BIOTECHNOLOGY IP & ETHICS

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use of IPRs to stimulate them has raised ethical red flags. As biotechnology slowly replaces combinatory chemistry in finding, testing and delivering new medicines, ethical questions will only rise in importance.

Of particular concern is the gap between business strategies surrounding the use of IPRs, scientific norms and the needs of the public health care system. The business community has learned relatively little from the mistakes of Myriad Genetics in trying to enforce its patent rights in Canada and in Europe over two breast and ovarian cancer-related genes. Companies continue to try to exercise their patent rights as if IPRs can easily be enforced, even when in doing so they run up against strongly held scientific and social norms. One of the major challenges of the coming years will be to find better strategies for managing IPRs that meet the needs not only of industry but of the research community and health-care system. In fact, a failure to address these concerns will likely result, as it did for Myriad, in a substantial loss of revenue.

We should be careful, however, in attributing all ethical concerns over biotechnology or commercialization of biotechnology to the IPR system. While IPRs are a significant tool used in the commercialization process, it is far from the most important. Regulation over the introduction of new medicines, university priorities and funding, research tax credits, the size of the Canadian market and access to skilled managers all play a more significant role in determining what research is conducted, to whom research results are assigned and if and how those results are distributed. Just as it is incorrect to credit the IPR system with biotechnological innovation — as noted earlier, the evidence in support of the incentive effect of patent rights is ambiguous — it is wrong to lay responsibility for all ethical concerns related to the commercialization of biotechnology on the IPR system. A better understanding of what the IPR system does and does not do is a good starting place for further consideration of its methods and goals.

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GENETIC RESEARCH TOOLS: RECENT TRENDS AND FUTURE OUTLOOK

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I. INTRODUCTION

The convergence of several factors contributed to the advent of the "golden age" of biotechnology commercialization in the final two decades of the 20th century.[1] During this period, biomedical resources lacking immediate therapeutic or diagnostic value were subject to mass patenting as genetic research tools in the United States. Burgeoning biotechnology companies applied for thousands of patents on expressed sequence tags ("ESTs") and single nucleotide polymorphisms ("SNPs") in the hope of finding the "El Dorado". The controversy generated by these patents went beyond the biotechnology forum and threatened the foundation of the patent system itself. Scholars, patient groups, non-governmental organizations ("NGOs"), politicians, patent office administrators and a variety of other actors took part in this vast debate.

However, there has been a change in outlook in recent years. Research tool patents have become more difficult to obtain and to enforce in North America and Europe. Their value, as well as the surrounding commercial hype around biotechnology, has significantly diminished.[2] Are biotechnology research tool patents no longer an issue? Is the vast amount of theoretical reflection that is available on the subject still relevant to current patenting practices?

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1 Richard F. Harris, "Patenting Genes: Is it Necessary and is it Evil?" (March 2000) 10 Current Biology R174.

2 Trisha Gura, "After the Gold Rush: Gene Firms Reinvent Themselves" (September 2002) 297 Science 1982.

This chapter will retrace the evolution of the practice of research tool patenting in the field of biotechnology (see section II). In addition, it will review the ethical, social and legal discourses generated by the controversy surrounding this type of patent (see section III). Before concluding, the chapter will discuss the current relevance of the debate for industry and consumers (see section IV). It will be argued that even if ESTs and SNPs patents are no longer at the centre of the controversy, other types of biotechnology patents, some being granted on new types of research tools, still remain problematic and warrant close monitoring. The arguments and empirical findings brought forward by researchers on the issue of DNA patents should be used as a foundation for future research on these new types of research tool patent applications. They could also help solve similar intellectual property issues in other emerging scientific fields.

II. THE "GENETIC GOLD RUSH"

Although the "genetic gold rush" did not start until the 1980s, warning signs of the event can be traced to more than a century ago. Indeed, it was more than 150 years ago (1833) that the first patent on a life form was granted in Belgium for a variety of yeast.[3]

Throughout the 20th century, American patent law, whose evolution has influenced contemporary intellectual property regulations in a majority of industrialized countries, was in constant expansion in order to respond to the new challenges set by human inventiveness.[4] Economic factors as well as ideological pressures contributed to this expansion to new fields of inventions such as plants (1930), surgical methods (1950), computer programs (1981) and animals (1988).[5]

It is in this era of growing significance of intellectual property that the "biotechnological revolution" took place. The discovery by James Watson and Francis Crick of the structure of DNA in 1953 opened a whole new world for biomedical research. Progress in the field of

3 E. Richard Gold, Yann Joly & Timothy Caulfield, "Genetic Research Tools, the Research Exception and Open Science" (2005) 3:2 GenEdit 1, online: HumGen <http://www.humgen.umontreal.ca/int/GE/en/2005-2.pdf>.

4 William W. Fisher III, "The Growth of Intellectual Property in the United States: A History of Ownership in the United States" in Hanne Sigrist & David Sugarman, eds., *Eigentum im internationalen Vergleich* (Göttingen: Vandenhoeck & Ruprecht, 1999) 265 at 269.

5 Yann Joly, "Biotechnologies et Brevets: le cas de la pharmacogénomique" (Summer 2005) 10:2 Lex Electronica 13, online: Lex-Electronica <http://www.lex-electronica.org/articles/v10-2/joly.pdf>.

biotechnology was then streamlined during the 1980s with the advent of bio-informatics.[6]

A defining event for what was to become known as the "genetic gold rush" era was the 1980s landmark ruling of *Diamond v. Chakrabarty*.[7] In the mid-1970s, a researcher working for the company General Electric developed a genetically modified micro-organism conceived to improve the degradation of petrol in oil spills. Subsequently, General Electric filed a patent application containing 36 claims related to the genetically modified micro-organism. This application contained three types of claims: process claims, claims for an inoculum and claims related to the bacteria. The United States Patent and Trademark Office[8] examiner granted the applications on the process and the inoculum, but rejected the claims covering the micro-organism for the reasons that it was a "product of nature" and that living things were not patentable subject matter under American patent law.[9]

The case was eventually brought before the United States Supreme Court, where the only question left open to answer was whether a "human-made, genetically engineered bacterium capable of breaking down crude oil, a property possessed by no naturally occurring bacterium", was patentable according to the language of the statute.[10] In a 5-4 majority decision, the Court ruled that a genetically modified organism, isolated and created by cloning, was no longer a product of nature. The interpretation of the terms used in the *Patent Act* was broad enough to include live genetically modified bacteria. The modified micro-organism claimed was a new variety of bacteria, created using human ingenuity and research, that possessed "different characteristics from any found in nature", as well as the potential for a "significant utility". Whether the organism was alive or not was deemed irrelevant for the application of the law. The distinction made by the Supreme Court was rather between "products of nature" (living or not) and "human-made invention". This distinction allowed for

6 Cindy Pham Lorentz *et al.*, "Primer on Medical Genomics — Part I: History of Genetics and Sequencing of the Human Genome" (August 2002) 77 Mayo Clin. Proc. 775.

7 447 U.S. 303 (1980).

8 Hereinafter "PTO".

9 Ananda M. Chakrabarty, "Patenting Life Forms: Yesterday, Today, and Tomorrow" in Scott Kieff, ed., *Perspective on Properties of the Human Genome Project* (San Diego: Elsevier Academic Press, 2003) 3 at 4.

10 Yann Joly, "Wind of Change: In Re Fisher and the Evolution of the American Biotechnology Patent Law" (2006) 24:1 Law in Context 67.

the subsequent conclusion that the genetically modified organism, isolated and created by cloning, was no longer a product of nature."[11]

This important judgment, along with the subsequent enactment of the *Bayh-Dole Act* in 1980, had the effect of encouraging the commercialization of inventions developed under federal funding by public institutions and small businesses. The creation of the Court of Appeals for the Federal Circuit also helped pave the way for two decades of intense commercialization of the fruits of biotechnology research in the United States.[12] Several other industrialized countries adopted an approach to biotechnology patenting similar to that in the United States (however, application of the patentability criteria differs between the various countries) as illustrated by the following joint statement made by the European Patent Office, the PTO and the Japan Patent Office:

> Purified natural products are not regarded under any of the three [European, Japanese and U.S.] laws as products of nature or discoveries because they do not in fact exist in nature in an isolated form. Rather, they are regarded for patent purposes as biologically active substances or chemical compounds and eligible for patenting on the same basis as other chemical compounds.[13]

However, biotech research tool patenting never reached the same level of effervescence elsewhere as it did in the United States.[14] The "genomic gold rush" reached its peak in the U.S. around the mid-1990s, five years prior to the publication of the first draft of the human genome. During this period, the National Institutes of Health filed patent applications for 6,800 ESTs. Although these applications would subsequently be withdrawn, the general trend continued. In 1996, Incyte Pharmaceuticals filed patent applications for as many as 400,000 ESTs.[15] Concurrently, a promising discipline amalgamating genomics and pharmaceutical science termed "pharmacogenomics" caught the eye of the biotechnology business

11 *Diamond v. Chakrabarty*, 447 U.S. 303 at 307 (1980).

12 Arti K. Rai & R.S. Eisenberg, "Bayh-Dole Reform and the Progress of Biomedicine" (Winter/Spring 2003) 66 Law & Contemporary Problem 290-92; Yann Joly, "Wind of Change: In Re Fisher and the Evolution of the American Biotechnology Patent Law" (2006) 24:1 Law in Context 67 at 68.

13 "Trilateral Co-operation of the US, European, and Japanese Patent Offices" (1988) 7 Biotechnology L. Rev. 163.

14 John H. Barton, "International Patent-Antitrust Principles: The United States-European Balances", statement for DOJ/FTC joint hearings (May 2002) 2, online: Federal Trade Commission <http://www.ftc.gov/os/comments/intelpropertycomments/bartonjohnh.pdf>.

15 Molly A. Hofman & Stephen R. Munzer, "Intellectual Property Rights in Genes and Gene Fragments: A Registration Solution for Expressed Sequence Tags" (March 2000) 85 Iowa L. Rev. 753.

community and led to the first patent applications on single nucleotide polymorphisms.[16] The intense pressure put on the PTO as a result of the complexity and sheer volume of these DNA patents, as well as the emergent critiques of its somewhat lenient 1999 *Utility Guidelines*,[17] convinced the organization to issue more restrictive revised guidelines in 2001.[18]

Genetic patents sparked controversy in Europe as well. However, Europe remained largely unaffected by the "genomic gold rush",[19] despite some favourable legislative and administrative reforms implemented to promote biotechnology patenting (*e.g.*, the *Biotechnology Directive*). In 1999, only about 200 or so patent applications for ESTs were pending at the European Patent Office, none of which had yet been examined.[20] The number of European patent applications on SNPs and their uses, however, was slightly higher and persistently increasing, according to the 2001 business report by the European Patent Office.[21]

While the patenting of living organisms had been long criticized on moral grounds by activists from a variety of disciplines, the large number of patent applications on basic genetic sequences in the United States also began raising more practical concerns amongst the scientific, medical and academic communities.[22] These detractors complained of the negative impacts of the liberal gene patenting policies originating from the United States on the progression of research and on the access to new biomedical treatments.[23] However, their arguments and criticism about the negative

16 Yann Joly, "Accès aux médicaments: le système international des brevets empêchera-t-il les pays du tiers monde de bénéficier des avantages de la pharmacogénomique?" (October 2003) 16 Les cahiers de la propriété intellectuelle 142.

17 U.S., United States Patent and Trademark Office, *Revised Interim Utility Examination Guidelines*, 64 Fed. Reg. 71440 (December 21, 1999).

18 U.S., United States Patent and Trademark Office, *Revised Interim Utility Examination Guidelines*, 66 Fed. Reg. 1092 (January 5, 2001); Yann Joly, "Wind of Change: In Re Fisher and the Evolution of the American Biotechnology Patent Law" (2006) 24:1 Law in Context 67 at 70.

19 Although some theoretical discussions on the validity of research tool patents took place in Europe, the bulk of the controversy concerns the more downstream applications of genetic research such as the patenting of human genes as a diagnostic test or stem cells patents.

20 Claire Baldock, "Patenting of ESTs" (March 1999) Patent World 2, online: Boult Wade Tennant <http://www.boult.com/information/articlePrint.cfm?articleID=2>.

21 European Patent Office, *Annual Report 2001: Business Report* (Munich, 2001) 5, online: European Patent Office <http://documents.epo.org/projects/babylon/eponet.nsf/0/5b6b5270b51fd1cbc125724c0040eb4b/$FILE/Annual_Report_2001_en.pdf>.

22 Wesley M. Cohen, "Patents and Appropriation: Concerns and Evidence" *(February 2005) 30* Journal of Technology Transfer 61.

23 *Ibid.*

impact of research tool patents were generally not supported by the available empirical data.[24] Most of the studies conducted on the topic came to the conclusion that the researchers surveyed had managed to avoid situations where, using its patents, a commercial or academic entity had blocked research in one or more broad therapeutic areas.[25]

Within the American legal forum, the controversy over patents on DNA sequences influenced several key decisions from the Court of Appeals for the Federal Circuit on the experimental use defence (*Embrex, Inc. v. Service Engineering Corp.*,[26] *Integra Lifesciences Ltd. v. Merck KGaA*[27] and *Madey v. Duke University*[28]) and convinced the PTO to substantially change its *Utility Examination Guidelines*,[29] first in 1999 and then again in 2001. It was in 2005 when the Supreme Court of the United States in *Merck v. Integra*,[30] a decision concerning the use of patented inventions in preclinical research, finally indicated a change in the position of the judiciary on the topic of research tool patents. Although the Court did not directly comment on the patentability of research tools, it rendered a judgment against the patent holder of a biological compound and gave a broad interpretation of the "safe harbour" statutory research exception. Even though there has been no indication as to whether research tools would be treated as a separate class of inventions, it is

24 Organization for Economic Cooperation and Development, *Genetic Inventions, Intellectual Property Rights and Licensing Practices: Evidence and Policies* (Paris: OECD, 2002), online: OECD <http://www.oecd.org/dataoecd/42/21/2491084.pdf>.

25 John P. Walsh, Wesley M. Cohen & Ashish Arora, "Patenting and Licensing of Research Tools and Biomedical Innovation" in Wesley M. Cohen & Stephen A. Merrill, eds., *Patents in the Knowledge-Based Economy* (Washington: National Academic Press, 2003) 285 at 335; Stephen Hansen *et al.*, *The Effects of Patenting in the AAAS Scientific Community* (2006), online: <http://sippi.aaas.org/survey/AAAS_IP_Survey_Report.pdf>; Sadao Nagaoka, "An Empirical Analysis of Patenting and Licensing Practices of Research Tools from Three Perspectives" (OECD Conference on Research Use of Patented Inventions, Madrid, May 18–19, 2006), online: <http://www.oecd.org/dataoecd/20/54/36816178.pdf>; Joseph Straus *et al.*, *Genetic Inventions and Patent Law: An Empirical Survey of Selected German R & D Institutions* (2004) [unpublished, archived at the Max Planck Institute for Intellectual Property, Competition and Tax Law]; Dianne Nicol & Jane Nielsen, *Patents and Medical Biotechnology: An Empirical Analysis of Issues Facing the Australian Industry* (Centre for Law & Genetics, Occasional Paper No. 6, 2003), online: Law Gene Centre <http://www.lawgenecentre.org/Publication%20PDF/OccPap%206%20contents.pdf>; John P. Walsh, Charlene Cho & Wesley M. Cohen, "View from the Bench: Patents and Material Transfers" (2005) 309 Science 2002.

26 216 F.3d 1343 (2000).

27 331 F.3d 860 (2003).

28 307 F.3d 1351 (2002).

29 United States Patent and Trademark Office, *Utility Examination Guidelines*, 60 Fed. Reg. 36263 (July 14, 1995).

30 545 U.S. 193 (2005).

likely that this ruling will affect the research exception by decreasing the legal protection available to holders of research tool patents.[31]

This new more restrictive trend toward biotechnology patents was confirmed in the landmark case of *Fisher v. Lalgudi*,[32] where the United States Court of Appeals for the Federal Circuit clarified the state of the law on the patenting of genetic sequences by validating the modifications made to the *Utility Guidelines* in 2001 by the PTO and adopting the "substantial utility" test set out by the Supreme Court in *Brenner v. Manson*. According to the Court:

> The basic quid pro quo contemplated by the Constitution and the Congress for granting a patent monopoly is the benefit derived by the public from an invention with *substantial utility*. Unless and until a process is refined and developed to this point — where *specific benefit* exists in currently available form — there is insufficient justification for permitting an applicant to engross what may prove to be a broad field.[33]

In Europe, the adoption of the *Biotechnology Directive*[34] in 1998 by the European Parliament and the Council of Europe in an attempt to harmonize the biotechnology patenting practices of its various member states was one of the most important legal developments concerning patents on genetic research tools. The controversial directive (it was only implemented recently, more than a decade after its adoption, by several members of the European Community under the pressure of legal recourses and remains the subject of debate)[35] was eventually incorporated into the *Implementing Regulations of the European Patent Convention* in September 1999.[36] Although the adoption of the directive promoted the commercialization of biotechnological research in Europe, patents on fundamental research tools did not become an issue due to the generally more restrictive legal framework (rigorous application of the non-obviousness criteria, broad statutory research exemption, exception based on morality/ordre public, *etc.*) both at the level of the European Patent Office and at the level of the various member states. In addition, it can be posited that biotechnology companies, for obvious economic reasons, had

31 Samuel Rubin, "Merck KGaA v. Integra Lifesciences I, Ltd.: Greater Research Protection for Drug Manufacturers" (March 2006) 1 Duke J. Con. Law & Pub. 83.

32 *In Re Dane K. Fisher and Raghunath v. Lalgudi*, 421 F.3d 1365 at 1372 (2005).

33 *Brenner v. Manson*, 383 U.S. 519 at 535 (1966).

34 European Parliament and the Council, *Council Directive 98/44/EC* (1998) O.J. (L 213) 13.

35 E. Richard Gold & Alain Gallochat, "The European Biotech Directive: Past as a Prologue" (September 2001) 7 Eu. L.J. 331.

36 Administrative Council of the European Patent Organization, *Decision of the Administrative Council of 16 June 1999 amending the Implementing Regulations to the European Patent Convention*, O.J. EPO (1999) 101.

a greater commercial incentive in protecting their intellectual property in the United States than in Europe and thus submitted fewer patent applications covering genetic research tools in European countries.

An international perspective on the patentability of research tools can be found in the 2000 comparative study from the Trilateral Co-operation. According to the study, the patent offices of Japan, Europe and the United States do not consider as patentable a sequence without an indication of its function or a specific asserted utility. In Europe and Japan, a DNA sequence showing no unexpected effects, obtained by a conventional method and assumed to be a part of a certain structural gene, based on its high homology with a known gene encoding a functional protein with a known function, would not be patentable. Furthermore, it was assessed that in all three of these regions, all nucleic acid molecular-related inventions, including full-length DNAs and SNPs, without an indication of a function or a specific, substantial and credible utility, would not satisfy the industrial applicability (utility), enablement or written description requirements.[37]

III. THE SOCIO-ETHICAL DEBATE OVER GENETIC RESEARCH TOOL PATENTS

The application of the patent system to human genetic material has generated controversy and has raised a number of different religious, legal, philosophical and political questions. Numerous authors with diverse backgrounds have contributed to the debate by elaborating arguments illustrating the potential dangers that could result from the patenting of genetic sequences and other biotechnological research tools.[38] This section will critically review some of the most popular theoretical and practical arguments advanced to date. It should be noted that concerns regarding other applications of human genetics such as genetic tests and pharmacogenetic medicine, and the misappropriation of genetic resources (*i.e.*, bio-piracy) have also been raised. These concerns are outside the scope of this chapter and will therefore not be addressed.

[37] *Trilateral Project B3b, Comparative Study on Biotechnology Patent Practices — Theme: Patentability of DNA Fragments* (2000), online: The Trilateral Co-operation <http://www.trilateral.net/projects/biotechnology/patentability_of_dna_fragments/patentability_of_dna_fragments.pdf>; Melanie J. Howlett & Andrew F. Christie, "An Analysis of the Approach of the European, Japanese and United States Patent Offices to Patenting Partial DNA Sequences (ESTs)" (2003) 34 Int'l Rev. Ind. Prop & C'right L. 581.

[38] David B. Resnik, *Owning the Genome: A Moral Analysis of DNA Patenting* (Albany: SUNY Press, 2004) at 93.

1. The Substantive Critiques

(a) The Moral Critiques

Proponents of the moral critiques are opposed to the practice of patenting genetic sequences on the premise that it is inherently wrong and therefore should be completely banned. According to them, there is a close connection between our genetic make-up and our humanity that makes the patenting of genes dehumanizing.[39]

Several types of "moral" critiques have been elaborated. To facilitate the discussion, they are presented under a single heading. Several of these critiques find their basis in religious beliefs whereby the genetic code is considered as being God's handiwork and thus any attempt to claim a proprietary right on the human genome (or even on individual genes) would be heresy.[40] Others have adopted the view that the patenting of genes violates fundamental human rights such as the right to autonomy and dignity of the human person.[41] According to these proponents, the human body and its various components cannot be treated as objects or commodities submitted to the laws of the market. This "Kantian Approach" assumes that patenting of genes will affect human dignity because it regards human beings as a "means" instead of an end in themselves.[42] An interesting "slippery slope" argument has also been raised. According to this argument, even though our humanity is more than a mere aggregate of our genes, allowing DNA patents would eventually create a downward spiral leading to the total disrespect of human beings and of their dignity.[43]

(b) The Communal Approaches

There are two communal approaches that have somewhat different theoretical foundations: gene as common heritage and global public good. However, they share important characteristics, making it appropriate to discuss them simultaneously. Even though they were not initially meant to be used as an argument against gene patenting, both approaches are often

[39] David B. Resnik, "The Morality of Human Gene Patents" (March 1997) 7 Kennedy Institute for Ethics Journal 56.

[40] James Boyle, "Enclosing the Genome: What Squabbles Over Genetic Patents Could Teach Us" in Scott Kieff, ed., *Perspective on Properties of the Human Genome Project* (San Diego: Elsevier Academic Press, 2003) 97 at 101.

[41] David B. Resnik, "The Morality of Human Gene Patents" (March 1997) 7 Kennedy Institute for Ethics Journal 56 at 57.

[42] *Ibid.* at 54.

[43] *Ibid.* at 56.

misinterpreted by contemporary theorists and invoked to support a general prohibition on genetic patents in order to remedy some of the "claimed adverse effects" of the patent system in the field of biotechnology.[44]

(i) The Common Heritage

The genome is not yet considered by international law as part of the common or public domain but it has been recognized by several non-binding instruments as a part of "the heritage of humanity".[45] For example, the first article of the *Declaration on the Human Genome and Human Rights*[46] establishes that "[t]he human genome underlies the fundamental unity of all members of the human family, as well as the recognition of their inherent dignity and diversity. In a symbolic sense, it is the heritage of humanity".[47] The common heritage of humanity is an evolving creation of international law designed to regulate the areas and resources of interest to humanity as a whole (*e.g.*, oceans, outer space, Antarctica, *etc.*). Important restrictions will apply to the use of these fundamental resources.[48] Since international law is constantly evolving, the repeated association of the concept of the common heritage of humanity with the human genome could, with the support of the international community, eventually result in the creation of a new rule of law.[49]

Contrary to popular belief, the qualification of the human genome as belonging to the common heritage of humanity would not necessarily justify a prohibition of the patenting of individual human genes. The concept of common heritage in the *Declaration on the Human Genome and Human Rights* was not meant to restrict or forbid biotechnology patenting; it was formulated by the International Bioethics Committee to

[44] See, for example, U.N. ESCOR, 1997, 29th Sess., 29 C/Resolution 19 at 41; World Health Organization, *Genetics, Genomics and the Patenting of DNA: Review of the Potential Implications for Health in Developing Countries* (Geneva: 2005) 31, online: WHO <http://www.who.int/genomics/FullReport.pdf>.

[45] David B. Resnik, "The Human Genome: Common Resource but Not Common Heritage" in Michiel Korthals ed., *Proceedings of the Frontis Worskshop on Ethics for Life Scientists* (Wageningen: Springer science & business media, 2004) at 197.

[46] UNESCO, *Universal Declaration on the Human Genome and Human Rights*, 29th Sess., 29C/Resolution 16 (1997).

[47] *Ibid.*, art. 1.

[48] Bartha M. Knoppers, "Biotechnology: Sovereignty and Sharing" in Timothy A. Caulfield & Bryn Williams-Jones, eds., *Proceedings of the Second International Conference on DNA Sampling: The Commercialization of Genetic Research: Ethical, Legal and Policy Issues* (New York: Kluwer Academic/Plenum Publishers, 1999) 1 at 3.

[49] Bartha M. Knoppers & Yann Joly, "Our Social Genome?" (2007) 25(7) Trends in Biotechnology 284 at 286.

apply to the human genome at the level of the species and not to an individual's genes.[50] The common interest in the human genome shared by current and future generations gives rise to duties of stewardship and justice. These obligations would imply a commitment to protect the genome from harm at the level of the species, such as the loss of genetic diversity or the propagation of harmful (human-induced) mutations.[51]

Nevertheless, authors and NGOs have increasingly attempted to use the common heritage argument to prohibit patenting of genetic research tools. For example, in 2002, UNESCO's International Bioethics Committee used the first article of the *Declaration on the Human Genome and Human Rights* as part of a framework of principles used to support a global moratorium on gene patents.[52] It will be interesting to see whether the international community embraces the extension of the notion of common heritage to individual genes.

(ii) Global Public Goods

Another concept from international law that has recently resurfaced is that of global public goods. David Hume and Adam Smith developed the concept of "public goods" in the 18th century.[53] In order to be considered a global public good, the good must produce a benefit with strong qualities of publicness, defined by the elements of non-rivalry in consumption and non-excludability. In other words, the benefits of the public good have to be enjoyed by all (non-excludable), and consumption by one individual should not deplete the good and should not restrict its consumption by others (non-rivalrous). Furthermore, the benefits of the global public good should be quasi-universal in terms of countries, people

[50] Lorraine Sheremeta & Bartha M. Knoppers, "Beyond the Rhetoric?: Population Genetics and Benefit Sharing" (January 2003) 11 Health L.J. 95.

[51] Bartha M. Knoppers, "Biotechnology: Sovereignty and Sharing" in Timothy A. Caulfield & Bryn William-Jones, eds., *Preceedings of the Second International Conference on DNA Sampling: The Commercialization of Genetic Research: Ethical, Legal and Policy Issues* (New York: Kluwer Academic/Plenum Publishers, 1999) 1 at 9.

[52] UNESCO, International Bioethics Committee, *Report of the IBC on Ethics Intellectual Property and Genomics*, SHS-503/01/CIB-8/2 Rev. (Paris, 2002), online: UNESCO <http://portal.unesco.org/shs/en/files/2139/10541304201FinalReportIP_en.pdf/FinalReportIP_en.pdf>.

[53] David A. Hume, *Treatise of Human Nature*, ed. by David Fate Norton & Mary J. Norton (London: Oxford University Press, 1739); Adam Smith, *Inquiry into the Nature and Causes of the Wealth of Nations*, 5th ed. by Edwin Cannan (London: Methuen and Co. Ltd., 1904).

and generations.[54] Ideally, humanity as a whole should benefit from a global public good and it should be able to meet the needs of present generations without jeopardizing those of future ones.

Genomic knowledge would likely qualify as a global public good.[55] However, it likely becomes a private good (rivalrous and excludable) when applied to a specific invention such as the discovery and isolation of new genes or genetic sequences meeting the patentability criteria. An exception could be made in the case of broad patents on biotechnology research tools that would create barriers to research, where it could be argued that these patents inhibit the potential of genomic knowledge as a global public good.[56] Thus, in the context of the global public good argument, another concept not initially antagonistic to gene patenting is now used to support calls for moratoria or prohibitions on patenting practices of biotechnology research tools. For example, according to the World Health Organization:

> A public good is one that is non-rivalrous and inappropriable, and some have claimed that DNA has this character. [T]o say that genomics, or more specifically genomic data, is a public good is to claim that people would be better off if everyone had access to it. Accepting that genomics is a public good means accepting placing certain limits on its appropriation for private gain.[57]

2. The Practical Concerns

Although the moral critiques and communal approaches have been dismissed rather summarily from the legal forum,[58] they raise important questions. These arguments, while often underdeveloped and generally not supported by legal interpretation, have stimulated a much needed moral

[54] Inge Kaul, Isabelle Grunberg & Marc A. Stern, "Defining Global Public Good" in Inge Kaul, Isabelle Grunberg & Marc A. Stern, eds., *Global Public Goods — International Co-operation in the 21 Century* (New York: Oxford Press Inc, 1999) 2 at 2-3.

[55] Halla Thorsteinsdóttir *et al.*, "Do Patents Encourage or Inhibit Genomics as a Global Public Good?" in Bartha M. Knoppers, ed., *Population and Genetics: Legal Socio-Ethical Perspectives* (Leiden: Martinus Nijhoff, 2003) 487 at 490.

[56] *Ibid.*

[57] World Health Organization, *Genetics, Genomics and the Patenting of DNA: Review of the Potential Implications for Health in Developing Countries* (Geneva, 2005) 31, online: WHO <http://www.who.int/genomics/fullReport.pdf>.

[58] See, for example, Canada, Canadian Biotechnology Advisory Committee, *Biotechnology and Intellectual Property: Patenting of Higher Life Forms and Related Issues, Interim Report to the Government of Canada Biotechnology Ministerial Coordinating Committee* (Ottawa: 2001) 16, online: Canadian Biotechnology Advisory Committee <http://www.ic.gc.ca/cic/site/cbac-cccb.nsf/vwapj/IPPHL_biotech_Interim_e.pdf/$FILE/IPPHL_biotech_Interim_e.pdf>.

debate in the academic community concerning the repercussions of the ownership and commercialization of human genetic material. The following critiques do not pretend to give rise to such a fundamental debate. They are the expression of practical concerns amongst some central participants of the debate regarding the possible adverse impact of authorizing gene patents on research tools. Even if they are less ambitious in scope, these critiques probably had a more profound impact on the evolution of the practice of patenting biotechnology research tools. For example, the seminal article by Heller and Eisenberg,[59] where they first raised concerns about the existence of an anticommon caused by abusive patents in biomedical research, has been quoted in support of a vast number of policy documents.[60]

(a) Genes as Discoveries

Common sense suggests that genes as well as other human genetic products are naturally occurring entities not artificially designed by man. Thus, a number of authors have questioned the patentability of human genetic material, arguing that genes and other human products are discoveries as opposed to inventions.[61] This argument has become particularly relevant outside the United States, where most countries have explicitly excluded discoveries from qualifying for the grant of a patent.[62] However, the vast majority of patent offices worldwide have adopted the position that when a researcher did not simply discover or confirm the existence of a gene but was the first to characterize it, to define it chemically and to make it available in a way that serves some useful purpose, the final product of his or her effort is an invention eligible for patent protection.[63] The logic behind the adoption of this legal fiction has to a certain extent weakened with the impressive development of bioinformatics

[59] Michael Heller & Rebecca S. Eisenberg, "Can Patents Deter Innovation? The Anticommons in Biomedical Research" (May 1998) 280 Science 698.

[60] C.J. Murdoch, Michael Sharp & Lori Sheremeta, "Biotechnology Patents and Policy: What's the Evidence?" Workshop Report (Health Law Institute, 2006), online: Health Law Institute at the University of Alberta <http://www.law.ualberta.ca/centres/hli/r_genome.html>.

[61] United Kingdom Nuffield Council on Bioethics, *The Ethics of Patenting DNA: A Discussion Paper* (London: Nuffield Council on Bioethics, 2002) at 25, online: Nuffield Council on Bioethics <http://www.nuffieldbioethics.org/ fileLibrary/pdf/theethicsofpatentingdna.pdf>.

[62] See, for example, *Convention on the Grant of European Patents*, October 5, 1973, art. 52(2)(a), online: European Patent Office <http://www.epo.org/patents/law/legal-texts/html/epc/1973/e/ma1.html>.

[63] United Kingdom Nuffield Council on Bioethics, *The Ethics of Patenting DNA: A Discussion Paper* (London: Nuffield Council on Bioethics, 2002) 25 at 26, online: Nuffield Council on Bioethics <http://www.nuffieldbioethics.org/fileLibrary/pdf/theethicsofpatentingdna.pdf>.

programs and techniques in the last 15 years. Such progression implies that activities such as DNA sequencing have now become a routine practice requiring little effort or innovation which can reinforce the strength of the "gene as discovery" critique.[64]

(b) Tragedy of the Anticommons

Michael Heller and Rebecca S. Eisenberg criticized the practice of patenting genetic research tools in their 1998 article "Can Patents Deter Innovation? The Anticommons in Biomedical Research".[65] This article suggested that in biomedical research, patents on concurrent DNA fragments and inadequate licensing practices had created a "tragedy of the anticommons".[66] According to the "anticommons" theory, in biotechnology research, multiple patented inputs have to be accessed to create a single useful product, and each of these patents can potentially create a tollbooth on the road to product development, adding to the cost and slowing the pace of downstream biomedical innovation.[67] Should this scenario materialize, researchers would likely be deterred from pursuing important research avenues because of the prohibitive costs in time and money. This theory has had a profound impact on the field of biotechnology and patent policymaking, and has remained influential over the past ten years despite the lack of supporting empirical evidence.[68]

64 *Ibid.* at 29.

65 Michael Heller & Rebecca S. Eisenberg, "Can Patents Deter Innovation? The Anticommons in Biomedical Research" (May 1998) 280 Science 698 at 698.

66 *Ibid.*

67 *Ibid.* at 699.

68 Timothy Caulfield *et al.*, "Evidence and Anecdotes: An Analysis of Human Gene Patenting Controversies" (2006) 24 Nature Biotechnology 1091-94; Sadao Nagaoka, "An Empirical Analysis of Patenting and Licensing Practices of Research Tools from Three Perspectives, Presentation at the OECD Conference on Research Use of Patented Inventions" (Madrid, May 18-19, 2006), online: OECD <http://www.oecd.org/dataoecd/20/54/36816178.pdf>; Dianne Nicol & Jane Nielsen, *Patents and Medical Biotechnology: An Empirical Analysis of Issues Facing the Australian Industry* (Centre for Law & Genetics, Occasional Paper No. 6, 2003); John P. Walsh, Charlene Cho & Wesley M. Cohen, "View from the Bench: Patents and Material Transfers" (2005) 309 Science 2002; John P. Walsh, Wesley M. Cohen & Ashish Arora, "Patenting and Licensing of Research Tools and Biomedical Innovation in Wesley M. Cohen & Stephen A. Merrill, eds., *Patents in the Knowledge-Based Economy* (Washington: National Academic Press, 2003) 285.

(c) Uniqueness of DNA Sequences

"Inventing around" is a strategy used to avoid infringement of patents, whereby an inventor creates a product that shares a similar function with the already patented invention but that is arranged in a different manner.[69] Several authors have argued that genes and genetic sequences have a unique informational content that makes it difficult, even impossible, for researchers to invent around them, affording a *de facto* "double" monopoly to the patentee.[70] This "uniqueness of DNA sequences" argument, if true, would add additional strength and credibility to the "anticommons" theory of Heller and Eisenberg, since it would make the multiple tollbooths on the road to product development unavoidable by the researchers. However, empirical evidence,[71] as well as theoretical arguments,[72] suggests that while inventing around a "patented gene" may be considerably more difficult when compared to other patented inventions, it is certainly not an impossible task.

This overview of the various critiques introduced against the patenting of genetic material bears witness to the important debates raised by this legal issue. The controversy generated by these critiques has given rise to a vast amount of literature in the social and human science fields. It has also compelled intellectual property proponents to reflect upon the necessity and usefulness of intellectual property and to justify its relevance when applied to biotechnological development.

69 United Kingdom Nuffield Council on Bioethics, *The Ethics of Patenting DNA: A Discussion Paper* (London: Nuffield Council on Bioethics, 2002) 25 at 50, online: Nuffield Council on Bioethics <http://www.nuffieldbioethics.org/fileLibrary/pdf/theethicsofpatentingdna.pdf>.

70 See Gert Matthijs, "Gene Patenting and Licensing. On and Beyond the BRCA's Case" (May 2004) European Society of Human Genetics Newsletter, online: European Society of Human Genetics <http://www.eshg.org>. See also Lori B. Andrews, "The Gene Patent Dilemma: Balancing Commercial Incentives With Health Needs" (2002) 2 Hous. J. Health L. & Pol'y 79.

71 John P. Walsh, Wesley M. Cohen & Ashish Arora, "Patenting and Licensing of Research Tools and Biomedical Innovation" in Wesley M. Cohen & Stephen A. Merrill, eds., *Patents in the Knowledge-Based Economy* (Washington: National Academic Press, 2003) 285.

72 Shamnad Basheer, "Block Me Not: Are Patented Genes 'Essential Facilities'?" (April 3, 2005), *Bepress Legal Series*, Working Paper 577, online: bepress Legal Respository <http://law.bepress.com/expresso/eps/577>.

IV. CURRENT RELEVANCE OF THE REFLEXION ON THE PATENTING OF GENETIC RESEARCH TOOLS

The advent of gene patenting has forced the major patent offices to adapt to the challenges raised by human genetics and, as a result, they now approach patent applications on genetic research tools somewhat more vigilantly.[73] This positive change does not infer that patent offices will no longer grant patents on genetic research tools or that biotechnology patenting is no longer an issue. Nor does it imply that nothing more can be learned from the decade-long debate on genetic research tool patenting. Just as patent practices have evolved in the last 15 years to accommodate these new advancements, so have genetics and genomics progressed by leaps and bounds. Researchers can now identify genes using EST datasets and gene prediction software. They are able to assign a proposed function to such genes through homology analysis, which confirms the existence of "motifs" (the unique amino acid patterns within genes that provide a specific biological function associated with classes of genes).[74] The expression data can direct researchers in the identification of genes to a "target" in the formulation of therapeutic drugs or diagnostic tests. As a result, patentees now routinely define their ESTs by their "sequence motifs". Where multiple sequence motifs are present and linked to a specific utility, an otherwise uncharacterized EST may be found to have a highly predictable utility that can thus meet the new, heightened American utility criteria. The use of sequence motifs in patents has become a widespread practice. More than 1,500 references to a "sequence motif" have already been used in United States patents and in patent applications to the United States PTO.[75]

Another example of scientific progress in the field of genomics that could have important implications for research tool patents in the field of pharmacogenomics is the recent improvement in genotyping technology that now allows for samples to be genotyped for millions of single nucleotide polymorphisms ("SNPs") cheaply and simultaneously.[76]

Some of the more generic issues (*i.e.*, also applicable to downstream biotechnological invention) raised by research tool patents have not yet been investigated in sufficient depth and therefore still warrant additional investigation and continuous discussion. One of these issues is related to

[73] *In Re Dane K. Fisher and Raghunath v. Lalgudi*, 421 F.3d 1365 (2005).

[74] Harold C. Wegner, "Developments in Patent Law 2004" (October 2004) 4 J. Marshall. Rev. Intell. Prop. L. 1 at 30.

[75] *Ibid.* at 30.

[76] Michael S. Phillips *et al.*, "Consent in Pharmacogenomic Research" (2007) 5:2 GenEdit 8.

the conflict between biotechnology research commercialization and the need to share information through publications in academia.[77] This tension is especially visible in the context of new research tools to which graduate students could have substantially contributed. Excessive secrecy can impair the careers of students and junior faculty members by preventing the publication of their research findings. What would then constitute an acceptable publication delay for these students? Is there any valid justification (from a moral standpoint) to delay the publication of research results once a patent application has been filed? These are only a few of the important ethical questions that are raised by the confrontation between the need to patent and the need to publish.

Evidence of these conflicts of interest created by biotechnology patents has been documented in several surveys.[78] Still very few studies in the literature discuss the origin of this problem, or propose recommendations or guidelines on ways to improve the current situation. Without this information, university technology transfer offices are likely to develop intellectual property policies that resemble those in the private sector and are more likely to conclude agreements with the industry that are detrimental to the progress of open academic science. Additional studies are needed to evaluate the impact of genetic research tool patenting practices on the rate and quality of academic publications. Recommendations will eventually need to be elaborated in order to improve this relationship.

The information gathered in the research tool patenting debate will also remain relevant to the elaboration of new policies in other emerging scientific fields. Nanotechnology, a current popular topic in patenting circles, is a good example. According to a recent article on this topic,[79] there are three distinguishing characteristics differentiating nanotechnology patenting from patenting in other fields: (1) nanotechnology is an emerging field where people patent early, and frequently go after the building blocks of the technology; (2) basic nanotechnology patents may have implications across many different fields of modern engineering; (3) nanotechnology patents are held in large proportions by universities.[80] Upon closer observation, the first and third "distinguishing"

[77] Julia Porter Liebeskind, "Risky Business: Universities and Intellectual Property" (September/October 2001) 87 Academe 49, online: American Association of University Professors <http://www.aaup.org/AAUP/pubsres/academe/2001/SO/Feat/Lieb.htm>.

[78] David Blumenthal *et al.*, "Relationships Between Academic Institutions and Industry in the Life Sciences — An Industry Survey" (February 1996) 334:6 N. Eng. J. Med. 368; Eric G. Campbell *et al.*, "Data Withholding in Academic Genetics: Evidence from a National Survey" (April 2002) 287 JAMA 1939.

[79] Mark A. Lemley, "Patenting Nanotechnology" (2005) 58 Stan. L. Rev. 601.

[80] *Ibid.*

characteristics can arguably also apply to genetic research tool patents. Indeed, in biotechnology research, oligonucleotides, SNPs, Polymerase Chain Reaction ("PCR") technology, Taq polymerase and other fundamental research tools can be considered as the building blocks necessary to develop more downstream applications such as genetic tests or pharmacogenomic medicine.

Similarly to what has been detected in the nanotechnology sector, a significant proportion of patents on fundamental biotechnology research tools are now held by universities (*e.g.*, the patent on human embryonic stem cells held by University of Wisconsin that covers the method of isolating the cells, the Cohen-Bayer patent claiming basic recombinant DNA technology held by Stanford University, and the University of Rochester patent for the COX-2 enzyme).[81] These similarities suggest that substantial insights could be gained for nanotechnology development from the debate on the commercialization of biotechnology research. Current discussions regarding the potential benefits of open source strategies in biotechnology for facilitating access to research tools could also be relevant for nanotechnology. Finally, the tragedy of the anticommons and the uniqueness of DNA sequence arguments discussed earlier also warrant the attention of academics in this emerging scientific field.

V. CONCLUSION

During the 1990s, genetic research tool patents were the focus of major ethical and legal debates. With the evolution of patent practices in recent years, it is now unlikely that a patent on a genetic sequence with no known specific utility would meet the heightened patentability criteria of any of the three major patent offices. Furthermore, statutory and common law research exceptions are also widely discussed in the legal community and could be invoked in many jurisdictions to facilitate academic research on patented research tools.[82] Considering this change in outlook, this chapter analyzed the ethical debate surrounding the patenting of biotechnology research tools and assessed its relevance to this new context where

[81] John P. Walsh, Wesley M. Cohen & Ashish Arora, "Patenting and Licensing of Research Tools and Biomedical Innovation" in Wesley M. Cohen & Stephen A. Merrill, eds., *Patents in the Knowledge-Based Economy* (Washington: National Academic Press, 2003) 285 at 296.

[82] E. Richard Gold, Yann Joly & Timothy Caulfield, "Genetic Research Tools, the Research Exception and Open Science" (2005) 3:2 GenEdit 1 at 2, online: HumGen <http://www.humgen.umontreal.ca/int/GE/en/2005-2.pdf>.

obtaining such controversial patents seems to have become both more difficult and less profitable.

It is likely that the productive ethical debate generated in large proportion by the excessive biotechnology patenting practices of the 1990s remains just as important today as it was in the past. Arguments and theories developed by opponents of research tool patents at that time were both diverse and insightful, challenging proponents of the patent system to reflect upon and justify the practices they defended. They provide a basis for assessing new research and should be used to inform current patent practices both inside and outside the biotechnology field.

Even with the current changes, it still remains possible to patent genetic research tools that meet the current "heightened" patentability standards set by the major patent offices. The ethical and practical arguments discussed in the second part of this chapter remain relevant to these new kinds of research tool patents. Indeed, the importance of genetic research tools in the development of new medical drugs and devices needed to improve healthcare continues to strongly militate in favour of policies granting broad inexpensive access to such fundamental tools.[83]

Arguments developed in the context of polemics on research tool patents have been used and could be used in the debate on the impact of patents on other types of more downstream inventions in the biotechnology sector (*e.g.*, patents on disease genetic tests or pharmacogenomic drugs). Furthermore, they can also be of interest for ethicists, lawyers and scientists involved in new emerging fields of technology, such as nanotechnology and regenerative medicine. The patent system, in relation to genetic research tools, has been enriched by its confrontation with bioethics. However, in order to prevent the calcification of the system, it is important to remain vigilant by continually questioning the uses and functions of this major legal institution.

[83] *Ibid.*

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