CHAPTER 1

BIOTECHNOLOGY IN MODERN TIMES

'Medieval biotechnology' would to most be an oxymoron.[1] This is hardly astonishing, for the common understanding of this human activity and its means and ends seems to be as deeply embedded in modernity as the very concept of technology itself. Is speaking of biotechnology in modern times merely a truism, then, rendering it superfluous to investigate matters further, since there simply is no other time in which biotechnology has been, presupposing, of course, that these days still are *modern* times? Perhaps. Yet, if the present is no longer 'modern', but e.g. postmodern or not modern at all, biotechnology might have lost its grounding, if not its entire *raison d'être*. This chapter will, therefore, begin with defining the concept of modernity, after which we turn to biotechnology and its *situation*, the latter understood in the Sartrean terms of the subject merely passing by the object without already instrumentalising them in the same act.[2] I intend to do precisely this, namely to see biotechnology simply as it *is*, namely as being there, while the questions of necessity or possibility relating to its being will be dealt with later in the book.

I take biotechnology to be a true project of modernity, then. This is the first part of my thesis, based upon my view of the modern project and its maker. The second is

[1]The nature of the oxymoron is, of course, to create ambiguity by virtue of its inherent contradiction, which is uncalled for in our present context: "L'oxymoron est ambigu, il n'est pas pour autant en équilibre, car un des deux termes semble vouloir rattraper l'autre. Ce n'est pas une ambivalence comme l'amour et la haine qui peuvent se côtoyer de manière symétrique chez des amants. (...) Non, le *"merveilleux malheur"* est lui de travers, il boite." De Brabandere (2002).

[2]Cf. Sartre (1956), 548f: "The situation can not [sic] be subjective, for it is neither the sum nor the unity of the impressions which things make on us. It is the*things themselves* and myself among things (...) that (...) simply are *there* as they are without the necessity or the possibility of being otherwise and that I am *there* among them (...) The situation is the subject illuminating things by his very surpassing, if you like."

L. Reuter, *Modern Biotechnology in Postmodern Times?*

that after the at least alleged crisis of modernity, this project now seems anachronistic, since the strong subject of modernity, on which biotechnology relies so heavily, has been weakened considerably, leading us to wonder whether that subject indeed can fulfill the role it has assigned itself. In this respect, it is worth remembering that the various forms of utopia envisioned from the late 1940s to the early 1970s also were modern projects that now have been abandoned, also quite literally.[3] Obviously, the notions of what modernity entails have changed, then, but how many changes would eventually void the concept?

Since the common endeavour of biotechnology does make an impression on 'us', i.e. society, and (parts of) our lives, its use has been discussed and regulated politically, e.g. by law. Furthermore, science is, like most of the academy, international in its scope, and so is biotechnology, especially because some of its foundations could only be established through the coordination of national initiatives, as in the Human Genome Project, begun in 1988[4] and preliminarily completed in 2000.[5] In Europe, biotechnology has been the object of coordinated funding as well as regulation. I shall attempt to illuminate its situation through the views on biotechnology offered in documents issued by the Council of Europe. This organisation forms a major European forum of debate and decisions on common economic, legal, and political policies with regards to biotechnology, reflecting varying levels of multilateral agreement reached on the European identity and scope of this field in these allegedly 'modern' days of ours.

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[3]In several European countries, public housing projects involving pre-fabricated elements have proven to be quite unpopular and deserted buildings have been torn down, while others have been diminished, remodelled or at least renovated. A systematic reflection on this topic is found in: Prak (1985). With regards to wider bearings of social housing, cf. Danermaerk and Elander (1994). The social aspects of this type of housing are discussed in: Power (1997). She also gives a survey of the historical development in: Power (1993).

[4]Cole (1998), 55.

[5]The working draft was completed in 2000: "June 26, 2000 will be remembered as an important day in the history of science and milestone for humanity. The international Human Genome Project (HGP) Consortium, which is composed of scientists from China, France, Germany, Japan, United Kingdom and the United States of America, announced the completion of the human genome working draft at 18:00 p.m. (Beijing Time) that very day." Yang (2000), 63.

1. THE CONCEPT OF MODERNITY

The time of 'modernity' is often perceived as a period evolving from Europe through a series of decisive developments: the voyages to the continents beyond, the discovery of a solar system in which the earth is merely a planet, the emancipation of the human mind from its divine creator and, thus, also from the Christian religion proclaiming 'him', the separation between church and state with its concomitant shift of power to the latter, and the increase in the human domination of nature especially by the means of science, all of which contributing to, if not resulting in the state of anthropocentrism.

Henceforth, humans do not just understand the world in human terms, the inevitability of which is self-evident, they also shape it in accordance with their mind *solely* on its own account: "The modern concept of subjectivity rests solidly in the idea of freedom, so much that many consider autonomy *the* characteristic of the new age."[6] This expression of autonomy is firmly established in the enlightenment, severing the human agent from its mundane and metaphysical contexts. Consequently, the only point of reference left for human agency is humanity itself, notwithstanding its possible (self-)transcending abilities as assumed e.g. in social contract theories or any other position linking the (practical) reason of the individual with an assumed commonwealth of (theoretical) reason. Realising this autonomy, a modern understanding[7] of human agency excludes any element of *ontological* otherness from the human act, neither promising nor granting relief for the rolling of our stones.[8] The *human* act *is* nothing more than it is, apparently. This raises questions of the precise nature of the subject acting, especially concerning its potential for agency, to which we shall return in chapter 2, section 3.

It would be somewhat ignorant, of course, to regard modernity as a sharply defined period on a historical continuum. Historical periodisation is a tool of comprehension

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[6]Dupré (1993), 120.

[7]This judgement does presuppose a particular view on modernity and its concomitant thinking. Depending on the how far this concept is extended, certain philosophical traditions or positions are not covered by it, e.g. a variety of phenomenological approaches that do seek to take ontological otherness into account.

[8]In this, the human subject would very much find itself in the situation of Camus' Sisyphus, who, as it is well-known, must be considered a happy man, because he has understood the inevitability of his situation. We might be condemned to freedom, but at least it is our own freedom. See Camus (1955).

rather than a description of reality, after all. It is, therefore, slightly more relevant to understand the term 'modernity' as a name for certain practices, attitudes, and relations marking human agents and their agency. In this sense, one might detect modern modes of being at various points in history, establishing forms of acute anachronisms, while maintaining inherent strains of synchrony in time. 'Modernity' as a concept may, thus, be parallelled with the way in which that of 'classicism' is employed: a specific notion of reading the world in art and architecture, re-emerging or rediscovered at various points in time since Greek-Roman classicism, e.g. at the turns of the 12th and 19th century.[9] A concept of time such as 'classicism' requires 'texts' in the sense of deliberate fixations of communication in writing, sculpturing, painting, or building construction, in this instance seeking its origin in the part of 'Antiquity' from which sources remain. Understanding the past as a sequel of distinct periods is a fallacy, because a period does not exist *per se*, but only to the extent people act in the ways they do, thus providing a folio for systematisation *a posteriori* with specific modes of actions, acts, and agency delicately dissected for this very purpose.

Granted, human actions are influenced by collective ideas such as societal norms and values, but the concept of a period first emerges when human actions by analysis are arranged to form precisely what one is looking for. Even periodisation faces the problem of human individuality, i.e. individual acts that do not conform with standardised behaviour, which sometimes is solved by classifying these acts of differing modes as "anachronistic". Logically speaking, they cannot be that, since any act is performed in its particular time. Inherently, no act is "anachronistic," but it may be deemed less in accordance with societal standards. In other words, the term is not descriptive, but normative.

One could define modernity in our present context, then, as a period in which modern modes of being are accepted as standard references for societal interaction and historical periodisation is employed to distinguish 'the past', here understood as 'history', from the present. The tentative openness of the last conjunction acknowledges that the present merely is future turning into past, evading an actual grasp of any kind, be it intellectual or physical, apart from the very elusive encounter

[9]The reason for distinguishing the concepts of 'emersion' and 'discovery' here is their difference in presupposition: is the historical period coined 'classicism' indeed an ontological idea emanating in time, the temporal thus shaped by the eternal, or is it merely a finite human vogue, having become a matter of fashion?

of its passing.[10] Moreover, this definition encompasses the co-existence of different contemporary periods in various parts of the world: if 'modernity' originally is a European concept, exported to other parts of the world by culture, war and trade in the course of roughly five centuries, it remains but one categorisation of human activity, complemented by all other forms of human civilisation. In view of the variety of concurring cultures, however, it is striking how the modern concept has secured its volatility compared to the alternatives: "There may be many forms of tribal society, many feudalisms, even many forms of early capitalism, but there is only one modernity and it is exemplified in our society, for good or ill."[11]

In competition with the other modes of societal identity and development, modernity has proven to be the most robust concept, formed and applied by individuals with very different backgrounds. Even if one were to argue that European colonialism (and its US-American heir)[12] had the force to mark, if not programme, the mobile members of societies anywhere, one would still need to account for the willingness with which people consume identical products and seek to conform with the standards of the Western hemisphere. This process is often called 'globalisation', which e.g. is characterised "as a new stage in the development of economies; while internationalisation points to an increasing border crossing of economic activities, globalisation implies the merging of national markets into one unbounded world

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[10]This raises the question of the nature of time, which cannot be answered here. The volatility of the present have inspired concepts of overcoming its condition by eternalising it. In this way, S. Kierkegaard's notion of the moment in Philosophical Fragments may be seen as an attempt to provide a robust structure: "The temporal point of departure is a nothing, because in the same moment that I have known the truth from eternity without knowing it, in the same instant that moment is hidden in the eternal, assimilated into it in such a way that I, so to speak, still cannot find it even if I were to look for it, because there is no Here and There, but only an*ubique et nusquam*. If the situation is to be different, then the moment in time must have such decisive significance that for no moment will I be able to forget it, neither in time nor in eternity, because the eternal, previously nonexistent, came into existence in that moment." ibid., p.13 with a view over the underlying discussion in the footnote, where especially Hegel's position in *Differenz des Fichteschen und Schellingschen Systems* is relevant: "Das wahre Aufheben der Zeit ist zeitlose Gegenwart, d.i. Ewigkeit."

[11]Feenberg and Hannay 1995, 6.

[12]I realise that using the term 'colonialism' with regards to the USA is somewhat delicate. There is little doubt, however, that this country has political as well as economic interests also manifesting itself in forms of hegemony. A brief discussion of the hegemon status of the USA as opposed to other major world powers is found in: Huntington (1999).

market. It signals a growing integration and interpretation of economic activities on a world-wide scale."[13] The precise scope of this concept is debated. Göran Collste sees it primarily as awareness of increasing interdependence[14], while others detect limitations to the extent of seeing it as a myth, because globalisation has only taken place within certain regions and branches of industry.[15] It seems more appropriate, then, to regard this process as one of sometimes deliberate standardisation, at least as far as fashion[16], business[17], travel[18], music[19], IT[20] and the academy[21] is concerned, with

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[13]Schienstock (2001), 51f.

[14]Collste (2001), 425, "the concept catches a wide spread impression that the world is shrinking and that, in an earlier unknown way, the lives of people living far apart are in many ways interdependent. There is a growing awareness that we are all sitting in the same boat."

[15]Schienstock (2001), 52, footnote 6: "Empirical data clearly show that up to now only within the regional economies of North America, Southeast Asia and Europe, and to a much lesser extent between these economies, has a process of economic integration and interpenetration started. Furthermore, globalisation has, as recent empirical studies show, progressed significantly only in a few industrial branches such as automobiles, chemical and consumer electronics as well as in some parts of the service sector such as banks and insurance, whereas other branches have been affected less by the globalisation process. (...) However, to conclude that globalisation is just a myth, underestimates the dynamics of economic development during the past decades and is definitely an exaggeration."

[16]Note e.g. the success of the Western models of the gentleman's suit (trousers, shirt, tie, jacket, belt) and the lady's dress (long with sleeves or two piece suit with blouse).

[17]E.g. the global stock market, now open 24 hours at least five days a week. Cf. also with the details of the business culture, such as the business card, the fairly standardised stationery etc.

[18]Take e.g. the full compliance with IATA (International Air Transportation Association) standards. It is remarkable that even peasants fleeing from tormented Somalia would be arriving on planes in Northern Europe.

[19]This ranges from Japanese children playing Mozart to the music channel MTV.

[20]The standardised internet access and setup, the almost complete hegemony of microsoft, the widespread use of branded search engines (e.g. 'Yahoo'), the duopoly of the Word Perfect and Word programmes etc. Collste (2001), 425f, describes the co-dependence of globalisation and IT as follows: "Information technology (IT), e.g. Internet and e-mail, has been a pre-requisite for the globalisation process. The global networks, or the Global Information Structure (GII) as it has been called, have made it easier and cheaper to communicate across the world to the extent that geographical distance in many instances has become irrelevant."

[21]The mere fact that I, although of Danish nationality, would write a book in English for a Dutch academic publisher. One could argue that, depending on the academic discipline, English has become lingua franca replacing Latin, German or French. Still, my point here is to show that regardless of your local heritage, you are adapting to the norms of the group to which you (would like to) belong and that group has now become a 'global player'.

remaining regional enclaves of local custom and folklore. As a deliberate enterprise, standardisation occurs especially in the technological sector, with the International Organization for Standardization (ISO) as "one main agent for technological globalisation."[22] In this context, standards can be defined as "documented agreements containing technical specifications or other precise criteria to be used as rules, guidelines or definitions."[23]

Since trade relies on the exchange of products, services and the tender representing it, a "main reason for global standardisation is to facilitate international trade (...) When international standards are widely used, suppliers can compete on many markets worldwide and customers have a wider choice of compatible offers. Another reason is that often one component, is used in different products."[24] Such forms of standardisation reflect particular interests, in casu reducing costs and increasing sales, which apparently meet the interests on the part of the consumers. Furthermore, they assume a freedom of human agency, expressed through the notion of choice, that is characteristic for modernity and its hallmark of technology. It is the technological development, then, that is accelerated by standardisation, resulting in possibilities and risks on a global scale.

The reactions on the attack on the World Trade Centre in New York, NY on 11th September 2001, have clearly demonstrated the power of this process, displaying an international public interest and resulting in a common response of military attack and tightened security measures affecting a remarkable number of travellers and insurance customers far beyond the borders of the USA.[25] Complete standardisation has not been achieved yet, in part because in every society, the relative number of those endorsing

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[22]Collste (2001), 428.

[23]Ibid.

[24]Ibid. Collste uses the format of credit, phone and smart cards as an example, where the setting of standards such as an optimal thickness warrants international operability.

[25]The confiscation of nail scissors from one's hand luggage in preparation for a Danish domestic flight from e.g. Århus to Copenhagen is in this regard significant in several ways: first of all, it links the individual to an incident with which he is hardly connected directly; secondly, it transforms the psychology of traveling within one's own country: when crossing the lines of security check, I am moving into an international zone of tension and surveillance, even though the flight never leaves Danish territory and the domestic terminals are separated from the international; thirdly, it inflicts quite arbitrarily on the individual's property right on alleged utilitarian grounds: if it were a matter of security indeed, travelers should not be allowed to bring metal pointed umbrellas, laptops or glass bottles bought duty free, all of which would make for excellent instruments of attack.

it varies according to the degree in which this Western concept is known and embodied by the individual. I speak of embodiment in this respect, because the adaption of modernity is more than the superficial colour change of the chameleon: it is difficult to see how a so distinct way of dressing, eating, washing, communicating and exposing oneself to the arts will not affect the whole person, provided one does not regard human personhood as substantially immune to the influences of e.g. human acts.

Modernity is, thus, created by modern modes of being, since the most fundamental of these modes, namely that of periodisation, is the prerequisite for establishing a period in time called 'modernity'. If there were no 'middle ages', neither could there be a subsequent period, which by the very periodisation of time has erected itself as the epitome of human development: "The "modern" outlook is that there are periods which have distinctive and proper thoughts and attitudes. If this were not true, there would be no "modernity" and we would have to settle with novitas and these not as "modern times" but simply the dies novissimi."[26] In other words, "[p]eriodization is itself a modern strategy." [27]

Ironically, employing the concept of modernity may reveal an underlying attitude of conservatism, attempting to preserve what is fragile and perishable, namely the novelty of any moment and action, by placing it in a category that by definition is constantly up to date. Yet, repetitious actions, seeking to copy a template, will always be carried out in a new temporal frame and context, because any human action is embedded in time and space, parallelled with a finite, but very large number of actions taking place at the same time.

Whenever the past as such or its interactions are understood periodically, 'modernity' thereby proves itself. This statement may seem circular. It is only so, though, to the extent that e.g. J. St. Mill, when presenting the foundations of his theory of utilitarianism, with regards to its basic principle of utility could state that "all desirable things (...) are desirable either for the pleasure inherent in themselves, or as means to the promotion of pleasure and the prevention of pain."[28] In other words, the desirable is that which is desired, as Elijah Milgram convincingly shows, and Mill's

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[26]Mark D. Holtz in an e-mail 14th April 2000, received at 1857 hrs GMT+1 at reuter@teologi.au.dk.

[27]Melehy (1997), 10.

[28]Mill (1985), 258.

argument, thus, an inference.[29] Likewise, the argument launched here is basically empirical, the conclusiveness of which depending on the acceptance of logic, however, very much similar to the definition of modernity in the OED (1989): "the quality or condition of being modern; modernness of character; something that is modern." Without being modern, no modernity, and without establishing 'modernity' through the act of periodisation, one could not identify something or someone as being modern. This logical truth is confirmed empirically, whenever someone uses the terms 'modern' or 'modernity' in the same sense as it is done here. Modernity is desired, then, but its desirability depends upon its very deliberate construction. The whole point of modernity is, then, "that it does *present* itself as a unity, as a period that may be narrated by a single subject[.]"[30]

There is also an inherent arbitrariness of historical periodisation, which is emphasised by the difficulty of firmly establishing the boundaries of such periods. With regards to 'modernity', the criteria have hitherto remained opaque: does it begin with the great voyages and expeditions, the renaissance, the reformation, absolutism, industrialisation, the enlightenment, the great revolutions, nationalism, capitalism, colonialism, parliamentarism, the ultimate suicide of the *anciens régimes* in the First World War, or fascism? And if it has ended, when did that happen: with the end of the Second World War, the movements of the sixties, culminating in the incidents of 1968, the 'oil crisis' in 1973, the alleged 'end of history' in the late eighties or the fall of the iron curtain just after it?

Since the aforementioned definition of modernity in the OED (1989) rests on the assumption that something can, indeed, be modern, the definition of that term is illuminating: "of or pertaining to the present and recent times, as distinguished from the *remote* past (my italics, LR); pertaining to or originating in the current age or period. In historical use commonly applied (in contradistinction to ancient and medieval) to the time subsequent of that time." It is clear, then, that the point made above is sustained: the concept of modernity is inherently dependent upon the periodisation of the time preceding it. With the earliest quote taken from T. Washington's translation of Nicholay's voyage, dating 1585, it is interesting to observe that according to this definition, the 16th century is not remote past, whereas the 14th century is. Following

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[29]Millgram (2000), especially 289. It is classified as 'inference', since there is a movement from evidence to conclusion, with desirable equaling the desired or $p \rightarrow p$

[30]Melehy (1997), 9.

the argument of periodisation strictly and ad absurdum, any person living in 1585 would be closer to us than to his predecessors living in, say, 1485. At least linguistically, such a position would be difficult to defend for many, if not all areas in Europe. The case may be different in terms of human self-understanding, especially with regards to human agency and identity. In this regard, it is interesting that some would use the term 'modern' to describe the process of evolution as having led to modern mankind and relate this development to the size of the brain, evoking that this feature would be of special significance in terms of human identity.[31] The bearings of these questions will be discussed in chapter 2, section 3.

At present, it will suffice to maintain that biotechnology has emerged in a time that some wish to call modern.

2. THE CONCEPT OF BIOTECHNOLOGY

With the following two sections, the examination of this concept and its wider bearings begins. First of all, it is necessary to clarify the meaning of the words used to name this concept, i.e. to analyse typical types of definition employed in this field and relating it to the notion of bioethics. I shall also present my own definition, serving as basis for the subsequent study. Secondly, some applications of biotechnology will be presented in order to show the reality of this concept.

2.1. Definitions

As most terms of categorisation, the word 'biotechnology' is a homonym. This is already evident in the way the OED (1989) defines the word "1. the branch of technology concerned with the development and exploitation of machines in relation to the various needs of human beings; 2. The branch of technology concerned with modern forms of industrial production utilizing living organisms, especially micro-organisms, and their biological processes."

The first definition seems oddly broad, if not tautological, for what machine would not have been developed or exploited by humans for the very sake of - ultimately -

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[31] "The outstanding feature in the evolution of modern man is the growth of the size of the brain, the greatest extent of this increase taking place in the cerebral cortex and its nuclei, and in the cerebellum." Duncker (2002), 57. See also ibid., 56: "...the development of the social and cultural beings of modern mankind."

serving the 'various needs of human beings'? The second definition is more to the point. Since biotechnology here is seen primarily as a *technological* instrument, it is shaped by advanced forms of industrial production, which I therefore take to exclude the forms of industrialisation dependent upon water, coal, iron, and wind. Biotechnology is in this sense a modern tool employed by humans for their own sake.

It is clear, then, that biotechnology and late modernity, i.e. the time *after* the industrial revolution, are inherently linked, since the former requires tools and knowledge first developed in the time of the latter.

The European Commission regards this transition as a "revolution (...) taking place in the knowledge base of life sciences and biotechnology, opening up new applications in health care, agriculture and food production, environmental protection, as well as new scientific discoveries. (...) The expansion of the knowledge base is accompanied by an unprecedented speed in transformation of frontier scientific inventions into practical use and products and thus also represents a potential for new wealth creation: old industries are being regenerated and new enterprises are emerging, offering the kind of skill-based jobs that sustain knowledge-based economies."[32]

Biotechnology does not merely comprise tools, then, together with the life sciences, it is depicted as the very foundation of new societies emerging from those based on old industries, which is expected to create work and wealth. The use of the term 'frontier'[33] is in this regard evoking 19th century images of ventures into territory unknown to Europeans, which, albeit already inhabited, would provide the fields for culturing the new world.[34]

For the commission, health care is one sector where biotechnological procedures

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[32]Commission of the European Communities: COM (2002) 27, 3f.

[33]Phillippe Busquin, European Commissioner for research, uses this term somewhat enthusiastically, maintaining that biotechnology is "indeed the new frontier in science and technology and it can be a major driver of innovation and wealth creation in Europe.": Speech at the Belgian-Danish Forum for Innovation in Biotechnology. Brussel 29 May 2002. Unpublished manuscript, 3.

[34]According to Frederick Jackson Turner's thesis, "the existence of an area of free land, its continuous recession, and the advance of American settlement westward, explain American development (...) this frontier accounted for American democracy and character, and (...) at the end of the 19th century the continental frontier finally closed forever, with uncertain consequences for the American future." Quoted in: Faragher (1994), 1. Cf. also Klein (1997). Lee attempts to avoid the cowboy ethos by tracing "a critical genealogy of the narrative traditions through which historians, philosophers, anthropologists, and literary critics have understood the European occupation of Native America, and (...) how those understandings shaped and were shaped by changing conceptions of history." Ibid., 6.

will be applied. Since it is not as such evident, however, that these two areas are related, I need to clarify in what ways they indeed are. The proof quotations given in the OED (1989) may be helpful in this respect. In 1969, the Scientific Journal June 50 states: "Biotechnology is just as concerned with the provision of tools for medical research as with the development of equipment for medical service." In 1972, a periodical called Biotechnology and Bioengineering Symposion has appeared. And in 1985, I. J. Higgins in I.J. Higgens et al.: Biotechnology, i, 2, explain why the technology has grown popular: "It is...the discovery of genetic engineering techniques via recombinant DNA technology..., which is responsible for the current 'biotechnology boom."

At this first glance, biotechnology appears as an area of fundamental research, the role of which increased as its results in understanding genetic engineering proved to be of value especially for the medical sector. In 2001, others see its roots in food production, arriving at a similar conclusion, worth quoting at length:

> "Historically, biotechnology evolved as an artisanal skill rather than a science, exemplified in the manufacture of beers, wines, cheeses etc. where the (...) molecular mechanisms went unknown (...) The traditional biotechnology products have now been added to with antibiotics, vaccines, monoclonal antibodies and many others, the production of which has been optimised (...) in particular, recombinant DNA (rDNA) technology, which is now giving bioscientists a remarkable understanding and control over biological processes (...) It is most probable that this rDNA technology or genetic engineering (...) will be increasingly viewed as a branch of modern science which will have profound impacts on medicine, (...) the development of new biopharmaceutical drugs and vaccines for human and animal use, the modification of microorganisms, plants and farmed animals for improved and tailored food production and to increased opportunities for environmental remediation and protection."[35]

This statement collects the central elements of our investigation: when the subject did no longer consider it sufficient merely to produce, but necessary to fathom, say fermentation, biotechnology turned into science, marking a step from the subject as an agent of sheer making to that of analysis, with which the subject distances itself from its own manufacture and the results of it so that it may 'objectify' by way of dissection. The goal of this endeavour is to 'optimise', i.e. to better the imperfect and to gain true control over the ways of nature, which the knowledge of rDNA promises to grant, here

[35]Smith (2001), 3f.

expressed by the use of the term 'remarkable', signifying that the degree of understanding and control is now closer to the actualisation of its potential. Hence, the use of rDNA united the disparate efforts of examining and understanding the laws of microorganisms, finding cures for disease in medicine, improving the production of animals and plants, and dealing with the environmental mess we make. According to this understanding of rDNA, it pledges that humans will be able to finally live without fear after having overcome the contingencies of our existence. A little pejoratively put: in utopia[36], we will be protected by vaccines and drugs, produce precisely the food we want and make our damages to the environment vanish. This is indeed a remarkable enterprise, which "was foreseen in the mid 1960s and came to fruition in the early 1970s (...) From (...) relatively modest beginnings, techniques for manipulating and analysing both types of nucleic acid (DNA and RNA) have become remarkably powerful and sensitive (...) The advent of recombinant DNA technologies led to the realisation that DNA could be analysed to a resolution that was unimaginable only a few years before and consequently the genomes of almost any organism, prokaryote, archaea or eukaryote, could be manipulated to direct the synthesis of biological products that were normally *only* [my italics, LR] produced by other organisms."[37] Similar to agriculture, the human subject ventures to direct the genetic ways of nature, including the determined movements of "other organisms," thereby subjecting the inherent laws of necessity to human will. This extends the realm of human influence and may therefore increase the sense of autonomy.

The view of biotechnology as a traditional practice having been transformed by the new techniques of biological change based on human insight into DNA and RNA is also sustained by the first definition on biotechnology given in a recommendation of the Parliamentary Assembly of the Council of Europe in 1993: "Biotechnology which in a sense has a history as long as bread making and brewing can be defined as the use of biological organisms, systems and processes in industrial, manufacturing and service activities. The elucidation of the nature and functioning of the nucleic acids (DNA and

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[36]The term is, of course, coined by Sir Thomas More in 1516, depicting "[a]n imaginary island (...) enjoying a perfect social, legal, and political system." (OED 1991, 370). His book is e.g published with a fine introduction as: More (1999). Further meanings listed in the OED 1991, 370-371 are: any imaginary, indefinitely-remote region, country, or locality; a place, state, or condition ideally perfect in respect of politics, laws, customs, and conditions; and, finally, an impossibly ideal scheme, esp. for social improvement, which is the sense in which I use the term here.

[37] Harwood and Wipat (2001), 65f.

RNA) in the 1950s has paved the way for the manipulation of the building blocks of living organisms so that cells or molecules can be altered."[38] Pivotal to this understanding of biotechnology are the notions of "production", "use", "manipulation", and "alteration", all of which presuppose an agent performing tasks intended to bring about the change within the biological (hyper-)structure of "organisms", "systems" and "processes" transcending the level of mere individual agency. At this point, it is important to stress that fundamentally speaking, the practices of biotechnology differ from those of technology in general by their trust in the ability of molecules to continue the processes instigated by the human agent.

The human interest in working with particular kinds of organisms or matter lies in their assumed response to the human act, which allows for carrying out such work in the hope of reaching goals that can only be achieved through this response. The more precisely this reaction can be anticipated, the more likely the outcome will match the expectation of the agent having caused it. While the human agency envisioned in this respect may be seen as an expression of human autonomy, the need for predictable response of the objects subjected to this agency may actually prove the assertive character of such a view. We shall return these questions in chapter 2.

In the Encyclopedia of Bioethics, the term is defined somewhat similarly, but more briefly than those presented so far: " Biotechnology' includes any technique that uses living organisms to make or modify products, to improve plants or animals, or to develop micro-organisms for specific uses."[39] Obviously, it is difficult to draw a very exact line between biotechnology and medicine, and if we take a statement from a representative of the industry, the connection becomes quite clear: "Modern Biotechnology and its application to human health care create an increasing number of innovative products and services, serving unmet medical needs."[40] In this sense, the very application of biotechnology can be understood as a medical deed, at least to the extent that it is used to satisfy the yet "unmet medical needs," for which traditional forms of medical practice have proven inadequate. This inadequacy is found whenever biotechnology promises to solve the problems it has identified, e.g. with regards to the improved effectiveness and profitability of antibiotics: "What in the 1950s to the 1980s

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[38]Parliamentary Assembly of the Council of Europe: Recommendation 1213 (1993) on developments in biotechnology and the consequences for agriculture, point 1.

[39]Nowell (1995), 283.

[40]Tambuyzer (2000), 192-197.

was the working domain of the chemist, microbiologist and chemical engineer, has now in the 1990s encompassed the skills of the molecular biologist, enzymologist, protein chemist and the biochemical engineer. Biotechnology continues to contribute dramatic changes to the ways antibiotics are manufactured through fermentation, yield improvements, recovery processes and final product purity."[41]

Notwithstanding the actual design of biotechnology, especially with regards to its respective technical or practical side, as *technology,* it still is a field of applied sciences, and as such science, and therefore dependent upon observation and experiment as modes of relation describing the activity of an agent over against the objects of its research. This objectification presupposes a profound development, namely the separation of the human agent from its surroundings, in particular from nature, of which man himself nevertheless remains part. This separation is concomitant with the evolvement of human emancipation. Hence, I see biotechnology as the result of the following chain of movements:

human emancipation → science → technology → biotechnology

Consequently, I use the term 'biotechnology' in the broadest sense, subsuming issues of biomedicine and biotechnology alike: it is the name for practices in the fields of biology, chemistry and medicine employed with the purpose of modifying organisms capable of continuing a process instigated by a human agent using tools and insights especially produced by genetic and biochemical knowledge.

The often public concerns raised by biotechnology have instigated a subsequent discipline of counterbalance, namely bioethics, originally bred by theologians, nourished by philosophers, and then growing into a distinct interdisciplinary field: "By the early 1970s, a genuine interdisciplinary conversation had blossomed, with its fruit a growing literature in which philosophy, theology, law, and other disciplines melded to describe, analyze, and advise on the questions of the new biology and the medicine."[42]

There is, of course, also a discussion of whether bioethics is an academic discipline. Albert R. Jonsen argues a little vaguely that "[i]n the strictest sense, it is not (...) A discipline is a coherent body of principles and methods appropriate to the analysis of some particular subject matter. Bioethics has no dominant methodology, no

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[41]Lowe (2001), 350.

[42]Jonsen (1998), 84.

master theory. It has borrowed pieces from philosophy and theology." Understanding the notion of a discipline in this way, he admits, is "attractive, but probably an archaism [,]" because disciplines are "mosaics of theories,"[43] so that in the end, this discussion demonstrates that it is maturing as a discipline after all.[44] Others regard it as having arrived as an autonomous discipline already, deeming it "an unprecedented story of success."[45] The regularity of world congresses on bioethics is a further indication of this autonomy.[46] At the same time, bioethics is sometimes regarded as dialectically strengthening tendencies it originally was envisioned to counterbalance. In a nutshell, this criticism maintains that while the discipline contributes to socially close the conflicts arising with regards to biotechnology, it stimulates developments in this field, because it is "streamlining the different voices participating in public discussion (...)"[47] There is, in other words, at least allegedly a dominant discourse on ethics that "consists of a well-designed strategy of self-restriction."[48] The result is that new techniques are normalised. This criticism, which actually may be aimed at a specific kind of discourse, applying principlistic approaches in bioethics, has in turn provoked a discussion of its legitimacy.[49]

To my mind, this variety of interdisciplinary approaches and discussions in the field of bioethics is rather an argument for than against regarding it as discipline, since the whole idea of the academy as universitas indeed is collaboration on general and particular questions that have been arranged in fields of study and teaching, i.e. disciplines. This book reflects this view: I consider it to be a contribution to the field of bioethics, using methods of ethics and philosophy of religion to discuss some of the fundamental questions raised by biotechnology. It is not a presentation of the European

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[43]Ibid., 345.

[44]Cf. ibid.

[45]ten Have (2001a), 1.

[46]Having met 2000 in London, the sixth world congress 2002 in Brasilia encompassed a number of national and international bioethics meetings, affirming the point made here.

[47]Kollek (2000), 156.

[48]Ibid.

[49]See e.g. Zwart (2000), 166: "...it is my contention that a legitimate and philosophically acceptable form of bioethics is possible, one that proceeds in a methodologically sound and well-considered manner and aims at recognising both the truths and the fallacies at work in scientific optimism as well as in public fear. The principlistic approach elaborated by Beauchamp and Childress and others often serves as a scapegoat for the kind of criticism articulated by Regine [scil. Regine Kollek]."

debate on bioethics, however, which can be found elsewhere[50], and neither a bioethical discussion of particular biotechnological practices. Instead, I see it as an attempt to contextualise the opaque concept of biotechnology in terms of its historical presuppositions, its systematic structure and current application in Europe.

2.2. Applications

Biotechnology is an expensive and exhaustive enterprise. In 2000, expenditures for research and development alone mounted to more than 4.9 billion € in the EU, with a venture capital investment of 3.8 billion €.[51] Especially small and medium sized companies, characterised by intensive research[52], are "structurally (...) very capital-intensive, and investments have long payback periods."[53]

During the 1980s, biotechnology was in Europe mainly carried out within large companies, but subsequently, small companies have been established, in 2001 amounting to a total of 1570 dedicated biotechnology companies with approx. 61,000 employees.[54] Still, "European biotechnology is (...) lagging significantly behind the US."[55] This is perceived as a deficit in European performance, which in part is related due to the late entry, with the most significant development taking place during the

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[50]See e.g Dekkers (2001), 121.

[51]Bruno Hansen, Director Research DG European Commission: Biotechnology Research in Europe. The Sixth Framework Programme. Unpublished manuscript of speech delivered at the Belgian-Danish Forum for Innovation in Biotechnology. Hilton Brussels 29 May 2002, 6.

[52]See Commission of the European Communities (2001), 110: "...most European DBFs [scil. dedicated biotechnology firms, LR] are either micro or small research-intensive firms. Only approximately 10 per cent of active European DBFs have more than 50 employees, while the majority (about 57%) has less than 20 employees." As explained on the same page, the real number of small companies is presumably even higher, since the younger firms may be incorporated in alliances, venture capitalist etc.

[53]Commission of the European Communities: COM (2002) 27, 10.

[54]ibid., 9.

[55]Commission of the European Communities (2001), 127f. The number of companies is now higher in Europe than in the US, with 1570 registered firms compared to 1273 in the US. See Commission of the European Communities: COM (2002) 27, 9.

1990s[56], and in part due to a variety of structural factors.[57]

Since the mid 1970s, most corporate investments have been made in health care, in particular in pharmaceutical development.[58] It is in this field that the European Commission on a global scale identifies "a huge need (...) for novel and innovative approaches to meet the needs of ageing populations and poor countries."[59] This need exists, because cures for half of the world's diseases are still not known and existing cures increasingly lose their effectiveness due to evolving drug resistance, e.g. in terms of antibiotics. The Commission's anticipation that innovations in biotechnology will be able to meet these needs rests, clearly, on the results it regards as having been achieved already: "human growth hormones without the risk of Creutzfeldt-Jacobs Disease, treatment of haemophiliacs with unlimited sources of coagulation factors free from AIDS and hepatitis *C* virus, human insulin [as opposed to animal with severe side-effects, LR], and vaccines against hepatitis *B* and rabies."[60]

Most companies would focus on one field or a limited variety of diseases[61] by exploring possible causes at the molecular level, leading to e.g. the development of molecule drugs, the mapping of protein interactions, detecting of translocations, production of enzymes and hormone replacements.[62]

In terms of national economies, this field is less significant than that of food and

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[56]Peak years for foundation of dedicated biotechnology firms (DBF) were 1997 an 1998. See for detailed graphs on distribution per country and year: Commission of the European Communities (2001), 108-112.

[57]Ibid., 127-130 presents a variety of difficulties, which can be summarised by quoting the very positive evaluation of the situation in the USA on p.128, according to which "US leadership in biotechnology derives from a unique blend of capabilities and institutional arrangements. These include a strong scientific, technological and industrial base; mechanisms that favour communication and transfer of knowledge between academia and industry; a financial system that promotes the start-up of new, risky ventures; strong intellectual property protection [scil. patents, LR]; and a favourable climate in terms of public perception and regulation that does not restrict genetic experimentation." It is pointed out, however, that the US model does not have to be followed necessarily.

[58]Bains and Evans (2001), 255.

[59]Commission of the European Communities: COM (2002) 27, 5.

[60]Cf. ibid.

[61]Such as infectious diseases, allergies, multiple sclerosis, leukemia, diabetes, haemostasis, arthritis, neurodegenerative diseases and cancer.

[62]These are just some of the areas presented by Danish biotechnology companies in: The Danish Trade Council. Royal Danish Ministry of Foreign Affairs. Belgian-Danish Forum for Innovation in Biotechnology. Hilton Brussels Boulevard de Waterloo. 29 May 2002. S.locus. 9-16.

agriculture, which nevertheless attracts fewer companies, because bluntly put, "a new food cannot be sold at $1000 a meal in the same way that a new drug can be sold at $1,000 a bottle."[63] There are exceptions within this sector, though. Recoupment of costs can be obtained, e.g., in breeding of crops and animals, which has instigated the development of new strains of plants as well as new animal reproduction techniques, such as cloning and transgenetic engineering.[64]

Generally speaking, the genetic modification (GM) of plants is envisioned as a means to solve the most likely increasing problem of providing food for a rapidly growing world population, the majority of which will live in poverty. GM plants are designed to resist natural calamities better, reducing the use of chemical pesticides[65], fertilisers and drugs, while increasing conservation tillage, leading to "more sustainable agricultural practices."[66] The mapping of the rice genome may in this regard prove to be of very high significance in order to allow for developing robust forms of this plant.[67] Therefore, a leading expert in the field, Marc van Montagu, exclaims: "Yes, we need GM plants and the tools of Biotechnology urgently."[68]

Genetically engineered enzymes are used e.g. for food processing and garment treatment. Other examples of application are the use of micro-organisms in the paper pulp and plastics industry.[69] Thus, one may encounter results of biotechnological techniques in the ordinary and extraordinary situations of one's life, sometimes even without being aware of it.

In all of these sectors, the actual techniques basically deal with the molecules of cells, such as lipids, nucleic acids, proteins, and phosphates. Since cells are viable, developing through the interaction of genetic information with an environment, and

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[63]Bains and Evans (2001), 259.

[64]Ibid.

[65]"Pesticides in general pose significant health risks for people exposed to them, especially children, and even unborn infants. Pesticides have been shown to affect reproductive cells and processes in other animals; if reproductive processes are affected in humans to the same extent, then the pesticides used today have the potential to impact future generations of human beings decades from now." Pimentel and Hart (2001), 97.

[66]Commission of the European Communities: COM (2002) 27, 6.

[67]Cf. Science, April 2002

[68]In his presentation at the first Belgian-Danish Forum for Innovation in Biotechnology, Brussel 29 May 2002.

[69]Bains and Evans (2001), 259f.

able to reproduce, cells are the most elementary forms of micro-organisms. With regards to micro-organisms, C. Ratledge formulates what could be seen as a first law of biology, namely that *the purpose of a micro-organism is to make another micro-organism*. Hence, the biotechnologist exploits the micro-organism in order to either produce as many of them as possible or to use them in order to produce something which he desires by way of diverting the reproductive capacity towards that goal.[70] In accordance with our definition of biotechnology given above, this principle could also be applied to biotechnology in general: a technique is used by a human agent in order to modify an organism, i.e. achieving a goal by making use of that organism's ability to continue the process instigated, which is why humans e.g. take medicine or sow.

In spite of its many fields of application, biotechnology is in the media mostly perceived as relating to the genetic engineering of food, animals, and humans, and less with the development of e.g. medication apart from its use of animals for trials. Particular concerns have been raised with regards to actual or potential[71] techniques subsumed under the headings of cloning, genetic modification of products and genetic testing.

As I here venture to illuminate the situation of biotechnology as if surpassing, i.e. seeing it the way it simply is, I also need to account for its actual application. I shall now do so by focussing on one of these debated topics, namely cloning, giving special attention to the new field of stem cell research, which, as you will see shortly, also is related to two of these debated fields. The idea is to use this as a *pars pro toto*, explaining the techniques used and identifying some of the issues raised in conjunction with them. This limitation to one topic is also necessary, because a presentation of all current biotechnological techniques would make little sense in view of the detailed reference works now available. Nevertheless, other procedures will feature, albeit briefly, whenever required for contextualisation in the following chapters.

The word "cloning" is commonly used for the copying of cells. This technique is used in different settings. For instance, in genetic engineering, the object of engineering

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[70]Cf. Ratledge (2001), 17.

[71]The notion of potentiality is in this respect a little vague. As we do not *know* the future, we cannot fully conceive the way in which anything will be used either. Furthermore, the more complex a matter is, the higher is the risk of misinterpreting the facts we encounter. Therefore, things and beings may hold potentials of which we are quite unaware, which means that fears surrounding the potentiality of present techniques may seem unwarranted in the light of actual possibilities, but not necessarily so as far as the potential for future use is concerned. We shall briefly return to this question in chapter 2, 2.

is the basic component of DNA, nucleic acid. By using bacteria as hosts, identical copies of fragments of DNA can be produced, i.e. cloned, which forms one important cornerstone of this field.[72] The techniques of such molecular cloning have "led to the production of such important medicines as insulin, growth hormones, erythropoietin (necessary to treat anemia associated with dialysis for kidney disease) or tissue plasmogen activator (tPa) to dissolve clots after a heart attack."[73]

Cloning is also used in plant breeding and it occurs spontaneously e.g. in the case of vertebrates and mammals, normally called 'twinning'. These forms of cloning do usually not stir public emotion, but reproductive cloning by somatic cell nuclear transfer (SCNT) does. This technique "consists of replacing the ovum's haploïd nucleus by a diploïd coming from a differentiated somatic cell, originating from a child or an adult individual."[74] In other words, the nucleus of an unfertilised eggcell, i.e. its DNA, is replaced with the DNA from the nucleus of a cell that is already developed, i.e. functioning in its genetically preprogrammed place. This somatic cell is diploïd, of course, because it has developed after fertilisation. Thus, there is only parent in the case of SCNT. The sheep called 'Dolly' resulted from the use of this technique after 277 attempts.[75] In the aftermath of its presentation, the use of this technique for artificially creating human twins has been banned internationally.[76] With the cloning of a monkey in 2000, some see research nevertheless moving towards human cloning, further fuelled

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[72]Harwood and Wipat (2001), 66f.

[73]Bart Hansen/Paul Schotsmans: Stem Cell Research: A Theological Interpretation. Manuscript of forthcoming publication, 2.

[74]Ibid., 3.

[75]A brief description of this process in biological terms is found in: Bart Hansen/Paul Schotsmans: Stem Cell Research: A Theological Interpretation. Manuscript of forthcoming publication, 3.

[76]The Universal Declaration on the Human Genome and Human Rights, adopted by the General Conference of UNESCO at its 29th session (1997), declares in art. 11: "Practices which are contrary to human dignity, such as reproductive cloning of human beings, shall not be permitted." The additional protocol to the Council of Europe Convention on Human Rights and Biomedicine on the Prohibition of Cloning Human Beings, opened for signature on 12 January 1998, states the prohibition in very clear terms in article 1: "Any intervention seeking to create a human being genetically identical to another human being, whether living or dead, is prohibited." The protocol has been signed by 29 countries, of which 13 have ratified it. The Charter of 28 September 2000 on Fundamental Rights of the European Union, approved by the European Council 14 October 2000, prohibits in article 3 "the reproductive cloning of human beings".

by researchers who provoke by claiming to break the ban.[77]

SCNT is also used for so-called therapeutic cloning techniques, where the aim is to treat specific diseases related to tissue degeneration rather than develop an embryo in vitro. The technique of cloning can therefore be used in order to achieve varying goals. Accordingly, it has been proposed to speak of (human) reproductive cloning and nuclear transplantation respectively, in order to mark the difference in objectives.[78]

In terms of using nuclear transplantation for treating human diseases, high hopes have been placed in the so-called (human) stem cells, because of their ability to "divide to produce either cells like themselves (immortality), or cells of one or several specific differentiated types (potentiality)."[79] For the European Commission, they offer the prospect of producing tissues and organs in order to treat degenerative diseases and injuries related to strokes, Alzheimer's and Parkinson's diseases, burns and spinal-cord injuries.[80] Research on these cells intensified after the US government in August 2001 decided to federally fund research on 64 stem cell lines derived from embryos, which allowed university laboratories to engage in this work.[81]

Commonly, yet not unanimously, stem cells are defined as "cells with the capacity for unlimited or prolonged self-renewal that can produce at least one type of highly differentiated descendant."[82] These cells exist throughout the stages of human development, but only embryonic stem cells (ES cells) possess pluripotentiality, i.e. the potential to develop into any cell type of a human adult, and so-called immortality, i.e. here to remain undifferentiated for a longer period. This latter feature allows for various forms of genetic engineering, in which e.g. a particular gene could be changed or added while the cell is kept in a petri-dish. ES cells are not totipotent, however, i.e.

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[77]The news of this result were published 14th January 2000. The monkey was cloned, i.e. split from an embryo after 107 embryos had been divided into two or four, resulting in 368 embryos in total, of which only one developed successfully.

[78]See e.g. Bart Hansen/Paul Schotsmans: Stem Cell Research: A Theological Interpretation. Manuscript of forthcoming publication, 4, with reference to P. Verspieren: Le clonage human et ses avatars, in: Etudes 391 (1999), 459-467 and B. Vogelstein/B. Alberts/K. Shine: Please don't Call It Cloning, in: Science 295 (2002), 1237-1238.

[79]Bart Hansen/Paul Schotsmans: Stem Cell Research: A Theological Interpretation. Manuscript of forthcoming publication, 4.

[80]Commission of the European Communities: COM (2002) 27, 6.

[81]Cf. Bart Hansen/Paul Schotsmans: Stem Cell Research: A Theological Interpretation. Manuscript of forthcoming publication, 7.

[82]Watt and Hogan (2000),1427.

they cannot develop into an embryo on their own. The term 'embryonic' is used, because these cells are typically derived at the blastocyst stage, i.e. the developmental stage five to six days after fertilisation of the ovum, where a cell cluster has been arranging from which placenta, foetus and other tissue will be formed.[83] Since the ES cells will become more specialised in the subsequent development, they will gradually lose their pluripotentiality.

In 2000, F. Watt and B. Hogan pointed out that the "spotlight on stem cells has revealed gaps in our knowledge that must be filled if we are to take advantage of their full potential (...)"[84] Since then, only some of these gaps have been filled and there still is a disagreement on whether to focus research on multipotent adult or pluripotent embryonic stem cells, depending on the ethical concerns identified with either. Therefore, research on adult stem cells has been intensified in the quest for embryo-saving alternatives due to the prevalent "technical obstacles of the human cloning combined with the ethical controversy about using embryos for research purposes[.]"[85] At the level of the European Union, the European group on ethics to the commission "stresses in particular that there should be European Union funding for research into adult stem cells. Such research is less attractive than other types of research for private investors given the difficulty of isolating these cells, but it does not raise the same ethical objections as does the removal of stem cells from human embryos."[86] The ethical objections referred to are raised, because the use of ES cells is inherently linked with the question of obtaining them. For in order to use embryonic stem cells, an embryo is needed from which these cells can be removed. Such embryos now typically stem from assisted fertilisation procedures, where among the number of embryos resulting from in-vitro-fertilisation, some or even most may not be implanted after all. They are often referred to as "*spare* [my italics, LR] embryos from in vitro fertilization procedures,"[87] which is not an altogether neutral description. The reason for using this term is that for IVF, several ova will be fertilised, since nidation often proves quite

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[83]Cf. Bart Hansen/Paul Schotsmans: Stem Cell Research: A Theological Interpretation. Manuscript of forthcoming publication, 6.

[84]Watt and Hogan (2000), 1427.

[85]Cf. Bart Hansen/Paul Schotsmans: Stem Cell Research: A Theological Interpretation. Manuscript of forthcoming publication, 5.

[86]European Commission (2001), 6.

[87]Watt and Hogan (2000), 1427.

cumbersome to achieve. It can be anticipated, therefore, that not all embryos will be needed, but not precisely determined how many will be left. The term 'spare' thus means 'not needed for artificial fertilisation', but could, misleadingly, also be understood to refer to the quality of the human embryo.[88] Given that research in this field is new, is not surprising that at the national European level, "stem cell research is not regulated as such."[89] Some countries have begun legislative procedures[90], while the Council of Europe convention on biomedicine and human rights prohibits it implicitly in its art. 18. At least the issue of ES cells clearly demonstrate how research in biotechnology advances faster than the concomitant societal reflection on its use and legal status.

[88]The European Group on Ethics defines it in this way: "spare embryos' (i.e. supernumerary embryos) created for infertility treatment to enhance the success rate of IVF, but no longer needed for this purpose. They are intended to be discarded, but instead, may be donated for research by the couples concerned[.]" Opinion of the European Group on Ethics No 15 (2000), 127.

[89]Opinion of the European Group of Ethics No 15 (2000), 128.

[90]France and Germany have legalised the import, but not the creation of ES cells.