press.

Rodríguez-Pose, Andrés (2002), *The European Union. Economy, Society, and Polity*, Oxford University Press.

Rosamond, Ben (2000), *Theories of European Integration*, Basingstoke: Palgrave Macmillan.

Rose, Nikolas (2007), *The Politics of Life Itself. Biomedicine, Power, and Subjectivity in the Twenty-First Century*, Princeton University Press.

Rose, Nikolas (2001), 'The politics of life itself', *Theory, Culture, and Society*, 18 (6): 1-30.

Ross, Andrew (1991), *Strange Weather: Culture, Science, and technology in the Age of Limits*, London: Verso.

Rossi, Paolo (2000), *The Birth of Modern Science*, Oxford University Press.

Salmon, Trevor and Nicoll, William (1997), *Building European Union: a Documentary History and Analysis*, Manchester University Press.

Salter, Brian and Mavis Jones (2002a), 'Human genetic technologies, European governance and the politics of bioethics', *Nature Review Genetics*, 3(10):808-814.

Salter, Brian and Mavis Jones (2002b), 'Regulating human genetics: the changing politics of biotechnology governance in the European Union', *Health, Risk & Society*, 4(3):325- 342.

Sass, Hans-Martin (2001), 'Introduction: European Bioethics on a Rocky Road', *Journal of Medicine and Philosophy: A Forum for Bioethics and Philosophy of Medicine*, 26 (3): 215-221.

Schierup, Carl-Ulrik, Hansen, Peo, and Castels, Stephen (2006), *Migration, Citizenship, and the European Welfare State*, Oxford University Press.

Schlesinger, Philip (1993), Europeanness: A New Cultural Battlefield?, in Hutchinson, John and Smith, Anthony (eds.), *Nationalism*, Oxford University Press.

Scott, John (2006), *Social Network Analysis*, London: SAGE.

Servan-Schreiber, Jean-Jacques (1968), *The American Challenge*, New York: Atheneum.

Shamblott, et al. (1998), 'Derivation of pluripotent stem cells from cultured human primordial germ cells', *Proceedings of the National Academy of Sciences of the United States of America* 95(23): 13726 -13731.

Shapin, Steven (2008), *The Scientific Life*, University of Chicago Press.

Shore, Chris (2006), 'In uno plures (?) EU Cultural Policy and the Governance of Europe', *Cultural Analysis*, 5: 7-26.

Shore, Chris (2000), *Building Europe. The Cultural Politics of European Integration*, London: Routledge.

Shore, Chris (1993), 'Inventing the 'People's Europe': Critical Approaches to European Community 'Cultural Policy'', *Man*, 28 (4): 779-800.

Silver, Lee M. (2004). 'Stalking life's second secret', *Nature*, October 21.

Sleebon-Faulkner, Margaret (2010), 'Contested embryonic culture in Japan - public discussion, and human embryonic stem cell research in an aging welfare society', *Medical Anthropology* 29(1).

Smith, Anthony (1993), 'A Europe of Nations or the Nation of Europe?', *Journal of Peace Research*, 30 (2): 129-135.

Smith, Anthony (1992a), 'National Identity and the Idea of European Unity', *International Affairs* 68 (1): 55-76.

Smith, Anthony (1992b), 'Europe versus the Nation?', *The New Federalist*.

Solter, David (2006), 'From teratocarcinomas to embryonic stem cells and beyond: a history of embryonic stem cell research', *Nature Reviews Genetics* 7: 319-327.

Soysal, Levent (2003), Topography of Migrant Youth Culture in Berlin, in Berezin and Schein (2003).

Soysal, Yasemin (1994), *Limits of Citizenship: Migrants and Postnational Membership in Europe*, Chicago University Press.

Sperling, Stefan (2004), 'Managing potential selves: stem cells, immigrants, and German identity', *Science and Public Policy* 31(2): 139-149.

Stake, Robert E. (1995), *The art of case study research*, London: SAGE.

Stevens, Leroy C. & Little, C. C. (1954), 'Spontaneous Testicular Teratomas in an Inbred Strain of Mice', *Proceedings of the National Academy of Sciences of the United States of America* 40(11): 1080-1087.

Sunder Rajan, Kaushik (2006), *Biocapital. The Constitution of Postgenomic Life*. Duke University Press.

Takahashi, Koji Tanabe et al (2007), 'Induction of Pluripotent Stem Cells from Adult Human Fibroblasts by Defined Factors', *Cell*, 131 (5): 861-872.

Testa , Giuseppe (2010), 'Stem cell theatrics', *Nature*, 465 (24 June 2010).

Testa, Giuseppe, Lodovica Borghese, Julius A. Steinbeck, and Oliver Bruestle (2007), 'Breakdown of the potentiality principle and its impact on global stem cell research', *Cell Stem Cell*, 1, August 2007.

The Nuffield Council on Bioethics (2000), *Stem cell therapy: the ethical issues*, April 2000.

Therborn, Göran (1995), *European Modernity and Beyond: The Trajectory of European Societies, 1945-2000*, London: SAGE Publications.

Thomson, James et al. (1998), 'Embryonic Stem Cell Lines Derived from Human Blastocysts,' *Science* 282(5391): 1145-1147.

Traweek, Sharon (1992), *Beamtimes and Lifetimes: The World of High Energy Physicists*, Harvard University Press.

UK Department of Health (2000), *Stem cell research: medical progress with responsibility*, 16 August 2000, available at: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4065084

UNESCO (1996), *Learning: the Treasure Within*, UNESCO Publishing.

Urwin, Derek (1995), *The Community of Europe: A History of European Integration since 1945*, New York: Longman Publishing.

van der Meer, Robert (1986), 'EC-biotechnology: a European challenge', *Trends in Biotechnology*, 4(11): 277-279.

Vogel, Gretchel (1999), 'Capturing the promise of youth', *Science*, 17 December 1999.

Wainwright, Steven et al (2006), 'Ethical boundary-work in the embryonic stem cell laboratory', *Sociology of Health & Illness* 28(6): 732-748.

Waldby, Catherine (2002), 'Stem Cells, Tissue Cultures and the Production of Biovalue', *Health* 6(3): 305-323.

Walters, LeRoy (2004), 'Human Embryonic Stem Cell Research: An Intercultural Perspective', *Kennedy Institute of Ethics Journal*, 14 (1): 3-38.

Wang, Jessica (1999), American Science in an Age of Anxieties. Scientists, Anti-Communism and the Cold War, University of North Carolina Press.

Wellman, Barry (1983), 'Network Analysis: Some Basic Principles', *Sociological Theory*, 1: 155-200.

Wilson-Kovacs, Dana, Susanne Weber and Christine Hauskeller (2010), 'Stem cells clinical trials for cardiac repair: regulation as practical accomplishment,' *Sociology of Health & Illness* 32(1): 89-105.

Wink, Rüdiger (ed.) (2006), *Deutsche Stammzellpolitik im Zeitalter der Transnationalisierung*, Baden-Baden: Nomos.

Wright Mills, Charles (1953), 'Two Styles of Research in Current Social Studies', in *Philosophy of Science*, 20 (4): 266-275.

Wright, Susan (1986), 'Recombinant DNA Technology and Its Social Transformation, 1972-1982', *Osiris* 2: 303-360.

Yin, Robert K. (1994), *Case study research*, London: SAGE.

Zabusky, Stacia (1995), *Launching Europe. An Ethnography of European Cooperation in Space Science*, Princeton University Press.

Zuckerman, Harriet (1996), *Scientific elite: Nobel laureates in the United States*, New Brunswick: Transaction Publishers.

ANNEX 1: INTERVIEWS

Title (gender), institute	Position	Date of interview
Administrator (M)	Training and Outreach Manager (Estools)	April 2007
Administrator (M), University of Sheffield	Project Manager (Estools)	April 2007
Civil Servant (M), European Parliament	Former Head of Scientific and Technological Options Assessment (STOA), European Parliament	November 2007
Civil Servant (M), European Commission	EU Scientific Officer (Estools)	September 2009 (phone interview)
Doctoral researcher (M), University of Sheffield	Researcher	April 2007
Junior Scientist (F), University of Sheffield	Researcher	April 2007
Junior Scientist (M), University of Sheffield	Researcher	April 2007
Junior Scientist (M), University of Sheffield	Researcher	April 2007
Postdoctoral researcher (F), University of Sheffield	Researcher	April 2007
Professor of Medical Ethics (M), Lund University	Ethics Director	September 2008 (e-mail exchange)
Research and Development Manager (M), Axordia Ltd	SME Researcher (Estools)	April 2007
Senior Scientist (F), University of Milan	Networking Director, Principal Investigator (Eurostemcell)	July 2006
Senior Scientist (M), University of Sheffield	Coordinator, Principal Investigator (Estools)	April 2007
Senior Scientist (M), University of Sheffield	Researcher	April 2007
Senior Scientist (M), University of Sheffield	Researcher	April 2007
Senior Scientist (M), University of Sheffield	Visiting Professor	April 2007
Senior Scientist, IFOM-IEO (Milan)	Associate Principal Investigator (Eurostemcell)	May 2008
Senior Scientist (M), Lund University	Deputy Coordinator, Principal Investigator (Eurostemcell)	October 2008
Senior Scientist (F), University of Milan	Principal Investigator (Estools)	November 2008
Senior Scientist (M), University of Cambridge	Coordinator (Eurostemcell), Deputy Coordinator (Estools), Principal Investigator	November 2008
Senior Scientist (F), University of Edinburgh	Training Director, Principal Investigator (Eurostemcell)	December 2008
Senior Scientist (M), University of Edinburgh	Principal Investigator (Eurostemcell)	December 2008
Senior Scientist (M), University of Edinburgh	Principal Investigator (Eurostemcell)	December 2008

ANNEX 2: EUROSTEMCELL

The consortium Eurostemcell (2004-2008) was a broad collaborative network on stem cell research and applications, funded by the EU under the Sixth Framework Programme with a budget of 11.9 million euros. The network brought together the capabilities of more than 100 researchers across 27 research groups in 19 partner institutions, with a broad range of expertise including stem cell biology, developmental biology, tissue repair, in vivo disease models and clinical cell transplantation. While the large majority of partners worked in academic institutions, the consortium included three private companies: Stem Cell Sciences in the UK, Neuronova AB in Sweden, and NsGene in Denmark. In the jargon of EU framework programmes, Eurostemcell was an *integrated project*, that is 'an instrument to support object-driven research where the primary deliverable is new knowledge', which should aim at either 'increasing Europe's competitiveness or addressing major needs in society'.[155]

The network was established in 2004 upon the initiative of Professor Austin Smith and Professor Anders Bjiorklund (see section 5.1). Professor Smith is a basic scientist with extensive expertise in the field of mouse developmental biology and human stem cell research. At that time, he was the director (and founder) of the first Institute for Stem Cell Research in the UK, at the University of Edinburgh, before moving to the University of Cambridge in 2006. Professor Björklund is a prominent neurobiologist, based at the Lund University in Sweden, and specialised in clinical applications of stem cell science. Over his 40-year scientific career, he has developed pioneering methods of cell transplantation for neurological diseases and particularly Parkinson's disease.

The research programme of the consortium aimed primarily to provide a foundation for translational research in the field of stem cells through the development of cell lines of therapeutic potential, derived from stem cells of embryonic, neural, and epithelial origin. In line with the standard organizational form of EU-funded projects, the programme was divided up into different 'work packages'. The first five work packages focused on the fundamental biology of stem cells, including the identification and isolation of

[155] http://cordis.europa.eu/fp6/instr_ip.htm

stem cells and the study of differentiation and self-renewal mechanisms. The other three work packages aimed to create a platform for the translation of basic knowledge into medical applications, by testing the cell lines generated in the 'fundamental' work-packages in disease models (see table below).

The overall research programme showcased six 'flagship projects', which spanned the eight work packages and focused on the development of support technologies such as a prototype European Stem Cell Database (see discussion in section 5.3) and Stem Cell Repository and the development of a forum for discussion on bioethical and societal issues. Given the clinical orientation of the project, the definition of a 'clinical roadmap' that could take research from bench to bedside was a key flagship project. To this aim, the consortium also organised some workshops to engage different stakeholders (e.g. clinicians, basic scientists, bio-industry representatives, bioethicists) and to define together a strategic plan towards the development of medical therapies. The first workshop, held in March 2006 at the Royal Society in London, was a general meeting on clinical applications of stem cell research. The other two workshops - held in Bonn, Germany (October 2006) and Bellagio, Italy (April 2007) – focused on specific applications for neurological diseases and muscular dystrophy. In the final stage of the project, the board of directors appointed a Clinical Advisory Panel, comprising both clinical scientists working within the project and external clinical scientists with expertise in neurological disease, muscle disease and epithelial repair. This panel was responsible for assessing progress towards clinical applications, evaluating realistic therapeutic goals and proposing guidelines for clinical trials.

Due to controversial issues surrounding the ethics of stem cell research and the diversity of regulatory frameworks in EU member countries where research was carried out, ethical considerations were central to the research programme (see section 5.4). The ethical component of Eurostemcell was led by Göran Hermerén, professor of medical ethics at Lund University with extensive experience as policy advisor both at the national and European level. Currently, Hermerén is president of the European Group on Ethics (see section 3.4.5) of the European Commission and involved in other EU-funded projects. The ethical component was structured around a series of workshops, which aimed to discuss and suggest solutions to specific issues of stem cell research and

applications, such as the establishment of repositories of stem cell lines and stem cell databases, commercialization and patentability of stem cells products.

Training and knowledge dissemination was another important project component. The internal training programme was aimed to facilitate the transfer of knowledge and key technologies within the consortium through workshops and exchange visits across partner laboratories. Other initiatives were aimed at researchers both inside and outside the consortium, including an annual conference on 'Advances in Stem Cell Research' and a summer school on 'Stem cell and regenerative medicine', held in the Greek island of Hydra, with training sessions on the biology of stem cells, clinical applications and ethical issues. In keeping with the policy imperative of public engagement with science (see section 3.4.6), the network organised a range of educational programmes and other initiatives for the wider public of non-specialists. In the UK, for example, Eurostemcell scientists ran several workshops in high schools that were aimed to raise interest and curiosity in prospective university students:

> The aim of the workshops was to give participants a taste of a career in stem cell research, before making their school subject choices. After a short introduction to stem cells and their role in the body, the students' first task introduced them to a one of the most important aspects of working in science - observation. Students used a microscope to look at a flask of cells grown in the lab from mouse embryos. The cells had begun to change into a more specialised cell type. We asked students to observe them for a few moments, to see if they could figure out, just by looking at them, what kind of cells they were. Once the participants had identified the heart cells, they conducted a simulated drug test on a sample of the cells, to rule out possible toxic compounds - drugs that would damage or kill the cells. This gave students a chance to don a pair of gloves and test their skills with a pipette, while also demonstrating an important biomedical application of stem cells.[156]

Finally, the consortium produced a series of educational short films which provide an accessible introduction to the world of stem cells, and related bioethical issues. For example, *A Stem Cell Story* is a 15 minutes feature, combining hand-drawn animations, cell photography and interviews with scientists to explain the basics of stem cell biology in a visually appealing style. *A Stem Cell Story* won several prizes at science film festivals, including the best TV/video production award at the Tromsø Science Media Festival, the best short film award at Scinema in Australia, and was selected to screen in

[156] http://archive.eurostemcell.org/Outreach/Miis.htm

competition at the Science Film Festival in Bangkok, at BaKaFORUM 2007 and at 'Vedere la Scienza' in Italy. Another film is *Conversations: ethics, science, stem cells*, a 19-minute feature that aims to encourage open debate about ethical issues around stem cell research by presenting the views of scientists, ethicists, theologians, and patients on ethical questions such as the beginning of personhood and the legitimacy of scientific research.

The Eurostemcell project concluded its multiannual programme in 2008. However, the project concept is still alive, but with a different format and goals (see section 5.6.1). The original website has become a permanent 'European stem cell portal', with specialised content both for researchers and the lay public, and the network has recently received additional funding from the European Union to organise dissemination activities.[157] The summer school in Greece is still ongoing.

[157] http://www.eurostemcell.org

GOVERNANCE: THE BOARD

Coordinator

Professor Austin Smith
Director of the Wellcome Trust Centre for Stem Cell Research, University of Cambridge, UK.

Prof. Smith was the overall leader for the project, chaired the meetings of the Board of Directors and the Project Steering Committee, and was responsible for all communication with the Commission on contractual matters.

Deputy Coordinator

Professor Anders Björklund
Chief of Section of Neurobiology, Lund Stem Cell Centre, Lund University, Sweden.

Prof Björklund assisted Prof. Smith in the co-ordination of EuroStemCell and was responsible for Technology Evaluation and Exploitation.

Training Director

Dr Clare Blackburn
Head of Developmental Immunology Group, Institute for Stem Cell Research, University of Edinburgh, UK

Dr Blackburn managed the Training and Outreach Programme, promoting the exchange of intellectual and methodological expertise between participating institutions, and ensuring the wider dissemination of knowledge to other stem cell scientists, clinicians and the public.

Networking Director

Professor Elena Cattaneo
Department of Pharmacological Sciences and Center of Excellence on Neurodegenerative Diseases, University of Milano, Italy.

Professor Catteneo was responsible for organizing the Annual Scientific Meetings.

SME Representative

Dr Tim Allsopp
Stem Cell Sciences UK

Dr Allsopp represented the interests of the three biotech companies that were involved in the project.

Scientific advisory board[158]

- **Dr Ron McKay,** *Director of the NIH-Human Stem Cell Facility.*
- **Professor Terrence Partridge,** *Centre for Genetic Medicine Research, Children's National Medical Center*
- **Professor Daniel Pipeleers,** *Professor of Molecular and Cellular Pathology, and Director of the Diabetes Research Centre (DRC) at the Free University, Brussels (VUB)*
- **Dr Gregory R. Stewart,** *Director CNS Drug Therapy Research & Development Medtronic Neurological*

[158] The Scientific Advisory Board provided an external perspective and evaluation of the Consortium's research. It prepared a formal written evaluation of Eurostemcell's research in the fourth year of the project, and contributed to open scientific conferences.

PARTNER INSTITUTES AND PRINCIPAL INVESTIGATORS

DENMARK

NsGene A/S, Ballerup, Denmark

- Dr Lars Wahlberg

FRANCE

Institut Pasteur, Paris, France

- Professor Margaret Buckingham
- Dr Ana Cumano
- Prof Jean-Francois-Nicolas
- Dr Shahragim Tajbakhsh
- Professor Tariq Enver (associate PI)
- Dr Benot Robert (associate PI)

Institute of Developmental Biology and Cancer, Université Nice Sophia Antipolis

- Dr Christian Dani (associate PI)

GERMANY

University of Bonn Medical Center, Bonn, Germany

- Professor Oliver Bruestle
- Dr Frank Edenhofer (associate PI)

ITALY

SCRI, San Raffaele Hospital, Milano, Italy

- Professor Giulio Cossu

University of Milan, Italy

- Professor Elena Cattaneo
- Dr Luciano Conti (associate PI)

EMBL- Monterotondo, Rome, Italy

- Dr Claus Nerlov
- Dr Liliana Minichiello (associate PI)

IFOM-IEO

- Dr Giuseppe Testa (associate PI)

SWEDEN

Karolinska Institute, Stockholm, Sweden

- Professor Ernst Arenas
- Dr Jonas Friesen
- Professor Urban Lendahal

NeuroNova AB, Stockholm, Sweden

- Dr Anders Haegerstrand

Stem Cell Center, Lund University, Sweden

- Prof. Andras Bjorklund
- Prof. Sten-Eirik Jacobsen
- Professor Olle Lindvall
- Dr Zaal Kokaia (associate PI)

Lund University, Faculty of Medicine

- Prof. Goran Hermeren

SWITZERLAND

Ecole Polytechnique Federale, Lausanne, Switzerland

- Yann Barrandon

UNITED KINGDOM

Institute for Stem Cell Research, University of Edinburgh, Scotland

- Dr Clare Blackburn
- Dr Alexander Medvinsky
- Dr Simon Tomlinson
- Dr Val Wilson
- Dr Brian Hendrich (associate PI)

Stem Cell Sciences UK Ltd, Cambridge

- Dr Tim Allsopp

Cancer Research UK, Cambridge

- Fiona Watt

The Wellcome Trust Sanger Institute, Cambridge

- Dr John McCafferty

The Wellcome Trust Centre for Stem Cell Research, University of Cambridge

- Professor Austin Smith

MRC Clinical Sciences Centre, London

- Dr Meng Li

WORKPACKAGES

FUNDAMENTAL BIOLOGY OF STEM CELLS

Workpackages 1A and 1B: Identification and Isolation of Stem Cells

WP1A: Identification and Isolation of Stem Cells - neural lineages
Leader: Austin Smith, University of Cambridge

WP1B: Identification and Isolation of Stem Cells - non-neural lineages
Leader: Shahragim Tajbakhsh, Institut Pasteur

These two workpackages focused on the identification, isolation and comparative characterization of stem cells for tissues of major clinical importance, including neural stem cells for brain repair, mesodermal stem cells for giving rise to blood cells and muscular tissue, epithelial stem cells for skin replacement and for generation of thymus and other epithelial organs.

WP2: Lineage Analysis and Differentiation Potential
Leader: Val Wilson, University of Edinburgh

Wp2 2 aimed to determine the normal routes a stem cell takes when differentiating into specialized cells and contributing to tissues. Analysis of cell lineages would highlight the intermediate cell types generated by stem cells, as well as their locations, migratory routes and cellular environments in normal individuals. This is an important source of information for the isolation, culture and differentiation of stem cells in the laboratory, and is therefore crucial if stem cells are to be used for stem cell regenerative therapies and drug discovery.

WP3: Self-renewal and Up-Scaling (for potential applications)
Leader: Tim Allsopp, Stem Cell Sciences UK Ltd

This workpackage aimed to analyse the factors that control stem cell self-renewal (the ability of a stem cell to make copies of itself indefinitely) and use this information to define the conditions and procedures that are required for the generation of expanded and clinically acceptable resources for cell therapies.

WP4: Control of Differentiation
Leaders: Claus Nerlov, EMBL; Ernest Arenas, Karolinska Institute

WP 4 aimed to develop tools that allow the reproducible generation of stem cell populations capable of efficient and directed differentiation into all the specialized cell types necessary for tissue repair.

APPLICATION OF STEM CELL THERAPIES

WP5: Applications in Neurological Disease
Leader: Oliver Brüstle, University of Bonn

WP 5 tested the ability of transplanted stem cells and cell lines, generated in workpackages 1,3 and 4, and derived from endogenous neural stem cells, to differentiate into therapeutically relevant cell types for the treatment of Parkinson's Disease, stroke and myelin diseases using animal models.

WP6: Applications in Muscle Repair and Neuromuscular Disease
Leader: Margaret Buckingham, Institut Pasteur

WP 6 tested the ability of stem cells and cell lines, generated in the other workpackages, for their capacity to contribute to skeletal muscle, using mouse models for muscular dystrophy.

WP7: Epidermal Repair
Leader: Fiona Watt, Cancer Research UK
WP7 aimed to use animal models to improve the techniques for grafting cultured epidermis and optimise the conditions for recreating hair follicles, sweat and sebaceous glands in the skin of human burns victims.

FLAGSHIP PROJECTS
FSP1: The Generation of Antibodies for Stem Cell Identification Leader: John McCafferty, Wellcome Trust Sanger Institute This project sought to widen the range of antibodies available in stem cell community and characterise their utility for identifying sub-populations of cells during differentiation, by taking advantage of existing efforts among partner institutions to generate antibodies and apply them to the stem cell research.
FSP2: The Development of a Prototype European Stem Cell Database and Stem Cell Registry Leader: Simon Tomlinson, University of Edinburgh This project established a stem cell database (Stem DB) containing a wide range of information about stem cells - from basic biology to clinical applications. The data was derived from new findings generated by the Eurostemcell consortium and existing published data.
FSP3: A Forum for Ethics and Societal Issues Related to Stem Cell Research Leader: Göran Hermerén, University of Lund This project considered a range of topical issues relating to stem cell research. The work was presented in a series of workshops, involving participants also from EU-funded stem cell consortia. Workshops aimed to identify and analyse issues, and come up with suggestions as to how they are to be handled and relate these proposals to current regulations in various countries where the research is carried out.
FSP4: Stem Cell Bioinformatics Leader: Simon Tomlinson, University of Edinburgh This project facilitated comparative analysis of the stem cell molecular profiling data generated in the other Eurostemcell workpackages, and foster bioinformatics collaborations among different participating groups.
FSP5: Clinical Roadmap Leader: Olle Lindvall, Lund University This project aimed to generate a 'roadmap to the clinic' - a statement on the steps necessary in developing clinical applications from stem cells. Clinicians, basic scientists, bioindustry representatives and ethicists were engaged in this process through a series of workshops focused on neurological, neuromuscular and skin disorders - corresponding to the research activities in workpackages 5, 6 and 7.
FSP6: Public Engagement and Outreach Leader: Clare Blackburn, University of Edinburgh This project involved the organisation of training programmes outreach activities, including educational shoprt films, workshops in high schools, and the summer school.

List of Publications

Included in this listing are papers directly related to the Eurostemcell project, as they were reported and organised by workpackages in the consortium website. This list is only a subset of publications by Eurostemcell partners and does not include many other publications that were relevant to the project but were directly supported by Eurostemcell.

Publications for WP1A

Barraud, Perrine, Simon Stott, Kjeld Møllgård, Malin Parmar, and Anders Björklund (2006), 'In vitro characterization of a human neural progenitor cell coexpressing SSEA4 and CD133', *Journal of Neuroscience Research*, 85 (2): 250-259.

Biella, Gerardo, Francesca Di Febo, Donato Goffredo, Alessia Moiana, Vanni Taglietti, Luciano Conti, Elena Cattaneo and Mauro Tosel, 'Differentiating embryonic stem-derived neural stem cells show a maturation-dependent pattern of voltage-gated sodium current expression and graded action potentials, *Neuroscience*, 149(1):38-52.

Conti, Luciano , Steven M. Pollard, Thorsten Gorba, Erika Reitano, Mauro Toselli, Gerardo Biella, Yirui Sun, Sveva Sanzone, Qi-Long Ying, Elena Cattaneo and Austin Smith (2005), 'Niche-independent symmetrical self-renewal of a mammalian tissue stem cell', *PLoS Biology*, 3(9): e283

Conti, Luciano, Elena Cattaneo and Evangelia Papadimou (2008), 'Novel neural stem cell systems', *Expert Opinion on Biological Therapy*, 8(2):153-60.

Conti, Luciano, Erika Reitano, Cattaneo Elena (2006), 'Neural stem cell systems: diversities and properties after transplantation in animal models of diseases', *Brain Pathology*, 16 (2), 143–154.

Glaser, Tamara, Alberto Perez-Bouza, Katja Klein and Oliver Brüstle (2005), 'Generation of purified oligodendrocyte progenitors from embryonic stem cells', *FASEB Journal*, 19: 112-114.

Glaser, Tamara, Steven M. Pollard, Austin Smith, Oliver Bruestle (2007), 'Tripotential Differentiation of Adherently Expandable Neural Stem (NS) Cells', *PLoS ONE* 2(3): e298.

Glaser, Tamara, Tanja Schmandt, Oliver Brüstle (2008), 'Generation and potential biomedical applications of embryonic stem cell-derived glial precursors', *Journal of the Neurological Science*, 265:47-58.

Gossrau, Gudrun, Janine Thiele, Rachel Konang, Tanja Schmandt and Oliver Bruestle (2007), 'BMP-mediated modulation of lineage diversification during neural differentiation of embryonic stem cells', *Stem Cells*, 25 (4): 939-949.

Haupt, Simone, Frank Edenhofer, Michael Peitz, Anke Leinhaas and Oliver Bruestle (2006), 'Stage specific conditional mutagenesis in mouse embryonic stem cell-derived neural cells and post-mitotic neurons by direct delivery of biologically active Cre recombinase', *Stem Cells*, 25 (1): 181-188.

Kunath, Tilo, Marc K. Saba-El-Leil, Marwa Almousailleakh, Jason Wray, Sylvain Meloche and Austin Smith (2007), 'FGF stimulation of the Erk1/2 signalling cascade triggers transition of pluripotent embryonic stem cells from self-renewal to lineage commitment', *Development*, 134: 2895-2902.

Lowell, Sally, Alexandra Benchoua, Barry Heavey and Austin G Smith (2006), 'Notch Promotes Neural Lineage Entry by Pluripotent Embryonic Stem Cells', *PLOS biology*, 4 (5): e121.

Nolden, Lars, Frank Edenhofer, Simone Haupt, Philipp Koch, F Thomas Wunderlich, Henrike Siemen & Oliver Bruestle (2006), 'Site-specific recombination in human embryonic stem cells induced by cell-permeant Cre recombinase', *Nature Methods*, 3: 461 – 467.

Parmar, Malin and Meng Li (2007), 'Early specification of dopaminergic phenotype during ES cell differentiation', *BMC Developmental Biology*, 7:86doi:10.1186/1471-213X-7-86

Patsch, Christoph and Frank Edenhofer (2007), 'Conditional Mutagenesis by cell-permeable proteins: potential, limitations and prospects', *Handbook of Experimental Pharmacology*, 178:203-232.

Peitz, Michael, Richard Jäger, Christoph Patsch, Andrea Jäger, Angela Egert, Hubert Schorle and Frank Edenhofer (2007), 'Enhanced purification of cell-permeant Cre and germline transmission after transduction into mouse ES cells', *Genesis*, 45:508-517.

Pollard, Steven and Luciano Conti (2007), 'Investigating radial glia in vitro', *Progress in Neurobiology*, 83(1):53-67.

Pollard, Steven, Alex Benchoua and Sally Lowell, 'Neural Stem Cells, Neurons, and Glia', *Methods in Enzymology*, 418: 151-169.

Pollard, Steven, Luciano Conti and Austin Smith (2006), 'Exploitation of adherent neural stem cells in basic and applied neurobiology', *Regenerative Medicine*, 1 (1): 111-118.

Pollard, Steven, Luciano Conti, Yirui Sun, Donato Goffredo, and Austin Smith (2006), 'Adherent neural stem (NS) cells from foetal and adult forebrain', *Cerebral Cortex*, 16(Supplement 1):i112-i120.

Scheffler, Björn, Frank Edenhofer and Oliver Bruestle (2006), 'Merging fields: Stem cells in neurogenesis, transplantation, and disease modeling', *Brain Pathology*, 16: 155-168.

Schmandt, Tanja, Eybe Meents, Gudrun Gossrau, Volker Gornik, Shigeo Okabe and Dr. Oliver Brüstle (2005), 'High purity lineage selection of embryonic stem cell-derived neurons', *Stem Cells Development*, 14:55-64.

Steven M Pollard, Luciano Conti and Austin Smith (2006), 'Exploitation of adherent neural stem cells in basic and applied neurobiology', *Regenerative Medicine*, 1 (1): 111-118.

Publications for WP1B

Adolfsson, Jörgen, Robert Månsson, Natalija Buza-Vidas, Anne Hultquist, Karina Liuba, Christina T. Jensen, David Bryder, Liping Yang, Ole-Johan Borge, Lina A.M. Thoren, Kristina Anderson, Ewa Sitnicka, Yutaka Sasaki, Mikael Sigvardsson, and Sten Eirik W. Jacobsen (2005), 'Identification of Flt3+ Lympho-Myeloid Stem Cells Lacking Erythro-Megakaryocytic Potential: A Revised Road Map for Adult Blood Lineage Commitment', *Cell*, 121, 295–306.

Bertrand, Julien, Sébastien Giroux, Rachel Golub, Michèle Klaine, Abdelali Jalil , Laurent Boucontet, Isabelle Godin, and Ana Cumano (2005), 'Characterization of purified intraembryonic hematopoietic stem cells as a tool to define their site of origin', *PNAS* , 102 (1), 134-139.

Biressi, Stefano Enrico Tagliafico, Giuseppe Lamorte, Stefania Monteverde, Elena Tenedini, Enrica Roncaglia, Sergio Ferrari, Stefano Ferrari, Maria Gabriella Cusella-De Angelis, Shahragim Tajbakhsh and Giulio Cossu (2007), 'Intrinsic phenotypic diversity of embryonic and fetal myoblasts is revealed by genome-wide gene expression analysis on purified cells', *Developmental Biology*, 304(2):633-51.

Buckingham, Margaret and Frédéric Relaix (2007), 'The Role of Pax genes in the development of tissues and organs: Pax3 and Pax7 regulate muscle progenitor cell functions', *Annual Review of Developmental Biology*, 23, 645-673.

Chapman, Gavin, Lining Liu, Cecilia Sahlgren, Camilla Dahlqvist, and Urban Lendahl (2006), 'High levels of Notch signaling downregulate Numb and Numblike', *Journal of Cell Biology*, 175, 535-540.

Cossu, Giulio and Shahragim Tajbakhsh (2007), 'Oriented cell divisions and muscle satellite cell heterogeneity', *Cell*, 129(5):859-61.

Depreter, Marianne, Natalie F. Blair, Terri L. Gaskell, Craig S. Nowell, Kathleen Davern, Adelina Pagliocca, Frances H. Stenhouse, Alison M. Farley, Adrian Fraser, Jan Vrana, Kevin Robertson, Grant Morahan, Simon R. Tomlinson, and C. Clare Blackburn (2008), 'Identification of Plet-1 as a specific marker of early thymic epithelial progenitor cells', *Proceedings of the National Academy of Sciences*, 105(3):961-6.

Esner, Milan, Sigolène M. Meilhac, Frédéric Relaix, Jean-François Nicolas, Giulio Cossu and Margaret E. Buckingham (2006), 'Smooth muscle of the dorsal aorta shares a common clonal origin with skeletal muscle of the myotom', *Development*, 133: 737-749.

Gayraud-Morel, Barbara, Fabrice Chrétiena, Patricia Flamanta, Danielle Gomèsa, Peter S. Zammite and Shahragim Tajbakhsh (2007), 'A role for the myogenic determination gene Myf5 in adult regenerative myogenesis', *Developmental Biology*, 312(1):13-28.

Kassar-Duchossoy, Lina, Ellen Giacone, Barbara Gayraud-Morel, Aurélie Jory, Danielle Gomès, and Shahragim Tajbakhsh (2005), 'Pax3/Pax7 mark a novel population of primitive myogenic cells during development', *Genes Development*, 19(12):1426-31.

Månsson, Robert, Anne Hultquist, Sidinh Luc, Liping Yang, Kristina Anderson, Shabnam Kharazi, Suleiman Al-Hashmi, Karina Liuba, Lina Thorén, Jörgen Adolfsson, Natalija Buza-Vidas, Hong Qian, Shamit Soneji, Tariq Enver, Mikael Sigvardsson and Sten Eirik W. Jacobsen (2007), 'Molecular evidence for hierarchical transcriptional lineage priming in fetal and adult stem cells and multipotent progenitors', *Immunity*, 26(4):407-19.

Relaix, Frédéric, Didier Rocancourt, Ahmed Mansouri and Margaret Buckingham (2005), 'A Pax3/Pax7-dependent population of skeletal muscle progenitor cells', *Nature*, 435, 948-953.

Shinin, Vasily, Barbara Gayraud-Morel, Danielle Gomès & Shahragim Tajbakhsh (2006), 'Asymmetric division and cosegregation of template DNA strands in adult muscle satellite cells', *Nature Cell Biology*, 8: 677-682.

Tajbakhsh, Shahragim (2005), 'Skeletal muscle stem and progenitor cells: Reconciling genetics and lineage', *Experimental Cell Research*, 306 (2): 364-372.

Yang, Liping, David Bryder, Jörgen Adolfsson, Jens Nygren, Robert Månsson, Mikael Sigvardsson, and Sten Eirik W. Jacobsen (2005), 'Identification of Lin Sca1 kit CD34 Flt3 short-term hematopoietic stem cells capable of rapidly reconstituting and rescuing myeloablated transplant recipients', *Blood*, 105 (7): 2717-2723.

Publications for WP2

Carlén, Marie, Konstantinos Meletisa, Fanie Barnabé-Heidera and Jonas Frisén (2006), 'Genetic visualization of neurogenesis. Experimental Cell Research', *Experimental Cell Research*, 312 (15): 2851-2859.

Esner, Milan, Sigolène M. Meilhac, Frédéric Relaix, Jean-François Nicolas, Giulio Cossu and Margaret E. Buckingham (2006), 'Smooth muscle of the dorsal aorta shares a common clonal origin with skeletal muscle of the myotom', *Development*, 133: 737-749

Legué, Emilie and Jean-François Nicolas (2005), 'Hair follicle renewal : organization of stem cells in the matrix and the role of stereotyped lineages and behaviors', *Development* 132: 4143-54.

Petit, Anne-Cécile, Emilie Legué and Jean-François Nicolas (2005), 'Methods in clonal analysis and applications', *Reproduction Nutrition Development*, 45: 321-339.

Sambasivan, Ramkumar and Shahragim Tajbakhsh (2007), 'Skeletal muscle stem cell birth and properties', *Seminars in Cell and Developmental Bioology*., 18(6):870-82.

Samir Taoudi and Alexander Medvinsky (2007), 'Functional identification of the hematopoietic stem cell niche in the ventral domain of theembryonic dorsal aorta', *PNAS*, 104 (22): 9399–9403.

Tajbakhsh, Shahragim (2005), 'Skeletal muscle stem and progenitor cells: Reconciling genetics and lineage', *Experimental Cell Research*, 306 (2): 364-372.

Taoudi, Samir, Aline M. Morrison, Hirofumi Inoue, Ruby Gribi, Janice Ure and Alexander Medvinsky (2005), 'Progressive divergence of definitive haematopoietic stem cells from the endothelial compartment does not depend on contact with the foetal liver', *Development*, 132: 4179-4191

Publications for WP3

Buza-Vidas, Natalija, Jennifer Antonchuk, Hong Qian, Robert Månsson, Sidinh Luc, Sasan Zandi, Kristina Anderson, Satoshi Takaki, Jens M. Nygren, Christina T. Jensen and Sten Eirik W. Jacobsen (2006), 'Cytokines regulate postnatal hematopoietic stem cell expansion: opposing roles of thrombopoietin and LNK', *Genes and Development* 20:2018-2023.

Donati, Chiara, Francesca Cencetti, Paola Nincheri, Caterina Bernacchioni, Silvia Brunelli, Emilio Clementi, Giulio Cossu, Paola Bruni (2007), 'Sphingosine-1-phosphate mediates proliferation and survival of mesoagnioblasts', *Stem Cells*, 25(7):1713-9.

Kirstetter, Peggy, Kristina Anderson, Bo T Porse, Sten Eirik W Jacobsen and Claus Nerlov (2006), 'Activation of the canonical Wnt pathway leads to loss of haematopoietic stem cell repopulation and multilineage differentiation block', *Nature Immunology*, 7: 1048-1056.

Nichols, Jennifer and Qi-Long Ying (2006), 'Derivation and Propagation of Embryonic Stem Cells in Serum and Feeder- Free Culture', *Methods in Molecular Biology*, 329:91-8.

Publications for WP4

Arenas, Ernest (2005), 'Engineering a Dopaminergic Phenotype in Stem/ Precursor Cells: Role of Nurr1, Glia-Derived Signals, and Wnts', *Annals of the New York Academy of Sciences*, 1049: 51-66.

Barraud, Perrine, Thompson, Lachlan, Kirik, Deniz; Bjorklund, Anders; Parmar, Malin 92005), 'Isolation and characterization of neural precursor cells from the Sox1-GFP reporter mouse', *European Journal of* Neuroscience, 22(7):1555-69.

Bryja, Vítězslav, Gunnar Schulte and Ernest Arenas (2007), 'Wnt-3a utilizes a novel low dose and rapid pathway that does not require casein kinase 1-mediated phosphorylation of Dvl to activate b-catenin', *Cellular Signalling*, 19 (3): 610-616.

Bryja, Vítězslav, Gunnar Schulte, Nina Rawal, Alexandra Grahn and Ernest Arenas (2007), 'Wnt-5a induces Dishevelled phosphorylation and dopaminergic differentiation via a CK1-dependent mechanism', *Journal of Cell* Science, 120(Pt 4):586-95.

Bryja, Vítzslav, Sonia Bonilla and Ernest Arenas (2006), 'Derivation of mouse embryonic stem cells', *Nature Protocols*, 1: 2082 – 2087.

Calella, Anna, Claus Nerlov, Rodolphe G Lopez, Carla Sciarretta, Oliver von Bohlen und Halbach, Oksana Bereshchenko and Liliana Minichiello (2007), 'Neurotrophin/Trk receptor signaling mediates C/EBPα, -β and NeuroD recruitment to immediate-early gene promoters in neuronal cells and requires C/EBPs to induce immediate-early gene transcription', *Neural Development*, 2:4 doi:10.1186/1749-8104-2-4.

Castelo-Branco, Gonçalo, Kyle M. Sousa, Vitezslav Bryja, Luisa Pinto, Joseph Wagner and Ernest Arenas (2006), 'Ventral midbrain glia express region-specific transcription factors and regulate dopaminergic neurogenesis through Wnt-5a secretion', *Molecular and Cellular Neuroscience*, 31:251-262.

Castelo-Branco, Gonçalo, Nina Rawal and Ernest Arenas (2004), 'GSK-3ß inhibition/ß-catenin stabilization in ventral midbrain precursors increases differentiation into dopamine neurons', *Journal of Cell Science*, 117:5731-7.

Chapman, Gavin, Lining Liu, Cecilia Sahlgren, Camilla Dahlqvist, and Urban Lendahl (2006), 'High levels of Notch signaling downregulate Numb and Numblike', *Journal of Cell Biology*, 175: 535-540.

Christophersen, Nicolaj, Xia Meijerc, Jesper R. Jørgensena, Ulrica Englundd, Mette Grønborga, Åke Seigere, Patrik Brundinb and Lars U. Wahlberg (2006), 'Induction of dopaminergic neurons from growth factor expanded neural stem/progenitor cell cultures derived from human first trimester forebrain', *Brain Research Bulletin*, 70(4-6):457-66.

Gustafsson, Maria, Xiaowei Zheng, Teresa Pereira, Katarina Gradin, Shaobo Jin, Johan Lundkvist, Jorge L. Ruas, Lorenz Poellinger, Urban Lendahl and Maria Bondesson1 (2005), 'Hypoxia requires Notch signaling to maintain the undifferentiated cell state', *Developmental Cell*, 9(5):617-28.

Hansson, Emil, Kia Strömberg, Susanne Bergstedt, Gang Yu, Jan Näslund, Johan Lundkvist and Urban Lendahl (2005), 'Aph-1 interacts at the cell surface with proteins in the active γ-secretase complex and membrane-tethered Notch', *Journal of Neuroschemistry*, 92: 1010-1020.

Hansson, Emila, Ana I. Teixeira, Maria V. Gustafsson, Takeaki Dohda, Gavin Chapman, Konstantinos Meletis, Jonas Muhr and Urban Lendahl, 'Recording Notch signaling in real time Stem Cells', *Developmental Neuroscience*, 28:118-127.

Maxwell, Sarah, Hsin-Yi Ho, Eva Kuehner, Suling Zhao, Meng Li (2005), 'Pitx3 regulates tyrosine hydroxylase expression in the substantia nigra and identifies a subgroup of mesencephalic dopaminergic progenitor neurons during mouse development', *Developmental* Biology, 282(2):467-79.

Nolden, Lars Frank Edenhofer, Michael Peitz and Oliver Bruestle(2007), Stem cell engineering using transducible Cre recombinase, in H. Hauser and M. Fussenegger (eds.), *Methods in Molecular Medicine: Tissue Engineering* (2nd Edition), Humana Press, pp. 17-32.

Patsch, Christoph and Frank Edenhofer (2007), 'Conditional Mutagenesis by cell-permeable proteins: potential, limitations and prospects', *Handbook of Experimental Pharmacology*, 178:203-232.

Paul, Gesine, Nicolaj S. Christophersen, Heather Raymon, Caroline Kiaer, Ruben Smith and Patrik Brundin (2007), 'Tyrosine hydroxylase expression is unstable in a human immortalized mesencephalic cell line-studies in vitro and after intracerebral grafting in vivo', *Molecular and Cellular Neuroscience*, 34: 390–399.

Peitz, Michael, Richard Jäger, Christoph Patsch, Andrea Jäger, Angela Egert, Hubert Schorle and Frank Edenhofer (2007), 'Enhanced purification of cell-permeant Cre and germline transmission after transduction into mouse ES cells', *Genesis*, 45:508-517.

Rawal, Nina, Clare Parish, Gonçalo Castelo-Branco and Ernest Arenas (2007), 'Inhibition of JNK increases the survival of transplanted dopamine neurons in Parkinsonian rats', *Cell Death and Differentiation*, 14: 381–383.

Rawal, Nina, Gonçalo Castelo-Branco, Kyle M Sousa, Kazuto Kobayashi, Hideyuki Okano, and Ernest Arenas (2006), 'Dynamic temporal and cell-type specific expression of Wnt signaling components in the developing midbrain', *Experimental Cell Research*, 312(9):1626-36.

Scheffler, Björn, Frank Edenhofer and Oliver Bruestle (2006), 'Merging fields: Stem cells in neurogenesis, transplantation, and disease modeling', *Brain Pathology*, 16:155-168.

Schulte, Gunnar, Vítezslav Bryja, Nina Rawal, Gonçalo Castelo-Branco, Kyle Sousa, Ernest Arenas (2005), 'Purified HA-Wnt5a increases differentiation of dopaminergic precursor cells and disheveled phosphorylation', *Journal of Neurochemistry*, 92:1550-1553

Strömberg, Kia, Emil M. Hansson, Hanna Laudon, Susanne Bergstedt, Jan Näslund, Johan Lundkvist and Urban Lendahl (2005), 'γ-Secretase complexes containing N- and C-terminal fragments of different presenilin origin retain normal γ-secretase activity', *Journal of Neurochemistry*, 95(3):880-90.

Thompson, Lachlan, Elin Andersson, Josephine B. Jensen, Perrine Barraud, Francois Guillemot, Malin Parmar and Anders Björklund (2006), 'Neurogenin2 identifies a transplantable dopamine neuron precursor in the developing ventral mesencephalon', *Experimental Neurology*, 198 (1): 183-198.

Tünnemann, Gilla, Rainer Martin, Simone Haupt, Christoph Patsch, Frank Edenhofer and M. Crisitna Cardoso (2006), 'Cargo-dependent mode of uptake and bioavailability of TAT-containing proteins and peptides in living cells', *FASEB Journal*, 20:1775-1784.

Zhao, Suling, Sarah Maxwell, Antonio Jimenez-Beristain, Joaquim Vives, Eva Kuehner, Jiexin Zhao, Carmel O'Brien, Carmen de Felipe, Elena Semina and Meng Li (2004), 'Generation of embryonic stem cells and transgenic mice expressing green fluorescence protein in midbrain dopaminergic neurons', *European Journal of Neuroscience*, 11:1133-1140.

Publications for WP5

Bajard, Lola, Frédéric Relaix, Mounia Lagha, Didier Rocancourt, Philippe Daubas, and Margaret E. Buckingham (2006), 'A novel genetic hierarchy functions during hypaxial myogenesis : Pax3 directly activates Myf5 in muscle progenitor cells in the limb', *Genes and Development*, 20(17):2450-64.

Buckingham, Margaret and Frédéric Relaix (2007), 'The role of Pax genes in the development of tissues and organs : Pax3 and Pax7 regulate muscle progenitor cell functions', *Annual Review of Cell and Developmental Biology*, 23: 645-673.

Cacci E., Villa A., Parmar M., Mandahl N., Lindvall O., Martinez-Serrano A. and Kokaia Z. (2007), 'Generation of human cortical neurons from a new immortal fetal neural stem cell line', *Experimental Cell Research*, 313 (3): 588-601

Collin, Tove, Andreas Arvidsson, Zaal Kokaia and Olle Lindvall (2005), 'Quantitative analysis of the generation of different striatal neuronal subtypes in the adult brain following excitotoxic injury', *Experimental Neurology*, 195: 71-80.

Darsalia Vladimer, Therése Kallur, Zaal Kokaia (2007), 'Survival, migration and neuronal differentiation of human fetal striatal and cortical neural stem cells grafted in stroke-damaged rat striatum', *European Journal of Neuroscience*, 26: 605-614.

Dellavalle, Arianna, Maurilio Sampaolesi, Rossana Tonlorenzi, Enrico Tagliafico, Dario Sacchetti, Laura Perani, Beatriz G. Galvez, Graziella Messina, Roberta Morosetti, Yvan Torrente, Stefano Ferrari, Paolo Bianco, and Giulio Cossu (2007), 'Pericytes of human skeletal muscle are myogenic precursors distinct from satellite cells', *Nature Cell Biology*, 9(3):255-67.

Galvez, Beatriz G., Maurilio Sampaolesi, Silvia Brunelli, Diego Covarello, Manuela Gavina, Barbara Rossi, Gabriela Constantin, Yvan Torrente, and Giulio Cossu (2006), 'Complete repair of dystrophic skeletal muscle by mesoangioblasts with enhanced migration ability', *The Journal of Cell Biology*, 174 (2): 231-243.

Gayraud-Morel, Barbara, Fabrice Chrétiena, Patricia Flamanta, Danielle Gomèsa, Peter S. Zammite and Shahragim Tajbakhsh (2007), 'A role for the myogenic determination gene Myf5 in adult regenerative myogenesis', *Developmental Biology*, 1 (1): 13-28.

Heldmann, Ursula, Pär Thoreda, Jan-Hendrik Claasenb, Andreas Arvidssona, Zaal Kokaiab and Olle Lindvall (2005), 'TNF-α antibody infusion impairs survival of stroke-generated neuroblasts in adult rat brain', *Experimental Neurology*, 196: 204-208.

Iosif , Robert, Christine Ekdahl, Henrik Ahlenius, Cornelis J. H. Pronk, Sara Bonde, Zaal Kokaia, Sten Eirik Jacobsson , Olle Lindvall (2006), 'Tumor Necrosis Factor Receptor 1 is a Negative Regulator of Progenitor Proliferation in Adult Hippocampal Mice', *Journal of Neuroscience*, 26(38):9703-12.

Jakubs, Katherine, Avtandil Nanobashvili, Sara Bonde, Christine T. Ekdahl, Zaal Kokaia, Merab Kokaia, and Olle Lindvall (2006), 'Environment Matters: Synaptic Properties of Neurons Born in the Epileptic Adult Brain Develop to Reduce Excitability', *Neuron*, 52: 1047–1059.

Kallur, Therése, Vladimer Darsalia, Olle Lindvall, Zaal Kokaia (2006), 'Human fetal cortical and striatal neural stem cells generate region-specific neurons in vitro and differentiate extensively to neurons after intrastriatal transplantation in neonatal rats', *Journal of Neuroscience Research*, 84: 1630-1644

Kassar-Duchossoy, Lina, Barbara Gayraud-Morel, Danielle Gome`s, Didier Rocancourt, Margaret Buckingham, Vasily Shinin & Shahragim Tajbakhsh (2004), 'Mrf4 determines skeletal muscle identity in Myf5:Myod double-mutant mice', *Nature*, 431:466-471.

Kobayashi, Tohru, Henrik Ahlenius, Pär Thored, Rina Kobayashi, Zaal Kokaia, Olle Lindvall (2006), 'Intracerebral Infusion of Glial Cell Line\NDerived Neurotrophic Factor Promotes Striatal Neurogenesis After Stroke in Adult Rats', *Stroke*, 37:2361.

Montarras, Didier, Jennifer Morgan, Charlotte Collins, Frédéric Relaix, Stéphane Zaffran, Ana Cumano, Terence Partridge, Margaret Buckingham (2005), 'Direct Isolation of Satellite Cells for Skeletal Muscle Regeneration', *Science*, 309: 2064-2067.

Parish, Clare, Gonçalo Castelo-Branco, Nina Rawal, Jan Tonnesen, Andreas Toft Sorensen, Merab Kokaia, Olle Lindvall and Ernest Arenas (2007), 'Wnt5a-treated midbrain neural stem cells improve dopamine cell replacement therapy in parkinsonian mice', *Journal of Clinical Investigation*, 118(1): 149–160.

Relaix, Frédéric Didier Montarras, Stéphane Zaffran, Barbara Gayraud-Morel, Didier Rocancourt, Shahragim Tajbakhsh, Ahmed Mansouri, Ana Cumano and Margaret Buckingham (2006), 'Pax3 and Pax7 have distinct and overlapping functions in adult muscle progenitor cells', *The Journal of Cell Biology*, 172(1):91-102.

Sampaolesi, Maurilio, Stephane Blot, Giuseppe D'Antona, Nicolas Granger, Rossana Tonlorenzi, Anna Innocenzi, Paolo Mognol, Jean-Lauren Thibaud, Beatriz G. Galvez, Ines Barthélémy, Laura Perani, Sara Mantero, Maria Guttinger, Orietta Pansarasa, Chiara Rinaldi, M. Gabriella Cusella De Angelis, Yvan Torrente, Claudio Bordignon, Roberto Bottinelli and Giulio Cossu

(2006), 'Mesoangioblast stem cells ameliorate muscle function in dystrophic dogs', *Nature*, 444: 574-579.

Thompson, Lachlan, Elin Andersson, Josephine B. Jensen, Perrine Barraud, Francois Guillemot, Malin Parmar and Anders Björklund (2006), 'Neurogenin2 identifies a transplantable dopamine neuron precursor in the developing ventral mesencephalon', *Experimental Neurology*, 198 (1):183-198

Thompson, Lachlan, Perrine Barraud, Elin Andersson, Deniz Kirik, and Anders Bjorklund (2005), 'Identification of Dopaminergic Neurons of Nigral and Ventral Tegmental Area Subtypes in Grafts of Fetal Ventral Mesencephalon Based on Cell Morphology, ProteinExpression, and Efferent Projections', *The Journal of Neuroscience*, 25(27):6467– 6477.

Thored, Pär, Andreas Arvidsson, Emanuele Cacci, Henrik Ahlenius, Therése Kallur, Vladimer Darsalia, Christine T. Ekdahl, Zaal Kokaia, Olle Lindvall (2005), 'Persistent production of neurons from adult brain stem cells during recovery after stroke', *Stem Cells Express*, 24 (3): 739-747.

Publications for WP7

Benitah, Salvador Aznar, Michaela Frye, Michael Glogauer, Fiona M. Watt (2005), 'Stem Cell Depletion Through Epidermal Deletion of Rac1', *Science*, 309 (5736): 933 – 935.

Estrach, Soline, Carrie A. Ambler, Cristina Lo Lo Celso, Katsuto Hozumi and Fiona M. Watt (2006), 'Jagged 1 is a ß-catenin target gene required for ectopic hair follicle formation in adult epidermis', *Development*, 133: 4427-4438.

Frye, Michaela and Fiona M. Watt (2006), 'The RNA Methyltransferase Misu (NSun2) Mediates Myc-Induced Proliferation and Is Upregulated in Tumors', *Current Biology*, 16 (10): 971-981.

Frye, Michaela, Amanda G. Fisher, and Fiona M. Watt (2007), 'Epidermal Stem Cells Are Defined by Global Histone Modifications that Are Altered by Myc-Induced Differentiation', *PLoS ONE*, 2(8): e763.

Gebhardt, Anneli, Michaela Frye, Steffi Herold, Salvador Aznar Benitah, Kristin Braun, Birgit Samans, Fiona M. Watt, Hans-Peter Elsässer, and Martin Eilers (2006), 'Myc regulates keratinocyte adhesion and differentiation via complex formation with Miz1', *The Journal of Cell Biology*, 172 (1): 139–149.

Honma, Masaru, Salvador Aznar Benitah, and Fiona M. Watt (2006), 'Role of LIM Kinases in Normal and Psoriatic Human Epidermis', *Molecular Biology of the Cell*, 17(4): 1888–1896.

Jadeja, Shalini, Ian Smyth, Jolanta E Pitera, Martin S Taylor, Mieke van Haelst, Elizabeth Bentley, Lesley McGregor, Jason Hopkins, Georges Chalepakis, Nicole Philip, Antonio Perez Aytes, Fiona M Watt, Susan M Darling, Ian Jackson, Adrian S Woolf & Peter J Scambler (2005), 'Identification of a new gene mutated in Fraser syndrome and mouse myelencephalic blebs', *Nature Genetics*, 37: 520 – 525.

Jensen, Kim and Fiona Watt (2006), 'Single-cell expression profiling of human epidermal stem and transit-amplifying cells: Lrig1 is a regulator of stem cell quiescence', *PNAS*, 103:11958-11963.

Jones, Philip, Benjamin D. Simons and Fiona M. Watt (2007), 'Sic transit Gloria. Farewell to the epidermal transit amplifying cell?', *Cell Stem Cell*, 1:371-381.

Nijhof, Joanne, Kristin M. Braun , Adam Giangreco, Carina van Pelt, Hiroshi Kawamoto, Richard L. Boyd, Rein Willemze, Leon H. F. Mullenders, Fiona M. Watt, Frank R. de Gruijl and

Willem van Ewijk (2006), 'The cell-surface marker MTS24 identifies a novel population of follicular keratinocytes with characteristics of progenitor cells.', *Development*, 133: 3027-3037.

Takeda, Hikaru, Stephen Lyle, Alexander J F Lazar, Christos C Zouboulis, Ian Smyth & Fiona M Watt (2006), 'Human sebaceous tumors harbor inactivating mutations in LEF1', *Nature Medicine*, 12(4):395-7.

Torres, Josema and Fiona M. Watt (2008), 'Nanog maintains pluripotency of mouse embryonic stem cells by inhibiting NFκB and cooperating with Stat3', *Nature Cell Biology*, 10: 194-201.

Watt, Fiona M, Cristina Lo Celso and Violeta Silva-Vargas (2006), 'Epidermal stem cells: an update', *Current Opinion in Genetics & Development*, 16 (5): 518-524.

ANNEX 3: ESTOOLS

Estools was the largest EU-funded consortium on human embryonic stem cell research. It was directed by Professor Peter Andrews, an experienced scientist from the University of Sheffield, with a long record of achievements in the biology of human embryonic stem cells and their malignant counterparts from teratocarcinomas. In many ways, Estools was closely linked to Eurostemcell. First, the two networks were tied together by interlocking leadership, as Austin Smith, the director of Eurostemcell, was concurrently deputy coordinator of Estools. Second, many partners of Eurostemcell became later involved also in Estools, such as Oliver Bruestle, Elena Cattaneo, Göran Hermerén, Meng Li, and Tariq Enver. Third, some activities were jointly organized by the two consortia, including two workshops on bioethical issues (in Germany and Sweden) and seminars on science communication.

Like Eurostemcell, Estools was a very ambitious project, bringing together the expertise of 21 academic and commercial research teams, based in ten countries (see table below). Estools was also funded under FP6 with a budget of 12 million euros, in the wider priority funding area of 'Life Sciences, Genomics, and Biotechnology for Health'. The scientific programme, however, was more specialised. While Eurostemcell aimed to build a broad platform for translation research in stem cell science, including stem cells of embryonic, neural, and epithelial origin, Estools was entirely focused on human embryonic stem cell research, and the study of molecular mechanisms that govern their differentiation into more specialized cell types.

Specifically, Estool aimed to (1) create optimal conditions for the proliferation in vitro of embryonic stem cells, without compromising their genetic and epigenetic identity, and (2) to direct their differentiation into pure populations of specialised cell types. In practice, as the name Estools suggests, the main goal was to develop *tools*, techniques, protocols and expertise needed for eventual medical, pharmaceutical and bio-industrial applications of human embryonic stem cells. In line with the usual configuration of EU-funded projects, the scientific programme of Estools was structured into different 'work packages', which focused on various aspects of the biology of human ES cells,

such as the development of culture methods, the study of mechanisms of self-renewal and neural differentiation.

While the project was under way, the publication of a landmark paper (Takahashi et al. 2007) describing the successful reprogramming of adult cells to an embryonic stem cell-like state (the so called induced pluripotent of iPS cells), opened up a new field of investigation, which could potentially solve the problem of immunorejection and also remove the need for human embryos in stem cell research. As a result, the scientific programme of Estools was partly reshaped to include research into this new promising area of biomedical research and applications. Significantly, the last Estools international symposium, held in Lisbon in May 2010, included a session that was titled 'Do we still need human embryonic stem cells?'

In addition to collaborative research and its dissemination in technical workshops, the consortium organized a pan-European training programme to build the capacities and knowledge base for the next generation of researchers. Driven by the recognition that stem cell science was still 'in its infancy', the training programme was meant to increase the pool of skilled researchers, both inside and outside the consortium. To this aim, Estools organised a long-term post-doc fellowship scheme, as well as exchange visits of junior and senior staff between participating laboratories. Also, it encouraged joint PhD projects with co-supervisors in different partner laboratories to facilitate early-career exposure to different techniques, methods and approaches. Finally, training activities included a summer school in Sheffield, in cooperation with EMBO, and a winter school in Lapland, Finland, both open to internal and external participants.

In compliance with EU rules, participating laboratories only used embryonic stem cell lines derived from IVF embryos that would not be transferred into the womb. These embryos were donated for research according to the procedures and legal requirements of the country of origin, with the informed consent of all donors. Thus, the research programme did not involve the derivation of new embryonic stem cell lines. However, throughout the duration of the project, embryo research remained highly controversial in many European countries (see section 4.2), including countries in which some key partners were working, such as Germany and Italy. Given controversies and the fragmented regulatory landscape across participating countries, bioethics was a key component of the

research project, under the leadership of Göran Hermerén, the professor in medical ethics from Lund University who was concurrently involved in Eurostemcell. Research in the ethical and social implications of research focused on three conditions necessary for the use of human ES cells: (1) the importance of research goals; (2) the proven need for human embryos to achieve those objectives; (3) the possibility of using less invasive or less controversial approaches. Researchers in the ethics work package, who were all medical ethicists, contributed to discussion on these issues at workshops and seminars by (1) identifying the main arguments for and against these conditions; (2) making a critical analysis of these arguments; (3) identifying unclear points in the interpretation and application of these arguments; and (4) identifying the knowledge gaps that must be filled to permit decisions about whether the three conditions were satisfied. Specific issues included the use of human embryonic stem cells in research, stem cell banks, repositories and registries in Europe, the ethical aspects of research on interspecies embryos and iPS cells (see section 5.4).

As part of the dissemination programme, Estools organised a number of events to engage the wider public of non-specialists. In partnership with Eurostemcell and Betacelltherapy (another EU-funded consortium, focused on the development of cell replacement therapy for diabetes), Estools organised a workshop on advanced communication techniques in Edinburgh in October 2007, followed by a media training workshop in Finland (April 2008), in collaboration with the School of Journalism at the Diaconia University of Applied Sciences. On this occasion, junior scientists described their research in a press conference-like event in front of an audience of students of journalism. Each student journalist wrote a press release, which was corrected by scientists and used as the basis of a discussion to improve communication. Estools was also involved in training other categories of experts on implications of embryonic stem cell research in ethics and law.

Finally, the consortium Estools organized a number of cultural events at the crossroad between science and art, including a photo exhibition with pictures of adult and embryonic stem cells, produced by scientists working in partner laboratories. This exhibition, titled ‘Smile of a Stem Cell’, was presented in many schools throughout Europe, in combination with educational activities on stem cell biology and ethics. In addition, the consortium Estool and other

partners commissioned a theatre piece on stem cell science, which dramatized the ethical dilemmas concerning embryo research. The premier of *Staminalia, a dream and a trial* was held at the Gulbenkian Foundation in Lisbon, on 27 May 2010 (see section 5.4).

GOVERNANCE: BOARD OF DIRECTORS

Coordinator

Professor Peter Andrews
University of Sheffield, UK

Professor Andrews was the overall leader for the project, chaired the meetings of the Board of Directors and the Project Steering Committee, interacted closely with the Project Manager and was responsible for communication with the Commission on contractual matters.

Deputy Coordinator

Professor Austin Smith
Cambridge University, UK

As deputy co-ordinator, Prof Smith assisted Professor Andrews in the co-ordination of EuroStemCell and was responsible for technology evaluation and exploitation.

Training Director

Professor Outi Hovatta
Karolinska Institute, Stockholm, Sweden

Networking Director

Dr Peter Dvorak
Institute of Experimental Medicine, Brno.

Responsible for networking activities such as consortium meetings.

SME Representative

Professor Oliver Bruestle
University of Bonn's Institute of Reconstructive Neurobiology and Life&Brain GmbH

Professor Bruestle was a board member from February 2009, replacing Dr Tim Allsop from Stem Cell Sciences Ltd.

Ethics Director

Professor Göran Hermerén
Lund University

Scientific advisory panel[159]

- Prof. Magdalena Götz
  Head of Institute, GSF-Institute of Stem Cell Research, Neuherberg, Germany
- Prof. Christine Mummery
  Professor of Developmental Biology, Hubrecht Laboratory / Netherlands Institute for Developmental Biology, Utrecht, The Netherlands
- Dr Andras Nagy
  Samuel Lunenfeld Research Institute, Mount Sinai Hospital, Toronto, Canada
- Prof. Martin Pera
  Director, Center for Stem Cell and Regenerative Medicine, Keck School of Medicine, University of Southern California, USA

Ethics Advisory Panel[160]

[159] The Scientific Advisory Panel was established to review, on an annual basis, our scientific progress. The panel also provides ongoing assessments of the quality of research activities, highlighting any deficiencies in approach or execution of experimental plans, and suggesting alternative approaches based upon experience outside the Consortium.

[160] The Ethics Advisory Panel was established to oversee ethical, societal, safety and human as well as animal welfare issues related to the ESTOOLS project. In particular the panel reviewed any issues relating to the planned use of different human ES cell lines in different partner laboratories, giving special consideration to local laws and rules.

- Dr. Christiane Woopen
  Institut für Geschichte und Ethik der Medizin, Universität zu Köln
- Prof. Demetrio Neri
  Professor of Bioethics, Università degli Studi di Messina
- Prof. Giuseppe Testa
  Istituto Europeo di Oncologia (European Institute of Oncology, Milan)
- Dr Kate Millar
  Centre for Applied Bioethics, School of Biosciences, University of Nottingham

***

PARTNER INSTITUTES AND PRINCIPAL INVESTIGATORS

CZECH REPUBBLIC

Institute of Experimental Medicine, Academy of Sciences of the Czech Republic (IEM)
- Dr Petr Dvorak

FINLAND

Tampere University of Technology
- Prof. Olli Yli-Harja

University of Helsinki
- Prof. Timo Otonkoski

University of Turku
- Prof. Riitta Lahesmaa

GERMANY

Genomics, BioInnovationsZentrum, University of Technology, Dresden
- Dr Konstantinos Anastassiadis

University of Bonn Medical Center, Institute of Reconstructive Neurobiology
- Prof. Oliver Brüstle

ITALY

University of Milan, Italy
- Professor Elena Cattaneo (biology of neural stem cells; Hungtinon's disease)
- Dr Luciano Conti (associate PI)

ISRAEL

The Hebrew University of Jerusalem
- Prof. Nissim Benvenisty

SCT Stem Cell Technologies
- Dr Danny Kitsberg

THE NETHERLANDS

The Netherlands Cancer Institute
- Prof. Maarten van Lohuizen

SPAIN

Bellvitge Institute for Biomedical Research (IDIBELL)
- Dr Manel Esteller

SWEDEN

Karolinska Institute, Stockholm
- Prof. Outi Hovatta

Lund University
- Prof. Göran Hermerén

SWITZERLAND

Biozentrum, University of Basel
- Prof. Yves-Alain Barde

UNITED KINGDOM

Axordia Ltd to 2009
- Dr Jim Walsh

Centre for Stem Cell Biology, University of Sheffield
- Prof. Peter Andrews

Wellcome Trust Centre for Stem Cell Research, University of Cambridge
- Prof. Austin Smith

Institute for Stem Cell Research, University of Edinburgh
- Dr Andrew JH Smith

MRC Clinical Sciences Centre, Imperial College London
- Dr Meng Li

MRC Weatherall Institute of Molecular Medicine, University of Oxford
- Prof. Tariq Enver

Stem Cell Sciences UK Ltd to 2009
- Dr Thorsten Gorba

***

WORKPACKAGES

FUNDAMENTAL BIOLOGY OF STEM CELLS

WP 1A: Development and optimisation of standard culture conditions for human ES cells
Leader: Outi Hovatta

This workpackage aimed to develop and optimize standard conditions for the growth and expansion of human ES cells in the laboratory. Specifically, it aimed to develop an automated cell culture system, and eliminate the use of feeder cells and animal substances – an important consideration if cells are to be transplanted in patients.

WP 1B: Self renewal of human ES cells
Leader: Tariq Enver

This workpackage aimed to identify and characterise the mechanisms that regulate the self renewal of human ES cells and their commitment to differentiation.

WP 1C:The genetic stability of human ES cells
Leader: Nissim Benvenisty

This workpackage investigated the genetic changes that occur during the culture of human ES cells, the mechanisms that drive these changes and the effect of culture conditions upon the appearance of genetic variants.

WP 2: Profiling of epigenetic regulation in human ES cell lines – influences on stability, self-renewal and lineage commitment.

Leader: Maarten van Lohuizen
This workpackage examined and mapped the role of epigenetic gene regulation in stability, self-renewal and differentiation of hES cells, including the characterisation of relevant epigenetic regulators.

WP 3: Recombination tools and genetic switches
Leader: Andrew JH Smith

This workpackage investigated and developed advanced methodologies and tools for the genetic manipulation of human ES cells, including homologous recombination, RNAi, conditional mutagenesis, enhancement of lineage selection and RMCE.

WP 4: Characterisation and control of neural lineage commitment
Leader: Meng Li

This workpackage deveoped an in-depth understanding of the mechanisms that control the commitment of human ES cells to the neural lineage. It was aimed to define the requirements for reliable generation and purification of pan-neural precursors, and of more specialized neuronal- and glial-restricted progenitor cells with distinct regional specification.

WP 5: Generating and characterizing differentiated neurons and glial cells using human ES cells
Leader: Yves Barde

This workpackage tested the possibility that human ES cells could be induced to generate specific populations of cells of the brain and nervous system. It aimed to define the requirements for the generation of these specialized cell types (neuronal sub-types, astrocytes and oligodendrocytes), paving the way for their use in modelling diseases of the nervous system.

WP 6: Ethical issues relating to basic human ES cell research
Leader: Göran Hermerén

This workpackage aimed to investigate and clarify the ethical issues raised by human ES cell research. It addressed the ethical standards acceptable and required throughout the European Research Area for research with human ES cells and for the commercial exploitation of that research.

WP 7: Induced pluripotent stem cells
Leader: Oliver Bruestle

This workpackage initiated development of a platform for robust conversion of human somatic cells into pluripotent stem cells that was aimed to enhance our understanding of the pluripotent state.

Publications

Included in this listing are papers directly related to the ESTOOLS project, reported in the consortium website. This list is only a subset of publications by ESTOOLS partners and does not include other publications by ESTOOLS partners relevant to the project that were indirectly supported by ESTOOLS. It is not intended to be a guide to, or to be typical of, the range of work undertaken or published by the ESTOOLS partners.

Anastassiadis, Konstantinos, Jun Fu, Christoph Patsch, Shengbiao Hu, Stefanie Weidlich, Kristin Duerschke, Frank Buchholz, Frank Edenhofer and A. Francis Stewart (2009), 'Dre recombinase, like Cre, is a highly efficient site-specific recombinase in E. coli, mammalian cells and mice', *Disease Models & Mechanisms*, 2(9-10): 508-515.

Andrews, Peter (2009), *Cellular divisions*, Public Service Review: European Union - Issue 18 October 2009 , pp. 246-8 .

Atlasi, Yaser, Seyed J. Mowla, Seyed A.M. Ziaee, Paul J. Gokhale, and Peter W. Andrews (2008), 'OCT4 Spliced Variants Are Differentially Expressed in Human Pluripotent and Nonpluripotent', *Cells Stem Cells*, 26 (12): 3068 -3074.

Avery Stuart, Gaetano Zafarana, Paul Gokhale, Peter Andrews (2010), 'The role of SMAD4 in human embryonic stem cell self-renewal and stem cell fate', *Stem Cells*, 28(5):863-73.

Baker, Duncan, Neil J Harrison, Edna Maltby, Kath Smith, Harry DMoore, Pamela J Shaw, Paul R Heath, Hazel Holden & Peter W Andrews (2007), 'Adaptation to culture of human embryonic stem cells andoncogenesis *in vivo*', *Nature Biotechnology*, 25: 207-215.

Barbaric Ivana, Paul Gokhale, Mark Jones, Adam Glen, Duncan Baker, Peter Andrews (2010), 'Novel regulators of stem cell fates identified by a multivariate phenotype screen of small compounds on human embryonic stem cell colonies', *Stem Cell* Research, 5(2):104-19.

Barbaric Ivana, Paul Gokhale, Peter Andrews (2010), 'High-content screening of small compounds on human embryonic stem cells', *Biochemical Society Transactions*, 38(4):1046-50.

Bárta Tomáš, Vladimír Vinarský, Zuzana Holubcová, Dáša Doležalová, Jan Verner, Šárka Pospíšilová, Petr Dvořák, Aleš Hampl (2010), 'Human embryonic stem cells are capable of executing G1/S checkpoint activation', *Stem Cells*, 28(7): 1143-52.

Benzing, Corinnea, Michaela Segschneider, Ankea Leinhaas, Joseph Itskovitz-Eldor, Oliver Brüstle (2006), 'Neural conversion of human embryonic stem cell colonies in the presence of fibroblast growth factor-2', *Developmental Neuroscience*, 17(16):1675-81 .

Blum, Barak and Nissim Benvenisty (2007), 'Clonal Analysis of Human Embryonic Stem Cell Differentiation into Teratomas', *Stem Cells*, 25;1924-1930.

Blum, Barak and Nissim Benvenisty (2008), 'The Tumorigenicity of Human Embryonic Stem Cells', *Advanced Cancer Research*, 100:133-58.

Blum, Barak, Ori Bar-Nur, Tamar Golan-Lev and Nissim Benvenisty (2009), 'The anti-apoptotic gene survivin contributes to teratoma formation by human embryonic stem cells', *Nature biotechnology*, 27 (3): 281-287.

Borghese, Lodovica, Dasa Dolezalova, Thoralf Opitz, Simone Haupt, Anke Leinhaas, Barbara Steinfarz, Philipp Koch, Frank Edenhofer, Ales Hampl, Oliver Brüstle (2010), '*Inhibition of Notch Signaling in Human Embryonic Stem Cell-Derived Neural Stem Cells Delays G1/S Phase Transition and Accelerates Neuronal Differentiation In Vitro and In Vivo*', *Stem Cells*, doi:10.1002/stem.408.

Bosnali Manal and Frank Edenhofer (2008), 'Generation of transducible versions of transcription factors Oct4 and Sox2', *Biological Chemistry*, 389(7):851-61.

Calvanese, Vincenzo, Angelica Horrillo, Abdelkrim Hmadcha, Beatriz Suarez-Alvarez, Agustın F. Fernandez, Ester Lara, Sara Casado, Pablo Menendez, Clara Bueno, Javier Garcia-Castro, Ruth Rubio, Pablo Lapunzina, Miguel Alaminos, Lodovica Borghese, Stefanie Terstegge, Neil J. Harrison, Harry D. Moore, Oliver Bruestle, Carlos Lopez-Larrea, Peter W. Andrews, Bernat Soria, Manel Esteller, Mario F. Fraga (2009), 'Cancer Genes Hypermethylated in Human Embryonic Stem Cells', *PLoS ONE*, 3(9): e3294.

Christoph Patsch, Michale Peitz, David Otte, Danieal Kessler, Johannes Jungverdorben, Frank Thomas Wunderlich, Oliver Bruestle, Andreas Zimmer, Frank Edenhofer (2010), 'Engineering cell-permeant FLP recombinase for tightly controlled inducible and reversible overexpression in embryonic stem cells', *Stem Cells*, 28(5):894-902.

Damjanov I, and Peter Andrews (2007), 'The terminology of teratocarcinomas and teratomas', *Nature Biotechnology*, 25(11):1212.

Darr, Henia, Nissim Benvenisty (2009), 'Genetic Analysis of the Role of the Reprogramming Gene LIN-28 in Human Embryonic Stem Cells', *Stem Cells*, 27:352–362.

Duprat, Sebastian (2008), 'Art and Human Embryonic Stem Cells: from the bench to the high street', *Stem Cell Research*, 2 (2): 97-100.

Eiselleova, Livia, Iveta Peterkova, Jakub Neradil, Iva Slaninova, Ales Hampl, and Petr Dvorak (2008), 'Comparative study of mouse and human feeder cells for human embryonic stem cells', *International Journal of Developmental Biology*, 52(4):353-63.

Eiselleova, Livia, Kamil Matulka, Vitezslav Kritz, Michaela Kunova, Zuzana Schmidtova, Jakub Neradil, Boris Tichy, Dana Dvorakova, Sarka Pospisilova, Ales Hampl, and Peter Dvorak (2009), 'A complex role for FGF-2 in self-renewal, survival, and adhesion of human embryonic stem cells', *Stem Cells*, 27: 1847-1857.

Enver, Tariq, Martin Pera, Carsten Peterson, and Peter W. Andrews (2009), 'Stem Cell States, Fates, and the Rules of Attraction', *Cell Stem Cell*, 4 (5): 387-397.

Fox, Victoria, Paul J. Gokhale, James R. Walsh, Maryam Matin, Mark Jones, Peter W. Andrews (2007), 'Cell-cell signaling through NOTCH regulates human embryonic stem cell proliferation', *Stem Cells*, 26(3):715-23.

Fu Jun, Medeleine Teucher, Konstantinos Anastassiadis, William Skarnes, Francis Stewart (2010), 'A recombineering pipeline to make conditional targeting constructs', *Methods in Enzymology*, 477:125-44.

Furue, Miho, Jie Na, Jamie P. Jackson, Tetsuji Okamoto, Mark Jones, Duncan Baker, Ryu-Ichiro Hata ‖ , Harry D. Moore, J. Denry Sato, and Peter W. Andrews (2009), 'Heparin promotes the growth of human embryonic stem cells in a defined serum-free medium', *Proceedings of the national Academy of Sciences*, 105:13409-13414.

Gennet Nicole, Lois M. Alexander, Rosario M. Sánchez-Martín, Jonathan M. Behrendt, Andrew J. Sutherland, Joshua M. Brickman, Mark Bradley and Meng Li (2009), 'Microspheres as a vehicle for biomolecule delivery to neural stem cells', *Nature Biotechnology*, 25 (6): 442-449).

Gokhale, Paul and Peter Andrews (2008), 'New insights into the control of stem cell pluripotency', *Cell Stem Cell*, 2(1):4-5.

Gokhale, Paul and Peter W Andrews (2009), 'Human embryonic stem cells: 10 years on', *Laboratory Investigation*, 89: 259–262.

Grinnemo Karl Henrik, Christer Sylvén, Outi Hovatta, Göran Dellgren and Matthias Corbascio (2007), 'Immunogenicity of human embryonic stem cells', *Cell Tissue Research*, 331(1):67-78.

Grinnemo Karl Henrik, Rami Genead, Makiko Kumagai-Braesch, Agneta Andersson, Christian Danielsson, Agneta Månsson-Broberg, Göran Dellgren, Anne-Marie Strömberg, Henrik Ekberg, Outi Hovatta, Christer Sylvén, Matthias Corbascio (2008), 'Costimulation Blockade Induces Tolerance to HESC Transplanted to the Testis and Induces Regulatory T-cells to HESC Transplanted into the heart', *Stem Cells*, 26 (7): 1850-1857.

Harrison Neil, Duncan Baker, Peter W Andrews (2007), 'Culture adaptation of embryonic stem cells echoes germ cell malignancy', *International Journal of Andrology*, 30(4):275-81.

Harrison, Neil J., James Barnes, Mark Jones, Duncan Baker, Paul J. Gokhale, Peter W. Andrews (2009), 'CD30 Expression Reveals that Culture Adaptation of Human Embryonic Stem Cells Can Occur Through Differing Routes', *Stem Cells*, 27:1057–1065.

Hermerén, Göran (2008), 'European values – and others. Europe's shared values: Towards an ever-closer Union?', *European Review*, 16: 373-385.

Holm Frida, Susanne Ström, José Inzunza, Duncan Baker, Anne-Marie Strömberg, Björn Rozell, Anis Feki, Rosita Bergström and Outi Hovatta1 (2010), 'An effective serum- and xeno-free

chemically defined freezing procedure for human embryonic and induced pluripotent stem cells', *Human Reproduction*, 25(5):1271-9.

Hovatta Outi, Miodrag Stojkovic, Maria Nogueira, Isabel Varela-Nieto (2010), 'European scientific, ethical, and legal issues on human stem cell research and regenerative medicine', *Stem Cells*, 28(6):1005-7.

Hovatta, Outi (2008), 'Human cell nucleus to animal embryo', *Lakartidningen*, 105(1-2):20-1.

Hug, Kristina (2009), '*Banks, Repositories and Registries of Stem Cell Lines in Europe: Regulatory and Ethical Aspects*', *Stem Cell Reviews and Reports*, 5:18–35.

Hug, Kristina (2009), 'Research on Human-animal Entities: Ethical and Regulatory Aspects in Europe', *Stem Cell Reviews and Reports*, 5 (3): 181-194.

International Stem Cell Initiative (2007), 'Characterization of human embryonic stem cell lines by the International Stem Cell Initiative', *Nature Biotechnology*, 25(7):803-16.

Jamet, Solene, Ruairi Friel, and P. Joseph Mee (2010), Signal Transduction in Embryonic Stem Cells and the rise of iPS cells, in: Ari Sitaramayya (ed.) *Signal Transduction Pathways: Mechanisms and Diseases*, Springer.

Koch, Philipp, Henrike Siemen, Andrea Biegler, Joseph Itskovitz-Eldor and Oliver Brüstle (2006), 'Transduction of human embryonic stem cells by ecotropic retroviral vectors', *Nucleic Acids Research,* 34 (18): e120.

Koch, Philipp, Thoralf Opitz, Julius A. Steinbeck, Julia Ladewig and Oliver Brüstle (2009), 'A rosette-type, self-renewing human ES cell-derived neural stem cell with potential for in vitro instruction and synaptic integration', *Proceedings of the National Academy of Sciences of the United States of America*, doi: 10.1073/pnas.0808387106.

Koch, Phulipp, Zaal Kokaia,Olle Lindvall,Oliver Brüstle (2009), 'Emerging concepts in neural stem cell research: autologous repair and cell-based disease modelling', *The Lancet Neurology*, 8 (9): 819-829.

Kong, L., Olli Yli-Harja, O., Autio R. (2009), Evaluating the effects of different library files in analysing affymetrix exon array expression data, *Proceedings of the 6th International Workshop on Computational Systems Biology* (WCSB 2009).

Konstantoulas, Constantine, Malin Parmar and Meng Li (2010), 'FoxP1 promotes midbrain identity in embryonic stem cell-derived dopamine neurons by regulating Pitx3', *Journal of Neurochemistry*, 113(4):836-47.

Kranc, Kamil, (2009), Hein Schepers, Neil P. Rodrigues, Simon Bamforth, Ellen Villadsen, Helen Ferry, Tiphaine Bouriez-Jones, Mikael Sigvardsson, Shoumo Bhattacharya, Sten Eirik Jacobsen, and Tariq Enver (2009), 'Cited2 is an essential regulator of adult hematopoietic stem cells', *Cell Stem Cell*, 5(6):659-65.

Kranz Andrea, Jun Fu, Kristin Duerschke, Stefanie Weidlich, Ronald Naumann, A. Francis Stewart, Konstantinos Anastassiadis (2010), 'An improved Flp deleter mouse in C57Bl/6 based on Flpo recombinase', *Genesis*, 48(8):512-20.

Kubikova, I., Konecna, H., Sedo, O., Zdrahal, Z., Rehulka, P., Hribkova, H., Rehulkova, H., Hampl, A., Chmelik, J., Dvorak, P. (2009), 'Proteomic profiling of human embryonic stem cell-derived microvesicles reveals a risk of transfer of proteins of bovine and mouse origin', *Cytotherapy*, 11 (3):330-430.

Ladewig, Julia., Philipp Koch, Elmar Endl, Banu Meiners, Thoralf Opitz, Sebastien Couillard-Despres, Ludwig Aigner, Oliver Brüstle (2008), 'Lineage selection of functional and cryopreservable and human embryonic stem cell-derived neurons', *Stem Cells*, 26: 1705-1712.

Laurila K. Lähdesmäki H. (2009), 'A probabilistic model for competitive binding of transcription factors', *Proceedings of the 6th International Workshop on Computational Systems Biology* (WCSB 2009).

Laurila, Kirsti and Harri Lähdesmäki (2009), 'Systematic analysis of disease-related regulatory mutation classes reveals distinct effects on transcription factor binding', *In Silico Biology*, 9 (4): 209-224.

Liew Chee-Gee, Jonathan S. Draper, James Walsh, Harry Moore, Peter W. Andrews (2006), 'Transient and stable transgene expression in human embryonic stem cells', *Stem Cells*, 25(6): 1521-8.

Liew, Chee Gee, Nadia Shah, Sarah J. Briston, Ruth M. Shepherd, Cheen Peen Khoo, Mark J. Dunne, Harry D. Moore, Karen E. Cosgrove, and Peter W. Andrews (2008), 'PAX4 enhances beta-cell differentiation of human embryonic stem cells', *PLoS ONE*, 3(3):e1783.

Martin-Ibañez R, Unger C, Strömberg A, Baker D, Canals J, Hovatta O. (2008), 'Novel cryopreservation method for dissociated human embryonic stem cells in the presence of a ROCK inhibitor', *Human Reproduction*, 23 (12): 2744-2754.

Mayshar, Yoav, Eran Rom, Irina Chumakov, Achia Kronman, Avner Yayon, Nissim Benvenisty (2008), 'Fibroblast growth factor 4 and its novel splice isoform have opposing effects on the maintenance of human embryonic stem cell self-renewal', *Stem Cells*, 26(3):767-74.

Michaela Kunova, Kamil Matulka, Livia Eiselleova, Petra Trckova, Ales Hampl and Petr Dvorak (2010), 'Development of humanized culture medium with plant-derived serum replacement for human pluripotent stem cells', *Reproductive BioMedicine Online*, doi:10.1016/j.rbmo.2010.06.027

Mikkola, Milla, Cia Olsson, Jaan Palgi, Jarkko Ustinov, Tiina Palomaki, Nina Horelli-Kuitunen, Sakari Knuutila, Karolina Lundin, Timo Otonkoski and Timo Tuuri (2006), 'Distinct differentiation characteristics of individual human embryonic stem cell lines', *BMC Developmental Biology*, 6:40.

Na Jie, Miho Furue, Peter Andrews (2010), 'Inhibition of ERK1/2 prevents neural and mesendodermal differentiation and promotes human embryonic stem cell self-renewal', *Stem Cell Research* 5(2):157-69.

Närvä, Elisa, Reija Autio, Nelly Rahkonen, Lingjia Kong, Neil Harrison, Danny Kitsberg, Lodovica Borghese, Joseph Itskovitz-Eldor, Omid Rasool, Petr Dvorak, Outi Hovatta, Timo Otonkoski, Timo Tuuri, Wei Cui, Oliver Brüstle, Duncan Baker, Edna Maltby, Harry D Moore, Nissim Benvenisty, Peter W Andrews, Olli Yli-Harja & Riitta Lahesmaa (2010), 'High-resolution DNA analysis of human embryonic stem cell lines reveals culture-induced copy number changes and loss of heterozygosity', *Nature Biotechnology*, 28: 371–377.

Nat, Roxana, Mats Nilbratt, Susanna Narkilahti, Bengt Winblad, Outi Hovatta, Agneta Nordberg (2006), 'Neurogenic neuroepithelial and radial glial cells generated from six human embryonic stem cell lines in serum-free suspension and adherent cultures', *Glia*, 55 (4): 385-399.

Nykter, Matti, Harri Lähdesmäki, Alistair Rust, Vesteinn Thorsson, Ilya Shmulevich (2009), 'A data integration framework for prediction of transcription factor targets: a BCL6 case study', *Annals of the New York Academy of Sciences*, 1158: 205-214.

Olariu, Victor, Neil J. Harrison, Daniel Coca, Paul J. Gokhale, Duncan Baker, Steve Billings, Visakan Kadirkamanathan and Peter W. Andrews *(2010)*, 'Modeling the evolution of culture-adapted human embryonic stem cells', *Stem Cell Research*, 4(1):50-6.

Opitz, Thoralf, Björn Scheffler, Barbara Steinfarz, Tanja Schmandt & Oliver Brüstle (2007), 'Electrophysiological evaluation of engrafted stem cell-derived neurons', *Nature Protocols*, 2, 1603 – 1613.

Outi Hovatta et al. (2010), *Human Stem Cell Research and Regenerative Medicine: European perspective on scientific, ethical and legal issues*, *ESF Science Policy Briefing* 38.

Paatero, Anja, Hilkka Turakainen, Lotta J. Happonen, Cia Olsson, Tiina Palomäki, Maria I. Pajunen, Xiaojuan Meng, Timo Otonkoski, Timo Tuuri, Charles Berry, Nirav Malani, Mikko J. Frilander, Frederic D. Bushman and Harri Savilahti (2008), '*Bacteriophage Mu Integration in Yeast and Mammalian Genomes*', *Nucleic Acids Research*, 36 (22): e148.

Papadimou, Evangelia, Alessia Moianaa, Donato Goffredo, Philipp Koch, Stefano Bertuzzi, Oliver Brüstle, Elena Cattaneo, and Luciano Conti (2009), 'p66(ShcA) adaptor molecule accelerates ES cell neural induction', *Molecular and Cellular Neuroscience*, 41(1):74-84.

Peter Andrews at al. (The International Stem Cell Banking Initiative) (2009), 'Consensus guidance for banking and supply of human embryonic stem cell lines for research purposes', *Stem Cell Reviews and Reports*, 5(4):301-14.

Pistoi, Sergio (2010), 'Stem Cells in Biology and Disease - ESTOOLS International Symposium', *The International Journal of Developmental Biology, 54: 1399 – 1404.*
Rajala, Kristiina, Bettina Lindroos, Samer M. Hussein, Riikka S. Lappalainen, Mari Pekkanen-Mattila, Jose Inzunza, Björn Rozell, Susanna Miettinen, Susanna Narkilahti, Erja Kerkelä, Katriina Aalto-Setälä, Timo Otonkoski, Riitta Suuronen, Outi Hovatta, Heli Skottman (2010), 'A defined and xeno-free culture method enabling the establishment of clinical-grade human embryonic, induced pluripotent and adipose stem cells', *PLoS One*, 5(4):e10246.

Rodin Sergey, Anna Domogatskaya, Susanne Ström, Emil M Hansson, Kenneth R Chien, José Inzunza, Outi Hovatta & Karl Tryggvason (2010), 'Long-term self-renewal of human pluripotent stem cells on human recombinant laminin-511', *Nature Biotechnology*, 28: 611–615.

Satomaa, Tero, Annamari Heiskanen, Milla Mikkola, Cia Olsson, Maria Blomqvist, Minna Tiittanen, Taina Jaatinen, Olli Aitio, Anne Olonen, Jari Helin, Jukka Hiltunen, Jari Natunen, Timo Tuuri, Timo Otonkoski, Juhani Saarinen and Jarmo Laine (2009), 'The N-glycome of human embryonic stem cells', *BMC Cell Biology*, 10(1):42.

Siemen, Henrike, Michael Nix, Elmar Endl, Philipp Koch, Joseph Itskovitz-Eldor and Oliver Brüstle (2008), 'Nucleofection of human embryonic stem cells', *Methods in Molecular Biology*, 423:131-8.

Stock Kristin, Lars Nolden, Frank Edenhofer, Tamara Quandel, and Oliver Brüstle (2010), 'Transcription factor-based modulation of neural stem cell differentiation using direct protein transduction', *Cellular and molecular life sciences*, 67(14):2439-49.

Sundberg, Maria, Linda Janssona, Johanna Ketolainena, Harri Pihlajamäkib, Riitta Suuronena, Heli Skottmana, José Inzunzae, Outi Hovattaa, and Susanna Narkilahti (2009), 'CD marker expression profiles of human embryonic stem cells and their neural derivatives, determined using flow-cytometric analysis, reveal a novel CD marker for exclusion of pluripotent stem cells', *Stem Cell Research*, 2(2):113-24.

Terstegge, Stefanie and Oliver Brüstle, Automated method for embryonic stem cell culture *(2009), i*n Uma Lakshmipathy, Jonathan D. Chesnut, Bhaskar Thyagarajan (eds.), *Emerging technology platforms for stem cells*, New Jersey: Wiley, pp. 275-28.

Terstegge, Stefanie, Barbara H. Rathb, Iris Laufenbergb, Nina Limbacha, Andrea Buchstallerc, Karin Schützec and Oliver Brüstle *(2009),* 'Laser-assisted selection and passaging of human pluripotent stem cell colonies', *Journal of Biotechnology*, 143(3):224-30.

Terstegge, Stefanie, Franziska Winter, Barbara H. Rath, Iris Laufenberg, Claudia Schwarz, Anke Leinhaas, Florian Levold, Andreas Dolf, Simone Haupt and Philipp Koch, et al. (2010), 'Laser-assisted photoablation of human pluripotent stem cells from differentiating cultures', *Stem Cell Reviews and Reports*, 6(2):260-9.

Terstegge, Stefanie, Iris Laufenberg, Jörg Pochert, Sabine Schenk, Joseph Itskovitz-Eldor, Elmar Endl, and Oliver Brüstle (2006), 'Automated maintenance of embryonic stem cell cultures', *Biotechnology and Bioengeneering*, 96(1):195-201.

Testa, Giuseppe, Lodovica Borghese, Julius A. Steinbeck, and Oliver Brüstle (2007), 'Breakdown of the Potentiality Principle and Its Impact on Global Stem Cell Research', *Cell Stem Cell*, 1 (1): 153-156.

Tonge Peter, Victor Olariu, Daniel Coca, Visakan Kadirkamanathan, Kelly E. Burrell, Stephen A. Billings, Peter W. Andrews (2010), 'Prepatterning in the stem cell compartment', *PLoS One*, 5(5):e10901.

Unger, Christian, Shuping Gao2, Marie Cohen, Marisa Jaconi, Rosita Bergstrom, Frida Holm, Amparo Galan, Eva Sanchez, Olivier Irion, Jean Bernard Dubuisson, Marc Giry-Laterriere, Patrick Salmon, Carlos Simon, Outi Hovatta, and Anis Feki (2009), 'Immortalized human skin fibroblast feeder cells support growth and maintenance of both human embryonic and induced pluripotent stem cells', *Human Reproduction*, doi: 10.1093/humrep/dep232.

Unger, Christian, Ulrika Felldin, Agneta Nordenskjöld, M. Sirac Dilber, Outi Hovatta (2008), 'Derivation of human skin fibroblast lines for feeder cells for human embronic stem cells', *Current Protocols in Stem Cell Biology*, 5:1C.7.1-1C.7.10.

Urbach Achia, Ori Bar-Nur, George Q. Daley, and Nissim Benvenisty (2010), 'Differential Modeling of Fragile X Syndrome by Human Embryonic Stem Cells and Induced Pluripotent Stem Cells', *Cell Stem Cell*, 6 (5): 407-411.

Vuoristo, Sanna, Ismo Virtanen, Minna Takkunen, Jaan Palgi, YamatoKikkawa, Patricia Rousselle, Kiyotoshi Sekiguchi, Timo Tuuri and TimoOtonkoski (2009), 'Laminin isoforms in human embryionic stem cells: Synthesis, receptor usage and growth support', *Journal of Cellular and Molecular Medicine*, 13 (8b): 2622-2633.

Wright, Andrew and Peter Andrews. 'Surface marker antigens in the characterization of human embryonic stem cells', *Stem Cell Research*, 3 (1): 3-11.

Yang Jian , Anuk van Oosten, Thorold Theunisse, Ge Guo, Jose Silva, Austin Smith (2010), 'Stat3 activation is limiting for reprogramming to ground state pluripotency', *Cell Stem Cell*, 7(3):319-28.

Zafarana, Gaetano, Stuart R. Avery, Katie Avery, Harry D. Moore, Peter W. Andrews (2009), 'Specific Knockdown of OCT4 in Human Embryonic Stem Cells by Inducible Short Hairpin RNA Interference', *Stem Cells*, 27 (4): 776 -782.

ANNEX 4: STEM CELL RESEARCH IN FP6

Name	Startdate	Funding	Instrument	Duration in years	Coordinator
3G-SCAFF	2005	1,699,998	STREP	3	SWE
ALLOSTEM	2004	8,000,000	IP	3.5	UK
Anti-tumortargeting	2005	2,420,000	STREP	3	AT
ARTEMIS	2007	1,985,420	STREP	3	SP
AUTOBONE	2004	2,296,892	STREP	4	IT
BARP+	2004	2,495,600	STREP	3	FR
BETACELLTHERAPY[161]	2005	11,788,000	IP	5	BE
BIOSYS	2005	1,999,700	STREP	3	DE
CARCINOGENOMICS	2006	10,440,000	IP	5	NL
CellPROM	2004	17,599,928	IP	4	DE
CELLSINTOORGANS	2004	7,200,000	NoE	5	NL
CLINT	2007	500,000	SSA	2	UK
CONSERT	2004	11,635,000	IP	4	NL
CONTROLCANCERSTEM	2005	1,499,892	NEST-	3	BE
CORDCELLBANKINGSTUD	2002	13,000		0.5	UK
CORNEAENGINEERING	2004	2,558,797	STREP	3	FR
CRYSTAL	2007	2,400,000	STREP	3	DE
Custom-IMD	2007	5,400,000	IP	4	SP
DNAREPAIR	2005	11,500,000	IP	4	NL
E.E.T.-Pipeline	2007	4,000,000	STREP	3	DE
EMBRYOMICS	2005	1,449,850	NEST-	3	FR
EMRS	2004	675,000	SSA	4	FR
EPISTEM	2006	2,500,000	IP	4	BE
EPI-VECTOR	2005	2,100,000	STREP	3	UK
ESTOOLS	2006	12,000,000	IP	5	UK
EUCOMM	2006	13,000,000	IP	3	DE
EUGENE2	2004	8,000,000	NoE	4	SWE
EUhESCregistry	2007	1,000,000	SSA	3	DE
EuReGene	2005	10,500,000	IP	5	DE
EuroBoNet	2006	13,218,960	NoE	5	NL
EUROCITS	2005	500,000	SSA	1.5	BE
EuroCSC	2007	1,900,000	STREP	3	DE
EuroHear	2004	12,500,000	IP	5	FR
EURO-Laminopathies	2006	2,565,000	STREP	3	AT
EUROPEANLEUKEMIANET	2004	6,000,000	NoE	5	DE
EUROPEANMCLNETWORK	2004	2,493,900	STREP	3	DE
EuroSTEC	2007	7,828,500	IP	5	NL
EUROSTEMCELL	2004	11,906,400	IP	4	UK

[161] Projects involving human embryonic stem cells are highlighted in pink.

EURO-THYMAIDE	2004	12,000,000	IP	5	BE
EUROXY	2004	8,000,000	IP	5	DEN
EURYTHRON	2004	2,875,996	Marie-CurieRTN	4	NL
EuTRACC	2007	9,600,000	IP	4	NL
EVGN	2004	9,000,000	NoE	5	FR
EVI-GENORET	2005	10,000,000	IP	4	BE
EXPERTISSUES	2004	7,300,000	NoE	5	PO
FIRST	2004	1,500,000	IP	2	NL
FunGenES	2004	8,500,000	IP	3	DE
GENOSTEM	2004	8,752,000	IP	4	FR
GIANT	2005	9,700,000	IP	5	UK
HeartRepair	2006	11,400,000	STREP	4	NL
HIPPOCRATES	2004	2,896,000	STREP	4	PO
imgbchimerashybrids	2005	600,424	CA	2	DE
INDUSTRYVECTORTRAIN	2004	176,000	SSA	2	FR
INTERDEVO	2005	2,000,000	STREP	3	SP
INTHER	2005	2,800,000	STREP	3	DE
INVITROHEART	2007	2,701,611	SME-STREP	3	SWE
INVIVOVECTORTRAIN	2003	161,620	SSA	2	FR
KIDSTEM	2006	2,463,000	Marie-CurieRTN	4	UK
LIVEBIOMAT	2005	2,299,906	STREP	3	DE
LYMPHANGIOGENOMICS	2004	9,000,000	IP	5	FI
M3CS-TUTH	2004	2,942,447	Marie-CurieRTN	4	IT
magselectofection	2006	2,800,000	STREP	4	DE
MCSCs	2006	2,150,068	STREP	5	NL
MODEST	2007	2,755,468	SME-STREP	3	DE
MOLCANCERMED	2004	4,000,000	IP	4	UK
MSCNET	2006	2,740,000	STREP	3	DEN
MUGEN	2005	11,000,000	NoE	5	GR
MYOAMP	2006	2,480,000	SME-STREP	3	FR
MYOCARDIALREPAIR	2005	400,000	SSA	2.5	PO
MYORES	2005	12,000,000	NoE	5	FR
NANOBIOCOM	2005	2,017,616	STREP	3	SP
NanoEar	2006	10,499,957	IP	4	FI
NEURO	2005	1,945,500	NEST-	3	IT
NEURONE	2005	8,300,000	NoE	4	UK
NEUROscreen	2006	2,050,000	STREP	3	UK
NEWBONE	2006	4,400,000	IP	4	FI
NSR	2004	2,600,335	Marie-CurieRTN	4	FR
ONCASYM	2006	2,820,000	STREP	3	DE
OsteoCord	2006	2,486,000	STREP	3	UK
Plurigenes	2006	2,500,000	STREP	3	FR
PREDICTOMICS	2004	2,259,754	STREP	3	SP
REGULATORYGENOMICS	2004	2,200,000	STREP	4	FI

REPROGENETICS	2004	980,000	STREP	3	BE
ReProTect	2004	9,100,000	IP	5	DE
RESCUE	2005	2,700,000	STREP	3	FR
RISET	2005	10,000,000	IP	5	BE
SC&CR	2004	1,954,200	STREP	3	IT
SENECA	2006	142,800	SSA	2	PO
SILKBONE	2005	1,599,304	SME-	2	UK
SIROCCO	2007	11,781,445	IP	4	UK
SKINTHERAPY	2005	2,079,900	STREP	3	FR
SmartCaP	2005	1,796,814	STREP	3	SP
StemCellPatents	2005	249,257	SSAS	4	UK
STEMDIAGNOSTICS	2007	2,500,000	SME-STREP	3	UK
STEM-HD	2006	2,500,000	STREP	3	FR
STEMS	2006	2,400,000	STREP	3	FR
STEMSTROKE	2007	2,475,508	STREP	3	SWE
STEPS	2005	13,063,154	IP	4	IT
STROKEMAP	2006	2,400,000	STREP	3	BE
SyntheGeneDelivery	2005	2,400,000	STREP	3	FR
THEEPIGENOME	2004	12,500,000	NoE	5	AT
THERAPEUSKIN	2005	1,523,000	STREP	3	FR
TherCord	2006	1,800,000	STREP	3	IT
TRANSCODE	2005	1,000,000	STREP	3	IT
TRANS-NET	2005	4,539,456	Marie-CurieRTN	4	UK
TRIE	2007	450,000	SSA	1.5	BE
TUMOR-HOSTGENOMICS	2005	2,700,000	STREP	3	FI
UlcerTherapy	2005	2,392,000	STREP	3	IT
VASCUPLUG	2005	2,300,000	STREP	3	DE
VITROCELLOMICS	2006	2,942,000	STREP	3	SWE
X-ALD	2004	1,800,000	STREP	3	AT
111projects	**TOTAL**	**532,712,377**			

Source: European Commission[162]

[162] European research projects involving stem cells in the 6th Framework Programme http://ec.europa.eu/research/fp6/p1/stemcells/pdf/stemcell_eu_research_fp6_en.pdf#view=fit&pagemode=bookmarks; see also Hogarth and Salter 2010.