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BIOLOGICAL PATENTS NEED A REFORMED CATEGORY IN PATENT LAWS OF US AND EU, COUPLED WITH MEDICAL AND RESEARCH-ORIENTED SAFEGUARDS AND INNOVATION INCENTIVES

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ABSTRACT

Patents are an important tool to strive innovation. In the field of biotechnology, the costs of research and development are often very high, necessitating legal protection of these investments. For many years, biological inventions, specifically naturally occurring genes in purified form and cDNA have been regarded as patentable both in the US and the EU. However, both fail patentability criteria due to being either products of nature, lacking novelty or being obvious for persons skilled in art. As the substance of patentability questions has been inadequately addressed in the past, decisions like in *Myriad* are likely to continue. It is necessary to specifically clarify the patentability status of purified naturally occurring genes and cDNA under separate category of patents in order to offer security to patentees that their patents are firmly grounded in law. In doing so, however, it is important to take into account issues relating to research obstacles, price and access to medical treatments and diagnostics potentially brought by such patents. On the other hand, it is vital to protect research-related investments. Therefore, several solutions such as patent pooling, compulsory licensing and possibly other patent rights limitations in exchange for longer protection period should be considered.

Keywords**:** gene, cDNA, patent, novelty, obviousness

INTRODUCTION

Biochemistry is a scientific discipline that has shaped the lives of people for more than hundred years and develops at an ever increasing pace. Through centuries, scientists have learned about the composition of matter, human anatomy, discovered and described cells. Methods were discovered that enabled to pinpoint to mutations causing genetic illnesses, to improve diagnostics, to discover new windows for treatment of devastating diseases and to create new organisms with altered genome. Recent years have made gene therapy - editing misformed genes to repair the damage - a reality.[1] In the face of those changes and the increasing pace of discovery, it is no surprise that biologics are involved more than ever in legal practice. Apart from laws related to the quality of medicines, pharmaceutical production, agriculture and research, biological material has entered intellectual property law. In particular, patent law has been developing along advances in biotechnology.

An area of biotechnology under scrutinity in patent law in recent times is gene patents. This area is becoming more and more important for several reasons. Firstly, this field offers promising advances towards personalized medicine and has high potential for reaching wide cure rates for illnesses yet incurable. Secondly, patentability issues can be related to the cost of healthcare and, circumstantially, to healthcare accessibility and quality. Thirdly, this question has a wider economic impact through its influence on the pharmaceutical industry and its influence on the GDP (gross domestic product) of different countries. For those reasons, the patentability of gene sequences is a topic that needs to be analyzed thoroughly from various points of view.

Naturally occurring genes in extracted and purified form as well as synthesized cDNA have been regarded as patentable in both US and EU for decades, resulting in granting of thousands of patents. However, a recent case in the United States (*Myriad*) brought change to the practice of granting biological patents and raised serious questions regarding the patentability of biological material, especially genetic material. Although earlier research has analyzed the effects of this

[1] Xiao-Jie, L., et al., (2015), CRISPR-Cas9: a new and promising player in gene therapy. *J. Med. Genet.*, Vol. 52, Iss. 5, pp 289-296. Accessed: https://jmg.bmj.com/content/52/5/289.long (1 May 2019)

decision on patent law in both sides of the Atlantic,[2] the present research opens new frontiers by examining the problems from a two-pronged viewpoint, analyzing legal criteria of patentability of biological material through utilizing scientific research and coupling the results of this analysis with analysis on potential issues arising from current practice in an attempt to find novel legal ways of achieving balance in patent law.

The aim of this paper is to holistically analyze whether current patent law and practice in the United States and European Union are adequate in dealing with biological material as the patentable subject matter or should the law be refined to adapt it to this rather specific area as has been done with other specialized areas. Shortcomings in either jurisdiction will be addressed through recommendations, taking into account the specificities of the subject matter. These recommendations will take into account both the needs of inventors as well as the needs of the general public, attempting to find a fair balance between patent law and public policy.

More specifically, the research attempts to find an answer to the following questions: 1) Do DNA-based patents fulfill subject matter, novelty and non-obviousness standards set out in patent laws of US and EU? 2) If DNA-based patents are maintained in the current state, which conflicts can possibly arise in terms of medical accessibility and research? 3) Can the interests of biotechnology sector and general society be balanced through addition of a new patent criteria, amendments to patent terms and licensing regulations?

Qualitative research methods are used in this paper, including analysis of patent law and practice in EU and US, comparative analysis between the two jurisdictions and between gene and software patenting to introduce an analogy. Legislation and case law as well as academic literature on the matter in the US and EU will be analyzed through a scientific viewpoint, evaluating the scientific adequacy of subject matter, obviousness and novelty analyses in practice. This interdisciplinary research attempts to use a two-front analysis, evaluating both the fulfilment of patentability criteria and possible resulting effects on other areas of law and society in general, focusing on issues related to accessibility of medicine and effects on further research and innovation.

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[2] Lai, J. C., (2015), Myriad Genetics and the BRCA Patents in Europe: The Implications of the U.S. Supreme Court Decision. *UC Irvine L. Rev.*, Vol. 5, Iss. 5, pp 1041-1076. Accessed through HeinOnline: https://heinonline.org/HOL/P?h=hein.journals/ucirvlre5&i=1053 (28 April 2019); Jervis, H. H., (2014), Seduced by the Sequence: An Analysis of the U.S. Supreme Court's Opinion in Association of Molecular Pathology v. Myriad Genetics, Inc. *Fla. Coastal L. Rev.*, Vol. 16, Iss. 1, pp 65-136. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/fclj16&collection=journals&id=71&startid=&endid=142 (23 July 2018)

Part 1 of this paper analyzes the patentability of biological material in the United States. This is done through scrutinizing the current approaches taken in each jurisdiction towards fulfilment of patentability criteria from a scientific-legal viewpoint. The patentability criteria focus on subject matter, novelty and obviousness analysis. Part 2 of this paper analyzes the shortcomings and dangers to future innovation and research. I addition, problems related to accessibility, personalization and cost of medicine are studied. Economical concerns posed by current state regarding biological patents are looked at. Part 3 introduces recommendations for the improvement of the two patent systems. These include IP category changes, patient protection mechanisms related to access to medicine. These measures are balanced by an overview of measures needed to protect investment in research and development. The paper finishes with conclusion of patentability of biological material currently under US and EU law, the problems associated with the current state and recommendations for rectifying problems found in patent regimes across the Atlantic.

1. PATENTABILITY OF DNA

Next, legislation and case law need to be reviewed in the US and EU to conclude if gene patents conform to the patentability criteria in these jurisdictions.

1.1. International Law

Article 27 of the TRIPS Agreement sets the criteria of patentability, involving technology that is new, inventive and able to be industrially applicable, with the exception of inventions against public order and morality allowable as well as allowable exceptions of methods related to surgery, therapeutics or diagnostics, animals and plants and natural processes for their production while Article 30 allows to make exceptions to patent rights in a reasonable manner, considering the legitimate interests of patent rights holder and third parties.[3] It has been proposed that TRIPS Agreement should be amended to exclusively ban patents on genes (as well as all natural substances) while providing for compulsory licensing.[4]

In most of Europe, patent laws of the states have been resumed under the European Patent Convention (EPC). This Convention establishes a legal system for patents across the continent.[5] The Convention specifies new technology encompassing inventive steps and having application in industrial sphere as patentable (Art. 52).[6] Importantly, paragraph 2 of the Article 52 excludes

[3] Agreement on Trade-Related Aspects of Intellectual Property Rights, Art.s 27, 30, April 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299. Accessed: https://www.wto.org/english/docs_e/legal_e/27-trips.pdf (7 April 2019)

[4] Fowler, C. A., (2010), Ending Genetic Monopolies: How the TRIPS Agreement's Failure to Exclude Gene Patents Thwarts Innovation and Hurts Consumers Worldwide. *Am. U. Int'l L. Rev.*, Vol. 25, Iss. 5, pp 1073-1106, pp 1101-1104. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/amuilr25&collection=journals&id=1087&startid=&endid=1120 (23 July 2018)

[5] Convention on the Grant of European Patents (European Patent Convention) of 5 October 1973 as revised by the Act revising Article 63 EPC of 17 December 1991 and the Act revising the EPC of 29 November 2000, Art. 1, 1065 U.N.T.S. 199. Accessed: https://www.epo.org/law-practice/legal-texts/html/epc/2016/e/EPC_conv_20190401_en_20190326.pdf (7 April 2019)

[6] *Ibid*. Art. 52.

discoveries as well as computer programs, among others.[7] Article 54 requires an invention to be novel - to not have been published in any form prior to application (with exceptions in Article 55).[8] Article 56 requires an inventive step - that the invention may not be obvious to the person who is skilled in the art.[9] Article 57 sets out the requirement of the ability of the invention to be used in industry.[10] The Implementing Regulations further explain patentability of biologics. Rule 26 considers biotechnological inventions as those inventions which consists of, uses, processes, produces biological material (containing genetic information and having ability to be reproduced), encompassing both products and processes and giving interpretation authority to European Community Directive 98/44/EC.[11] Rule 27 sets limits for patentability of biotechnological inventions, declaring biological material patentable if isolated or technologically produced, if it involves animals or plants unless technology is limited to special varieties, if it involves microbiological process or product.[12] Rule 28 precludes certain human and animal genetic modifications.[13] Rule 29 states that human body and its constituents, including gene sequences, are not patentable unless these constituents are isolated or technically produced, in which they may be patentable.[14] The EPC provides for a European patent which has raised concerns that in countries with more stringent patentability conditions compared to EPC, patentees are more likely to get wider European patent.[15]

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7 Gitter, D. M., (2001), International Conflicts over Patenting Human DNA Sequences in the United States and the European Union: An Argument for Compulsory Licensing and a Fair-Use Exemption. *N. Y. U. L. Rev.*, Vol. 76, Iss. 6, pp 1623-1691, p 1645. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/nylr76&collection=journals&id=1643&startid=&endid=1711 (5 May 2019)

8 European Patent Convention, *supra nota* 5, Art. 54, 55.

9 Gitter (2001), *supra nota* 7, p 1676.

10 European Patent Convention, *supra nota* 5, Art. 57.

11 *Ibid*. Rule 26.

12 *Ibid*. Rule 27.

13 Stazi, A., (2015), *Biotechnological Inventions and Patentability of Life: The US and European Experience*. (Great Britain: Edward Elgar Publishing Limited), p 198.

14 Sterckx, S., Cockbain, J., (2012), *Exclusions from Patentability: How Far Has the European Patent Office Eroded Boundaries?* (New York: Cambridge University Press), pp 116-117.

15 Ann, C., (2006), Patents on Human Gene Sequences in Germany: On Bad Lawmaking and Ways to Deal with It. *German L.J.*, Vol. 07, No. 03, pp 279-292, pp 290-291. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/germlajo2006&collection=journals&id=287&startid=&endid=300 (22 July 2018)

1.2. Legislation in the European Union

Next, it is important to review the status of gene patents in the European Union. In the EU law, specifically, Directive 98/44/EC is meant to protect biotechnological inventions.[16] Recital 20 subjects such patentability to condition that patent rights are not able to affect humans and naturally occurring substances do not fall under patent rights.[17] Article 2 of the Directive defines biological material the same way as EPC.[18] Article 3 affirms the patentability of new, inventive and industrially applicable products and processes containing or producing biological material, whereas allowing possible patentability of biologics isolated or otherwise produced even if it previously exists in nature.[19] Article 5 states that human-origin substances, including gene sequences are not patentable while allowing patentability for isolated substances and sequences.[20] Meanwhile, Article 6 forbids inventions against public order and morality – an approach which has been criticized.[21] Article 8 extends substance protection to any other biological material produced on its basis and process patent to biological material produced through the process while Article 9 extends genetic information protection to all related material containing or functioning through this genetic information.[22]

1.3. Case Law in the European Union

Next, case law of the Court of Justice of the EU must be examined to elucidate the practical application of legal provisions regarding biotechnological inventions.

In *Monsanto*, the issue in question concerns a DNA sequence patented by Monsanto and present in glyphosate-resistant soybean and the extent of such protection to soy cake produced from that

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16 Directive 98/44/EC of the European Parliament and of the Council of 6 July 1998 on the Legal Protection of Biotechnological Inventions, Recital 1-3, 1998 O.J. (C 213), 30.7.1998, pp 13-21, p 13 [hereinafter Biotech Patent Directive]. Accessed: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:31998L0044&from=EN (7 April 2019)

17 *Ibid.*, Recital 20, p 15.

18 *Ibid.*, Art. 2, p 18.

19 *Ibid.*, Art. 3, p 18.

20 Gitter (2001), *supra nota* 7, p 1648.

21 Inch, A., (2007), The European Patent Convention: A Moral Roadblock to Biotechnological Innovation in Europe. *Hous. J. Int'l L.*, Vol. 30, Iss. 1, pp 203-242. Accessed through HeinOnline: https://heinonline.org/HOL/P?h=hein.journals/hujil30&i=209 (28 April 2019)

22 Biotech Patent Directive, *supra nota* 16, Art. 8-9, p 19.

kind of soybean.[23] The main question was if the patent protection to the gene sequence still applies if the gene does not perform its function anymore.[24] The Court found that there is requirement of functionality at present time in material containing the patented sequence.[25] The Court found that in this case, the function of the sequence is performed when the plant is protected against glyphosate.[26] The Court concluded that the sequence is not protected when it no longer performs the initial function.[27]

In *Daiichi v DEMO*, Daiichi hold a patent for a compound used in therapy and the producer of the generic version of the compound was granted market access as Greece did not consider pharmaceutics and chemicals patentable.[28] The Court found that pharmacological inventions are patentable, flowing from TRIPS Agreement.[29] The Court excluded general prohibition of patenting pharmaceutical products that arises from necessity of preventing commercialization of medicine.[30]

In *Eli Lilly v Human Genome Sciences*, the Court reached the opinion that merely functional (as opposed to structural) description of a substance is not precluded from claims if conclusions regarding that substance are still possible to be reached.[31] This allows to widen possible claims for gene patents. For example, this allows to patent genes for which a complete sequence is yet unknown but the function of which is clarified.

1.4. Legislation of the United States

In order to analyze patentability of DNA-based inventions in the US, legislation must first be studied.

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[23] Court decision, 6.7.2010, *Monsanto Technology*, C-428/08, EU:C:2010:402, para 15-21. Accessed: http://curia.europa.eu/juris/document/document.jsf?text=&docid=80491&pageIndex=0&doclang=en&mode=lst&dir=&occ=first&part=1&cid=823736 (7 April2019)

[24] *Ibid*., para 33.

[25] *Ibid*., para 35.

[26] *Ibid*., para 36.

[27] Stazi (2015), *supra nota* 13, pp 208-209.

[28] Court decision, 18.7.2013, *Daiichi Sankyo and Sanofi-Aventis Deutschland*, C-414/11, EU:C:2013:520, para 23-30. Accessed: http://curia.europa.eu/juris/document/document.jsf?text=&docid=139744&pageIndex=0&doclang=en&mode=lst&dir=&occ=first&part=1&cid=823811 (7 April 2019)

[29] *Ibid*., para 65, 66.

[30] *Ibid*., para 67.

[31] Court decision, 12.12.2013, *Eli Lilly and Company*, C-493/12, EU:C:2013:835, para 39. Accessed: http://curia.europa.eu/juris/document/document.jsf?text=&docid=145535&pageIndex=0&doclang=en&mode=lst&dir=&occ=first&part=1&cid=823889 (7 April 2019)

Title 35 of the U.S. Code regulates patents in the jurisdiction of the United States. Here, the main interest lies in Part II of the Title concerning the patentability of inventions, more specifically, Chapter 10 (patentability).[32]

First, Section 100 sets forward the required definitions.[33] Section 101 sets the general criteria for patentability, providing that patent can be issued to new inventions and discoveries with a use and that those include processes, compositions of matter, machines and manufacturing methods and improvements of those.[34] Inclusion of the composition of matter appears to make it possible to include molecules present in organisms into the category of patentable inventions. Large biomolecules and their complexes could well be put under the patentables if their composition is sought to be patented.

Section 102 sets out an important limitation to patentability - the novelty requirement. It requires that the patentable invention must not be available for public or in use in any form prior to submitting the patent application.[35] This can be considered highly relevant in connection to the naturally-occurring biological substances. Substances naturally occurring in living organisms are in use by those organisms as part of their metabolic activity. That requirement could potentially render any naturally occurring biomolecule unpatentable as the substance is in use by all organisms possessing such biomolecule.

Another issue concerning biological patents is brought out in Section 103 that negates patent rights for inventions that are obvious to the people who are skilled in the art, based on prior art.[36] In gene patents, this issue is especially relevant. If a gene has been pinpointed to a particular disease or other function, it is obvious for a biotechnologist to sequence the gene. In such case, the sequence of the gene could also be considered obvious. Invention process in biotechnology is highly

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[32] Kane, E. M., (2004), Splitting the Gene: DNA Patents and the Genetic Code. *Tenn. L. Rev.*, Vol. 71, Iss. 4, pp 707-768, p 725. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/tenn71&collection=journals&id=733&startid=&endid=794 (7 April 2019)

[33] 35 U.S.C. § 100. Accessed at Cornell Legal Information Institute: https://www.law.cornell.edu/uscode/text/35 (7 April 2019)

[34] *Ibid.*, § 101; Kane (2004), *supra nota* 32, p 725.

[35] *Ibid.*, § 102(a)

[36] *Ibid.*, § 103; Maxey, J. L., (2011), A Myriad of Misunderstanding Standing: Decoding Judicial Review for Gene Patents. *W. Va. L. Rev.*, Vol. 113, Iss. 3, pp 1033-1072, p 1038. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/wvb113&collection=journals&id=1039&startid=&endid=1078 (7 April 2019)

complex but normally consists of known approaches and technologies, making it difficult to determine what is a prior art.

In order to determine whether technology under question is obvious to expert or not, the court would need to gain testimony from several experts in the field whose opinions would then be considered in the obviousness argumentation. However, if experts are not included in the case, there is a risk of over- or underinterpreting the obviousness of a solution. There could be cases where the sequencing of a gene would be the obvious step but the process of reaching to that connection is so complicated and full of uncertainties that even inventors themselves could not foresee the discovery of such link in the beginning.

It must be said, though, that the regulation in terms of biological inventions appears to have been clearer before the Leahy-Smith America Invents Act of 2012. Section 103(b) used to describe the non-obviousness of biotechnological process where a novel composition of matter is created or used.[37] It also stated that process patent also contains composition of matter, also defining the biotechnological process as one that makes alterations to an organism in order to express introduced sequence, inhibit this expression or introduce a specific characteristic as well as processes of cell fusion that result in a cell line expressing desired proteins.[38] This would solve several issues regarding the process aspect of invention. As such, these definitions also provided for the opportunity to include the entire multi-step process under the same patent. However, the new and reformed Title 35 does not contain such provisions anymore. The exclusion of those provisions by the reforming Act may cause considerable confusion. This is especially perplexing as the Bill introduced in 2011[39] aimed to improve the quality of patents.[40]

The obviousness of the invention based on prior art has a profound impact on patentability. However, obviousness issues must be considered carefully to avoid mistakes in approving patent rights.

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37 35 U.S.C., *supra nota* 33, § 103 (pre-AIA)

38 *Ibid.*

39 S.23- America Invents Act, 112th Cong. (2011-2012), Bill. Accessed at: https://www.congress.gov/bill/112th-congress/senate-bill/23/summary/00 (25 July 2018)

40 "Statements on Introduced Bills and Joint Resolutions", 157:10 Cong. Rec. S128 (daily ed. Jan. 25, 2011), pp S128-S241, pp S130-S142. Accessed at: https://www.congress.gov/congressional-record/2011/01/25/senate-section/article/S128-2 (22 October 2018)

In terms of issues under question here, AIA Section 33 (that is related to Sec 101 of Title 35) provides that patent cannot be granted to applications with claims directed to human organism or encompassing it that is filed on the enactment date or afterwards.[41] It attempts to avoid the patenting of human organism in any form, including clones and transgenics. As such, this provision is important in protecting human rights. However, there can be considerable questions regarding the limits of this provision. The question that may come up is if this provision also applies to gene therapy applications, gene sequences, biomolecules. To gain insight into this question, it is necessary to review case law.

1.5. Case law in the United States

Gene patentability has been brought up in the US case law, making it important to thoroughly analyze available cases to determine the practice of patenting DNA.

The first case to be analyzed is a pioneering one, *Mayo*, where Prometheus developed a method of dose adjustment based on thiopurine drug metabolism rate in patients.[42] In the case, the Court has confirmed conclusions of previous cases that exclude patentability for natural occurrences and laws of nature as well as ideas present in abstract.[43] However, the Court cautiously states that the interpretation of natural occurrences cannot be too wide as it may damage patent law as all inventions contain abstract ideas or rely on natural laws to some extent.[44] The Court had previously found that to grant a patent, the claim must have an application of the law of nature rather than a mere statement of such application.[45] The Court found that measuring thiopurine metabolite levels in blood to adjust dose does not turn natural laws into successful applications.[46] The Court found that at the time of patenting, it was already known that effectiveness of drug dose varies in relation to the amount of its metabolites in the bloodstream of the patient, with the contribution of the

41 35 U.S.C. Uncodified law, § 33 America Invents Act, Sept. 16, 2011, Public Law 112-29, § 33, 125 Stat. 284
42 *Mayo Collaborative Services, DBA Mayo Medical Laboratories, et al. v. Prometheus Laboratories, Inc.*, 566 U.S. 66, 1 (2012). Accessed: https://www.supremecourt.gov/opinions/11pdf/10-1150.pdf (7 April 2019)
43 Ho, K. L., (2015), American Invents – And So Can You: The Dichotomy of Subject-Matter Eligibility Challenges in Post-Grant Proceedings. *Colum. L. Rev.*, Vol. 115, pp 1521-1562, p 1525. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/clr115&collection=journals&id=1593&startid=&endid=1634 (6 May 2019)
44 *Mayo, supra nota* 42, p 2.
45 *Ibid*., p 3.
46 *Ibid*.

patentee only being increasing the level of precision of such assessment.[47] The Supreme Court sees that the law of nature exists between dose effect of the drug and serum metabolite level but the human action of administration of the drug merely manifests, recites this law of nature.[48] Referring to previous cases, the Court noted that even when an invention uses a natural law as the basis of operation, the addition of steps into process makes the invention patentable as the resulting process was rendered non-obvious and patent only prevented use of this specific process by others, not underlying law of nature.[49]

Another relevant case related to the subject matter is that of *Diamond v. Chakrabarty*, where the invention consisted of a variety of bacteria capable of degrading different hydrocarbons like those found in crude oil.[50] The Patent Office apparently had rejected the application due to the products of nature doctrine and due to the issue of potential non-patentability of the assessed subject matter.[51] The Supreme Court decided on the matter that the invention in question was different from natural bacteria for the reason that this strain of bacteria does not occur in nature and is well defined.[52] The key issue in the *Chakrabarty* case is that the patented microorganisms are not present in nature and have specifically been produced via technical means inside laboratory. The creation of those microorganisms involved inventiveness. The essence of the case was that the microorganisms in question were not derived from nature and were, as such, patentable.

The most relevant case for this discussion is *Myriad*.[53] In this case, Myriad patented sequences of a mutated gene that have been associated with increased incidence of ovarian and breast cancer, BRCA1 and BRCA2.[54] The issue of the case is if DNA sequences that occur naturally are patentable through isolation.[55] Another issue concerns complementary DNA (cDNA) produced by the patentee.[56] The Court concedes that the extraction of DNA in itself and also the reverse

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47 Lim, S. S., (2014), Gene Patents in the Wake of Association for Molecular Pathology v. Myriad Genetics, Inc.: An International Perspective on Pharmacogenomics. *Cardozo J. Int'l & Comp. L.*, Vol. 23, Iss. 1, pp 99-132, pp 104-105. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/cjic23&collection=journals&id=117&startid=&endid=150 (7 April 2019)

48 *Mayo, supra nota* 42, pp 8, 9.

49 *Ibid*., pp 11-12.

50 *Diamond, Commissioner of Patents v. Chakrabarty*, 447 U.S. 303, 305 (1980). Accessed: https://supreme.justia.com/cases/federal/us/447/303/ (7 April 2019)

51 *Ibid*., p 306.

52 *Ibid*., pp 309-310.; Lim (2014), *supra nota* 47, p 105.

53 *Association of Molecular Pathology, et al. v. Myriad Genetics, Inc., et al.*, 569 U. S. 576 (2013). Accessed: https://supreme.justia.com/cases/federal/us/569/12-398/case.pdf (7 April 2019)

54 *Ibid*., p 2.

55 *Ibid*., p 1.

56 *Ibid*.

transcription (the process of synthesizing complementary DNA sequence based on mRNA sequence) are well known methods in genetics.[57] The Court also noted that although heritance of breast and ovarian cancers was previously known, the cancer-associated genes were located and sequenced by Myriad.[58] Knowing the location of those genes made it possible for Myriad to sequence them and develop gene tests for detecting mutations in patients.[59] The Court realizes that if Myriad's patent is valid, Myriad has exclusive right to extract BRCA1 and BRCA2 genes and produce their cDNA.[60] The District Court ruled that the DNA sequences, also including cDNA sequences, are products of nature and hence the patent belonging to Myriad is invalid, a decision that was overturned by Federal Circuit.[61] The Federal Circuit decided that both the original sequence and cDNA are patentable, with disagreements regarding the application of isolation of DNA being inventive in character or not.[62] Judge Lourie of the Federal Circuit insisted that the separation of covalent bonds between nucleotides in the extraction process of DNA creates a new DNA molecule, rendering it different from the natural state.[63] Judge Moore disagreed but relied on parties' interests and previous practice.[64] Judge Bryson opined that breaking covalent bond does not necessarily give rise to a novel product and resulting sequence is the same, leading to non-patentability of isolated sequence as covalent bonds breaking is not inventive.[65] The Supreme Court affirmed the approach taken in *Mayo* towards patents involving laws of nature.[66] The Court considers that Myriad did not alter any structures in natural BRCA1 and BRCA2 genes but merely found the location and discovered the structure of the natural genes.[67] The Supreme Court considers that Myriad's actions amount to discovery but no novel composition of matter exists.[68] However, the Court finds that cDNA creation results in the creation of an unnatural molecule due to the exclusion of introns.[69] The opposition to that has been that even cDNA sequences are based

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57 *Ibid*., p 3.
58 *Ibid*., p 4.
59 *Ibid*., pp 4-5.
60 *Ibid*., p 6.
61 Whitley, N. C., (2015), An Examination of the United States and European Union Patent Systems with Respect to Genetic Material. *Ariz. J. Int'l & Comp. L.*, Vol. 32, Iss. 2, pp 463-495, p 469. Accessed: http://arizonajournal.org/wp-content/uploads/2015/11/Whitley.Final_2.pdf (14.04.2019)
62 *Myriad*, *supra nota* 53, p 8.
63 Milkov, R. M., (2013), Patentability and Scope of Protection for DNA Sequence-Related Inventions from the Perspective of the United States of America and Europe. *J. Intell. Prop. Info. Tech. & Elec. Comm. L.*, Vol. 4, Iss. 1, pp 36-52, p 40. Accessed through HeinOnline: https://heinonline.org/HOL/P?h=hein.journals/jipitec4&i=38 (7 May 2019)
64 *Myriad*, *supra nota* 53, p 9.
65 *Ibid*., pp 9-10.
66 *Ibid*., p 11.
67 *Ibid*., p 12.
68 Ho (2015), *supra nota* 43, p 1529.
69 Whitley (2015), *supra nota* 61, p 469.

on nature.[70] The Court, however, further stressed that the resulting sequence is nevertheless different from natural.[71] The Court sees the opportunity that a cDNA sequence is unpatentable if it bears no difference to natural sequence.[72]

As can be seen, court practice in the United States is unsure on the matter of gene patenting. In this light, it is necessary to turn to international and European law.

1.6. Analysis of DNA patentability in EU and US

Next, patentability of DNA in EU and US must be analyzed.

1.6.1. Subject matter

The *Myriad* decision is groundbreaking, defining the limits of gene patents. This decision is welcome and helps to remove uncertainties in patent law. However, there are issues which will now be analyzed. Indeed, it has been opined that the Court errs in its scientific explanations.[73]

The opinion of Judge Lourie of the US Federal Circuit is of interest. Judge Lourie argued that breaking covalent bonds in the DNA molecule while extracting the gene causes change to molecule and that the resulting isolated gene is a different molecule than the intact DNA. On one hand, there is substance to this argument. It is indeed commonly known in chemistry that covalent bonds are one of the most common types of chemical bonds. Atoms form this bond consisting of two shared electrons which is strong enough to form molecules.[74] Therefore, forming and breaking covalent bonds would alter the original molecule. However, it must be noted that DNA is a macromolecule, a polymer where repeating subunits are linked together. In polymeric molecules, removing one or more monomers does not significantly change the chemical properties of the polymer. Therefore, considering parts of a polymer a different molecule than the longer part of same polymer is not entirely accurate. Even though there have been opinions that DNA in isolated state has different properties, including potential therapeutic use, than natural DNA[75], this cannot be agreed with.

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70 *Myriad*, *supra nota* 53, p 17.
71 *Ibid*.
72 *Ibid*.
73 Jervis (2014), *supra nota* 2, pp 89-96.
74 Lodish, H., et al., (2013), *Molecular Cell Biology* (7th ed. 2013). New York: W. H. Freeman and Company; England: Macmillan Higher Education (international edition), p 24.
75 McHugh, A., (2010), Invalidating Gene Patents: Association for Molecular Pathology v. U.S. Patent & Trademark Office. *Hastings L.J.*, Vol. 62, Iss. 1, pp 185-220, p 208. Accessed:

The Supreme Court decision reached the conclusion that naturally occurring gene sequences are unpatentable. This view has been asserted before.[76] However, the decision regarding cDNA brings concerns. Firstly, the assertion that cDNA is unnatural, is dubious at best. The defining part of the gene is an exon that encodes protein sequence.[77] Even though the Court asserts that functionality does not play a role in determining whether cDNA is natural, functionality is highly relevant in the field of biology and cDNA has no transcriptionary differences from original DNA. Moreover, cDNA is not exclusively technical production. cDNA exists in certain type of RNA viruses.[78] In fact, the production of cDNA uses viral enzyme for the conversion.[79] A cDNA sequence could hence be derived from genomic sequences.[80] Therefore, the production of cDNAs is a natural process, it is merely applied in a different setting from its natural analog.

In the European Union, subject matter problem has been addressed by the already mentioned Biotech Directive that specifically approves biotechnology product patentability. EU has, therefore, created a separate category of biotechnological inventions. This Directive has been implanted into the EPC rules as well, widening its impact somewhat outside of the EU. That means that questions such as those in *Myriad* in the US do not come up in case law. DNA as subject matter is declared patentable and unlike US, there is legal certainty in that regard in Europe. Therefore, subject matter analysis would not become especially complex nor decisive for determining the patentability of an invention based upon DNA of either natural or man-made

https://heinonline.org/HOL/Page?handle=hein.journals/hastlj62&collection=journals&id=186&startid=&endid=221 (22 July 2018); Stankovic, B., Stankovic, M., (2012), The Selfish Patent. *Case W. Res. J.L. Tech. & Internet*, Vol. 3, Iss. 1, pp 1-25, pp 6-8. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/caswestres3&collection=journals&id=217&startid=&endid=250 (23 July 2018)

[76] Looney, B., (1994), Should Genes Be Patented - The Gene Patenting Controversy: Legal, Ethical, and Policy Foundations of an International Agreement. *Law & Pol'y Int'l Bus.*, Vol. 26, Iss. 1, pp 231-272, p 237. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/geojintl26&collection=journals&id=241&startid=&endid=282 (23 July 2018); Mashburn, D. D., (2011), Patenting Eden: Limiting Human Gene Ownership. *UMKC L. Rev.*, Vol. 80, Iss. 1, pp 173-198. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/umkc80&collection=journals&id=175&startid=&endid=200 (22 July 2018)

[77] Blake, C. C. F., (1979), Exons Encode Protein Functional Units. *Nature*, Vol. 277, p 598. Accessed: https://www.nature.com/articles/277598a0.pdf (10 April 2019)

[78] Baltimore, D., (1970), Viral RNA-Dependent DNA Polymerase: RNA-Dependent DNA Polymerase in Virions of RNA Tumour Viruses. *Nature*, Vol. 226, p 1209. Accessed: https://www.nature.com/articles/2261209a0 (10 April 2019)

[79] Spiegelman, S., Watson, K. F., Kacian, D. L., (1971), Synthesis of DNA Complements of Natural RNAs: A General Approach. *Proc. Nat. Acad. Sci.*, Vol. 68, No. 11, pp 2843-2845. Accessed through PubMed: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC389539/ (10 April 2019)

[80] Haas, A. K., (2001), The Wellcome Trust's Disclosures of Gene Sequence Data into the Public Domain & (and) the Potential for Proprietary Rights in the Human Genoma. *Berk. Tech. L.J.*, Vol. 16, Iss. 1, pp 145-164, pp 158-159. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/berktech16&id=157&collection=journals&index= (02 August 2018)

origin, as long as it has either been extracted or purified. The focus of evaluation would then shift to other patentability criteria: obviousness and novelty of the proposed inventive composition or process.

1.6.2. Obviousness

Obviousness can aquire a major role in determining the patentability of an invention, that is especially so in the controversial case of DNA patents. An issue with cDNA patents, for example, is that producing cDNAs is obvious to a person skilled in the art.[81] As the US Supreme Court itself stated, producing cDNAs is a common practice in genetics.[82] It has been noted that in some cases, the changes of court practice regarding the obviousness criteria can be damaging to biotechnology industry.[83] However, production of cDNA is obvious for specialists in the field of molecular biology. cDNA creation is necessary as an intermediary process for a number of research applications such as molecular cloning[84], RT-qPCR[85], conducting transfection[86], among others. Therefore, the production of cDNA is necessary to conduct different kinds of experiments and to produce desirable material, rendering cDNA production as obvious and ancillary to other research methodology. It must also be taken into account that as technology develops and novel approaches

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81 Chin, A., (2011), Gene Probes are Unpatentable Printed Matter. *Fed. Cir. B. J.*, Vol. 20, Iss. 4, pp 527-546, p 530. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/fedcb20&id=543&collection=journals&index= (02 August 2018); Olsen, B. V., (1997), The Biotechnology Balancing Act: Patents for Gene Fragments, and Licensing the Useful Arts. *Alb. L.J. Sci. & Tech.*, Vol. 7, Iss. 2, pp 295-334, p 325. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/albnyst7&collection=journals&id=301&startid=&endid=340 (03 August 2018)

82 Heath, A., (2005), Preparing for the Genetic Revolution - The Effect of Gene Patents on Healthcare and Research and the Need for Reform. *Canterbury L. Rev.*, Vol. 11, Iss. 1, pp 59-90, p 65. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/cblrt11&id=63&collection=journals&index= (02 August 2018); Sestric, A. E., (2012), Taking Nature Back: Why Tax Strategy Law Is Relevant To Gene Patents. *Mo. L. Rev.*, Vol. 77, Iss. 3, pp 879-908, p 896. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/molr77&id=889&collection=journals&index= (02 August 2018)

83 Kwan, J., (2010), A Nail in the Coffin for Gene Patents. *Berk. Tech. L.J.*, Vol. 25, Iss. 1, pp 9-32, pp 29-32. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/berktech25&collection=journals&id=13&startid=&endid=36 (07 August 2018)

84 Sestric (2012), *supra nota* 82, pp 882-883; Humphries, P., et al., (1977), Molecular cloning of extensive sequences of the in vitro synthesized chicken ovalbumin structural gene. *Nucleic Acids Res.*, Vol. 4, No. 7, pp 2389-2406, pp 2390-2392. Accessed through PubMed: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC342573/pdf/nar00480-0280.pdf (10 April 2019)

85 Kurimoto, K., Saitou, M., (2010), Single-cell cDNA microarray profiling of complex biological processes of differentiation. *Curr. Opin. Genet. Dev.*, Vol. 20, pp 470-477. Accessed through ScienceDirect: https://www.sciencedirect.com/science/article/pii/S0959437X10001036?via%3Dihub (10 April 2019)

86 Wan, D., et al., (2004), Large-scale cDNA transfection screening for genes related to cancer development and progression. *Proc. Nat. Acad. Sci.*, Vol. 101, No. 44, pp 15724-15729. Accessed: https://www.pnas.org/content/101/44/15724.long (10 April 2019)

become mainstream, the obviousness analysis could be affected.[87] Therefore, the standards of obviousness - the skill levels of a professional - are in constant increase. There are also opinions that the obviousness of the use of a discovery still allows the invention to be considered inventive.[88]

Obviousness has sometimes been interpreted in terms of whether a gene sequence could reasonably have been predicted based on polypeptide sequence of a substance.[89] This also presents problems. First, it has been found that possibilities of gene sequences corresponding to the amino acid sequence are limited in number.[90] Even though there exist numerous possibilities of gene sequence based on polypeptide, it is possible to reduce such uncertainty, especially with the help of informatics. Nowadays, it is conceivable to build a computer program that would analyze the genome, convert sequences and compare results. This would render gene searching obvious.

In Europe, it is clear from law that obviousness is understood similarly to the US. However, the standards of obviousness do not seem to be adapted to biotechnological inventions. The corresponding Directive makes no mention about different obviousness analysis. Rather, it merely states that inventions must be novel and non-obvious. This can present issues as it is determined from previous analysis that creation of cDNA and purification and extraction of natural DNA is obvious. It will remain to be seen in the future if and how this controversy will be addressed.

1.6.3. Novelty

Novelty must also be considered. Even if the patentability of DNA would be verified through using purification doctrine, this would only apply to the first pure form of deoxyribonucleic acid

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87 Conley, J. M., (2009), Gene Patents and the Product of Nature Doctrine. *Chi.-Kent L. Rev.*, Vol. 84, Iss. 1, pp 109-132, p 129. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/chknt84&collection=journals&id=115&startid=&endid=138 (22 July 2018)

88 Hawkins, N., (2010), Human Gene Patents and Genetic Testing in Europe: A Reappraisal. *SCRIPTed*, Vol. 7, Iss. 3, pp 453-473, pp 456-457. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/scripted7&collection=journals&id=453&startid=&endid=473 (22 July 2018)

89 Nicol, D., (2005), On the Legality of Gene Patents. *Melb. U. L. Rev.*, Vol. 29, Iss. 3, pp 809-842, p 832. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/mulr29&collection=journals&id=817&startid=&endid=850 (22 July 2018)

90 Lesciotto, K. M., (2008), KSR: Have Gene Patents Been KO'D - The Non-Obviousness Determination of Patents Claiming Nucleotide Sequences when the Prior Art Has Already Disclosed the Amino Acid Sequence. *Wash. U. L. Rev.*, Vol. 86, Iss. 1, pp 209-240, pp 235-240. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/walq86&collection=journals&id=211&startid=&endid=242 (22 July 2018)

(patented a long time ago[91] or subsequent new purification methods[92]) and would not cover individual sequences, as those pieces are not chemically different from entire DNA in a chromosome. Although it is suggested that purified gene sequence can be a separate and novel chemical compound[93], this view cannot be agreed with due to the nature of polymers. There are also opinions that isolated DNA is different as it is not in complex with histones, is not methylated.[94]

This is reflected in the practical adoption of doctrine of extracts of natural substances whereby naturally occurring substances become novel through extraction.[95] However, an interesting analogy to the extraction principle has been brought out by a commentator who saw that extracted and purified water remains water nevertheless.[96] Another commentator has linked the level of originality of extracted gene sequences to the originality of a map in cartography.[97] Therefore, gene extraction would fail originality requirement as the gene exists without input from inventor.[98]

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91 U.S. Patent No. 4,273,875 (March 5, 1979) ("Plasmid and Process of Isolating Same"). Accessed at USPTO: http://pdfpiw.uspto.gov/.piw?Docid=4273875&idkey=NONE&homeurl=http%3A%252F%252Fpatft.uspto.gov%252Fnetahtml%252FPTO%252Fpatimg.htm (08 October 2018); U.S. Patent No. 3,755,086 (Feb. 9, 1971) ("Diagnostic Method Utilizing Synthetic Deoxyrilionucleotide Oligomer Template"). Accessed at USPTO: http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PALL&p=1&u=%2Fnetahtml%2FPTO%2Fsrchnum.htm&r=1&f=G&l=50&s1=3,755,086.PN.&OS=PN/3,755,086&RS=PN/3,755,086 (08 October 2018)

92 U.S. Patent No. 4,283,489 (Nov. 23, 1979) ("Purification of nucleotide sequences suitable for expression in bacteria"). Accessed at USPTO: http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO2&Sect2=HITOFF&u=%2Fnetahtml%2FPTO%2Fsearch-adv.htm&r=156554&f=G&l=50&d=PTXT&s1=((gene+AND+DNA)+AND+sequence)&p=3132&OS=gene+AND+DNA+AND+sequence&RS=((gene+AND+DNA)+AND+sequence) (08 October 2018)

93 McHugh (2010), *supra nota* 75, pp 212-214; Stankovic (2012), *supra nota* 75, p 8.

94 Nicol. D., Liddicoat, J., (2012), Legislating to Exclude Gene Patents: Difficult and Unhelpful, or Useful and Feasible. *J.L. Inf. & Sci.*, Vol. 22, Iss. 1, pp 32-54, p 36. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/jlinfos22&collection=journals&id=44&startid=&endid=66 (22 July 2018); Rogers, E. J., (2011), Can You Patent Genes - Yes and No. *J. Pat. & Trademark Off. Soc'y*, Vol. 93, Iss. 1, pp 19-56, pp 39-41. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/jpatos93&collection=journals&id=21&startid=&endid=58 (23 July 2018)

95 Poulsen, M., (2011), Jurisprudential and Economic Justifications for Gene Sequence Patents. *Neb. L. Rev.*, Vol. 90, Iss. 1, pp 196-239, pp 206-209. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/nebklr90&collection=journals&id=198&startid=&endid=241 (21 July 2018)

96 de Carvalho, N. P., (2004), The problem with Gene Patents. *Wash. U. Global Stud. L. Rev.*, Vol. 3, Iss. 3, pp 701-754, pp 730-731. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/wasglo3&collection=journals&id=731&startid=&endid=784 (22 July 2018)

97 Liivak, O., (2007), Maintaining Competition in Copying Narrowing the Scope of Gene Patents. *U.C. Davis L. Rev.*, Vol. 41, Iss. 1, pp 177-238, pp 204-206. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/davlr41&collection=journals&id=179&startid=&endid=240 (22 July 2018)

98 Liivak, O., (2005), The Forgotten Originality Requirement: A Constitutional Hurdle for Gene Patents. *J. Pat. & Trademark Off. Soc'y*, Vol. 87, Iss. 4, pp 261-297, pp 292-293. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/jpatos87&collection=journals&id=263&startid=&endid=299 (22 July 2018)

The novel function, compared to the natural one, is what could be considered as the necessary prerequisite for patentability of extracted substance.[99]

In essence, the novel function requirement might salvage the patentability of gene sequences. However, as sequence itself is rarely directly performing the final function, such approach might not be the most secure one compared to patenting the final product or process. This can be problematic in both Europe and in US. It can be difficult to find new uses for specific sequences. If new use is not found, novelty would be under serious question, even in EU where DNA as subject matter is patentable as novelty is still required. It has been observed that the subject matter is not a question in EU but the inventiveness is important, discoveries not being inventions.[100] However, the patentability standards in the EU have been described as confusing.[101] Future will show if novelty standards will be altered in the face of gene patenting.

1.7. Conclusion on Patentability

Based on legislation and case law, it is clear that in Europe, naturally occurring genes are patentable as long as they are isolated with any technical process and have a function (even if predicted), have an inventive step and are novel[102] whereas in the aftermath of *Myriad* decision, they are not patentable at all in the US. It seems that in Europe, the definition of the important patentability criteria such as "essentially biological" remains unclear.[103] This unclarity can potentially do disservice to the patent system, decreasing certainty among technology companies and investors towards the patent system. In the future, cases such as *Myriad* might become common in the EU as well, although not through subject matter debates but rather through obviousness or novelty analysis. However, this can be an undesired consequence. The rules should be clear from the start to ensure the proper functioning of the patent system and confidence of innovators towards the protection of their inventions.

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99 Poulsen (2011), *supra nota* 95, p 218.
100 Lai (2015), *supra nota* 2, p 1043.
101 Inch (2007), *supra nota* 21.
102 Cole, P., (2015), Patentability of Genes: A European Union Perspective. *Cold Spring Harbor Perspectives in Medicine*, Vol. 5, pp 1-12. Accessed: http://perspectivesinmedicine.cshlp.org/content/5/5/a020891.long (30 July 2018)
103 Nenow, L., (2001), To Patent or Not to Patent: The European Union's New Biotech Directive. *Hous. J. Int'l L.*, Vol. 23, Iss. 3, pp 569-608, pp 586-587. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/hujil23&collection=journals&id=577&startid=&endid=616 (23 July 2018)

In the US, subject matter issue will remain along with obviousness and novelty issues as a potential shadow over gene patents while in Europe, obviousness and novelty are main concerns. One way of addressing these shortcomings would be to change obviousness and novelty standards for biotechnological patents. However, this could cause issues in other areas of law that must be analysed now.

2. EFFECTS OF KEEPING CURRENT LEGISLATION AND PRACTICE VERSUS CHANGING THEM

As the current legislation and case law in EU and US have been analyzed and issues found and as changes have been proposed, it is next necessary to assess the effects of those changes and the effects of keeping patent system unchanged.

2.1. Cost of medicine

Cost of medicine is an important issue in patent law. Indeed, the patentability of treatment, diagnostics and surgical methods has the potential of making healthcare more expensive and reduce the availability of those new methods of healthcare improvement. As patent protection gives the producers of patented invention a 20-year monopoly, this can mean that the patentee is able to set the price for their product without fearing any price competition. This can cause the price of the medical invention to skyrocket[104], leading either to a potentially overwhelming financial impact on the patients if those patients are able to afford the method or if the patient is unable to afford such method, this can deplete patients of the opportunity to benefit from the invention.[105] In countries with private insurance-based healthcare, many insurers might not be willing to cover the high cost of newly developed medical products under patent protection[106] or if they do, the insurance payments can make the insurance unaffordable for many. Likewise, in states with public healthcare, the abundance of expensive patented medical products can lead to the overwhelming of the state's healthcare budget, potentially leading to either depletion of funds and standard of healthcare provided to the population or the neglect of patented products from remuneration schemes.[107] In both types of healthcare systems, the monopoly brought about by patent protection can induce significant problems regarding the affordability of medicine. This can

[104] Heath (2005), *supra nota* 82, p 64.
[105] Sestric (2012), *supra nota* 82, p 895.
[106] McHugh (2010), *supra nota* 75, p 197.
[107] Heath (2005), *supra nota* 82, pp 68-71.

be especially apparent in genetic testing applications.[108] The cost of medical products skyrocketing after patent protection have already happened.[109] Myriad Genetics offered genetic testing for patients to detect mutations in BRCA1 and BRCA2 genes for 3000 dollars.[110] In addition, the need to patent developments rapidly could cause concern regarding the actual accuracy of such tests.[111] It has been suggested that such occurrences could be controlled via applying the antitrust law and essential facilities doctrine.[112]

2.1.1. US analysis

In the present discussion, if the subject matter can be used in diagnostics, treatment as well as in surgery, the cost of medicine becomes relevant. If the patent system is maintained as it is, this leads to different effects in the United States and in Europe.

In the US, as previously discussed, patenting DNA sequences on their own is not possible. This is an important distinction as it allows competitors to develop their own patentable inventions based on naturally occurring sequences. Such research can result in another mode of treatment of the same illness, employing different mechanism or substances. This allows to maintain prices at a reasonable level as it generates competition among different producers. If two patentees have patents to a medical product useful for detecting or treating the same illness, they are competitors despite having patent protection over their invention as their inventions have equivalent effect and can perhaps used interchangeably. This prevents either producer raising their prices too high as their competitor would gain more customers in expense of the first company. Of course, to avoid

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[108] Nese, B., (2009), Bilski on Biotech: The Potential for Limiting the Negative Impact of Gene Patents. *Cal. W. L. Rev.*, Vol. 46, Iss. 1, pp 137-176, p 138. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/cwlr46&collection=journals&id=139&startid=&endid=178 (22 July 2018)

[109] Sestric (2012), *supra nota* 82, p 879.; Zadorozny, B., (2009), The Advent of Gene Patenting: Putting the Great Debate in Perspective. *SMU Sci. & Tech. L. Rev.*, Vol. 13, Iss. 1, pp 89-120, pp 107-108. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/comlrtj13&collection=journals&id=91&startid=&endid=122 (22 July 2018)

[110] Lauer, A., (2011), The Disparate Effects of Gene Patents on Different Categories of Scientific Research. *Harvard Journal of Law & Technology*, Vol. 25, No. 1, pp 179-198, p 180. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/hjlt25&collection=journals&id=185&startid=&endid=204 (23 July 2018); Heath (2005), *supra nota* 82, p 70.

[111] Nese (2009), *supra nota* 108, p 154; Williams-Jones, B., (2002), History of a Gene Patent: Tracing the Development and Application of Commercial BRCA Testing. *Health L.J.*, Vol. 10, pp 123-146, pp 138-139. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/hthlj10&collection=journals&id=129&startid=&endid=152 (22 July 2018)

[112] Fernandes, J. C., (2013), Duty to Deal: The Antitrust Antidote to the Gene Patent Dilemma. *UC Irvine L. Rev.*, Vol. 3, Iss. 2, pp 431-466. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/ucirvlre3&collection=journals&id=437&startid=&endid=473 (22 July 2018)

any price agreements and market sharing deals, competition law must be applied with care. For process patents, the issue remains the same. Likewise, it is possible for competitors to engineer around the patent and get a competing product on the market.

The problem with current patent system arises from the patentability of cDNA sequences. As already mentioned, cDNA sequence is highly similar to natural sequences and should there arise a situation where partial cDNA sequences are patented, this could also interfere with natural DNA sequence use. In addition, should there be genes without introns, this issue could also be present. cDNA production is, as discussed, a common method used in research. Patenting cDNA sequences can severely damage the ability to conduct functionality analysis and can also hamper the possibility for competitors to engineer around the patent as cDNA is a necessary step in many research applications. If research methods utilising cDNA cannot be used, this can prevent competitors from conducting meaningful research and further innovation. Even if the competitors would be able to create a better product or have a new approach of using the gene sequence, a patent on cDNA sequence can potentially nullify such efforts.

2.1.2. EU analysis

In Europe, medical patents (for surgery, diagnostics and surgery) are forbidden.[113] This could alleviate the issue as no company would get a monopoly on their product. As no monopoly is created, there is competition in the field. However, this can create problems with willingness to innovate. As competitors can normally easily find out the active ingredient in a drug or disassemble a piece of equipment, it is not too difficult for them to gain access to the knowledge behind them. Having no protection on their inventions would likely mean that companies are willing to spend less resources for innovation as it would be difficult to regain those investments due to possible willful copying by competitors. Such copying would give an unfair advantage to the innovator's competitors who do not have to spend time, effort and funds to research. In EU competition law sphere, there is also limit to the use of intellectual property rights.[114] This means that companies are unable to earn back their investments and may become cautious towards further research.

[113] European Patent Convention, *supra nota* 5, Art. 53(c).

[114] Commission Regulation (EU) No 316/2014 of 21 March 2014 on the Application of Article 101(3) of the Treaty on the Functioning of the European Union to Categories of Technology Transfer Agreements (Text with EEA Relevance), 2014 O.J. (L 93), 28.3.2014, pp 17-23. Accessed: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32014R0316&from=EN (7 April 2019)

In Europe, as mentioned, DNA sequences are also patentable as well as any substances extracted from human body. This means that nobody else but the innovator can research or develop products based on those natural substances. It might be possible to develop a product with modifications to the original gene sequence. However, this requires the original sequence to be extracted before modifications are made. Although it is possible to produce the sequence based on the written sequence, it is difficult to do without trespassing such patent. Similarly, if sequences and natural substances are patented, they cannot be used to develop new processes either, despite the differences between substance and process patents. This is partially alleviated by the requirement of functionality along with sequence itself. However, for process patents, this does not remove obstacles as the general function might remain the same while the process is modified. This can happen when, for instance, procedural improvements allow to omit a step in the production process, increase product purity or change product structure. These changes to the process could be averted by inclusion of the end function of the gene in the patent.

To conclude, as DNA is certainly patentable, issues regarding obstruction of competition in medicine are more likely to arise than in the United States where court in *Myriad* declared mere extraction unpatentable. Nevertheless, continuing patenting cDNA can bring roughly similar effects as it is used for many applications in both research and production. On the other hand, there are restrictions on medical patenting in place in Europe which can lead to low innovation incentives and cause problems regarding access to medicine. Access will be discussed next.

2.2. Access denial

Another concern connected to patenting is its effects on the access to inventions. As biological patents are commercially mainly connected to medicine, this issue will be viewed from that perspective. Access to medicine is connected to cost. However, as the investments made for research are not regained through monopolistic sales of the product, there might be little incentive for the producer to place their product on the market to be taken advantage of competitors who can gain market leadership through price competition.[115] Therefore, especially large companies may refuse supplying small markets where their inventions are not protected and more willing to provide access to their inventions if they are protected in those markets.[116] This can bring about

[115] Lauer (2011), *supra nota* 105, p 186.
[116] Heath (2005), *supra nota* 82, p 66.

the inability of the residents to access state-of-the-art medicine. Lack of access to new, patent-protected medical products can result in the stagnation of healthcare. Patients that do not have access to newest advances in medicine can have lower quality of life and lower life expectance. In addition, the inability to provide adequate medical services, especially for illnesses that spread fast, can bring about undesirable effects for the general population and can even cause public health crisis. For example, lack of access to new and effective vaccine can result in undercoverage of many areas, especially in poorer countries that can eventually cause an epidemic that can spread to wealthier areas. Additionally, lack of availability of the most effective treatment can increase the average disability-adjusted lifespan in the society and could therefore affect the economy, reducing the amount of workforce and resulting tax income as well as general economic slowdown. Another concern is human rights and the right of access to medicine.

A similar situation can occur if healthcare service providers are not willing to pay as much for the patented medical product as the company would like and therefore, the company may refuse to service this provider, even if it is the only healthcare service provider in a given area. This can result in the lack of coverage of the area with the patented medical product and lower the overall quality of healthcare in relation to those areas where the product is available. In the *Myriad* case, competing service providers did not manage to get license for testing BRCA1 and BRCA2 mutations in patients for a reasonable remuneration.[117] A proposed way of sneaking past cDNA patents that can be obstacles for genetic testing, whole genome sequencing has been proposed.[118]

Another concern for patented medical products is the potential denial of licensing requests.[119] Often, pharmaceutical producers are interested in licensing patent rights in order to produce their own product. However, patentees might refuse any requests to license their patented invention in order to avoid competition. in such a way, they are able to control pricing, despite licensing bringing in part of the competitor's profit. This can result in the inability to produce enough of the medication for it to become affordable and well accessible.

[117] Lauer (2011), *supra nota* 105, p 180.
[118] Atkinson, B., (2013), Patents without Teeth: Whole Genome Sequencing and Gene Patent Infringement After AMP v. Myriad. *Jurimetrics*, Vol. 54, Iss. 1, pp 65-84. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/juraba54&collection=journals&id=73&startid=&endid=92 (22 July 2018)
[119] Heath (2005), *supra nota* 82, p 67.

2.3. Personalized medicine

Personalized medicine has become the buzzword of this century. The prospect of adjusting treatment individually to a person's body is an attractive idea and the abundance of allergies, treatment resistance and different efficacy levels and side effects of treatment modes necessitate such developments. But personalized medicine can bring conflicts with patent law.

If cDNAs are patentable, this can render the approaches for personal medicine fruitless. It could be possible that the efficacy or suitability of certain kinds of medical products depend on the genetics of the person. In order to tailor a suitable method of treatment for the patient, production of cDNA under patent protection might become necessary. If a company offers tailored medical products to patients, licensing all different cDNA sequences for all illnesses and people's genotypes could become financially overwhelming and dissuade service providers from offering personalized treatment.

The prohibition of EU's legislation to patents for diagnostics, surgery and therapeutics means that personalized medicine products do not fall under patent protection either. On one hand, this can be welcomed as this would allow to prevent increased cost to small subset of patients receiving specific treatment. Also, the provision of personalized medicine could not be monopolized if patent protection does not apply. However, the multitude of genes involved in disease etiology can potentially make personalized medicine approaches difficult to reach and difficult to be affordable.[120] There might be too few economic incentives for companies to make investments that inevitably occur to develop modes of offering personalized medicine. Such modes could be automated testing, statistical analysis, strategy assessment. If those cannot be patented, service providers might be unwilling to make investments for providing such opportunities. Likewise, such prohibition does not necessarily make such treatment affordable as the price is governed by the amount of procedures done to ensure the best treatment (physical exam, taking of samples, maintenance of IT systems, testing samples, interpretation of results, production of special treatment). Yet, genetic testing can be useful to determine how efficient which mode of treatment is in the individual with a specific genetic profile.[121]

[120] Lauer (2011), *supra nota* 105, p 195.
[121] Haas (2001), *supra nota* 80, p 147.

A possible effect of patents on gene therapy can be similar. Here, cDNA patentability can have detrimental effect on the gene therapy concept materialization. As cDNA sequences correspond to the exons of the genes, the mRNA-encoding parts of the gene, those sequences are inevitably included in the entire gene sequence. Gene consists of both introns and exons. While exons, as mentioned, encode RNA and ultimately, proteins, introns as non-coding sequences have a different function. Introns are involved in the regulation of gene expression.[122] For the successful application of gene therapy, non-coding regions also beyond the gene sequence itself need to be considered and new tools for regulating transgene expression must be developed.[123] However, if whole gene sequences along with regulatory areas are introduced as transgene constructs, they inevitably contain the exon sequences. Despite those sequences being separated into distinct exons rather than as one long sequence in cDNA, it nevertheless could cause concern regarding possible patent infringement. This can directly arise from the all elements rule. As no sequences are omitted, rather, introns and other regulatory sequences are merely added, this could cause the infringement upon cDNA patent. It has also been noted that scientists and medical professionals have not looked upon patenting some gene manipulation methods that are considered so wide that they essentially patent a medical procedure (with the analogy of patenting heart transplantation procedure)[124]. Medical professionals are also concerned of the possible cross-infringements and restriction of access to medically relevant information.[125]

Not only would cDNA patent become obstacle to gene therapy application but also its research, as inevitably, gene sequences need to be synthesized. The same problem occurs when targeting transgenes to a specific site. If transgene enters into a necessary gene sequence, it may disrupt that gene and cause illness while its insertion into an oncogene might activate the oncogene and cause cancer.[126] However, site-specific targeting requires the use of target-specific tags that contain a sequence complementary to the patented sequence. As such tags have been patented on a wide scale, research requiring many tags faces increased costs.[127] While in the EU, ethical

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[122] Sippel, A. E., (1996), Gene Therapy - A New Medical Technique and Point to Consider. *JRE*, Vol. 4, pp 35-48, p 40. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/jaret4&collection=journals&id=45&startid=&endid=58 (14 April 2019)

[123] *Ibid*., p 40.

[124] *Ibid*., p 42.

[125] Magnus, D., (1998), Disease Gene Patenting: The Clinician's Dilemma. *Cambridge Q. Healthcare Ethics*, Vol. 7, Iss. 4, pp 433-435. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/cqhe7&collection=journals&id=441&startid=&endid=449 (22 July 2018)

[126] Sippel (1996), *supra nota* 122, p 41.

[127] Haas (2001), *supra nota* 80, pp 160-161.

considerations have their role in IP legislation, it has been found to be different in the US.[128] To counter possible negative effects from patented sequence tags, it has been proposed to treat them only as use patents and require extensive proof of utility with accompanying compulsory licensing scheme.[129] Until such proposals materialize, however, it may be very difficult to offer gene therapy and other forms of personalized medicine on the market without trespassing several DNA patents.

2.4. Effects on innovation

Patent system exists to provide inventors an incentive to innovate.[130] In terms of gene patents, it has been seen as a motivation to develop drugs based on human genes.[131] This incentive is a 20-year monopoly on production and selling of their invention. This is meant to allow inventors to earn back investments and gain enough profit to provide motivation for inventing.[132] It has been observed that as genetic patents do not give absolute rights, they might not have enough protection and, therefore, incentives for their research.[133] It has been noted that patenting is especially necessary in the pharmaceutical sphere where generic drugs can be easily introduced by competitors.[134] On the other hand, if the patent is too wide, it can hamper further research by monopolizing the entire field of research.[135] The Supreme Court in *Mayo* emphasized that too wide interpretation of patentability resulting in patenting of natural laws may impede further research

[128] Kevles, D. J., Berkowitz, A., (2001), The Gene Patenting Controversy: A Convergence of Law, Economic Interests, and Ethics. *Brook. L. Rev.*, Vol. 67, Iss. 1, pp 233-248, pp 241-248. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/brklr67&collection=journals&id=243&startid=&endid=258 (22 July 2018)

[129] Lopez-Beverage, C. D., (2005), Should Congress Do Something about Upstream Clogging Caused by the Deficient Utility of Expressed Sequence Tag Patents. *J. Tech. L. & Pol'y*, Vol. 10, Iss. 1, pp 35-92, pp 85-91. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/jtlp10&collection=journals&id=39&startid=&endid=96 (22 July 2018)

[130] Lauer (2011), *supra nota* 105, p 183.

[131] Holman, C. M., (2009), Learning from Litigation: What Can Lawsuits Teach Us about the Role of Human Gene Patents in Research and Innovation. *Kan. J.L. & Pub. Pol'y*, Vol. 18, Iss. 2, pp 215-272, pp 220, 225-229. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/kjpp18&collection=journals&id=223&startid=&endid=280 (23 July 2018)

[132] Lauer (2011), *supra nota* 105, p 186; Haas (2001), *supra nota* 80, p 148; Heath (2005), *supra nota* 82, p 64; Sestric (2012), *supra nota* 82, p 895; Zadorozny (2009), *supra nota* 109, pp 100-103.

[133] Bradshaw, J., (2001), Gene Patent Policy: Does Issuing Gene Patents Accord with the Purpose of the U.S. Patent System. *Willamette L. Rev.*, Vol. 37, Iss. 4, pp 637-660, pp 642-643. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/willr37&collection=journals&id=661&startid=&endid=684 (22 July 2018)

[134] Haas (2001), *supra nota* 80, p 148.

[135] Lawson, C., (2002), Patenting Genes and Gene Sequences and Competition: Patenting at the Expense of Competition. *Fed. L. Rev.*, Vol. 30, Iss. 1, pp 97-134, pp 128-133. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/fedlr30&collection=fijournals&id=107&startid=&endid=144 (13 December 2018)

and development of new technology as it would inhibit the use of those natural laws.[136] While Prometheus argued the cost of research and need of protection as reasons for granting patents in such situations, the Court found, relying on several professional associations' opinions that such practice could monopolize critical information and prevent decent medical care.[137] It has been noted before that especially gene patents can threaten research through genetic monopolies.[138] This is especially so in the area of biological patents. In that sense, it has been found that banning gene patents can increase therapeutics developments through removing obstacles.[139] Allowing natural gene sequences as well as cDNA sequences, RNA and polypeptide sequences as well as other naturally occurring biomolecules to be patented can potentially prevent anyone else besides the patentee from conducting research in the field.[140] If any part of the DNA that has been extracted would be considered a separate molecule, this can include short sequence tags that may occur among other gene sequences as well.[141] Theoretically, it could produce a situation where an entity patents four short DNA sequences: TACA, TACT, TACC, TACG. Those sequences all contain a codon TAC that corresponds to the start codon for protein synthesis. This would mean that no gene sequences could be produced by anyone else but the patentee as such sequences would be present in every gene. Such a case would monopolize genetics for a single patentee and effectively destroy progress. The potential of patenting SNPs has caused opinions of concern.[142] Research obstruction has occurred in the case of *Myriad*, where the company applied for claims regarding screening for substances that could be used for cancer therapy.[143] If screening method like that is granted patent, this could potentially prevent anyone else conducting research into potential cancer treatment targets. This would make it harder for competitors to find new therapeutic methods. Such eventuality does not damage only one subset of population but everyone. Every cancer patient, rich and poor, would be affected by the lack of innovation that can result from the lack of allowable

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136 *Mayo*, *supra nota* 42, pp 16-17.
137 *Ibid*. pp 22-23.
138 Lauer (2011), *supra nota* 110, p 183; Chin (2011), *supra nota* 81, p 528.
139 Lauer (2011), *supra nota* 110, p 192.
140 Heath (2005), *supra nota* 82, pp 66-67.
141 Chin (2011), *supra nota* 81, pp 529-530; Morrison, A. E., (2001), The U.S. PTO's New Utility Guidelines: Will They Be Enough to Secure Gene Patent Rights. *J. Marshall Rev. Intell. Prop. L.*, Vol. 1, Iss. 1, pp 142-162, p 152. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/johnmars1&collection=journals&id=160&startid=&endid=182 (22 July 2018)
142 Murry, J., (1999), Owning Genes: Disputes Involving DNA Sequence Patents. *Chi.-Kent L. Rev.*, Vol. 75, Iss. 1, pp 231-258, pp 241-242. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/chknt75&collection=journals&id=247&startid=&endid=274 (22 July 2018)
143 Lauer (2011), *supra nota* 110, p 181.

research. there can never be certainty that screening patent holder has motivation, finance or ability to find suitable targets.

There has also been an issue regarding purified versions of the various biomolecules. In *Myriad* case, the Federal Circuit considered that as isolated DNA was not in complex with other material that normally interacts with DNA (histones), it is chemically different from the initial, natural, DNA.[144] Such practice would, however, deny any other entity besides the patentee from studying the gene as it is necessary to isolate the gene in order to clarify its structure, function, mutations, ways of alteration, structure and functionality of its products, affinity of the products and other research directions. As a result, it has been suggested that US should follow German example, where human gene patent function claims need great precision to combat too large restrictions on research.[145] On the other hand, it has been viewed that gene patent does not give rights to protein unless possession of the substance is indeed proven[146], allowing scientists to still conduct research.

Biological patents in Europe are allowed even for naturally occurring, merely purified substances, as long as they are coupled with the description of their function for which they are patented. As mentioned previously, it is clear that a given gene (or other biomolecules) have their functions. Improvement in utilizing their functions nevertheless maintain those functions. Apoptotic genes remain apoptotic even when they are upregulated. However, if they are patented together with their function, it could make it almost impossible to study their upregulation for a potential therapeutic effect for cancer treatment. Also, patenting genes with their functions can also prevent those gene sequences from being used in diagnostic tests. It has been noted that gene patents can dissuade independent development of diagnostics due to fear of committing patent infringement.[147] It has been seen that licensing patent rights allows to reduce or limit the effects of such dissuation.[148] However, a problem is also seen in diagnostic research sphere. This problem becomes apparent in research involving diseases that can have complex genetic backround, necessitating research on multiple genes and aquiring rights for every patented gene involved,

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144 *Ibid.*, p 182.

145 Bryan, E., (2009), Gene Protection: How Much is too Much - Comparing the Scope of Patent protection for Gene Sequences between the United States and Germany. *J. High Tech. L.*, Vol. 9, Iss. 1, pp 52-65. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/jhtl9&collection=journals&id=52&startid=&endid=65 (22 July 2018)

146 Safran, J., (2002), Genentech, Inc. v. Chiron Corp. 220 F.3D 1345 (Fed. Cir. 2000) Should a Patent for a Genetic Sequence Cover Its Resultant Protein. *Temp. Envtl. L. & Tech. J.*, Vol. 21, Iss. 1, pp 69-92, pp 87-89. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/tempnlt21&collection=journals&id=75&startid=&endid=98 (22 July 2018)

147 Lauer (2011), *supra nota* 110, p 189; Heath (2005), *supra nota* 82, p 68.

148 Lauer (2011), *supra nota* 110, pp 189-190.

increasing the costs of obtaining all necessary licenses beyond the prohibitive limit.[149] Stacking licenses where licensee sublicenses the patent rights for additional cost can raise financial burden further.[150] However, it has also been noted that concerns about such mounting costs have not become a reality, that licensing is common and rather simple, research can be conducted in jurisdictions where a particular gene is not protected and patents can be challenged as well as rarity of infringement procedures against researchers can play a role.[151] Of course, normally, it is in the interests of patentees to grant licenses as they provide a stable source of income. It is especially so for either smaller patentees who are unable to successfully commercialize their product or large entities uninterested in commercializing it. However, despite problems being uncommon, they might nevertheless occur. The centiments in the society and business culture can change. To achieve legal certainty, the issue of patentability of genes must be made clear. Compulsory licensing has been brought out as a possible solution to problems related to innovation and medicine.[152]

It has been argued that the development and research costs for pharmaceutical companies are very high with additional costs related to clinical trials and other required safety analyses.[153] There are also opinions that biotechnology companies with less drug development capacity than pharmaceutical companies need gene patentability.[154] There are opinions that the research and development sector of pharmaceuticals is declining in an alarming rate specifically due to the intricacies of the patent system: the unclarity of standards and the slow pace in addressing them, applying new interpretation or principles retroactively.[155] It has also been found that a ban on gene

[149] *Ibid.*, pp 190-191, 193; Haas (2001), *supra nota* 80, pp 159-160; Sestric (2012), *supra nota* 82, p 905; Morrison (2001), *supra nota* 141, pp 152, 155; Azher, A. I., (2004), Antitrust Regulators and the Biopharmaceutical Industry: Compulsory Licensing Schemes Ignoring Gene Therapy Patients' Needs. *U. Pa. J. Int'l Econ. L.*, Vol. 25, Iss. 1, pp 383-422, pp 389-390. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/upjiel25&collection=journals&id=405&startid=&endid=444 (22 July 2018)

[150] Azher (2004), *supra nota* 149, p 391.

[151] Lauer (2011), *supra nota* 110, pp 191, 193, 194; Stankovic (2012), *supra nota* 75, pp 9-15; Holman (2009), *supra nota* 131; Holman, C. M., (2007), The Impact of Human Gene Patents on Innovation and Access: A Survey of Human Gene Patent Litigation. *UMKC L. Rev.*, Vol. 76, Iss. 2, pp 295-362, pp 301-303. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/umkc76&collection=journals&id=303&startid=&endid=370 (22 July 2018)

[152] Lauer (2011), *supra nota* 110, pp 196-197; Heath (2005), *supra nota* 82, pp 81-82; Mueller, J. M., (2011), Facilitating Patient Access to Patent-Protected Genetic Testing. *J. Bus. & Tech. L.*, Vol. 6, Iss. 1, pp 83-102, pp 98-99. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/jobtela6&collection=journals&id=85&startid=&endid=104 (23 July 2018)

[153] Lauer (2011), *supra nota* 110, p 185; McHugh (2010), *supra nota* 75, p 188.

[154] Nicol (2005), *supra nota* 89, p 37.

[155] Holman, C. M., (2011), Unpredictability in Patent Law and its Effect on Pharmaceutical Innovation. *Mo. L. Rev.*, Vol. 76, Iss. 3, pp 645-694. Accessed:

patents can potentially lessen the crucial scientific information available to be studied[156] and that such a ban might not alleviate concerns of genetic testing patents as a whole.[157] In addition, it has been observed that generic companies have the opportunity to engage in research before patent expiry and gain market access immediately afterwards.[158] In this perspective, it has been noted that in the absence of patent protection, companies might opt for the trade secret regime instead, choosing to protect their intellectual property this way, especially in regards to therapeutics difficult to reverse engineer and develop independently, depriving of potential licensors of the opportunity to use the knowledge.[159] Such concern has also been brought out as potentially occurring even under patent regime before filing patent application.[160] It is also found that the new ability of FDA to grant a dozen-year monopoly instead of a gene patent to reward new therapeutic protein invention can be both positive and negative.[161] A possible way to encourage pharmaceutical producers to give up trade secret approach towards their therapeutics would be to require FDA to reveal or ask revelation of necessary data as a prerequisite for the market monopoly granting.[162]

It has been suggested that gene patents are not necessary for developing diagnostics as the expenses for creating diagnostic tests are relatively low in comparison with the development of therapeutics, allowing companies to easily get remunerated.[163] In addition, the low cost of diagnostics development gives the ability for non-commercial entities to develop such tests.[164] It has been found that *Mayo* and subsequent case law has changed diagnostics in essence unpatentable.[165] There exist opinions that banning gene patents would make genetic testing pointless as it would

https://heinonline.org/HOL/Page?handle=hein.journals/molr76&collection=journals&id=651&startid=&endid=700 (04 August 2018)

156 Lauer (2011), *supra nota* 110, p 187.

157 Nicol (2005), *supra nota* 89, p 44.

158 Moore, J. D., (2011), The Forgotten Victim in the Human Gene Patenting Debate: Pharmaceutical Companies. *Fla. L. Rev.*, Vol. 63, Iss. 5, pp 1277-1306, p 1301. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/uflr63&collection=journals&id=1295&startid=&endid=1324 (22 July 2018)

159 Lauer (2011), *supra nota* 110, p 187.

160 Nese (2009), *supra nota* 108, p 156.

161 Lauer (2011), *supra nota* 110, p 186.

162 *Ibid.*, p 187.

163 *Ibid.*, p 188.

164 *Ibid.*, p 188-189.

165 Kim, E., (2017), Biotech Patent Eligibility: A New Hope. *Colum. Bus. L. Rev.*, Vol. 2017, Iss. 3, pp 1157-1199, pp 1174-1189. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/colb2017&collection=journals&id=1175&startid=&endid=1217 (23 July 2018)

eliminate treatment development as well as eliminating other useful technologies such as RNAi and biological systems synthetically produced.[166]

There have also been suggestions that gene patents still allow for engineering around for achieving the same end product.[167] Additionally, opportunity is seen to develop products based on US patent elsewhere to escape infringement litigation.[168] It has also been expressed that banning gene patents would lessen the interest in basic research funding.[169] On the other hand, gene patents might overemphasize basic and underemphasize end product research.[170] Gene patent effect has also been brought up as a means of ensuring most effective research not wasting time on duplication.[171]

In conclusion, the effects of gene patents appear restrictive, causing concerns of possible infringements by researchers and the possible stagnation of development. On the other hand, it has been found that research might be restricted instead when DNA becomes unpatentable as opportunities to regain investments would be limited. Overall, the effects on research are varied and in constant development.

2.5. Ownership of human genome

There have also been issues regarding ownership of human genome.[172] In addition, there have been concerns of indigenous peoples having been exploited through patenting cell lines derived from their members.[173] As the patenting of human genes increase, concerns can arise that entire human genome could be put under patent protection. This would cause a rather serious ethical dilemma concerning ownership of human genetic material and, by circumstance, humans themselves.

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166 Ellis, G. C., (2008), Emerging Biotechnologies Demand Defeat of Proposed Legislation that Attempts to Ban Gene Patents. *Rich. J.L. & Tech.*, Vol. 15, Iss. 1, pp 1-36, pp 4, 31-34. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/jolt15&collection=journals&id=5&startid=&endid=40 (22 July 2018)

167 Lauer (2011), *supra nota* 110, p 191; Holman (2009), *supra nota* 131, pp 220, 225-229.

168 Holman (2009), *supra nota* 131, pp 229-231, 236-237.

169 Lauer (2011), *supra nota* 110, p 192; Heath (2005), *supra nota* 82, p 66.

170 Johnson, E., (2012), Myriad Problems: An Analysis of the Challenges to Gene Patents and the Policy Questions Raised. *U. Tol. L. Rev.*, Vol. 43, Iss. 3, pp 695-724, p 716. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/utol43&collection=journals&id=711&startid=&endid=740 (22 July 2018)

171 Looney (1994), *supra nota* 76, pp 242-243.

172 Chin (2011), *supra nota* 81, p 528.

173 Harry, D., (2009), Indigenous Peoples and Gene Disputes. *Chi.-Kent L. Rev.*, Vol. 84, Iss. 1, pp 147-196, pp 179-181. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/chknt84&collection=journals&id=153&startid=&endid=202 (22 July 2018)

Besides, patenting genomic sequence of humans would complicate conducting research. Some of those concerns have been alleviated now that the human genome sequence is in public domain. Additionally, patent does not grant its holder any right to use the invention, merely preventing others from using it.[174] Further concerns of genome sequencing possibly infringing on gene patents have been regarded as baseless.[175] However, it has been found that placing human genomic sequence into public domain can damage the interests of potential innovators and give benefits to those making the sequence public.[176] The emerging genomic companies aim to offer access to data, develop diagnostics and pharmaceuticals as part of their business plan while relying on patent protection.[177] Having a patent on genomic information could create a complex interplay in biomedical sphere where the developers of downstream products have to license-in this information for payment from genomic companies that are hence generally against releasing genomic data to the public.[178] The releasers have argued that raw genetic sequence should not be protected.[179] In addition, it has been found that information contained in the sequence is not patentable.[180] Nevertheless, patenting genomic data can become an obstacle for developing downstream pharmaceutical products.[181] In that sense, the disclosure of genomic information can promote the development of products and benefit the system of patenting in general.[182] It has been proposed that in order to reduce problems arising from gene patenting, an international body based on balanced geography and expertise should be created that would be able to grant licenses.[183] International harmonization of various patent laws in terms of gene patents is seen as necessary solution in the modern world.[184]

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174 Holman (2007), *supra nota* 151, pp 301-303.

175 Holman, C. M., (2011), Will Gene Patents Impede While Genome Sequencing: Deconstructing the Myth that 20% of the Human Genome is Patented. *IP Theory*, Vol. 2, Iss. 1, pp 1-16. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/ipthey2&collection=journals&id=1&startid=&endid=16 (23 July 2018)

176 Haas (2001), *supra nota* 80, p 145.

177 *Ibid.*, p 150.

178 *Ibid*.

179 *Ibid.*, p 152.

180 Rogers (2011), *supra nota* 94, pp 45-46.

181 Haas (2001), *supra nota* 80, p 154.

182 *Ibid.*, p 157.

183 Looney (1994), *supra nota* 76, pp 269-271.

184 Robinson, J. M., (2016), A Myriad of Controversy over the Question of Human Gene Patent Eligibility: A Comparison of the Differing Approaches in the United States and Australia. *Hous. J. Int'l L.*, Vol. 38, Iss. 3, pp 913-940, pp 939-940. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/hujil38&collection=journals&id=943&startid=&endid=970 (22 July 2018)

2.6. Economic concerns

One wider economic effect of gene patents that has been brought out is that if patentees are foreign inventors, granting such patent will lead to increased flows of funds outside the country.[185] This can be a relevant concern for countries without large-scale research and development industry. The developing countries do not have sufficient funds to participate in a scientific arms race, yet they often bear significant costs associated with patented inventions. On one hand, one might be tempted to dismiss such concerns as irelevant. On the other hand, leaving aside ethical concerns, excess pressure on developing countries in this sphere can lead to a situation where IP protection is formally accepted by such nations but practical enforcement is lacking in reality. This in turn can lead to the diminishing effects of patent rights in those developing economies.

Many concerns related to gene patents exist. Most common issues are potential price increases for medicine, potential lack of access for medical products, pharmaceuticals and diagnostic testing, cooling effects on innovation, ownership of human body and also economic effects on developing countries. In order to ensure the proper functioning of the patent system, it is necessary to take concerns seriously and work towards solutions that adequately address those issues.

[185] Heath (2005), *supra nota* 82, p 65.

3. POTENTIAL SOLUTIONS

Next, possible solutions to issues must be analyzed.

3.1. Possible alternatives to patentability

As a result of the previous analysis, it must be concluded that genes could not be patentable in the US unless there are novel biological products, unless these biologics are used for novel functions or unless processes are patented.[186] Therefore, it must be asked: what to do with the genetic sequences which are products of creation nevertheless? There should be a mechanism for protecting them.

Perhaps it is worth looking towards computer software for inspiration. After all, genes could also be viewed as programs for performing certain function.[187] In terms of software patents, US legislation makes no particular reference towards the possibility of patenting computer programs. Of course, should such programs fulfill the requirements of novelty, non-obviousness and result in a novel and functional substance, machine, manufacturing method or process, they could be part of the patentable invention. Indeed, the question of software patentability has been observed in case law previously. In *Gottschalk v. Benson*[188], the Supreme Court examined an earlier case regarding telegraphs where it was decided that using a natural law generally in patent would prevent anyone else using this natural law combined with improved machinery.[189] It found that the case was later interpreted as using the underlying law in connection with a particular process is

[186] Lorentzen, D. M., (2012), Do These Genes Fit: The Gene as Patentable Subject Matter. *Drake L. Rev.*, Vol. 60, Iss. 3, pp 933-966, pp 960-964. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/drklr60&collection=journals&id=945&startid=&endid=978 (22 July 2018)

[187] Torrance, A. W., (2010), Gene Concepts, Gene Talk, and Gene Patents. *Minn. J.L. Sci. & Tech.*, Vol. 11, Iss. 1, pp 157-192, pp 159-160, 167-170. Accessed through HeinOnline: https://heinonline.org/HOL/Page?handle=hein.journals/mipr11&collection=journals&id=157&startid=&endid=192 (14 April 2019)

[188] *Gottschalk, Acting Commissioner of Patents v. Benson et al.*, 409 U.S. 63 (1972). Retrieved from the Library of Congress, http://cdn.loc.gov/service/ll/usrep/usrep409/usrep409063/usrep409063.pdf (14 April 2019)

[189] *Ibid*., p 68.

patentable.[190] Analysis of previous case law made the Court consider that the mode of inducing change can be patented and such mode can contain a natural law.[191] In the end, the Court held that the program for converting decimal numbers in binary code to binary numbers on its own is only a calculation and is not a patentable process.[192]

In *Diamond v. Diehr*, the question regarded a rubber molding process utilizing computer software that enables to adjust rubber curing time according to temperature feedback.[193] The Court found that despite algorithm being employed, the patent was applied for the protection of rubber curing process and use of the algorythm by others is prevented only if all other steps in the process are the same as well.[194] The Court confirmed that simply restricting the use of a natural law or algorythm to a certain technology does not make it patentable but if it is employed in a process that patent law protects, it is patentable.[195] In process patents, all elements of a claim must be considered together as a whole, irrespective of their novelty, as even processes with completely old elements can occur in a novel combination of old and otherwise non-patentable steps.[196] The steps themselves are not being patented in process patents but their sequence, their combination is. Therefore, the patentability of any step individually should not come into play.

In conclusion, it seems that computer programs can be included in the realm of patents but only if they form a part of a patentable process. Computer programs themselves, in isolation or application of abstract ideas through the use of computer programs do not appear to be patentable.

In the European Union, computer programs are protected by copyright.[197] They are specifically excluded from the patent regime by placing them under copyrightable material. This appears to be a different approach in comparison with the one taken in the US where, although computer programs are patented rarely, they are still, in principle, patentable if they constitute a necessary part of a patented process.

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[190] *Ibid*., pp 68-69.
[191] *Ibid*., p 70.
[192] *Ibid*., p 63.
[193] *Diamond, Commissioner of Patents and Trademarks v. Diehr et al.*, 450 U.S. 175, 175 (1981). Retrieved from the Library of Congress: http://cdn.loc.gov/service/ll/usrep/usrep450/usrep450175/usrep450175.pdf (14 April 2019)
[194] *Ibid*., pp 176, 187, 188.
[195] *Ibid*., pp 191, 192.
[196] *Ibid*., pp 182-184, 188.
[197] Directive 2009/24/EC of the European Parliament and of the Council of 23 April 2009 on the Legal Protection of Computer Programs, Art. 1, 2009 O.J. (L 111), 5.5.2009, pp 16-22, p 18. Accessed: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0024&from=EN (7 April 2019)

There are many similarities between computer programs and genes. Genes can essentially be understood as biological programs for performing a certain function in the organism. Like the source code of a program is not patentable in isolation, so should mere gene sequence be ineligible for patenting. Gene sequence contains in itself instructions for producing proteins. Admittedly, modern advances in genetic engineering have allowed to construct genetic material artificially. Nevertheless, even artificial genes employ the genetic code - a near-universal natural phenomenon. Therefore, genes could only be a part of a patentable process, not a separately patentable substance. However, it has been pointed out that patenting processes could more likely fail the obviousness analysis.[198]

It is clear that there is little creativity in natural gene sequences[199] or mere correction of a mutation. Therefore, patenting of natural genes and cDNA as well as mutations could not be protectable, only novel technologies for performing such tasks could be covered. However, if protection is not granted to artificial genetic creations, there might not be any incentive for industry to innovate and this can result in a lack of development. There have been proposals for the introduction of a new kind of IP protection.[200] For sequences that are artificially created, computer science might provide a clue. Computer software copyrightability is well established in law. Likewise, artificially engineered gene sequences could also be protected by copyright. Analogy to copyright law's interpretation of originality has been brought out as a possible inspiration for patent law that would help to narrow the scope of gene patents to an acceptable level as the nature-derived sequences are not as inventive as some other applications.[201] In addition, copyright protection also has advantages over patent protection such as longer protection and free use. This would enable to upkeep innovation and using creation in overwhelmingly important applications such as for medical use. Undoubtedly, however, switching genes under copyright regime would invalidate the protection of nature-extracted genes to a large extent.

In terms of artificially created sequences and their patentability discussed in the previous part of this article, this unpatentability results from its structural equivalence to natural DNA sequences. However, such sequences still need protection. Hence, copyright protection is proposed as a

[198] Whitley (2015), *supra nota* 61, p 472.
[199] Nese (2009), *supra nota* 108, pp 164-165.
[200] Mead, K. M., (2013), Gene Patents in Australia: A Game Theory Approach. *Pac. Rim L. & Pol'y J.*, Vol. 22, Iss. 3, pp 751-786, pp 782-783. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/pacrimlp22&collection=journals&id=769&startid=&endid=804 (22 July 2018)
[201] Liivak (2007), *supra nota* 97, pp 184-186.

solution for protecting artificially created sequences. Copyright protection allows to protect the exact sequences from exploitation by competitors. At the same time, principle of free use[202] allows to use the sequences for medical and research purposes, allowing the innovation to continue and achieve practicability. In addition, copyright protection is useful for the reason of its properties. Copyright protection does not require registration. The economic rights last for 70 years after the death of the copyright holder.[203] An issue that might arise, however, would be the prohibition of reproducing the required sequence due to copyright protection. Certainly, some reproduction and use of the sequence can be protected by free use as long as there is no commercial use. If that should not be sufficient, however, for protecting research and medical application, it might be conceivable to introduce an exceptions to copyright protection in a way that does not cause unnecessary harm for copyright holders.

Copyright protection on biological sequences helps to ensure their commercial application, despite lack of patent protection. It allows the innovators to earn back their investment and prevent competitors from coming to the markets with alternatives. Licensing to commercial users allows the innovators to earn back their investments while allowing to supply different, even small markets. Nevertheless, if the innovator is unwilling to license their economic rights under copyright regime, compulsory licensing should be applied. The licenses should be given for a reasonable remuneration, not exceeding certain level of profit to ensure price affordability and resulting product's accessibility. Applying principles of copyright to biological inventions allows to grant protection to specifically created sequences while eliminating issues related to patenting those inventions.

However, a few concerns must be kept in mind. Unlike in current patent climate where genes tend to be patented as chemical substances, the view under copyright would be rather different. The

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[202] Berne Convention for the Protection of Literary and Artistic Works (as amended on September 28, 1979)(authentic text), adopted Sept. 9, 1886, 1161 U.N.T.S. 3, art. 9(2), 10, 10bis. Accessed: https://wipolex.wipo.int/en/text/283698 (7 April 2019); WIPO Copyright Treaty (WCT)(authentic text), (adopted in Geneva on December 20, 1996), 2186 U.N.T.S. 152, Art. 10. Accessed: https://wipolex.wipo.int/en/text/295166 (7 April 2019); Directive 2001/29/EC of the European Parliament and of the Council of 22 May 2001 on the Harmonisation of Certain Aspects of Copyright and Related Rights in the Information Society, Art. 5, 2001 O.J. (L 167), 22.6.2001, pp 10-19, pp 16-17. Accessed: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32001L0029&from=EN (7 April 2019); 17 U.S.C. § 107. Accessed at Cornell Legal Information Institute: https://www.law.cornell.edu/uscode/text/17 (07 April 2019)

[203] Directive 2006/116/EC of the European Parliament and of the Council of 12 December 2006 on the Term of Protection of Copyright and Certain Related Rights, Art. 1, 2006 O.J. (L 372) 27.12.2006, pp 12-18, p 13. Accessed: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32006L0116&from=EN (7 April 2019); 17 U.S.C., *supra nota* 202, § 302.

physical substance itself would not be protected, only the information component – the sequence – would be protected as the expression of its creator's ideas. This would mean that the expression may take any form, whether on paper, as an electronic file or physical manifestation as a strand of DNA. Under copyright, only creation of new genetic material could be protected, as opposed to naturally preexisting material. Perhaps, some protection would still be afforded to cDNA, applying principles of legal interpretation similar to those evaluating copyrightability in cartography. It must be remembered that DNA copyright would essentially treat DNA as a language and specific sequence would be considered as analogy to written works (somewhat similarly to source code of computer programs). However, there would be no material protection on chemical or physical sphere, only on the expression contained within a newly created sequence.

As a result, it must be said that the analysis on possible copyrightability of artificial sequences and regime change effects on innovation are too little studied to provide a more in-depth analysis. For this reason, although copyrighting DNA is an intriguing thought, it cannot be recommended as a solution to gene patenting issues in present state.

3.2. Increased utility and process patents

The USPTO has addressed concerns related to the random patenting of sequences by adopting more stringent requirements on the inventions' written descriptions[204] and by increasing utility requirement standards in its guidelines, but that has also attracted criticism.[205] Luckily, the judiciary has addressed this issue as well, requiring increased utility standards for patenting gene sequences while not directly determining the expressed sequence tag patentability.[206] Also in Europe, utility has been attributed great significance and it has been seen to promote development

[204] Chisholm, D. P., (2001), The Effect of the USPTO's Written Description Guidelines on Gene Patent Applications. *Suffolk U. L. Rev.*, Vol. 35, Iss. 3, pp 543-570, pp 562-570. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/sufflr35&collection=journals&id=551&startid=&endid=578 (22 July 2018)

[205] Esoy, C. A. P., (2002), The PTO's 2001 Revised Utility Examination Guidelines for Gene Patent Applications: Has the PTO Exceeded the Scope of Authority Delineated by the Court's Interpretation of a Useful Invention. *Seton Hall. L. Rev.*, Vol. 33, Iss. 1, pp 127-166, p 157. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/shlr33&collection=journals&id=137&startid=&endid=176 (22 July 2018)

[206] Recent Cases, (2006), Patent Law - Utility - Federal Circuit Holds That Expressed Sequence Tags Lack Substantial and Specific Utility Unless Underlying Gene Function Is Identified - In re Fisher. *Harv. L. Rev.*, Vol. 119, Iss. 8, pp 2604-2611. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/hlr119&collection=journals&id=2636&startid=&endid=2643 (22 July 2018)

of science.[207] However, it has been noted that biotechnologically altered plants giving rise to novel varieties are unpatentable in Europe.[208] It might also be possible to obtain patent protection shielding a sequence by patenting a method that uses the sequences.[209] Method (or process) patents have been found to increase rewards received if the process is useful and decrease it if new, better processes come along, with the end result reflecting the efficient distribution of resources towards research.[210] However, method patents have been found to be potentially more difficult to enforce as the users of the method are infringers rather than producers of substances.[211]

3.3. Special category of biological patents

It appears clear that under current legislation and case law, genes as such might, in essence, be considered as a patentable subject matter if products of nature doctrine could be avoided. This is especially so in Europe where subject matter analysis is no longer an issue. However, the novelty and non-obviousness arguments could likely defeat attempts of patenting genes in the future or give rise to successful challenges to gene patents. Certainly, plaintiffs arguing against the validity of patents are likely to bring out the arguments already mentioned. It is only the matter of time before cases invalidating patents on those grounds become more frequent. Such a situation, however, may bring considerable uncertainty to the innovators who cannot be certain of the strength of their patents. As this uncertainty can deter innovation by scaring away investors or forcing companies to use the trade secret regime more often, this warrants changes to the patent system. Of course, in common law systems such as the US, case law has a vital role in the legal regime. However, in certain cases, changes of circumstances warrant action by Congress to introduce legislation on a matter where court approach turns out to be inadequate or inconsistent and where there exists a need for firm regulations. This is exactly such a case. In Europe, common law has lesser effect. However, case law may bring up uncomfortable questions in the future and

[207] Whitley (2015), *supra nota* 61, p 477.
[208] *Ibid.*, p 478.
[209] Noonan, D., (2008), Fencing Fisher: Alternative Methods for Patenting Expressed Sequence Tags. *Health Matrix*, Vol. 18, Iss. 2, pp 441-462, pp 459-460. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/hmax18&collection=journals&id=445&startid=&endid=466 (22 July 2018)
[210] Greenfield, M. S., (1992), Recombinant DNA Technology: A Science Struggling with the Patent Law. *Stan. L. Rev.*, Vol. 44, Iss. 5, pp 1051-1094, p 1084. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/stflr44&collection=top30&id=1067&startid=&endid=1110 (07 December 2018)
[211] Smith, M. B., (2002), An End to Gene Patents - The Human Genome Project Versus the United States Patent and Trademark Office's 1999 Utility Guidelines. *U. Colo. L. Rev.*, Vol. 73, Iss. 2, pp 747-786, pp 774-775. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/ucollr73&collection=journals&id=777&startid=&endid=816 (22 July 2018)

produce bizarre decisions. Therefore, it is best to prevent such cases through refinement of patent law.

3.3.1. United States

One approach that could be adopted for legislative change would be extending the patent system for discoveries. Indeed, there have been suggestions before that genes should belong to a separate patent group with shorter duration of protection, research sharing and patent pooling obligations.[212] This idea must be examined. In terms of plant patents, action has been taken to include them under patent umbrella under a specific category. It can be tempting to introduce discovery patents into the law. This temptation can be especially large as the boundaries between invention and discovery are blurred and investment needs for both are high. However, a few considerations must be born in mind. Firstly, discoveries themselves often include less investment than a full development of a product, meaning that the financial pressure on discovery innovation is not as large. Secondly, in the case of US, the introduction of discovery patents would necessitate the amendment of Constitution, a challenging task. Patent system as such has always focused on rewarding invention and its revelation to the public for the general good. However, discoveries have not been traditionally rewarded in the patent system. It is clear that discoveries as such need considerable investment and motivation for pursuit. This is especially so in the case of discoveries that necessitate significant work. One might dismiss the need of protection of those discoveries that happen by chance but it is more compelling to discuss the protection of discoveries that are the result of long and hard work and sometimes, a high amount of innovative thinking. However, patent system does not appear to be the answer. Discoveries as such are still revelations of natural phenomena. If discoveries were patentable, this could potentially close those discoveries from further research and development into inventions and applications that would otherwise benefit mankind. Therefore, if discoveries were to be protected by any instrument, it would have to be a completely new form of IP protection. Trade secret protection would be able to protect discoveries (at least until they are independently rediscovered), however, this does not serve the general interests. Furthermore, the system of scientific publication partially alleviates concerns of protecting discoveries. Publication allows discoverer to reveal their discovery and claim the title as discoverer, ensuring recognition and employment opportunities as well as possible generous

[212] Lanning, C. E., (2013), Mapping Our Future: The Impact of Gene Patents on Scientific Research and Health Care in the United States. *J.L. & Health*, Vol. 26, Iss. 2, pp 374-414, pp 407-412. Accessed through WestLaw: https://www.westlaw.com/Document/Ice324c95006b11e38578f7ccc38dcbee/View/FullText.html?transitionType=Default&contextData=(sc.Default)&VR=3.0&RS=cblt1.0 (14 April 2019)

offers for sharing connected useful information (that could be protected under trade secrets). For this reason, the current system of excluding discoveries from IP regime (apart from limited rights arising from copyright and trade secrets) appears adequate, although it would be beneficial to further analyze the effectiveness of such a system.

Another opportunity would be to take example from plant patents and create a separate patent category for genetic material. Perhaps even more widely, it might be beneficial to consider the idea of creating a special category of biological patents that would subsume gene patents, plant patents, animal breeds, microorganisms, novel biomolecules, transgenic animals, cell lines under one category. This would allow to ensure the patentability of biological material in clear and unambiguous way. Creation of such a category would make plant patents seem less out-of-place as well as make it possible to avoid another *Myriad*-type decision where patenting practices can change overnight.

On the other hand, creation of such a category would present its problems. As gene patents have already revealed, there are considerable concerns related to the access of medical products and increases in their price[213], genetic testing, new technologies, second opinions, there could be restriction on research and even moral considerations regarding ownership of human body as well as negative economic impact on non-innovative countries. Creating a separate category for biological inventions would not help to alleviate these concerns whether they are real or merely of hypothetical nature. Therefore, it is necessary to introduce safeguards into the system while maintaining the incentives for innovation. Due to the need to find a delicate balance between the need to get return of investment for research and due to the need to protect the public, protective measures are proposed in the following part of this paper. These protective measures are meant to counterbalance negative effects that can arise from a new patent category. The purpose of the new patent category together with significant limitations in patent rights but with considerable increase of protection time could allow to balance the interests of patients and society in general with that of the innovators. It would allow for a fair access of people to medicines and access for researchers to innovative product while maintaining economic incentives for the innovators. Such a balancing system could serve the interests of the general population and indeed, economy, better than current uncertain patent system.

[213] Heath (2005), *supra nota* 82.

3.3.2. Europe

In the European sphere, that special category already exists.[214] However, the main issues are the interplay between novelty, non-obviousness and biotechnological patents. In addition to allowing biotechnological patents as such, it is also necessary to define novelty and non-obviousness differently for such patents, lowering the threshold. Such step would enable to lose the conflict between essentially permissible patent category and possible failure of patent applications in this category due to lack of novelty or obviousness. In that sense, European patent system still needs to be reformed. Once obviousness and novelty standards are refined, however, patentability issues could be solved. At the same time, it is necessary to ensure that proper mechanisms are in place to protect medical accessibility, research and privacy.

Another issue is the banning of patents on medical technology, diagnostics and surgical procedures. It is highly appreciable that consumers and patients as well as medical practitioners are protected through banning such patents. However, there can be risks in this type of approach. European innovators might be unwilling to innovate if their inventions cannot be afforded patent protection. Those innovators who have innovated in other jurisdictions might be unwilling to proceed to the European market with their innovations when they know that competitors are free to copy their inventions. Moreover, this exclusion might not have the full intended effect as pharmaceutical product (and presently genetic material) are still considered patentable and they have a major impact on medicine as a whole. Perhaps better results could be achieved if patents on medical equipment, procedures and surgical techniques are allowed but under very strict limits such as infringement exemption for patients and medical practitioners in treatment setting, compulsory licensing and pricing as a percentage of profit. In addition, other compensatory measures such as publicity, advantaged access to experimental and trial data and other measures could be discussed.

3.4. Consumer protection mechanisms

As mentioned in the third part of this article, several solutions have been proposed to alleviate the negative impacts of gene patents on research and medicine. Consumer protection mechanisms are

[214] Biotech Patent Directive, *supra nota* 16.

important to be established. This allows for the public to accept the patentability of biological material and helps to alleviate concerns currently widespread in the society.

3.4.1. Patent pooling

One solution frequently brought out by commentators is the possibility of patent pooling. Best practices doctrines, patent pooling as well as clearinghouses approaches have been suggested to overcome concerns of gene patent effects on innovation, although there might be concerns of reluctance to join such schemes by some entities.[215] Patent pools have been found especially useful in genetic testing applications.[216] Patent pooling appears to have several benefits. It allows a mutual exchange of intellectual property licenses, allowing formerly competing companies to partially work together. This can make it possible to end the strict monopoly of a single patentee, allowing for competitors to come to market with an alternative product - a solution that could enable patients access to other providers of treatment or diagnostics. Licensing fees would enable patentees to continue earning revenue from their patent while having limited competition. Every product sold would keep earning revenue for the patentee while allowing the invention to potentially reach new markets and become affordable. In addition, patent pools would allow the patentee to gain access to the further improvements of their invention as well as to competitors' innovative solutions. This mutually beneficial cooperation can help foster the climate of innovation, maintaining incentives for inventing while providing adequate alternatives for the consumers and promoting cooperative atmosphere.

On the other hand, patent pooling can bring difficulties in terms of antitrust laws in the US and competition law in EU. Competing companies pooling together their patents can reach a situation where competition is not promoted but hindered - they might create a cartel. A group of companies pooling together their intellectual property rights might be tempted to make agreements establishing fixed prices or sharing markets between themselves. In such an event, competition on the market would be severely damaged. This, in turn, would damage consumers instead of protecting them. Situations like this must be avoided. If patent pooling is to be considered as a remedy against the harmful effects of biological patents, competition law must set firm limits on the conduct of companies pooling their IPR resources together. Any pooling agreements must be

[215] Lauer (2011), *supra nota* 110, pp 197-198.

[216] Scala, C. C., (2009), Making the Jump from Gene Pools to Patent Pools: How Patent Pools Can Facilitate the Development of Pharmacogenomics. *Conn. L. Rev.*, Vol. 41, Iss. 5, pp 1631-1668, pp 1661-1666. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/conlr41&collection=journals&id=1641&startid=&endid=1678 (22 July 2018)

submitted for regulatory competition authority for approval and such agreements must be furthering competition on the market and have reasonable terms. The role of patent pooling in this context is to allow the consumer have more choice amongst service providers in the market while allowing patentees to continue realizing the economic potential of their inventions. Only if balance of interests of participating parties and the public are taken into account, can patent pooling be truly serving the purpose of consumer protection.

3.4.2. Compulsory licensing

Another solution frequently mentioned is the introduction of compulsory licensing as already mentioned in discussion relating to special patent category. Compulsory licensing would enable to avoid the situation brought about by the *Myriad* saga - where the patentee or exclusive licensee refuses to license the technology to competitors, causing harmful effects on research and public health. Compulsory licenses would enable to force patentees to license their technology patents for reasonable compensation. Under such a policy, the level of compensation would be tied to the income received from exploitation of the patent.[217] The consumers would benefit from the compulsory licensing schemes in two ways. Firstly, such schemes would allow new service providers to come to the market, giving consumers more choice. Secondly, the requirement of reasonable compensation can potentially help to avoid arbitrary pricing policies that could become overwhelming for the consumers. Additionally, researchers would benefit from compulsory licensing, being free to pursue research and potentially innovate further without spending the majority of their research funds on IPR licensing. It could be possible to cross-license any improvements made under licensed research, bringing further benefit to the patentee.

To alleviate issues related to medical need of patented products, the EU has adopted regulation, requiring compulsory licensing of pharmaceutical patents to export them to countries that have public health issues.[218] Accessibility issue in third countries could be improved by the Regulation that obliges the innovators to provide licenses to any reasonable requests. This allows to ensure that access to innovation is not denied to less fortunate part of the population. It has also been proposed that medical application on patients could exempt the users of invention from

[217] Gitter (2001), *supra nota* 7, p 1679.

[218] Regulation (EC) No 816/2006 of the European Parliament and of the Council of 17 May 2006 on Compulsory Licensing of Patents Relating to the Manufacture of Pharmaceutical Products for Export to Countries with Public Health Problems, 2006 O.J. (L 157), 9.6.2006, pp 1-7, 1-7. Accessed: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32006R0816&from=EN (7 April 2019)

infringement lawsuit which could help increase patient access to medicine.[219] Another proposed solution puts emphasis on march-in rights whereby the patentee that refuses or is unable to develop or apply their invention loses their rights to the patent.[220]

Compulsory licensing would mandate patentees to allow consumers and competitors to use the invention at a reasonable cost and terms while allowing the patentee to still exercise their monopoly rights to a somewhat limited extent. Even though compulsory licensing would remove true monopolistic state, entire market would still be saturated by the patentee's invention or its improvements and every piece sold would earn patentee revenue and recognition. However, there are concerns that compulsory licensing schemes may cause harm to the patent system due to the potential of licensees not following safety regulations, prompting regulatory authorities to stop clinical trials, with the proposed potential solution of the issue via patentee's control of licensee's experimental design, subject to oversight.[221] It must be born in mind that exclusive licensing could prevent further research[222], necessitating the requirement of non-exclusive licenses. It has been seen that compulsive licensing, if obliging licensor to allow licensees to develop improvements of the invention, may stimulate the innovation.[223]

3.4.3. Fair-use excemption

A fair-use excemption has been proposed for experimental use of gene patents[224], though it might pose a threat to innovation promotion granted by the current patent system as a great deal of research has commercial aspects.[225] In the Europe, experimental use exception is established.[226] It has been proposed that compulsory licensing and research-related fee exemptions in European style should be imposed in the US, but those views have not gained support.[227] Some commenters

[219] McHugh (2010), *supra nota* 75, p 216.
[220] Poulsen (2011), *supra nota* 95, pp 235-236.
[221] Azher (2004), *supra nota* 149, pp 418-420.
[222] Tribble, J. L., (1998), Gene Patents Pharmaceutical Perspective. *Cambridge Q. Healthcare Ethics*, Vol. 7, Iss. 4, pp 429-432, pp 431-432. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/cqhe7&collection=journals&id=437&startid=&endid=440 (22 July 2018)
[223] Pins, M. N., (2010), Impending Access to Quality Patient Care and Patient Rights: How Myriad Genetics' Gene Patents are Unknowingly Killing Cancer Patients and How to Calm the Ripple Effect. *J. Intell. Prop. L.*, Vol. 17, Iss. 2, pp 377-416, pp 406-407, 410-411. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/intpl17&collection=journals&id=381&startid=&endid=420 (23 July 2018)
[224] Heath (2005), *supra nota* 82, pp 79-81.
[225] Lauer (2011), *supra nota* 110, p 196; McHugh (2010), *supra nota* 75, p 217.
[226] Lai (2015), *supra nota* 2, p 1070.
[227] Schmieder, S., (2004), Scope of Biotechnology Inventions in the United States and in Europe – Compulsory Licensing, Experimental Use, and Arbitration: A Study of Patentability of DNA-Related Inventions with Special Emphasis on the Establishment of an Arbitration Based Compulsory Licensing System. *Santa Clara Computer*

have found that gene patenting does not prevent experimenting due to functionality requirements.[228] Some have suggested that despite the ability of research to still be performed in the absence of gene patents, there might be effects on the application and commercialization of the results of such research.[229] It has also been viewed as damaging the basic research of scientific institutions.[230] Fair use exemption would allow to innovate for scientific purposes, using patented genes. It would also allow to offer *bona fide* medical treatment to those unable to afford expensive medicines. However, commercialization of new discoveries could become limited still, putting in question investment incentives into such research. As some patents also concern genes related to rare diseases and as those patients are often unable to afford special treatment, entire business plan and therefore, investment incentives, would be destroyed for the producer by fair use exceptions. As a result, investment protection measures must be reviewed as well.

Applying previous measures, profits per patent are likely to fall somewhat. In addition, even a small cost can be prohibitive for many patients and smaller research institutions. One potential solution could be a compulsory licensing system employing licensee's profit-based approach. According to this approach, the patentee (licensor) would be entitled to a predetermined percentage of the profits that the licensee receives from the use of the license. This would enable both parties to gain profits while allowing non-profit uses of the invention be free or for a nominal fee, improving research and healthcare-accessibility of the invention. This solution could potentially facilitate the growth of smaller research laboratories that do not have available resources for paying for multiple licenses. It would also enable poorer segments of patients to gain access to modern therapies and diagnostics that would otherwise be out of reach. A compulsory licensing scheme with profit-based fee system would facilitate consumer protection and research activity while maintaining the ability of the patentees to earn revenue.

& High Tech. L.J., Vol. 21, Iss. 1, pp 163-234, pp 207-209. Accessed through HeinOnline: https://heinonline.org/HOL/P?h=hein.journals/sccj21&i=173 (1 May 2019)

[228] Mcgee, G., (1998), Gene Patents Can Be Ethical. *Cambridge Q. Healthcare Ethics*, Vol. 7, Iss. 4, pp 417-421. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/cqhe7&collection=journals&id=425&startid=&endid=429 (22 July 2018)

[229] Schilling, S. H., (2011), DNA as Patentable Subject Matter and a Narrow Framework for Addressing the Perceived Problems Caused by Gene Patents. *Duke L.J.*, Vol. 61, Iss. 3, pp 731-774, pp 755-756. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/duklr61&collection=top30&id=737&startid=&endid=780 (7 December 2018)

[230] Parker, D. L., (1994), Patent Infringement Exemptions for Life Science Research. *Hous. J. Int'l L.*, Vol. 16, Iss. 3, pp 615-664, p 659. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/hujil16&collection=journals&id=637&startid=&endid=686 (23 July 2018)

3.4.4. Maintaining protection on research investment

The aforementioned safeguards do have the likely effect of reducing the return of investments from biological patents. However, a possible future *Myriad*-like decision invalidating biological patents could potentially even further negate any profitability of such research. The inability to earn profits would push away potential investors of research, potentially affecting the speed of innovation as well as the general economy through fall of value of biotechnological companies. However, it has been observed that as research often takes place in multinational setting, it is unfair to provide patent protection to merely some of the participants.[231] It has been seen that innovation may suffer if scope of protection to gene patents becomes too narrow.[232] Investors would hesitate to invest into companies that lack the potential for profitability or those that have no guarantees of success. These guarantees are often reflected by the intellectual property owned by the companies. In biotechnology sector, those IPR rights mainly belong to patent law. Clearly, this result is not desirable.

Maintaining patentability of biologicals by the introduction of a special patent category together with consumer- and research-oriented protection through compulsory licensing with profit-based fee and patent pooling would allow to maintain economic incentive to innovate. However, lowering profits could cool down investments into biotechnology sector still. The profit margins and protection from competition would remain lower and potentially contribute towards insecurity in investment sector. In order to balance this effect, perhaps it would be conceivable to extend this limited patent protection term for a longer period, for example, 30 years. Inevitably, product development process is long and in the medical sector, achieving marketing permit can take more than half of the current patent term of 20 years due to safety-related regulations and lengthy procedures. Such a short period of protection often does not allow for the patent to become profitable. Unprofitable patents, in turn, deter investment. If the patent protection term is increased, however, there would be enough time for the patentees to carry on product development and still reach profitability. This would allow the patentees to earn lower revenues but maintain a position of advantage in the market for a longer period, allowing the total return of investment per patent to potentially remain similar while allowing researchers and patients better access to innovation.

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[231] Contreras, J. L., (2016), Narratives of Gene Patenting. *Fla. St. U. L. Rev.*, Vol. 43, Iss. 4, pp 1133-1200, p 1154. Accessed: https://heinonline.org/HOL/Page?handle=hein.journals/flsulr43&collection=journals&id=1173&startid=&endid=1240 (22 July 2018)

[232] Whitley (2015), *supra nota* 61, p 489.

Longer protection period would achieve the necessary balance between the needs of consumers and researchers versus patentees. With longer patent protection terms, it is possible to maintain innovation incentives for biotechnological companies while protecting the needs of consumers and researchers.

CONCLUSION

As biotechnology develops, it begins to have increasin impact on people's lives. Likewise, the influence of laws related to biotechnology will increase. The aim of this paper was to analyze if current patent law and practice related to patetability criteria of subject matter, novelty and obviousness in the United States and in European Union are adequate in relation to biotechnological advancements and which possible issues regarding medical accessibility, research obstruction may arise how to improve upon possible issues.

Patenting of biological material is well established, especially in the United States. However, despite this well-spread practice, patenting several types of biological material, especially extracted and purified DNA as well as synthesized cDNA does not correspond to patentability criteria set in law and in practice related to other technologies. Extracted and purified DNA is inherently a product of nature. Extraction and purification do not change the DNA molecule into another chemical compound to warrant an alternative view on this matter. The properties of the double helix, the information it carries within, its affinity with other molecules remains. Therefore, extracted and purified DNA is a product of nature and hence unpatentable. Although cDNA is fundamentally different in the sense that it is artificially synthesized, it nevertheless contains the same exons as the natural variants. Its only difference with the naturally occurring DNA is the lack of introns. For this reason, cDNA must be considered as a product of nature as well. However, should the DNA be throught of as patentable subject matter, it would fail in novelty analysis. DNA has been extracted and purified for decades - there is nothing novel about the process. Nowadays, there are even commercial kits available for this task. Different sequence of DNA does not make it a different compound. Therefore, using a known method for a function common in practice, with the difference merely being the sequence of DNA, does not make the process novel. The same can be said about cDNA synthesis. Therefore, DNA extraction and purification nor cDNA synthesis are novel but they are part of prior art. Finally, extraction and purification of DNA and cDNA production are commonplace practices in genetic research and applied on a daily basis. Those procedures are, therefore, obvious to persons skilled in art. As a result, it turns out that purified and extracted DNA and cDNA are not patentable subject matter, are not novel and are obvious.

Despite this, they have been considered patentable in the US and by law are also patentable in the EU. This patentability can bring several concerns. The necessity for patent holders to recover development costs and to earn profit can increase the cost of new, potentially life-saving medicines. Predatory pricing policies may occur due to monopolistic status of patent owner in the market. This temporary monopoly can also cause lack of access to innovative medicine as patent owner may refuse to license the patent to competitors and may refuse to develop the technology, impairing ability for the population to benefit from innovation. Especially in relation to DNA, monopolistic power of patent owner can prevent the development of personalized medicine through controlling genetic testing and personalized drug development. Another conflict area has been the potential inability for other researchers to experiment with patented matter, which can cause lack of further development and lack of even basic research opportunities, all of which can hurt innovation. Those effects combined can also have a negative impact on economy.

In order to improve this situation, several remedies need consideration on their own and together. In the United States, there is no special patent category for biological patents. However, plant patents for breeders of plant varieties do exist. Perhaps creation of a new patent category could alleviate patentability concerns. In the EU, biological patents do exist separately, but there can be uncertainty nevertheless regarding novelty and obviousness of such innovation. Perhaps for EU, the best option would be to adapt these criteria for biological patents. In both US and EU, it is important, however, not to forget mechanisms that can balance issues brought by biological patents. Patent pooling could be utilized to bring necessary competition to the market and prevent predatory pricing. Compulsory licensing coupled with profit-based pricing could be used to help non-profit entities provide necessary help to those in need but unable to afford full price. At the same time, to keep innovation incentive, research expenses need to be recouped. To accomplish this in a novel, weaker patent category, perhaps increasing patent protection term could be useful. If the patent protection term was 30 years, this would allow patent owners longet time to earn back their investments, reducing the need for higher prices and enabling to keep research activities ongoing.

This paper aims to induce the clarification of patent law. It is clear that gene patenting as presently practiced, presents several problems. However, it must be borne in mind that patent law does not operate separately from the rest of the legal system. And law does not operate separately from the rest of the society. Discussion of public's interests is necessary to prevent alienating population

from the patent system which can bring unfavourable legislative changes to the patent system in the future. It is necessary to gather together all views from different sides and think of solutions to issues presented. This is what the present paper aims to start. By carefully crafting changes to the patent system in both US and Europe, it is possible to create a system of harmony that allows patentees return of investments while looking after researchers and consumers at the same time.

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