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Jurisprudential and Economic Justifications for Gene Sequence Patents

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Jurisprudential and Economic Justifications for Gene Sequence Patents

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I. INTRODUCTION

With the recent decision in *Association for Molecular Pathology v. United States Patent & Trademark Office*¹ (*AMP*), the attack on the genetics patent regime has reached a crescendo. While the ruling in *AMP* was startling to most in the genetics industry,² pressure from critics of gene sequence patenting has been building for the last decade. Concerns raised by gene sequence patenting opponents are summarized in Michael Crichton's statement in the *New York Times*, in which he boldly stated:

You, or someone you love, may die because of a gene patent that should never have been granted in the first place. . . . Gene patents are now used to halt research, prevent medical testing and keep vital information from you and your doctor. Gene patents slow the pace of medical advance on deadly diseases. And they raise costs exorbitantly . . . [b]ecause the holder of the gene patent can charge whatever he wants, and does. . . . The gene may exist in your body, but it's now private property.³

If true, Crichton's claims would certainly cast a dark light on the practice of genetics patenting. Statements such as Crichton's are currently in vogue, and support of such sentiments is gaining momentum even at the policymaking level. In 2007, at the urging of Crichton, Congressmen Xavier Becerra and Dave Weldon introduced the Genomic Research and Accessibility Act (GRAA).⁴ The GRAA, if passed, would have established that "no patent may be obtained for a nucleotide sequence, or its functions or correlations, or the naturally occurring products it specifies."⁵ Although the GRAA did not move out of committee, its breadth was startling. Based on the plain language of the bill, it not only would ban the patenting of gene sequences themselves, but also would potentially ban the patenting of methods derived from gene sequences.⁶

Undeterred by the 2007 GRAA failure, the American Civil Liberties Union (ACLU) pushed forth in *AMP*, alleging that patents held by Myriad Genetics pertaining to the BRCA1 and BRCA2 gene sequences, associated with hereditary breast and ovarian cancer, are

1. 702 F. Supp. 2d 181 (S.D.N.Y. 2010).

2. See John Schwartz & Andrew Pollack, *Judge Invalidates Human Gene Patent*, N.Y. TIMES, Mar. 29, 2010, at B1; Sharon Begley, *In Surprise Ruling, Court Declares Two Gene Patents Invalid*, NEWSWEEK (Mar. 29, 2010), <http://www.newsweek.com/blogs/the-human-condition/2010/03/29/in-surprise-ruling-court-declares-two-gene-patents-invalid.html>.

3. Michael Crichton, Editorial, *Patenting Life*, N.Y. TIMES, Feb. 14, 2007, at A23.

4. See H.R. 977, 110th Cong. (2007); Robert Cook-Deegan, *Gene Patents*, HASTINGS CENTER, <http://www.thehastingscenter.org/Publications/BriefingBook/Detail.aspx?id=2174> (last visited Feb. 26, 2011).

5. H.R. 977 § 2(a).

6. *Id.*; Christopher M. Holman, *The Impact of Human Gene Patents on Innovation and Access: A Survey of Human Gene Patent Litigation*, 76 UMKC L. REV. 295, 296 (2007).

patent ineligible because they cover “products of nature, laws of nature and/or natural phenomena, and abstract ideas or basic human knowledge or thought.”⁷ The ACLU further claimed that the Myriad patents create a monopoly that inhibits research, limits women’s healthcare options, and is unconstitutional.⁸

Judge Robert W. Sweet of the Southern District of New York surprised nearly all those in the genetics community when he found Myriad’s patents ineligible under section 101 of the U.S. patent statute.⁹ Noting the unique information-carrying character of gene sequences, Judge Sweet departed from the traditional products of nature analysis and, instead of focusing on physical and functional differences, based his decision on the commonality of the information carried on the native DNA and Myriad’s cDNA sequences.¹⁰

Only days after the *AMP* ruling, echoing the allegations made by the ACLU, Congressman Becerra rejoined the fray by pronouncing that he would “once again introduce legislation banning gene patenting to ensure patients’ access to their own medical information, reduce the costs of gene tests and increase scientific research into personalized medicine.”¹¹ Moreover, in his proposed 2010 version of the GRAA, Becerra reportedly seeks to expand the 2007 version by extending the proposed prohibition on gene patenting to all species, including animals and plants.¹²

As expected, Myriad has filed a notice of appeal with the District Court for the Southern District of New York, thus bringing the gene sequence patent question before the Court of Appeals for the Federal Circuit (CAFC).¹³ While the CAFC has not yet weighed in on the matter, the United States Department of Justice (DOJ) surprisingly filed an amicus brief with the CAFC.¹⁴ In its brief, the DOJ has taken a

7. Complaint at 29, *Ass’n for Molecular Pathology v. U.S. Patent & Trademark Office*, 702 F. Supp. 2d 181 (S.D.N.Y. 2010) (No. 09 Civ. 4515).

8. *Id.* at 18–19; Ann Weibaecher, *Can Patent Protections Trample Civil Liberties? The ACLU Challenges the Patentability of Breast Cancer Genes*, 15 PUB. INT. L. REP. 10, 10–11 (2009); AM. CIVIL LIBERTIES UNION, LEGAL CHALLENGE TO HUMAN GENE PATENTS 1, 5 (2009), available at http://www.aclu.org/pdfs/freespeech/brca_qanda.pdf [hereinafter “ACLU STATEMENT”].

9. See 35 U.S.C. § 101 (2006); *Ass’n for Molecular Pathology*, 702 F. Supp. 2d at 238.

10. See *Ass’n for Molecular Pathology*, 702 F. Supp. 2d at 228–32.

11. Press Release, Congressman Xavier Becerra, Rep. Becerra Applauds Court Decision on Gene Patenting (Mar. 30, 2010), available at http://becerra.house.gov/index.php?option=Com_content&view=article&id=412:rep-becerra-applauds-court-decision-on-gene-patenting&catid=3:press-releases&Itemid=4#.

12. See Kevin E. Noonan, *Congressman Becerra Once Again Tries to Ban Gene Patenting by Statute*, PATENT DOCS (Apr. 8, 2010), <http://www.patentdocs.org/2010/04/hes-baaack.html>.

13. See Notice of Appeal, *Ass’n for Molecular Pathology*, 702 F. Supp. 2d 181 (No. 09 Civ. 4515).

14. See Brief for the United States as Amicus Curiae in Support of Neither Party, *Ass’n for Molecular Pathology*, 702 F. Supp. 2d 181 (No. 09 Civ. 4515).

middle ground by stating that genetic patents that require both isolation and alteration should receive the benefit of patent eligibility, while those patent claims directed merely at isolation of genetic material should be denied such protection.¹⁵ Specifically with respect to the Myriad patent claims, the DOJ asserts that patent claims directed at complimentary DNA, discussed further herein, require both isolation and alteration of naturally occurring genetic material, thus rendering the Myriad patent claims eligible for patent protection.¹⁶ In contrast, the DOJ opposes patent eligibility of patent claims directed at genomic DNA, which the DOJ asserts merely amounts to isolating the genomic DNA from the human body.¹⁷

A number of economic theorists have analyzed the usefulness of the genetics patenting regime as an engine for innovation.¹⁸ Many critics have pointed to the increased patenting activity in “upstream” areas of the biotechnology industry as reason for concern, suggesting that over-appropriation of upstream subject matter could lead to a tragedy of the anticommons,¹⁹ resulting in a stifling of “downstream” product and diagnostic development.²⁰ Most of these theoretical claims, however, fail to recognize aspects of reality which act to mitigate the anticommons effect, such as the inertia required for a patentee to impose his exclusive right on an academic researcher,²¹ the large amount of upstream subject matter controlled by publicly funded agencies,²² and the fact that the U.S. Patent and Trademark Office (USPTO) and the courts have drawn a line demarking non-appropriable upstream subject matter by essentially banning patents on express

15. *Id.* at 9–10.

16. *Id.*

17. *Id.* at 10.

18. *See, e.g.*, Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575 (2003); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698 (1998); Richard Li-dar Wang, *Biomedical Upstream Patenting and Scientific Research: The Case for Compulsory Licenses Bearing Reach-Through Royalties*, 10 YALE J.L. & TECH. 251 (2007).

19. *See infra* section V.B.

20. *See* Burk & Lemley, *supra* note 18, at 1611; Heller & Eisenberg, *supra* note 18, at 699; Wang, *supra* note 18, at 258–61. The terms “upstream” and “downstream” denote the relative position of a particular piece of subject matter in the fundamental research-to-consumer ready production continuum. The more “upstream” a piece of subject matter resides the closer that subject matter is to pure fundamental research having no direct consumer utility. In contrast, the more “downstream” a piece of subject matter is the closer that subject matter is to supplying direct consumer utility.

21. Rebecca S. Eisenberg, *Noncompliance, Nonenforcement, Nonproblem? Rethinking the Anticommons in Biomedical Research*, 45 Hous. L. REV. 1059, 1062 (2008).

22. Chester J. Shiu, *Of Mice and Men: Why an Anticommons Has Not Emerged in the Biotechnology Realm*, 17 TEX. INTELL. PROP. L. J. 413, 415 (2009).

sequence tags (ESTs).²³ Much in the same way non-zero transaction costs in the real world cause social efficiency to fall below idealized Coasian levels in a private property regime,²⁴ costs of patent enforcement can inhibit the emergence of the tragedy of the anticommons.²⁵ Indeed, empirical studies suggest that the anticommons concern is largely exaggerated, as only a very small percentage of researchers indicate that licensing requirements or the existence of patents impact their activities.²⁶

Unfortunately, much of the outcry which has seemingly driven the ACLU's course of action in *AMP* is based on the assumption that gene patents inhibit research and make medical care more expensive.²⁷ While gene patents, just as any other class of patents, provide a limited right of exclusivity to the patentee, temporarily restricting a competitor's access to related subject matter, critics overlook the positive aspects of patent protection, namely private investment and the resulting advances in technology. Irrespective of the outcome in *AMP*, the continued use of gene sequence patenting as a tool in the United States' innovation policy should not hinge on hyperbole. Rather, the future of gene sequence patents should be based on (1) whether gene sequence patents meet the technical and legal requirements of patent eligibility under section 101 of the patent statute, and (2) whether gene sequence patents hinder or stimulate innovation in the biotechnology industry.

While statements such as Crichton's and Congressman Becerra's are currently fashionable,²⁸ it is important for the courts, lawmakers, and the public to appreciate the full implications of abandoning the gene patenting regime. Just as a truly malfunctioning gene patenting regime would certainly lead to detrimental effects felt by researchers and patients, abandoning a functioning regime would have an equally negative impact. If gene patents do, in fact, provide more societal benefit than cost, then "[y]ou, or someone you love, may die"²⁹ because biotechnology firms were unable to attract the capital necessary to bring to the market the fruits of their ground-breaking genetics research.

Part II of this Article introduces the scientific background necessary to understand the practice of gene sequence patenting from a technical perspective. This Part will dispel a number of misconcep-

23. See *In re Fisher*, 421 F.3d 1365, 1369–78 (Fed. Cir. 2005); Utility Examination Guidelines, 66 Fed. Reg. 1,092-02, 1,095 (Jan. 5, 2001).

24. See generally Ronald Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960).

25. See Eisenberg, *supra* note 21, at 1062.

26. *Id.* at 1061.

27. See ACLU STATEMENT, *supra* note 8, at 1.

28. See Crichton, *supra* note 3; Press Release, Congressman Xavier Becerra, *supra* note 11.

29. Crichton, *supra* note 3.

tions related to the practice of gene sequence patenting, specifically what a gene patent represents and the limited bundle of exclusionary rights a gene sequence patent provides. This Part will also explain, from a technical perspective, the difference between non-patent eligible native DNA sequences and patent eligible man-made cDNA gene sequences.

Part III introduces and attempts to synthesize the century-long products of nature doctrine, which supplies the standard for composition patent eligibility under section 101 of the patent statute.³⁰ Additionally, this Part includes a discussion of the heightened utility standards promulgated by the USPTO³¹ and adopted by the *In re Fisher* court,³² which has severely limited the practice of patenting upstream subject matter such as gene fragments and ESTs.

Part IV of this Article constructs an alternative standard for patent eligibility of genetic composition claims which simultaneously applies an information preemption analysis in concert with a functional and physical difference analysis under the products of nature doctrine. This Part further explains Judge Sweet's erroneous application of the "markedly different" standard under the products of nature doctrine to only the informational character of native DNA and the cDNA sequences claimed in Myriad's patents.³³

Part V of this Article introduces the underlying patent prospect theory used to justify the granting of patent rights. This Part describes the theory of the tragedy of the anticommons and its application to the biotechnology industry. In doing so, this Part introduces theories which suggest that the proliferation of patents in areas of upstream research, such as gene sequences, may amplify the risk of the tragedy of the anticommons. Part V further explains how factors such as large public agency control of upstream subject matter, enforcement costs on patent holders, and the stricter utility requirements promulgated by the USPTO all act to mitigate anticommons effects. Finally, this Part provides an overview of mitigating options, such as a statutory experimentation defense and expanded march-in rights, available to Congress to help stave off any threat of an anticommons market malfunction.

II. CLARIFICATIONS AND SCIENTIFIC BACKGROUND

Much of the backlash against the practice of gene sequence patenting is a result of widespread misunderstanding as to what a "gene pat-

30. See 35 U.S.C. § 101 (2006).

31. See Utility Examination Guidelines, 66 Fed. Reg. 1,092-02 (Jan. 5, 2001).

32. 421 F.3d 1365 (Fed. Cir. 2005).

33. See Ass'n for Molecular Pathology v. U.S. Patent & Trademark Office, 702 F. Supp. 2d 181, 227-31 (S.D.N.Y. 2010) (citing *Diamond v. Chakrabarty*, 447 U.S. 303, 310 (1980)).

ent” actually represents. For example, some critics have suggested that an individual might be guilty of patent infringement simply because his body contains a patented gene.³⁴ Congressman Becerra even suggested that “we have absolutely no say in what [gene patent owners] do with our genes.”³⁵ The reality is that gene sequence patents do not and cannot produce a positive property right in a person’s genes as suggested by these hyperbole-laden criticisms. To suggest otherwise simply ignores both the fundamental way in which patent protection operates and more specifically the scope of the subject matter a gene sequence patent holder is provided. In order to properly understand why an individual’s genes are in no danger of appropriation, one must first grasp an elementary understanding of genetics, specifically the differences between gene sequences found in living organisms and the gene sequences that are protected in gene sequence patent claims.

Since the founding discovery of J. D. Watson and F. H. C. Crick, in which the double helix structure of deoxyribonucleic acid (DNA) was deduced,³⁶ the scientific community has recognized DNA and ribonucleic acid (RNA) as the carriers of genetic information in all life forms on Earth.³⁷ From a chemical perspective, DNA consists of two long anti-parallel polymer chains, known as nucleotides.³⁸ Each nucleotide backbone is comprised of sugar and phosphate groups, wherein each sugar is attached to one of four bases.³⁹ These bases include Adenine (A), Cytosine (C), Guanine (G), and Thymine (T).⁴⁰ The sequence of these bases along the DNA polymer backbone acts to encode genetic information, with each nucleotide sequence arrangement representing a different information set.⁴¹ The genetic code serves as the keystone between a DNA sequence and a corresponding protein, specifying the sequence of amino acids within a given protein.⁴² The genetic code consists of codons, with each codon made up of a different three-base triplet of the four bases types, creating a total of sixty-four possible codons.⁴³ These sixty-four possible codons corre-

34. Utility Examination Guidelines, 66 Fed. Reg. at 1,093.

35. 153 CONG. REC. 3,637 (2007).

36. See J. D. Watson & F. H. C. Crick, *Molecular Structure of Nucleic Acids: A Structure for Deoxyribose Nucleic Acid*, 171 NATURE 737 (1953).

37. See Eric S. Lander & Robert A. Weinberg, *Genomics: Journey to the Center of Biology*, 287 SCI. 1777 (2000). See generally HARVEY LODISH ET AL., *MOLECULAR CELL BIOLOGY* (3d ed. 1995).

38. LODISH ET AL., *supra* note 37, at 104.

39. *Id.* at 102.

40. *Id.*

41. *Ass’n for Molecular Pathology v. U.S. Patent & Trademark Office*, 702 F. Supp. 2d 181, 194 (S.D.N.Y. 2010).

42. *Id.* at 194–96; LODISH ET AL., *supra* note 37, at 113–14.

43. *Ass’n for Molecular Pathology*, 702 F. Supp. 2d at 194; LODISH ET AL., *supra* note 37, at 120.

spond to the twenty amino acids.⁴⁴ As a result, the genetic code is degenerate, meaning a given amino acid may have more than one possible codon, as most do.⁴⁵

In all animal species nearly all encoding portions of a gene, known as exons, are interspersed with non-encoding sequences, known as introns.⁴⁶ More specifically, introns do not encode for the protein corresponding to the gene in question.⁴⁷ Thus, in order for a DNA sequence to code for a particular protein several intermediate steps must occur. First, the entire gene, both exons and introns, is transcribed into pre-messenger RNA (pre-mRNA).⁴⁸ Then, via splicing, the non-coding introns are deleted from the RNA sequence, resulting in a mature mRNA sequence containing only the exons used to code for the protein in question.⁴⁹ In the cell, the mature mRNA is transported from the nucleus to the cytoplasm, where it serves as a template in the assembly of the protein.⁵⁰

Geneticists take advantage of this natural process to create man-made DNA copies of the isolated mature mRNA sequences.⁵¹ This is particularly advantageous because the mRNA molecule is relatively instable, making DNA a superior research tool.⁵² In doing so, scientists isolate a given mRNA sequence containing only coding exons, and then create a complimentary DNA (cDNA) sequence.⁵³ It is this man-made cDNA molecule that is sequenced, in which the order of the four bases in the given sequence is determined, and patented.⁵⁴ This cDNA molecule can then be used in downstream applications such as gene therapy, diagnostic testing, research tools, and purified protein production.⁵⁵

Researchers are not restricted from using a given gene and the corresponding genetic information. In actuality, USPTO requirements mandate that gene sequence data be disclosed in exchange for the corresponding patent right.⁵⁶ As a result, gene sequence data is freely

44. *Ass'n for Molecular Pathology*, 702 F. Supp. 2d at 194.

45. *Id.*

46. *Id.*

47. *Id.*

48. *See id.* at 197–98.

49. *Id.*

50. *Id.*; see LODISH ET AL., *supra* note 37, at 234–36.

51. *See Ass'n for Molecular Pathology*, 702 F. Supp. 2d at 198–99.

52. *See id.* at 199; LODISH ET AL., *supra* note 37, at 234–36.

53. *Ass'n for Molecular Pathology*, 702 F. Supp. 2d at 198–99.

54. *See id.* at 198–200; LODISH ET AL., *supra* note 37, at 234–36.

55. Laurie L. Hill, *The Race to Patent the Genome: Free Riders, Hold Ups, and the Future of Medical Breakthroughs*, 11 TEX. INTELL. PROP. L.J. 221, 227–29 (2003); Lisa Larrimore Ouellette, Note, *Access to Bio-Knowledge: From Gene Patents to Biomedical Materials*, 2010 STAN. TECH. L. REV. N1, ¶ 17 (2010).

56. *See* Utility Examination Guidelines, 66 Fed. Reg. 1,092-02, 1,095 (Jan. 5, 2001) (citing 35 U.S.C. §§ 101, 112 (2000)).

and systematically made available to the public. Researchers can then use the native genes and/or the genetic information to identify genetic polymorphisms, make gene sequence comparisons, produce protein via recombinant processes, or perform an array of other scientific studies, irrespective of the scope of an existing cDNA gene patent.⁵⁷

Critics also consistently claim that over 20% of genes are patented.⁵⁸ This, however, is a very large misrepresentation. In addition to the physical differences between genes that reside in a person's cellular DNA and man-made cDNA gene sequences, as discussed above, gene sequence patents only cover a narrow use for a given gene sequence.⁵⁹ Studies have shown that a single gene sequence may be claimed in up to twenty different patents.⁶⁰ As a result, researchers that reside horizontally to a given gene sequence patent holder are still able to develop subject matter that implicates the given cDNA gene sequence, provided they develop a use different from that already patented—a desirable aspect of a functioning patent system. When combined with the ability to freely use the native gene and the corresponding non-patent eligible genetic information, horizontal researchers are afforded a significant amount of breathing room. Since a given gene sequence patent only provides a right of excludability for the claimed non-natural cDNA gene sequence and the corresponding use of that gene sequence, it is absurd to contend that a patented cDNA gene sequence somehow leads to an appropriation of the genes found in a person's body.

III. LEGAL BACKGROUND

The constitutional basis for the patent grant is provided by the Patent and Copyright Clause of the Constitution, which gives Congress the power “[t]o promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.”⁶¹ Congress has generally taken a very broad and hands-off approach in delineating what subject matter is and is not patent eligible under its constitutional patent-granting authority. Section 101 of the patent statute provides that a patent may be awarded to “[w]hoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof.”⁶² Thus,

57. *See In re Fisher*, 421 F.3d 1365, 1372–74 (Fed. Cir. 2005).

58. Kyle Jensen & Fiona Murray, *Intellectual Property Landscape of the Human Genome*, 310 SCI. 239, 239 (2005).

59. Ouellette, *supra* note 55, at ¶ 17.

60. Jensen & Murray, *supra* note 58, at 239.

61. U.S. CONST. art. I, § 8, cl. 7.

62. 35 U.S.C. § 101 (2006).

the threshold requirements for patent eligibility under section 101 comprise “novelty, utility, and statutory subject matter.”⁶³ In addition to these requirements, Congress further requires that subject matter be nonobvious in order to receive patent protection.⁶⁴ Congress, to date, has purposefully maintained this agnostic approach to patent eligibility affording the U.S. patent system the ability to adapt with the ever changing technological regimes.⁶⁵ The result, however, is a statutory patent regime that provides very little guidance in terms of patent eligibility, leaving the judiciary to determine the edges of patent eligible subject matter. Consequently, most of the biotechnology patent law doctrine has been gradually etched out in an ever-evolving interplay between the subordinate federal courts, the Supreme Court, and the USPTO.

A. Products of Nature Doctrine

In terms of biological compounds and biotechnology in general, the most widely utilized test for patent eligibility is the “products of nature” doctrine.⁶⁶ As a general matter, the patent law doctrine has been described as forbidding the patenting of “laws of nature, natural phenomena, and abstract ideas.”⁶⁷ These categories of patent ineligible subject matter are quite vague and take on very different meanings depending on the technology contexts in which they are implemented.⁶⁸ In many ways, the products of nature test may more aptly be looked at as a subset of the broader patent ineligible “law of nature” baseline.⁶⁹ With regard to compositions created by nature, particularly biological compounds, the products of nature doctrine is deemed by many to ban the patenting of “naturally occurring organisms and molecules.”⁷⁰ There are, however, as will be outlined below, many caveats to this understanding.⁷¹

One of the most famous and widely cited applications of the products of nature doctrine came in 1948 in *Funk Bros. Seed Co. v. Kalo Inoculant Co.*⁷² In *Funk Bros.*, the Supreme Court held invalid a

63. *Ass'n for Molecular Pathology v. U.S. Patent & Trademark Office*, 702 F. Supp. 2d 181, 219 (S.D.N.Y. 2010) (quoting *In re Bergy*, 596 F.2d 952, 960 (C.C.P.A. 1979)).

64. *See* 35 U.S.C. §§ 101–103.

65. *See* Burk & Lemley, *supra* note 18, at 1630–31.

66. *See, e.g., Ass'n for Molecular Pathology*, 702 F. Supp. 2d at 218–19.

67. *Diamond v. Diehr*, 450 U.S. 175, 185 (1981) (citing *Parker v. Flook*, 437 U.S. 584, 593 (1978); *Gottschalk v. Benson*, 409 U.S. 63, 67 (1972); *Funk Bros. Seed Co. v. Kalo Inoculant Co.*, 333 U.S. 127, 130 (1948)).

68. *See* Burk & Lemley, *supra* note 18, at 1577.

69. *See Diehr*, 450 U.S. at 185.

70. Eileen M. Kane, *Splitting the Gene: DNA Patents and the Genetic Code*, 71 TENN. L. REV. 707, 732 (2004).

71. *See, e.g., Funk Bros.*, 333 U.S. at 131–32.

72. *Id.* at 127.

product patent for a mixture of six bacteria species (genus *Rhizobium*) that allowed inoculated plants to properly fix nitrogen from the air.⁷³ The Court held that the patent amounted to a “discovery of phenomena of nature” and the “qualities of these bacteria, like the heat of the sun, electricity, or the qualities of metals, are part of the storehouse of knowledge of all men.”⁷⁴ The Court, however, did provide some guidance as to where the line between patent eligible and patent ineligible subject matter might lie by explaining that “if there is to be invention from such a discovery, it must come from the application of the law of nature to a new and useful end.”⁷⁵ Provided the other statutory patentability standards are met, *Funk Bros.* seems to suggest that subject matter is patent eligible when a law of nature is applied to a novel and useful purpose.⁷⁶

While the products of nature doctrine represents a baseline for patent ineligible subject matter, it is worth asking these questions: First, what products or processes truly constitute “laws of nature, natural phenomena, [or] abstract ideas,”⁷⁷ and second, what is required for an invention to come “from the application of the law of nature to a new and useful” end?⁷⁸ Over a century’s worth of litigation in the biotechnology sector has, with mixed success, incrementally attempted to answer these questions, significantly carving away at the seemingly broad products of nature doctrine.

B. Natural Extracts Doctrine

One of the largest and most contentious carve-outs to the products of nature doctrine is the “natural extracts doctrine.”⁷⁹ In a general sense, the natural extracts doctrine provides an exception to the products of nature doctrine for those creations in which human intervention causes an extracted natural product to become a “new” product. The larger question that the courts have struggled with is how to determine whether an extracted product is in fact patentable. As a result, the natural extracts doctrine has evolved over the last century and a half in a series of sometimes inconsistent judicial opinions.⁸⁰

73. *Id.* at 128–29.

74. *Id.* at 130.

75. *Id.*

76. Kane, *supra* note 70, at 734.

77. *Diamond v. Diehr*, 450 U.S. 175, 185 (1981).

78. *Funk Bros.*, 333 U.S. at 130.

79. See, e.g., Allen K. Yu, *Why it Might be Time to Eliminate Genomics Patents, Together with the Natural Extracts Doctrine Supporting Such Patents*, 47 IDEA 659 (2007).

80. *Compare Parke-Davis & Co. v. H. K. Mulford Co.*, 189 F. 95 (C.C.S.D.N.Y. 1911), with *Am. Wood-Paper Co. v. Fibre Disintegrating Co.*, 90 U.S. (23 Wall.) 566 (1874).

The following section summarizes the decisions most relevant to gene sequence patentability.

In the context of biological products, *Parke-Davis & Co. v. H. K. Mulford Co.*⁸¹ is often referenced as the modern embodiment of the natural extracts doctrine.⁸² In *Parke-Davis*, Judge Learned Hand held valid a patent for purified adrenaline, an otherwise natural compound existing in the human body.⁸³ Judge Hand reasoned that upon purification and extraction, the product became different from the naturally occurring form of adrenaline and became “for every practical purpose a new thing commercially and therapeutically.”⁸⁴ In his decision, Judge Hand took a very pragmatic approach, justifying his finding of patent eligibility by pointing to the utility of the invention as opposed to analyzing the technical scientific differences between the purified adrenaline and the natural adrenaline.⁸⁵ At the heart of the question, however, Judge Hand may have simply struggled with the realization that to some degree all products are in fact products of nature, and therefore distinguishing a “man-made” object on the basis of the underlying chemical makeup is probably no less arbitrary than focusing on the utility of the “new” product when measured from a therapeutic and commercial perspective.

Preceding *Parke-Davis*, in the 1874 case of *American Wood-Paper Co. v. Fibre Disintegrating Co.*,⁸⁶ the Supreme Court expounded on the question of physical novelty.⁸⁷ In *American Wood-Paper*, the Supreme Court held that a more purified cellulose product used in paper production could not be considered a “new manufacture” in light of “approximately pure” cellulose present in the prior art.⁸⁸ The Court further reasoned by example and provided that “if one should discover . . . a process by which prussic acid could be obtained from a subject in which it is not now known to exist, he might have a patent for his process, but not for prussic acid.”⁸⁹ The *American Wood-Paper* Court did not seem to appreciate the “newness” of the purified material with respect to the original naturally formed material, as it focused not on the improved utility of the purified form, but on the physical similarities between the new material and natural material.⁹⁰

Decades after *American Wood-Paper*, the Supreme Court further clarified the natural extracts exception to the products of nature doc-

81. 189 F. at 95.

82. See Yu, *supra* note 79, at 678.

83. *Parke-Davis*, 189 F. at 103.

84. *Id.*

85. *Id.* at 95; see Kane, *supra* note 70, at 739.

86. 90 U.S. (23 Wall.) 566 (1874).

87. *Id.* at 593–95.

88. *Id.*

89. *Id.* at 594.

90. See *id.*

trine in *American Fruit Growers, Inc. v. Brogdex Co.*⁹¹ The *American Fruit Growers* Court, in analyzing whether an orange rind impregnated with borax (used to prevent decay) constituted patent eligible subject matter, found that the “[a]ddition of borax to the rind of natural fruit does not produce from the raw material an article for use which possesses a new or distinctive form, quality, or property,” thus rendering the subject matter patent ineligible as a product of nature rather than a manufacture.⁹²

The Fourth Circuit in *Merck & Co. v. Olin Mathieson Chemical Corp.*,⁹³ largely aligned its reasoning with that provided by Judge Hand in *Parke-Davis*. The *Merck* court, as in *Parke-Davis*, focused on the new therapeutic utility of a purified B-12 vitamin produced through the fermentation of a class of fungi.⁹⁴ The court reasoned that “[t]he patentees have given us for the first time a medicine which can be used successfully in the treatment of pernicious anemia, . . . a medicine subject to accurate standardization and which can be produced in large quantities and inexpensively.”⁹⁵ The court then concluded that “[t]he new products are not the same as the old, but new and useful compositions entitled to the protection of the patent.”⁹⁶ The *Merck* ruling would suggest that purification and isolation of a compound which gives the new product a new utility not observed in the natural form would lead to patent eligibility under section 101 of the patent statute.

The Supreme Court case of *Diamond v. Chakrabarty*⁹⁷ is often considered the case that opened the gates of section 101 of the patent statute to the modern biotechnology industry, spawning a vast expansion of private investment into the field.⁹⁸ The Court in *Chakrabarty* noted the expansive role of section 101 of the patent statute and referred to and adopted language from congressional committee reports associated with the 1952 Patent Act, which indicated that Congress intended to provide patent eligibility to “include anything under the sun that is made by man.”⁹⁹ *Chakrabarty*, however, outlined the edges of this expansive view of section 101 patent eligibility by reiterating that “[t]he laws of nature, physical phenomena, and abstract

91. 283 U.S. 1, 11 (1931).

92. *Id.* at 11–12; see also *In re Merz*, 97 F.2d 599, 601 (C.C.P.A. 1938) (holding that “mere purification of known materials does not result in a patentable product,” unless “the product obtained in such a case had properties and characteristics which were different in kind from those of the known product rather than in degree”).

93. 253 F.2d 156 (4th Cir. 1958).

94. *Id.* at 157.

95. *Id.* at 164.

96. *Id.*

97. 447 U.S. 303 (1980).

98. See, e.g., Wang, *supra* note 18, at 255.

99. *Chakrabarty*, 447 U.S. at 309 (quoting S. REP. No. 1979, at 5 (1952)).

ideas” are not patentable.¹⁰⁰ Under its view, the Court reasoned that “a new mineral discovered in the earth or a new plant found in the wild is not patentable subject matter. Likewise, Einstein could not patent his celebrated law that $E=mc^2$; nor could Newton have patented the law of gravity.”¹⁰¹ The *Chakrabarty* Court, however, did conclude that the genetically altered bacterium in question indeed constituted “[a] nonnaturally occurring manufacture or composition of matter—a product of human ingenuity . . . with markedly different characteristics from any found in nature and one having the potential for significant utility.”¹⁰²

C. Heightened Utility Standard

While the above cases address the eligibility of subject matter under section 101 of the patent statute, none specifically discuss the patent eligibility of gene sequences. More recently, the courts and the USPTO itself have addressed gene sequence patentability, even though not on purely section 101 bases.¹⁰³ Many critics have suggested that the claiming of an isolated and purified gene sequence is merely a “lawyer’s trick” that unfairly allows a patentee to appropriate rights to genetic information created by nature.¹⁰⁴ Many others focus on the potential ill economic effects of patenting subject matter that resides in upstream areas of research, pointing to past attempts at patenting expressed sequence tags (ESTs) as evidence.¹⁰⁵

ESTs are small portions of DNA sequence that represent portions of expressed genes and can be used as tools to construct genome maps.¹⁰⁶ Critics claimed that ESTs resided too far into the upstream portion of the biotechnology industry and that ESTs did not provide any real world utility in and of themselves.¹⁰⁷ Due to the upstream location of ESTs, it was convincingly argued that limiting their use as

100. *Id.* (citing *Parker v. Flook*, 437 U.S. 584, 593 (1978); *Gottschalk v. Benson*, 409 U.S. 63, 67 (1972); *Funk Bros. Seed Co. v. Kalo Inoculant Co.*, 333 U.S. 127, 130 (1948); *O’Reilly v. Morse*, 56 U.S. (15 How.) 62, 112–21 (1853); *Le Roy v. Tatham*, 55 U.S. (14 How.) 156, 175 (1853)).

101. *Id.*

102. *Id.* at 309–10.

103. *See In re Fisher*, 421 F.3d 1365 (Fed. Cir. 2005); Utility Examination Guidelines, 66 Fed. Reg. 1,092-02 (Jan. 5, 2001).

104. *E.g.*, *Ass’n for Molecular Pathology v. U.S. Patent & Trademark Office*, 702 F. Supp. 2d 181, 185 (S.D.N.Y. 2010) (quoting John M. Conley & Roberte Makowski, *Back to the Future: Rethinking the Product of Nature Doctrine as a Barrier to Biotechnology Patents*, 85 J. PAT. & TRADEMARK OFF. SOC’Y 301, 305 (2003)).

105. *See, e.g.*, Jonathan Kahn, *What’s the Use? Law and Authority in Patenting Human Genetic Material*, 14 STAN. L. & POL’Y REV. 417, 420–21 (2003).

106. *See Fisher*, 421 F.3d at 1367–68.

107. *See Heller & Eisenberg*, *supra* note 18, at 699.

a research tool would greatly inhibit downstream development, while providing no counterbalancing benefit to society.¹⁰⁸

This concern, however, was largely addressed by the USPTO's promulgation of the Utility Examination Guidelines and the courts' subsequent adoption of these heightened utility standards in the context of gene patents. The Utility Guidelines, in part, provide that "[i]f a patent application discloses only nucleic acid molecular structure for a newly discovered gene, and no utility for the claimed isolated gene, the claimed invention is not patentable."¹⁰⁹ Moreover, the Utility Guidelines provide that the utility of the claimed isolated sequence must be "specific, substantial, and credible," having "particular practical purpose . . . credible by a person of ordinary skill in the art."¹¹⁰

The *In re Fisher* court largely adopted the standards set out by the Utility Guidelines when analyzing the patentability of five ESTs related to maize genes.¹¹¹ In finding that the ESTs were not patentable, the court stated that "the claimed ESTs have not been researched and understood to the point of providing an immediate, well-defined, real world benefit to the public meriting the grant of a patent."¹¹² In supporting the view proffered by the USPTO, the court set out the requirements for substantial and specific utility. The court concluded that the substantial utility requirement required the patentee to "show that the claimed invention has a significant and presently available benefit to the public."¹¹³ The specific utility requirement required the disclosure of "a use which is not so vague to be meaningless."¹¹⁴ While these requirements do not preclude the patenting of ESTs outright, they do require a patentee to identify a use that is clearly farther down the innovation stream than their current primary use as a tool in gene sequencing.¹¹⁵ As a result, the patenting of ESTs has largely been cut off, effectively drawing a line in terms of how far upstream patents may flow.

In contrast, the USPTO establishes that patentability will arise when the patent application discloses both the molecular structure for a newly discovered gene and the utility of the claimed gene.¹¹⁶ This dividing line should serve to chill the criticism that gene patents are

108. *See id.*

109. Utility Examination Guidelines, 66 Fed. Reg. 1,092-02, 1,093 (Jan. 5, 2001).

110. *Id.* at 1,093, 1,098.

111. *Fisher*, 421 F.3d at 1367, 1372.

112. *Id.* at 1376.

113. *Id.* at 1371.

114. *Id.*

115. *See id.* at 1368.

116. Utility Examination Guidelines, 66 Fed. Reg. 1,092-02, 1,093 (Jan. 5, 2001).

sought opportunistically using only “lawyer’s trick[s]”¹¹⁷ and that encroachment of gene sequence patents into upstream work risks the health of the genomics industry.

IV. ASSOCIATION FOR MOLECULAR PATHOLOGY V. UNITED STATES PATENT & TRADEMARK OFFICE

The first analysis of gene sequence patent eligibility on section 101 grounds came in the recent *AMP* decision.¹¹⁸ Judge Sweet of the Southern District of New York nearly single-handedly overturned three decades of biotechnology jurisprudence by holding the subject matter contained in Myriad’s composition and method claims pointed to patent ineligible subject matter.¹¹⁹ The Myriad gene sequence patents implicated in *AMP* largely exemplify the canonical gene sequence patents discussed in Part II of this Article.¹²⁰ This Part will analyze the patent eligibility of Myriad’s man-made BRCA1 and BRCA2 cDNA gene sequence composition claims. This Part will not address the patent eligibility of the method claims directed at diagnostic testing implicating the BRCA1 and BRCA2 genes,¹²¹ as they should be analyzed under a *Bilski*-like analysis,¹²² and such an analysis is beyond the scope of this Article. Likewise, the constitutional arguments raised by the ACLU in the *AMP* complaint¹²³ are also beyond the scope of this Article and will not be discussed herein.

The *AMP* court dismissed Myriad’s contention that the various incarnations of the products of nature test developed in *Funk Bros.*, *Parke-Davis*, *Merck*, and *Chakrabarty* differ from the law of nature test, such as that delineated in *Diehr*.¹²⁴ Judge Sweet concluded, “[a]lthough the distinction between [product of nature and law of nature] categories is unclear, it is well established that ‘products of nature’ are not patentable.”¹²⁵ The *AMP* court is certainly correct in concluding that neither products of nature nor laws of nature constitute patent eligible subject matter.¹²⁶ However, while much of the prior analysis related to the two categories overlaps, one has to be cognizant of the possibility that these terms are not necessarily interchangeable. While the ultimate baseline for patent eligible subject

117. *Ass’n for Molecular Pathology v. U.S. Patent & Trademark Office*, 702 F. Supp. 2d 181, 185 (S.D.N.Y. 2010) (quoting Conley & Makowski, *supra* note 104, at 305).

118. *See id.* at 181.

119. *See id.* at 185.

120. *See id.* at 211–17; *supra* Part II.

121. *See Ass’n for Molecular Pathology*, 702 F. Supp. 2d at 232–37.

122. *See Bilski v. Kappos*, 130 S. Ct. 3218 (2010).

123. Complaint, *supra* note 7, at 29.

124. *Ass’n for Molecular Pathology*, 702 F. Supp. 2d at 218 n.40.

125. *Id.*

126. *See supra* section III.A.

matter mandates that “laws of nature, physical phenomena, and abstract ideas”¹²⁷ do not fall within the scope of section 101, a product of nature is not necessarily equivalent to these terms, from either a scientific or jurisprudential perspective. To compound the confusion, the terms are often used nearly interchangeably throughout the case law.¹²⁸ Upon close reading, however, it becomes evident that in most composition cases courts first establish the law of nature baseline and then continue by undergoing the more tailored calculus required to determine whether an invented composition constitutes a product of nature or is instead a product of “human ingenuity.”¹²⁹ For example, the Supreme Court in *Chakrabarty* relied on prior court dicta to reiterate that “[t]he laws of nature, physical phenomena, and abstract ideas” are not patentable, thus establishing the law of nature baseline.¹³⁰ The *Chakrabarty* Court, however, then went on to establish the metric that a composition would be measured by, namely the product of human ingenuity standard, which requires the new product be “markedly different” than the product found in nature.¹³¹

The rule in *Chakrabarty*, however, should not be interpreted as the only measure by which to determine whether subject matter clears the law of nature baseline. For instance, the Supreme Court in *Diamond v. Diehr*¹³² applied an information preemption analysis when considering whether the implementation of a mathematical formula in a patent claim constituted patenting a law of nature.¹³³ In *Diehr*, the Court asked whether a process for molding rubber, which implemented a mathematical formula in a computer system context, constituted patent eligible subject matter.¹³⁴ The Court noted that “when a claim recites a mathematical formula (or scientific principle or phenomenon of nature), an inquiry must be made into whether the claim is seeking patent protection for that formula in the abstract.”¹³⁵ Reiterating the holding in *Mackay Radio & Telegraph Co. v. Radio Corp. of America*,¹³⁶ the *Diehr* Court attempted to draw the line between patent eligible and patent ineligible subject matter by pointing out that “[w]hile a scientific truth, or the mathematical expression of it, is not a patentable invention, a novel and useful structure created with

127. *Diamond v. Chakrabarty*, 447 U.S. 303, 309 (1980).

128. *See, e.g., Funk Bros. Seed Co. v. Kalo Inoculant Co.*, 333 U.S. 127 (1948).

129. *Chakrabarty*, 447 U.S. at 309.

130. *Id.* (citing *Parker v. Flook*, 437 U.S. 584, 593 (1978); *Gottschalk v. Benson*, 409 U.S. 63, 67 (1972); *Funk Bros.*, 333 U.S. at 130; *O'Reilly v. Morse*, 56 U.S. (15 How.) 62, 112–21 (1854); *Le Roy v. Tatham*, 55 U.S. (14 How.) 156, 175 (1853)).

131. *Id.* at 309–10.

132. 450 U.S. 175 (1981).

133. *See id.*

134. *Id.* at 191.

135. *Id.*

136. 306 U.S. 86 (1939).

the aid of knowledge of scientific truth may be.”¹³⁷ The Court held that the computer-executed process which implemented the Arrhenius equation in one of the process steps was indeed patent eligible.¹³⁸ The Court concluded that the respondent’s “process admittedly employs a well-known mathematical equation, but they do not seek to pre-empt the use of that equation. Rather, they seek only to foreclose from others the use of that equation in conjunction with all of the other steps in their claimed process.”¹³⁹ Thus, the patent law jurisprudence would indicate that the products of nature test, formulated in *Funk Bros.*, *Chakrabarty*, and *Merck*, and the information preemption analysis, formulated in *Diehr*, are but subsets of the broader law of nature baseline for purposes of section 101. As a result, a court must look to the details of the subject matter at hand when determining the analysis which should be employed. In the case of DNA, a court must look to both its physical and informational duality when answering this question.

Judge Sweet attempted to distinguish the subject matter related to gene sequences by pointing to the duality of DNA as both a chemical composition and an information carrier.¹⁴⁰ The unique character of genetic sequences is not under contention. The information-carrying capacity of natural DNA and man-made genetic sequences certainly makes these molecules unique from a scientific perspective.¹⁴¹ Judge Sweet, however, strained his analysis in order to incorporate a comparison of the informational character of the natural DNA and the man-made gene sequences under the products of nature doctrine.¹⁴² This straining led to an outcome inconsistent with both the products of nature line of cases under *Funk Bros.*, *Merck*, and *Chakrabarty*, and the information preemption analysis under *Diehr*. The remainder of this Part will discuss the AMP court’s treatment of the Myriad composition patent claims under the products of nature analysis, and set up an alternative analysis under an information preemption framework.

A. Product of Nature Analysis – BRCA1 and BRCA2

From a precedential perspective, Judge Sweet went to great lengths to avoid applying established products of nature doctrine to the Myriad gene sequences. Judge Sweet correctly pointed out that “Supreme Court precedent has established that products of nature do not constitute patentable subject matter absent a change that results

137. *Diehr*, 450 U.S. at 188 (quoting *Mackay Radio*, 306 U.S. at 94).

138. *Id.* at 187–88.

139. *Id.* at 187.

140. *See Ass’n for Molecular Pathology v. U.S. Patent & Trademark Office*, 702 F. Supp. 2d 181, 228–29 (S.D.N.Y. 2010).

141. *Id.*

142. *See id.* at 228–32.

in the creation of a fundamentally new product.”¹⁴³ As established in Part III of this Article, what does and does not pass the product of nature threshold is primarily a matter of the degree of “change” a composition from nature undergoes, and to some degree all new compositions can be traced back to natural origin.¹⁴⁴ The case law, including *Parke-Davis*, *Funk Bros.*, *American Fruit Growers*, *Merck*, and *Chakrabarty*, provides a number of data points which occupy the continuum between patent eligible and patent ineligible compositions.

On one end of the spectrum, the Supreme Court in *American Wood-Paper* held that refined and extracted cellulose from purified pulp was patent ineligible because the resultant product was merely a more pure version of the natural version.¹⁴⁵ On the other end of the spectrum, the court in *Merck* held that purified B-12 indeed constituted patentable subject matter as the purification led to more than a “mere advance in the degree of purity of a known product.”¹⁴⁶ The delineating feature, which Judge Sweet correctly establishes, is “that purification of a product of nature, without more, cannot transform it into patentable subject matter. Rather, the purified product must possess ‘markedly different characteristics’ in order to satisfy the requirements of [section] 101.”¹⁴⁷

An additional data point that weighs heavily in favor of gene sequence patent eligibility is the ruling in *Parke-Davis*, where Judge Hand held valid a patent for purified adrenaline on the basis of its altered characteristics.¹⁴⁸ Judge Sweet, however, dismisses the ruling in *Parke-Davis*, concluding that Judge Hand erroneously relied on novelty when holding that isolated adrenaline constituted patent eligible subject matter because it was a “new thing commercially and therapeutically.”¹⁴⁹ Ironically, Judge Sweet himself points out that patent eligibility turns on whether there is “a change that results in the creation of a fundamentally new product.”¹⁵⁰ Moreover, *American Wood-Paper*, which Judge Sweet relied on heavily, found that the purified and isolated composition could not be considered a “new manufacture” in light of “approximately pure” cellulose present in the prior art.¹⁵¹ While Judge Hand used the word “new” in *Parke-Davis*, it is

143. *Id.* at 222.

144. *See supra* Part III.

145. *Am. Wood-Paper Co. v. Fibre Disintegrating Co.*, 90 U.S. (23 Wall.) 566, 593–95 (1874).

146. *Merck & Co. v. Olin Mathieson Chem. Corp.*, 253 F.2d 156, 164 (4th Cir. 1958).

147. *Ass'n for Molecular Pathology*, 702 F. Supp. 2d at 227 (quoting *Diamond v. Chakrabarty*, 447 U.S. 303, 310 (1980)).

148. *See Parke-Davis & Co. v. H. K. Mulford Co.*, 189 F. 95, 103 (C.C.S.D.N.Y. 1911).

149. *Ass'n for Molecular Pathology*, 702 F. Supp. 2d at 224–26 (quoting *Parke-Davis*, 189 F. at 103).

150. *Id.* at 222.

151. *Am. Wood-Paper Co. v. Fibre Disintegrating Co.*, 90 U.S. (23 Wall.) 566, 594 (1874).

important to recognize that he did so in a manner that actually points to the utility of the purified adrenaline in question.¹⁵² In so doing, he firmly established that the purified adrenaline constituted patentable subject matter because of its new commercial and therapeutic character, which allowed it to be used by humans in a different way than in its natural form.¹⁵³ While a portion of Judge Hand's ruling may no longer be good law, it is clear that his "new . . . commercial[] and therapeutic[]"¹⁵⁴ character justification for finding that the purified and isolated adrenaline constituted patent eligible subject matter is entirely consistent with the markedly different characteristics standard provided in *Chakrabarty*¹⁵⁵ and the "distinctive form, quality, or property" standard in *American Fruit Growers*.¹⁵⁶ Therefore, it appears relatively disingenuous to distinguish *Parke-Davis* on the issue of novelty. In the end, *Parke-Davis* does not establish a particularly unique rule in terms of the products of nature doctrine, but it does establish a data point along the patent eligible-patent ineligible continuum that pushes isolated man-made gene sequences closer to the patent eligible side of the line.

The most closely related data point found in the case law is *Merck*. As discussed in Part III, the *Merck* court relied heavily on the functional differences between natural B-12 and the new B-12 compound, pointing out that while purification alone was not enough to establish patent eligibility, when the new compound "is therapeutically available and the [natural compound was] therapeutically unavailable—patentability would follow."¹⁵⁷ The court noted that the patented B-12 "did not exist in nature in the form in which the patentees produced it and was produced by them only after lengthy experiments."¹⁵⁸

It would appear straightforward to apply *Merck's* standard of therapeutic availability as the measurable characteristic to be used under *Chakrabarty's* markedly different characteristics standard.¹⁵⁹ Myriad points out a number of aspects which would appear, under *Merck* and *Chakrabarty*, to justify the patent eligibility of the isolated BRCA1 and BRCA2 sequences.¹⁶⁰ And, indeed, Judge Sweet did conclude that *Merck* was "entirely consistent with the principle set forth

152. See *Parke-Davis*, 189 F. at 103.

153. *Id.*

154. *Id.*

155. *Diamond v. Chakrabarty*, 447 U.S. 303, 310 (1980).

156. *Am. Fruit Growers, Inc. v. Brogdex Co.*, 283 U.S. 1, 11 (1931).

157. *Merck & Co. v. Olin Mathieson Chem. Corp.*, 253 F.2d 156, 163 (4th Cir. 1958) (quoting *Kuehmsted v. Farbenfabriken of Elberfeld Co.*, 179 F. 701, 705 (7th Cir. 1910)).

158. *Id.* at 164.

159. See *Chakrabarty*, 447 U.S. at 310.

160. See *Ass'n for Molecular Pathology v. U.S. Patent & Trademark Office*, 702 F. Supp. 2d 181, 227–32 (S.D.N.Y. 2010).

in *Funk Brothers and American Fruit Growers*.”¹⁶¹ Rather, however, than apply the logic proffered by the *Merck* and *Chakrabarty* courts, Judge Sweet went to great lengths to distinguish the purification and isolation of native DNA and the man-made production of cDNA from the compositions discussed in the prior case law, concluding that the functional advantages of cDNA, which make the information in DNA useful, did not lead DNA and cDNA to be markedly different.¹⁶²

Myriad first points out that, while in its natural state, DNA found in the nuclei of eukaryotic cells is intimately intertwined with chromosomal proteins, together forming chromatin.¹⁶³ As a result, isolated DNA, which is devoid of these chromosomal proteins, is structurally different than the chromatin found in the nuclei.¹⁶⁴ Judge Sweet dismisses this argument, noting that “the proper comparison is between the claimed isolated DNA and the corresponding native DNA, and the presence or absence of chromosomal proteins merely constitutes a difference in purity that cannot serve to establish subject matter patentability.”¹⁶⁵ In doing so, Judge Sweet does not provide a reason as to why the purification merely amounts to a “difference in purity” and why it does not lead to a degree of increased therapeutic utility so as to justify patentability as provided for in *Merck*.¹⁶⁶ From a therapeutic perspective, it is clear that but for the purification and isolation, as claimed in the Myriad patents, the gene sequences in question would be useless to mankind.¹⁶⁷ The Myriad purification does not amount to a mere marginal improvement of the level of purity, creating simply a more pure version of the original DNA. Rather, it creates a new composition both from a commercial and therapeutic perspective, and to conclude it is merely a “purification”¹⁶⁸ seems diametrically opposed to the *Merck* court’s rationale.

Judge Sweet also dismisses Myriad’s contention that the Myriad sequences should be patentable because the man-made BRCA1 and BRCA2 cDNA molecules contain only protein encoding exons and do not contain the introns that exist in corresponding native DNA sequences.¹⁶⁹ With respect to Myriad’s cDNA sequences, Judge Sweet relies on the fact that “the coding sequences contained in the claimed DNA [are] identical to those found in native DNA.”¹⁷⁰ He further argues that the “particular arrangement of those coding sequences is the

161. *Id.* at 227.

162. *See id.* at 228–32.

163. *Id.* at 229–30.

164. *Id.*

165. *Id.*

166. *See id.*

167. *Id.* at 231.

168. *Id.*

169. *Id.* at 230.

170. *Id.*

result of the natural phenomena of RNA splicing.”¹⁷¹ In *Merck*, however, it was not the molecular differences between the B-12 compositions that made the new B-12 composition patentable, but rather the purification and isolation of B-12 that created a new material from a therapeutic and commercial perspective that rendered it patentable.¹⁷² Judge Sweet focuses on the fact that the operative informational components of the isolated cDNA are the same as the operative informational components of the native DNA and then concludes that they are thus not markedly different.¹⁷³ This is a significantly strained reading of *Merck*. Not only does he completely dismiss the differences between the DNA and the cDNA from a chemical structure perspective, Judge Sweet also overlooks the fact that in *Merck* the operative characteristics of natural B-12 and the man-made B-12 were the same.¹⁷⁴ Rather, it was the creation of a new composition that retained the operative character of natural B-12 but in a form therapeutically accessible to man which made it patentable.¹⁷⁵ It is difficult to see how the creation of cDNA, wherein introns are removed from the native DNA, making the cDNA useful to mankind,¹⁷⁶ does not pass the threshold established in *Merck*.

Moreover, Judge Sweet also dismisses Myriad’s contention that the functional differences between the isolated DNA and the native DNA should allow for patentability because the native DNA cannot be used in “molecular diagnostic tests (e.g., as probes, primers, templates for sequencing reactions), in biotechnological processes (e.g., production of pure BRCA1 and BRCA2 protein), and even in medical treatments (e.g., gene therapy).”¹⁷⁷ It is only through the man-made production of the cDNA molecule that the above uses of DNA can be realized.¹⁷⁸ Judge Sweet essentially concludes that the functional differences do not lead to patentability because the basis for the various uses of the isolated DNA is the fact that the native DNA’s nucleotide sequence is preserved in the isolated BRCA1 and BRCA2 DNA.¹⁷⁹ He then states:

While the absence of proteins and other nucleotide sequences is currently required for DNA to be useful[,] . . . the purification of native DNA does not alter its essential characteristic—its nucleotide sequence—that is defined by na-

171. *Id.*

172. *See Merck & Co. v. Olin Mathieson Chem. Corp.*, 253 F.2d 156, 161–64 (4th Cir. 1958).

173. *See Ass’n for Molecular Pathology*, 702 F. Supp. 2d at 230–32.

174. *See Merck*, 253 F.2d at 156; *Ass’n for Molecular Pathology*, 702 F. Supp. 2d at 230–32.

175. *See Merck*, 253 F.2d at 164.

176. *See Ass’n for Molecular Pathology*, 702 F. Supp. 2d at 198–99, 231.

177. *Id.* at 230–31.

178. *Id.* at 230.

179. *Id.* at 231.

ture and central to both its biological function within the cell and its utility as a research tool.¹⁸⁰

Again, while Judge Sweet's position is defensible from a purely semantical perspective, in that the native and isolated sequences do share important characteristics, he completely ignores the meaning of *Merck* and *Chakrabarty*. The *Merck* court clearly established that changes in therapeutic utility should be looked upon when analyzing whether the character of a natural product and an isolated product are different for purposes of eligibility.¹⁸¹ In fact, in Judge Sweet's own words, "the absence of proteins and other nucleotide sequences is currently required for DNA to be useful."¹⁸² This observation is directly in line with the reasoning provided in *Merck*, *Chakrabarty*, *Funk Bros.*, *American Wood-Paper*, and *Parke-Davis*, and which should lead to patent eligibility.

For example, if Judge Sweet's analysis were applied to the facts in *Merck* it would become apparent that natural B-12 and the isolated and purified B-12, when measured from a molecular perspective, would share the same "essential characteristics."¹⁸³ However, the isolated B-12 product in *Merck* was patentable not because it was molecularly different than natural B-12, but because it existed in an isolated and purified state which led it to be useful to mankind in a manner it was not when in its natural state.¹⁸⁴ This same rationale applies to the purified and isolated adrenaline in *Parke-Davis*,¹⁸⁵ but is distinguishable from *Funk Bros.* in that the purified cellulose in that case was simply more purified with respect to natural cellulose and did not fundamentally change the utility of the product when measured from a therapeutic or commercial perspective, but only increased the utility by some incremental degree.¹⁸⁶ In the case of the isolated gene sequences, it is only through isolation and purification that the nucleotide sequences become useful to mankind in the first place.¹⁸⁷ The isolation and purification of the BRCA1 and BRCA2 gene sequences, therefore, must be looked at as a fundamental change in character—amounting to an alteration of the sequences—consistent with the outcomes in *Merck* and *Parke-Davis*, as opposed to an incremental change in purity as observed in *Funk Bros.*

Judge Sweet claims to have applied the products of nature test in *AMP*, but nevertheless completely disregards the physical and func-

180. *Id.*

181. *See Merck & Co. v. Olin Mathieson Chem. Corp.*, 253 F.2d 156, 164 (4th Cir. 1958).

182. *Ass'n for Molecular Pathology*, 702 F. Supp. 2d at 231.

183. *Id.*; *see Merck*, 253 F.2d at 156.

184. *See Merck*, 253 F.2d at 163-64.

185. *See Parke-Davis & Co. v. H. K. Mulford Co.*, 189 F. 95, 103 (C.C.S.D.N.Y. 1911).

186. *See Funk Bros. Seed Co. v. Kalo Inoculant Co.*, 333 U.S. 127, 130-31 (1948).

187. *Ass'n for Molecular Pathology*, 702 F. Supp. 2d at 231.

tional differences existing between the native DNA and the Myriad gene sequences—hallmarks of the products of nature test.¹⁸⁸ The products of nature test was not developed to compare information commonality, as nearly all compositions in the products of nature jurisprudence constitute non-genetic materials.¹⁸⁹ Moreover, the Supreme Court rulings in *Chakrabarty* and *Diehr* indicate that a court should not robotically apply the markedly different standard to the informational character of native DNA and corresponding cDNA, as the common information carriage does not preclude the possibility that the two sets of molecules are markedly different from a therapeutic and commercial perspective.¹⁹⁰ By overlooking this divergent treatment of information and composition, and by focusing on the commonalities of the native DNA and cDNA, while at the same time ignoring physical and functional differences, Judge Sweet warped the products of nature doctrine into a test that would likely not be passed by most of the subject matter that was used to develop it.

B. Law of Nature – BRCA1 and BRCA2

A number of commentators have suggested applying a law of nature test when analyzing the patentability of isolated gene sequences.¹⁹¹ In doing so, Eileen Kane, a staunch opponent of gene sequence patents, points out that “the genetic code should be characterized as a law of nature, based on its essential attributes, its historical treatment in scientific literature and public discourse, and its centrality in modern molecular biology.”¹⁹² In making this conclusion, Kane further advocates for a treatment of the genetic code and DNA under an information preemption analysis developed in the software/algorithm patent law context.¹⁹³

1. *Isolated Gene Sequences Are Not Embodiments of the Laws of Nature*

Whether Kane is correct and the genetic code is considered a law of nature for purposes of patent law doctrine may be an arguable point. That issue will not, however, be argued herein as there is no question of the fundamental and informational nature of the genetic code.

188. *See id.* at 222–32.

189. *See, e.g., Funk Bros.*, 333 U.S. at 127.

190. *See* *Diamond v. Diehr*, 450 U.S. 175 (1981); *Diamond v. Chakrabarty*, 447 U.S. 303 (1980).

191. *See, e.g.,* Rebecca S. Eisenberg, *Patenting the Human Genome*, 39 EMORY L.J. 721, 724 (1990) (quoting *Funk Bros.*, 333 U.S. at 130); Kane, *supra* note 70, at 744; Arti K. Rai, *Intellectual Property Rights in Biotechnology: Addressing New Technology*, 34 WAKE FOREST L. REV. 827, 836 (1999).

192. Kane, *supra* note 70, at 752.

193. *Id.* at 752–53.

While it is true that DNA contains a physical representation of the genetic code, it is also true that the native DNA molecule contains much more than just that information, such as the noncoding introns and numerous polymorphisms of the native DNA.¹⁹⁴ Generally speaking, the genetic code consists of a “set of rules by which information encoded” in DNA or mRNA “is translated into proteins.”¹⁹⁵ Therefore, even if the genetic code is a law of nature, the native DNA molecule is not; rather, it is only a result of that presumed law of nature. Consequently, DNA should not receive treatment as a law of nature under patent eligibility analysis.

Even more convincing is the fact that a portion of the Myriad claims in question are directed toward man-made cDNA, which is derived from native DNA and is void of the noncoding introns and numerous polymorphisms found in native DNA.¹⁹⁶ This fact is often overlooked by the popular media and critics,¹⁹⁷ but it is a fact that clearly pulls the Myriad gene sequences even farther from the realm of law of nature. The idea that cDNA is patentable even though it is derived from DNA is further supported by both Supreme Court rulings in *Diehr* and *Mackay Radio*,¹⁹⁸ with the conclusion that “a novel and useful structure created with the aid of knowledge of scientific truth may be” patent eligible.¹⁹⁹

Since native DNA and surely the isolated Myriad cDNA gene sequences do not exemplify laws of nature for the purposes of patent law doctrine, an information preemption analysis under *Diehr* is not warranted. This, however, does not automatically lead to patent eligibility. It is recognized that native DNA is certainly a product of nature,²⁰⁰ just as native B-12 in *Merck* and natural adrenaline in *Parke-Davis* were products of nature.²⁰¹ This fact likely establishes that native DNA is not patent eligible, a conclusion that many gene sequence patent proponents would not dispute. In its analysis, the CAFC, and eventually the Supreme Court, should turn to the question of whether the isolated Myriad sequences constitute products of human ingenuity, with functional and physical attributes that are markedly different than the native DNA.²⁰² This is distinguishable

194. See generally LODISH ET AL., *supra* note 37.

195. *Genetic Code*, SCI. DAILY, http://www.sciencedaily.com/articles/g/genetic_code.htm (last visited May 19, 2011).

196. See *Ass'n for Molecular Pathology v. U.S. Patent & Trademark Office*, 702 F. Supp. 2d 181, 198–99, 211–15 (S.D.N.Y. 2010).

197. See, e.g., Crichton, *supra* note 3.

198. See *Diamond v. Diehr*, 450 U.S. 175 (1981); *Mackay Radio & Tel. Co. v. Radio Corp. of Am.*, 306 U.S. 86 (1939).

199. *Diehr*, 450 U.S. at 188 (quoting *Mackay Radio*, 306 U.S. at 94).

200. E.g., *Utility Examination Guidelines*, 66 Fed. Reg. 1,092-02, 1,093 (Jan. 5, 2001).

201. See *Merck & Co. v. Olin Mathieson Chem. Corp.*, 253 F.2d 156 (4th Cir. 1958); *Parke-Davis & Co. v. H. K. Mulford Co.*, 189 F. 95 (C.C.S.D.N.Y. 1911).

202. See *Diamond v. Chakrabarty*, 447 U.S. 303, 309–10 (1980).

from the approach taken by Judge Sweet in that the informational character of the native DNA and cDNA sequences should only be analyzed under the approach set out in *Diehr*, whereas the functional and physical differences should be subjected to the products of nature analysis discussed above.

2. *BRCA1 and BRCA2 Patents Do Not Preempt Genetic Code*

Even if one accepts that natural DNA is an embodiment of a law of nature, this does not mean that the genetic information encoded in the native DNA cannot be included in subject matter that is patent eligible. As discussed above, the AMP court noted that a nucleotide sequence of the native DNA is preserved in the isolated BRCA1 and BRCA2 DNA and erroneously applied the products of nature analysis to conclude that the two were therefore not markedly different due to information commonality.²⁰³ In order to properly analyze the information commonality of the native and isolated gene sequences, the court should have applied the law of nature preemption analysis formulated in *Diehr* and suggested by Kane.²⁰⁴

By analogizing the mathematical formula implicated in *Diehr* to the information content of the genetic code, the AMP court should have analyzed the information preemptive effect of Myriad's BRCA1 and BRCA2 patents. Just as the mathematical formula in *Diehr* was not patentable,²⁰⁵ neither is the information contained in the genetic code, which is encoded in both the DNA and cDNA sequences.²⁰⁶ The *Diehr* Court, however, established that the patent eligibility of an invention did not hinge on the inclusion of a mathematical formula.²⁰⁷ Rather, the Court looked to the preemptive effect the issuance of the patent would have on the use of the formula in other settings.²⁰⁸ Likewise, even if DNA is deemed as an embodiment of a law of nature, which has been argued to the contrary,²⁰⁹ the validity of a gene sequence patent should not hinge on the inclusion of genetic information in man-made cDNA. The AMP court should have looked to whether the Myriad patents preempt the use of the genetic information encoded in the BRCA1 and BRCA2 sequences in other settings.

It is true that the Myriad patent limits the use of the BRCA1 and BRCA2 sequences. That is, however, the fundamental mechanism by

203. See *Ass'n for Molecular Pathology v. U.S. Patent & Trademark Office*, 702 F. Supp. 2d 181, 228–29 (S.D.N.Y. 2010).

204. See *Diehr*, 450 U.S. at 187; Kane, *supra* note 70, at 751–54.

205. See *Diehr*, 450 U.S. at 191–92.

206. Utility Examination Guidelines, 66 Fed. Reg. 1,092-02, 1,093, 1,095 (Jan. 5, 2001).

207. See *Diehr*, 450 U.S. at 187–88.

208. See *id.*

209. See *supra* subsection IV.B.i.

which patent protection provides incentive to invest.²¹⁰ Simply because a patent limits one use of a law of nature should not lead to patent ineligibility. The raw genetic sequence data associated with the BRCA1 and BRCA2 sequences can be used for a number of purposes, such as sequence comparison and detecting polymorphisms.²¹¹ This is completely analogous to the limited but real uses that remained in *Diehr*, wherein a subsequent party could still utilize the mathematical formula present in the *Diehr* patent claim in contexts that did not include the other steps of the patent.²¹² Moreover, in nearly all gene sequence patent applications, the raw gene sequence data is disclosed in the written description.²¹³ Although not binding, the USPTO Utility Examination Guidelines explain that “[w]hile descriptive sequence information alone is not patentable subject matter, a new and useful purified and isolated DNA compound described by the sequence is eligible for patenting.”²¹⁴ The Utility Guidelines further provide that disclosed gene sequence data “represented by strings of the letters A, T, C and G alone is raw, fundamental sequence data, i.e., nonfunctional descriptive information.”²¹⁵ Contrary to the contention that gene sequence patents preempt the use of genetic information, the USPTO mandates that the information cannot be appropriated.

Judge Sweet himself states that the “requirement that the DNA used [as a research tool] be ‘isolated’ is ultimately a technological limitation to the use of DNA in this fashion, and a time may come when the use of DNA for molecular and diagnostic purposes may not require such purification.”²¹⁶ This exemplifies a lack of preemption. The mere fact that the genetic information in question may be used in other contexts and other technologies indicates that the genetic information associated with BRCA1 and BRCA2 is not preempted. Moreover, it represents one of the most important effects of a functioning patent regime, in that it forces horizontal competitors to work around the patents in question, thus developing adjacent subject matter.²¹⁷ It is clear that the patenting of isolated and purified gene sequences limits the use of genetic information, but it certainly does not preempt it. Therefore, the commonality of information in the native and iso-

210. Burk & Lemley, *supra* note 18, at 1580.

211. See Jensen & Murray, *supra* note 58, at 239.

212. *Diehr*, 450 U.S. at 187–88.

213. Utility Examination Guidelines, 66 Fed. Reg. 1,092-02, 1,095 (Jan. 5, 2001).

214. *Id.* at 1,093.

215. *Id.*

216. *Ass’n for Molecular Pathology v. U.S. Patent & Trademark Office*, 702 F. Supp. 2d 181, 231 (S.D.N.Y. 2010).

217. See WENDY H. SCHACHT & JOHN R. THOMAS, CONG. RESEARCH SERV., RL 32996, PATENT REFORM: INNOVATION ISSUES 3–5 (2005), available at http://www.lawandinnovation.org/cli/documents/crs_report_patent_reform.pdf.

lated BRCA1 and BRCA2 gene sequences should not lead to patent ineligibility.

V. INCENTIVE THEORY

As discussed at the outset of this Article, proposals are once again being made in Congress to fundamentally overhaul the genomics patent regime.²¹⁸ Ideally, the success of these proposals will depend on the usefulness of gene sequence patents in stimulating overall innovation, as opposed to hyperbole-filled statements used to sway public opinion.

In justifying a ban on gene patents, Crichton, the ACLU, Congressman Becerra, and others seem to simply conclude as fact that gene patents limit research, increase the cost of healthcare, and limit people's healthcare options.²¹⁹ Unfortunately, claims such as these are made with little empirical support. Moreover, critics often overlook the very real possibility that without gene patents the healthcare options they so vehemently claim are too expensive might not exist at all.²²⁰ In addition, criticisms of the genetics patent regime are often applicable to the pharmaceutical industry, the medical equipment industry (e.g., MRI and topography technology), and virtually any area of healthcare.²²¹ In all cases, the market would provide cheaper alternatives to currently existing technologies if patents were simply eliminated.²²² That, however, is assuming those technologies would come to market as efficiently as possible (or at all) in the absence of such patents. The less sophisticated criticisms refuse to consider the broader innovation policy underlying a functioning patent regime. Rather, they tend to myopically focus on the cost of a single treatment in existence today or the effect on an individual researcher or firm who might potentially have to pay licensing fees to a patentee.²²³ These same critics often overlook the fact that the existence of patents encourages competing horizontal entities to move to more fertile areas of research and development, expanding society's technological options and avoiding creation of redundant lines of technology development.²²⁴

Any worthwhile analysis of the utility of patents in stimulating genetics and biotechnology innovation must be based on a thorough and nuanced study of the state of the genomics industry. The question is

218. See Press Release, Congressman Xavier Becerra, *supra* note 11.

219. See Complaint, *supra* note 7, at 29; ACLU STATEMENT, *supra* note 8, at 6–7; Crichton, *supra* note 3.

220. See Burk & Lemley, *supra* note 18, at 1580.

221. See *id.* at 1581–95.

222. See *id.* at 1580.

223. See, e.g., Complaint, *supra* note 7, at 29.

224. See SCHACHT & THOMAS, *supra* note 217, at 3–5.

not whether a single researcher is inhibited, or whether a single diagnostic test could presently be less expensive if a related patent was invalidated. These same arguments could be made with respect to nearly any patented technology. The ultimate question is whether the genetics patent regime hinders or fosters overall innovation. The answer to this question is critical to fashioning appropriate public policy.

Fortunately, there are a number of thoughtful opinions on the matter, viewpoints which have looked at the gene patent regime from a larger innovation policy perspective. Several economic theorists have suggested the possibility that over-patenting in portions of the biotechnology industry, particularly in upstream regions such as genetics, may lead to the development of an anticommons, creating a less-than-optimal innovation regime.²²⁵ Other theorists have pointed out that mitigating factors present in the real world cause these dire predictions to fall short.²²⁶ Ultimately, as the issue of genetic patenting turns from the courts to Congress, lawmakers must consider the impact gene patenting has on the genomics industry and supply a gauged response. This response may range from leaving the genetics regime intact to banning genetic sequence patenting altogether, with the possibility of implementing mitigating measures falling somewhere in the middle. Congress's ultimate goal, however, should not be to justify one extreme or the other, but to craft a regime which will optimize social good.

A. Prospect Theory

While numerous scholars have analyzed the role and the effectiveness of the patent system,²²⁷ it is clear that from the outset of our nation its primary purpose has been "[t]o promote the Progress of Science and useful Arts."²²⁸ The extent to which patents are awarded, in terms of scope, duration, and timing, is a topic for debate in nearly all realms of innovation and technology. However, in the case of biotechnology, and to a larger degree the genetics industry, many academics, politicians, and public figures have taken a more apprehensive view when asking when and to what degree patent protection should be granted.²²⁹

From a general perspective, there are two commonly accepted modes in which patent rights theoretically act to stimulate innovation.

225. See, e.g., Heller & Eisenberg, *supra* note 18, at 698; Wang, *supra* note 18, at 253.

226. See, e.g., Eisenberg, *supra* note 21, at 1061-63.

227. See, e.g., Burk & Lemley, *supra* note 18; Heller & Eisenberg, *supra* note 18; Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265 (1977).

228. U.S. CONST. art. I, § 8, cl. 7.

229. See Heller & Eisenberg, *supra* note 18, at 698; Rai, *supra* note 191, at 827; Crichton, *supra* note 3; Press Release, Congressman Xavier Becerra, *supra* note 11.

First, patent rights have classically been thought to provide an ex ante reward to a patentee, giving the patentee a temporary monopoly on the commercial exploitation of the patented subject matter, incentivizing the would-be inventor to invent.²³⁰ Edmund Kitch, however, expounded on the utility of patents in his “prospect theory” by analogizing patent rights to mineral rights in the American West.²³¹ Kitch believed that providing broad patent rights early on in the discovery process gave a patent-holding entity the ability to develop a given technology without competition.²³² According to Kitch, provided that resources were allocated efficiently, the patent right was owned by the entity best equipped to develop it, and information was disseminated efficiently between the various entities, then this prospect right, when coupled with the ability to license or transfer the right, would lead to the most efficient means of commercialization and product development.²³³ In his theory, optimal efficiency is realized by allocating the associated patent rights to a single entity, who may unilaterally manage downstream development activity or may alternatively sell or license the right to another entity who values the right to a greater degree, and is thus presumably better positioned to develop it.²³⁴

In essence, Kitch’s theory is the intellectual property equivalent to the private property solution to Garrett Hardin’s “tragedy of the commons.”²³⁵ Hardin first introduced the concept of the tragedy of the commons to explain the need for intervention when protecting scarce environmental resources from over-exploitation.²³⁶ Hardin described a hypothetical group of cattle ranchers, each having open grazing access to the same pasture.²³⁷ In this framework, an individual rancher is not incentivized to conserve the pasture land because the negative impacts of overgrazing are borne by all of the ranchers in the community and only the individual farmer reaps the benefits of his grazing.²³⁸ Hardin argued that because the individual rancher does not feel the negative impacts imparted to the other farmers (i.e., the negative externalities), the rancher will not, and from a rational perspective should not, take those negative impacts into account when deciding to increase the size of his herd.²³⁹ As a result, all ranchers are incentivized to add more and more cattle to their herd and in the

230. See Burk & Lemley, *supra* note 18, at 1600; Kitch *supra* note 227, at 266.

231. Kitch, *supra* note 227, at 266.

232. *Id.*

233. See *id.* at 266, 274.

234. See *id.*; Burk & Lemley, *supra* note 18, at 1600.

235. See Garrett Hardin, *The Tragedy of the Commons*, 162 *SCI.* 1243 (1968).

236. *Id.* at 1244.

237. *Id.*

238. *Id.* at 1244–45.

239. *Id.* at 1244.

end the pasture is overgrazed.²⁴⁰ A common solution to the tragedy of the commons is a market-based private ownership regime.²⁴¹ Under the idealized conditions put forth in the Coase Theorem, in a perfectly frictionless market place, where property is tradable, transaction costs to trade the property are nonexistent, information is perfect, and actors are rational, the property is allocated in an optimally efficient way, irrespective of the original owner of the good.²⁴² This is because in the no-transaction-cost world rational market participants most valuing a given right (i.e., market participants who can put that right to its greatest commercial use) will ultimately obtain that right, as they are willing to pay the largest price for the given right and no barriers to the transaction exist, allowing a given transaction to take place solely on the basis of price.²⁴³ In terms of social efficiency, as transaction costs tend toward zero, the observed efficiency tends towards perfect efficiency, known as Pareto optimality, which exists when no trade or redistribution can squeeze out any more social value.²⁴⁴

The breadth of an underlying patent prospect claim serves as an important parameter to consider when analyzing the efficiency of a given regime and could serve as a potential “lever” when seeking to more fully optimize the given system.²⁴⁵ Kitch believed that broad patent rights could help avoid the over-fishing of a given area of subject matter, which according to Kitch leads to an inefficient outcome.²⁴⁶ In contrast, however, Roberto Mazzoleni and Richard Nelson argue that limiting the number of inventors who compete within a given technological area runs the risk of having an area undeveloped if the entity awarded the broad patent is not optimally suited to develop the technology.²⁴⁷ They suggest that a balance should be struck, where patent rights are broad enough to avoid overlapping inventions, but narrow enough to encourage an array of inventors to develop a given area of subject matter.²⁴⁸

An additional metric that may serve to define and adjust the rights within the genetics patent regime is the timing of when a patent right should be awarded. Kitch believed that patent rights should be

240. *Id.*

241. *See* Coase, *supra* note 24, at 64–68; Hardin, *supra* note 235, at 1245.

242. *See* Coase, *supra* note 24, at 1–44.

243. *See id.*

244. Gerard Debreu, *Valuation Equilibrium and Pareto Optimum*, 40 *PROC. NAT'L ACAD. SCI.* 588, 588 (1954).

245. Burk & Lemley, *supra* note 18, at 1579.

246. Kitch, *supra* note 227, at 265; *see also* Roberto Mazzoleni & Richard R. Nelson, *Economic Theories About the Benefits and Costs of Patents*, 32 *J. ECON. ISSUES* 1031, 1042 (1998) (explaining Kitch's theory as requiring broad patent rights in order to avoid wasteful outcomes).

247. *See* Mazzoleni & Nelson, *supra* note 246, at 1042–43.

248. *See id.*

awarded early on in the development of a given technology, so as to supply the grantee enough breathing room to effectively develop the underlying subject matter.²⁴⁹ Much in the same way overly broad patent rights can inhibit horizontal innovation,²⁵⁰ opponents counter that rights awarded too far upstream in the research and development process can inhibit vertical innovation, stifling downstream development.²⁵¹

Clearly, Coase's world does not exist, a fact not lost on Coase himself, who developed his famous theory in part to highlight the breakdown of idealized property management regimes.²⁵² Therefore, the utility of Kitch's prospect theory hinges greatly on the magnitude of transaction costs, the quality of information, and the rationality of the involved entities within an intellectual property regime. Assuming adequate information and reasonable rationality (sometimes a relatively large assumption), the question is whether the transaction costs, both vertical and horizontal, within the genetics patent regime are small enough that more social utility is produced with gene sequence patents than without. It is important to note, however, that the legitimacy of genetic patents as useful engines of innovation stimulation does not depend on whether transaction costs exist in the genetics industry or whether genetic patenting can sometimes raise downstream costs—there is little question that they do.²⁵³ Rather, the question is how far from the idealized Coasean bargaining and optimal social output levels does the genetics regime actually deviate, and does that deviation create a situation in which more social utility would be squeezed out of society through an alternative innovation regime.

B. The Tragedy of the Anticommons

In any intellectual property regime that allocates rights of exclusivity in accordance with the Kitchian prospect theory or classical reward theory, policymakers must be wary of the potential for an emerging "tragedy of the anticommons."²⁵⁴ A tragedy of the anticommons is at risk of developing when multiple parties have ownership rights in a particular resource, yet none of them have the right of exclusion.²⁵⁵ Michael Heller first developed the concept of the tragedy of the anticommons in an attempt to explain the inefficient use of com-

249. Kitch, *supra* note 227, at 269.

250. See Burk & Lemley, *supra* note 18, at 1614.

251. See, e.g., Heller & Eisenberg, *supra* note 18, at 698.

252. See Coase, *supra* note 24, at 1–2.

253. See Burk & Lemley, *supra* note 18, at 1611; Eisenberg, *supra* note 21, at 1062.

254. See Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621 (1998).

255. *Id.* at 622.

mercial property in post-socialist eastern European cities.²⁵⁶ Heller observed that due to the large number of entities possessing rights or licenses to a given store front property, it became nearly impossible for any one individual to take control of the property and make use of it.²⁵⁷ As a result, stores remained empty even though more easily ascertainable kiosks sprouted up in droves.²⁵⁸ In a Coasian world, a tragedy of the anticommons will always be avoided because transaction costs are non-existent, information is perfect, and actors are rational.²⁵⁹ As a result, the various rights to a resource are aggregated by the actor who most values use of that resource.²⁶⁰ Since a Coasian world, however, does not exist, the tragedy of the anticommons can only be overcome when transaction costs, information quality, and the behavior of individuals remain workable. If any of these factors grows too unwieldy the market may freeze and the entire resource may be wasted.

In 1998, Heller and Rebecca Eisenberg first extended Heller's idea of the tragedy of the anticommons to the burgeoning biotechnology industry.²⁶¹ Typically, in a technology regime, anticommons theory points out that the biggest risk of anticommons development exists when upstream research becomes overly privatized, since that subset of innovation serves as an input into the downstream commercial development portion of the industry.²⁶² The reason for this increased risk is that transaction costs to bring a given product to fruition are amplified because the licensee may have to negotiate with several generations of underlying patent holders.²⁶³ Therefore, when an anticommons emerges, or is at a great risk of emerging, the two most common remedies to optimizing innovation are either aggregating the various patent rights required to bring a given technology to commercial fruition, or disallowing patenting in upstream portions of the vertical market.²⁶⁴ In the case of biotechnology, Heller and Eisenberg suggested that the escalation of patenting in upstream areas of the biotechnology industry (e.g., gene sequence and gene fragment patenting), which historically employed commons-based innovation fueled by

256. *Id.* at 622–24.

257. *Id.*

258. *Id.*

259. *See* Coase, *supra* note 24.

260. *See id.*

261. *See* Heller & Eisenberg, *supra* note 18.

262. *Id.* at 698–99.

263. *Id.* at 698.

264. Burk & Lemley, *supra* note 18, at 1624.

government funding,²⁶⁵ could stifle development in downstream biotechnology markets (e.g., drug development).²⁶⁶

C. Evidence for the Anticommons

While several economic theorists have provided warnings of an oncoming biotechnology anticommons,²⁶⁷ generally speaking little evidence for such a market malfunction exists. Even so, Congressman Becerra justifies his attempt to ban gene patenting by claiming that he has “long believed that gene patents hurt patients by limiting access to life-saving tests and preventing scientists from conducting cutting-edge research.”²⁶⁸

A survey conducted by John Walsh, Wesley Cohen, and Charlene Cho of over four hundred genetic researchers indicated that only about 5% of those researchers even question whether a given research tool is patent protected when choosing to undergo a research project using that research tool.²⁶⁹ Moreover, only 1% of respondents reported having to delay or change the course of their research due to an existing patent, while none of the researchers reported having to abandon a project.²⁷⁰ A survey of scientists in the United States, Germany, Japan, and the United Kingdom by the American Association for the Advancement of Science (AAAS), through its Project on Science and Intellectual Property in the Public Interest (SIPPI), has also yielded little evidence of an anticommons effect.²⁷¹ In the United States, for example, only 1% of the respondents indicated that they abandoned a research project due to an existing patent.²⁷² Further, in their 2005 study, Zhen Lei, Rakhi Juneja, and Brian Wright found that only about 10% of respondents indicated that they inquired as to whether or not a research tool used in their work was patented.²⁷³ These studies clearly suggest that there is very little anticommons effect in upstream research and the concerns related to the inhibition of upstream research activities have largely been exaggerated.

Theoretical predictions suggesting an emerging anticommons often point to the sheer increase in the total number of biotechnology pat-

265. See Bayh-Dole Act, Pub. L. No. 96-517, 94 Stat. 3019 (1980) (codified as amended at 35 U.S.C. §§ 200–212 (2006)).

266. Heller & Eisenberg, *supra* note 18, at 698–99.

267. See, e.g., *id.*

268. Press Release, Congressman Xavier Becerra, *supra* note 11.

269. John P. Walsh, Charlene Cho & Wesley M. Cohen, *View from the Bench: Patents and Material Transfers*, 309 SCI. 2002, 2002 (2005).

270. *Id.*

271. Eisenberg, *supra* note 21, at 1066–67.

272. *Id.* at 1067.

273. Zhen Lei, Rakhi Juneja & Brian D. Wright, *Patents Versus Patenting: Implications of Intellectual Property Protection for Biological Research*, 27 NATURE BIOTECH. 36, 37 (2009).

ents issued over the last few decades as a reason for concern.²⁷⁴ For example, Richard Li-dar Wang argues that the overall increase in biotechnology patents, specifically upstream gene patents, is a reason to expect a future biotechnology anticommons.²⁷⁵ David Adelman and Kathryn DeAngelis, however, correctly establish that this approach is far too simplistic and the reliance upon “patent counts” is a primary reason for the “divergence between data and theory.”²⁷⁶ The complexity of patent rights in biotechnology makes patent counting relatively valueless in modeling the health of an innovation regime.²⁷⁷ The timing and scope of a patent right and the likelihood of its enforcement all represent metrics that likely play a significantly larger role in the efficient operation of a given innovation regime than the mere number of patents in that regime.²⁷⁸

Eisenberg herself, in a follow-up study to her seminal work with Heller, notes that one reason the dire anticommons predictions have not yet come to fruition is due to the existence of a number of mitigating factors which act to stave off the onset of an anticommons.²⁷⁹ Eisenberg explains that the “burden of inertia” rests with a patent owner to enforce their intellectual property rights against an infringing party.²⁸⁰ In situations where the cost of identification of a user and enforcement of the underlying patent rights is high, the likelihood that a patent holder will attempt to enforce his or her rights diminishes.²⁸¹ Moreover, as the reward for enforcing a patent lessens, the likelihood of such enforcement also decreases.²⁸² In many ways, this represents the mirror image of the transaction costs which operate in the Coase/Hardin tragedy of the commons framework, where the existence of transaction costs results in the observed market efficiency falling below the theoretical optimality.²⁸³ In the patent enforcement context, the existence of transaction costs in finding infringers and enforcing patent rights against them acts to mitigate the formation of the theoretically predicted anticommons.²⁸⁴ Rather than serving as a cause to the development of an anticommons, the searching and bargaining transaction costs act as a buffer to academic researchers who reside relatively upstream from commercial product deployment, as in

274. See Heller & Eisenberg, *supra* note 18, at 698–99; Wang, *supra* note 18, at 253.

275. See Wang, *supra* note 18, at 255.

276. David E. Adelman & Kathryn L. DeAngelis, *Patent Metrics: The Mismeasure of Innovation in the Biotech Patent Debate*, 85 TEX. L. REV. 1677, 1681 (2007).

277. See *id.* at 1682.

278. See *id.*; Eisenberg, *supra* note 21, at 1062–63.

279. Eisenberg, *supra* note 21, at 1062.

280. *Id.*

281. *Id.*

282. *Id.*

283. See Coase, *supra* note 24; Hardin, *supra* note 235.

284. Eisenberg, *supra* note 21, at 1062.

many cases it is simply not worth the effort to enforce a patent against an infringing researcher.²⁸⁵ This dynamic at least partly explains why no appreciable anticommons effect has been observed in upstream research activity. It is imperative that policymakers note this reality when considering whether to impose measures intended to streamline transaction costs—such as compulsory license regimes²⁸⁶—in an attempt to lessen the likelihood of an anticommons. Otherwise, ignorance of this reality when reforming the genetic sequence realm of the biotechnology industry will likely result in reduced enforcement costs and, ironically, could potentially result in increasing the likelihood of an emerging anticommons in upstream portions of the industry.

Another mitigating factor inhibiting the creation of an anticommons is the fact that a large amount of upstream subject matter is under the control of publicly funded entities such as the National Institutes of Health (NIH), which dole out research dollars to academic researchers.²⁸⁷ Chester Shiu points out that NIH policies help stave off an anticommons effect by (1) mandating liberal licensing of funded research; (2) fostering the development of a pool of upstream innovators that for-profit firms “dare not sue;” and (3) taking steps to thwart the development of anticommons-based business models, such as by releasing subject matter into the public domain.²⁸⁸ This represents a contrast to the claims made by many gene patent critics that the Bayh-Dole Act of the 1980s has led to an over-privatization of the upstream areas of the biotechnology industry.²⁸⁹ The policies of funding agencies such as the NIH represent a healthy balance between fundamental research and the commercial interests fostered by the Bayh-Dole Act.²⁹⁰

While there is little empirical evidence supporting the existence of an emerging anticommons in the biotechnology industry, one cannot simply rule out the possibility of an anticommons developing in the future as a result of shifting norms. The pertinent question is not whether a growing number of patents in the biotechnology industry in general might lead to an anticommons. As discussed, there is little evidence suggesting that a mere increase in the number of biotechnology patents will have a significant impact on the industry as a whole, and a mere scaling of the number of patents is unlikely to create a fundamental change in the efficiency of the industry. Rather, the

285. *See id.* at 1061–65.

286. *See* Wang, *supra* note 18, at 251.

287. Shiu, *supra* note 22, at 415.

288. *Id.*

289. Wang, *supra* note 18, at 256; *see* Bayh-Dole Act, Pub. L. No. 96-517, 94 Stat. 3019 (1980) (codified as amended at 35 U.S.C. §§ 200–212 (2006)).

290. *See* Bayh-Dole Act § 200.

more precise inquiry, as originally suggested by Heller and Eisenberg, and the issue to which policymakers should direct their focus, is whether the creeping of biotechnology patents further and further upstream will serve as a trigger to the creation of an anticommons, resulting in the stifling of innovation in downstream research and development.²⁹¹

One practice that Heller and Eisenberg pointed to that was particularly worrisome was the growth in patent applications related to ESTs.²⁹² More specifically, they directed their concern to the growing practice of filing patent applications for ESTs and gene fragments without identifying a “corresponding gene, protein, biological function, or potential commercial product.”²⁹³ Based on this practice, there is little surprise as to why Heller and Eisenberg expressed concern over the potential development of an anticommons. However, as discussed in Part III, in 2001 the USPTO heeded their warning and promulgated more stringent utility requirements in the Utility Examination Guidelines.²⁹⁴ These guidelines, after being embraced by the *Fisher* court, severely limit the practice of EST and gene fragment patenting.²⁹⁵ The new utility requirements effectively established an upstream line-in-the-sand that private appropriation cannot cross, one of the classic cures to an anticommons.²⁹⁶ The upstream vertical extent to which patent rights must be aggregated in order to bring a given downstream product (e.g., pharmaceutical product) to market has been largely capped by the heightened utility requirements promulgated in the USPTO Utility Guidelines and adopted by the *Fisher* court. As a result, the likelihood of an anticommons developing in the downstream market due to the proliferation of upstream patenting is greatly reduced.

In sum, the claims made by lawmakers and public figures suggesting that gene patents limit healthcare access to patients and prevent researchers from conducting research largely appear to be untrue. The reality is that scientists at the upstream level of research are largely oblivious to patents covering portions of their research. Researchers rarely pay patent licensing fees, and the associated patents are rarely enforced against these researchers because the burden of inertia resides with the patent owner.²⁹⁷ Not only has no appreciable anticommons effect been observed, but enforcement costs, NIH policies, and the implementation of the USPTO Utility Guidelines create

291. See Eisenberg, *supra* note 21, at 1076–78; Heller & Eisenberg, *supra* note 18, at 698–99; Ouellette, *supra* note 55, at ¶ 26–27.

292. See Heller & Eisenberg, *supra* note 18, at 699.

293. *Id.*

294. See Utility Examination Guidelines, 66 Fed. Reg. 1,092-02 (Jan. 5, 2001).

295. See *In re Fisher*, 421 F.3d 1365 (Fed. Cir. 2005).

296. See Heller, *supra* note 254, at 641.

297. Eisenberg, *supra* note 21, at 1062.

a biotechnology regime where there is likely little risk of suffering from a tragedy of the anticommons due to genetic sequence patenting.

D. Trade Secret and Contract Law

In addition to a potential anticommons effect due to the proliferation of patents, policymakers must be cognizant of the potential for market breakdowns through other legal pathways. One problematic issue relates to the difficulty some researchers have experienced in obtaining research tools and research materials.²⁹⁸ One study found that while patents did not in themselves create delays or abandonment in the biotechnology regime, 42% of respondents reported delays in obtaining tools and materials for research, with a mean duration of 8.7 months.²⁹⁹ The tools in question ranged from information about gene sequences and proteins to cell lines and microbial strains.³⁰⁰ The study concluded that the delays in acquiring the above research materials and tools were a byproduct of patenting, as university administrators forced academic researchers to protect their prospective intellectual property rights using material transfer agreements (MTAs).³⁰¹ It was found that researchers were more often forced to acquire a patented technology through MTAs than through patent licenses.³⁰² The study concluded that delays in obtaining materials is not because of “patents *per se*, but patenting as an institutional imperative in the post-Bayh-Dole era.”³⁰³ While there is certainly truth in this statement, it largely oversimplifies the matter. The study’s authors replace the idea of commercial interest in developing a technology with patenting the subject matter related to that technology. Granted, the realization of commercial interest in academic research may have been stoked by the Bayh-Dole Act, causing academic institutions to look at their academic research with commercial eyes.³⁰⁴ Removing gene patents, however, will not likely end this practice.

In fact, the banning of gene patents will likely exacerbate the effect observed by the study’s authors. The use of MTAs has been witnessed in a vast array of areas implicating genetics and biotechnology, such as transgenic mice and databases.³⁰⁵ For example, Stephen Munzer points out that since the cutting off of EST patenting through the implementation of the USPTO Utility Examination Guidelines in

298. *See id.* at 1063–64; Lei, Juneja & Wright, *supra* note 273, at 38; Ouellette, *supra* note 55, at ¶ 71–77.

299. Lei, Juneja & Wright, *supra* note 273, at 38.

300. *Id.*

301. *Id.* at 36–38.

302. *Id.* at 38.

303. *Id.* at 36.

304. *See* Bayh-Dole Act, Pub. L. No. 96-517, 94 Stat. 3019 (1980) (codified as amended at 35 U.S.C. §§ 200–212 (2006)).

305. *See* Eisenberg, *supra* note 21, at 1073–74.

Fisher,³⁰⁶ entities have largely turned to trade secret law to protect their intellectual property (IP) related to ESTs.³⁰⁷ Rather than hold a patent, firms house their valuable IP in the form of secret EST databases.³⁰⁸ If all gene sequence patents were cut off in a similar way, it is quite likely that many firms would turn in part to trade secret law to protect their IP, especially in areas where technologies are expensive to reverse engineer.

Compounding the matter is the fact that the public will not reap the benefits of open disclosure of gene sequence nucleotide data that goes along with a gene sequence patent application.³⁰⁹ While trade secret law will allow reverse engineering to freely occur, it will diminish information exchange, making it more difficult to build off the work of others.³¹⁰ As a result, market inefficiencies will develop due to the replication of work and horizontal competitors will no longer be forced to “invent around” the given subject matter by moving to more fertile ground, stripping society of one of the positive byproducts of the patent system’s road-block effect.³¹¹ There is little reason to expect that the abandonment of the genetic patenting regime will result in less delay and restrictions when seeking to acquire research tools and material. Rather, it will lead to an even further entrenchment of MTAs and trade secret law, and will make information exchange and cooperation even more difficult. If Congress believes MTAs create an impediment to research and development, then direct steps should be taken to limit their use by firms funded by federal research dollars. It would be largely irresponsible, however, to restrict the patent regime in the hopes of quelling the use of MTAs and risk both destroying the positive impact patents provide and driving subject matter into trade secret law.

E. Mitigating Measures Available to Congress

Although it is clear that the threat of an anticommons has been largely exaggerated and there is no need to institute a wholesale ban on gene sequence patenting, Congress should still consider mitigating the potential negative aspects of the patent regime through moderate policy “levers.”³¹² Two measures most suitable for a diverse industry

306. See *In re Fisher*, 421 F.3d 1365 (Fed. Cir. 2005); Utility Examination Guidelines, 66 Fed. Reg. 1,092-02 (Jan. 5, 2001).

307. Stephen R. Munzer, *Commons, Anticommons, and Community in Biotechnological Assets*, 10 THEORETICAL INQUIRIES L. 271, 284 (2009).

308. *Id.*

309. See Utility Examination Guidelines, 66 Fed. Reg. at 1,095; *supra* Part II.

310. See Munzer, *supra* note 307, at 284.

311. SCHACHT & THOMAS, *supra* note 217, at 4 (quoting Rebecca S. Eisenberg, *Patents and the Progress of Science: Exclusive Rights and Experimental Use*, 56 U. CHI. L. REV. 1017, 1028 n.44 (1989)).

312. See Burk & Lemley, *supra* note 18, at 1575.

such as biotechnology, having a large vertical landscape with a significant amount of activity occurring in upstream portions of the market, are march-in rights and an experimentation defense. These two mitigating mechanisms provide baseline protection against wasteful activity while at the same time maintaining the incentives for commercial investment created by a functioning patent regime.

1. *March-In Rights*

While prospect theory would dictate that it is largely inefficient to have multiple entities developing a single area of subject matter,³¹³ this idealization overlooks the reality that a patentee is simply unable to develop all downstream applications, especially in an industry that is as vertically extensive as biotechnology. In most cases this limitation is merely a byproduct of limited resources, but in some instances an entity might actually be incentivized to refuse to develop a particular technology. For example, Lori Andrews has suggested that GlaxoSmithKline “has filed for a patent on a genetic test to determine the effectiveness of one of its drugs, but will not develop the test, or let anyone else develop it, possibly because such a test would cause the company to lose customers.”³¹⁴ In situations where a patent holder is not actively developing or licensing a given patent for development, such as in Andrews’s GlaxoSmithKline example, the use of march-in rights³¹⁵ may serve as a powerful tool to avoid a tragedy of the anticommons.

Moreover, march-in rights already exist within the Bayh-Dole framework.³¹⁶ The Bayh-Dole march-in right provides a funding government agency the ability to unilaterally, or upon petition, disregard the exclusivity of the patent holder’s patent grant, provided the agency determines one of four conditions is met.³¹⁷ Most pertinent to the mitigation of an anticommons, the agency may impose march-in rights when “action is necessary because the contractor or assignee has not taken, or is not expected to take within a reasonable time, effective steps to achieve practical application of the subject invention in such field of use.”³¹⁸ This right would be particularly useful when a firm such as GlaxoSmithKline deliberately chooses not to develop pat-

313. *See supra* section V.A.

314. Lori B. Andrews, *Genes and Patent Policy: Rethinking Intellectual Property Rights*, 3 *NATURE REVIEWS GENETICS* 803, 804 (2002).

315. March-in rights allow the government “to step in and grant a new license or revoke an existing license if the owner of a federally funded invention (or the owner’s licensee) has not adequately developed or applied the invention within a reasonable time.” *BLACK’S LAW DICTIONARY* 1052 (9th ed. 2009).

316. *See* Bayh-Dole Act, Pub. L. No. 96-517, § 203, 94 Stat. 3019, 3022–23 (1980) (codified as amended at 35 U.S.C. § 203 (2006)).

317. *Id.*

318. *Id.*

ented subject matter in order to leverage their position in a separate technology. A more robust march-in right tailored toward upstream biotechnology patents, as opposed to only patents falling under the auspices of Bayh-Dole, may be warranted. While the details must be carved out so that a company legitimately developing a technology, or attempting to license it, is not unfairly stripped of its rights, this provision would help guard against spoiling of subject matter due to an individual firm's nefarious tactics.

2. *Experimentation Defense*

Additionally, patented gene sequences might also give rise to breakthroughs in related areas of technology, wherein the gene sequences serve as a tool to map out new subject matter, and where the resulting technology would not infringe upon the original patent. While an earlier section outlines why enforcement of patents against most upstream researchers is infrequent,³¹⁹ it is not out of the realm of possibilities that a patent holder might seek to enforce his or her patent against a researcher. The *AMP* case serves as a rare example where a patent holder zealously enforced gene sequence patent rights against academic institutions.³²⁰ In the case of the BRCA1 and BRCA2 gene sequences, Myriad held relatively strict control over the patented subject matter.³²¹ While it did provide access to a number of academic institutions and cancer clinics, it limited their use to only a handful of mutations.³²² Further, Myriad did not allow the development of other genetic tests based on the BRCA1 and BRCA2 subject matter.³²³

As a general matter an experimentation defense³²⁴ already exists within the patent jurisprudence. The court in *Madey v. Duke University*³²⁵ delineated the lines of the common law experimentation defense in a relatively narrow fashion. The court held that "so long as the act is in furtherance of the alleged infringer's legitimate business and is not solely for amusement, to satisfy idle curiosity, or for strictly philosophical inquiry, the act does not qualify for the very narrow . . . experimental use defense."³²⁶ This stance is remarkably narrow and in most cases renders the defense useless. Under the *Madey* ruling, a

319. See *supra* section V.C.

320. See *Ass'n for Molecular Pathology v. U.S. Patent & Trademark Office*, 702 F. Supp. 2d 181 (S.D.N.Y. 2010).

321. See Wang, *supra* note 18, at 295–96.

322. *Id.* at 295.

323. *Id.*

324. A robust experimentation defense would preclude claims of patent infringement when "the construction and use of the patented invention was for scientific purposes only." BLACK'S LAW DICTIONARY 659 (9th ed. 2009).

325. 307 F.3d 1351 (Fed. Cir. 2002).

326. *Id.* at 1362.

university would fall outside an experimentation defense because one of its business objectives was to attract research grants.³²⁷ As a result, it would seem that most academic researchers and their institutions would be unable to avail themselves of the *Madey*-type experimentation defense.

Congress should consider providing a statutory experimentation defense provision for subject matter related to biotechnology. In particular, Congress should focus its attention on upstream subject matter, which in many cases serves as a research tool in the investigation of adjacent subject matter. In situations where the secondary researcher is not competing directly and commercially with the patent holder, a statutory experimentation defense would save the secondary researcher from a potential infringement action. And while empirical data shows that infringement action against upstream researchers is quite rare, an experimentation defense would provide a baseline level of protection against the more cutthroat commercial firms.

VI. CONCLUSION

In sum, the Court of Appeals for the Federal Circuit, and potentially the Supreme Court, should apply a two-level analysis when determining whether Myriad's isolated BRCA1 and BRCA2 cDNA gene sequences meet the patent eligibility requirements of section 101 of the patent statute. First, the court should apply an information preemption analysis, as set out in *Diehr*,³²⁸ to the genetic code information encoded in the DNA molecules in order to determine whether genetic code information is being preempted by the Myriad gene sequence patents. A mere limitation on one type of use of the genetic information does not qualify as preemption, just as the patented computer program implementing the Arrhenius equation did not amount to preemption of that equation.³²⁹ Since the genetic code information is placed in the public domain upon patenting,³³⁰ other parties may use the information in a variety of substantial ways. As a result, the genetic code information is not preempted by the patenting of man-made cDNA sequences.

Following preemption analysis, the court should apply a products of nature analysis consistent with *Chakrabarty* and *Merck* in order to determine whether the BRCA1 and BRCA2 gene sequences constitute "a nonnaturally occurring . . . composition of matter . . . with markedly different characteristics from" the natural DNA, "having the potential

327. Wang, *supra* note 18, at 262–63.

328. See *Diamond v. Diehr*, 450 U.S. 175 (1981).

329. See *id.* at 191–93.

330. See Utility Examination Guidelines, 66 Fed. Reg. 1,092-02, 1,095 (Jan. 5, 2001).

for significant utility.”³³¹ In applying the products of nature test, the markedly different standard should be used to analyze the functional and physical differences between the native DNA and the cDNA molecules, as opposed to the information commonality of the sequences. The cDNA sequences represent man-made molecules which did not exist in nature prior to human intervention. More importantly, the deletion of the non-encoding introns does not create merely an incrementally more pure substance, but rather a fundamentally new composition that was not usable by mankind prior to the isolation. Therefore, there is little question that the Myriad sequences, and others like them, should pass the products of nature standard. It is, therefore, my contention that on appeal the Myriad gene sequences should pass both information preemption and products of nature analysis and the *AMP* decision should be overturned.

Irrespective of the judicial decision in *AMP*, policymakers must determine whether gene sequence patents foster or hinder innovation. While many commentators have provided theoretical models in which biomedical patents “may” lead to a tragedy of the anticommons, very little empirical evidence points to a significant anticommons effect. Just as transaction costs and imperfect information cause Coase’s theoretical optimal solution to the tragedy of the commons to fall short of optimal efficiency,³³² an anticommons will fail to manifest when the inputs (e.g., vast private ownership of upstream rights, enforcement of those rights, and/or compliance with those rights) into the theoretical anticommons analysis fall below threshold levels.³³³ In other words, just as reality forces efficiency to fall below optimal efficiency in the Hardin and Coase framework, reality also may lead to a mitigation of the anticommons effect.³³⁴

By and large upstream researchers ignore patents on tools and research material and experience the most difficulty in obtaining tools and materials when MTAs are used by the owner of the technology.³³⁵ Commentators have suggested that the existence of patents as an institutional imperative has created this problem, as university officials mandate the protection of potentially patentable technologies.³³⁶ While it may be true that the Bayh-Dole Act opened the flood gates to the commercialization of academic research, which was its intended

331. *Diamond v. Chakrabarty*, 447 U.S. 303, 309–10 (1980); *see also Merck & Co. v. Olin Mathieson Chem. Corp.*, 253 F.2d 156, 164 (4th Cir. 1958) (holding that the subject matter at issue was patentable because “products of great therapeutic and commercial worth have been developed” from the subject matter’s “useless” natural form).

332. *See Coase, supra* note 24.

333. *See Eisenberg, supra* note 21, at 1061–63.

334. *See id.* at 1098–99.

335. *See id.*; Lei, Juneja & Wright, *supra* note 273, at 36–37.

336. *See Lei, Juneja & Wright, supra* note 273, at 36.

goal,³³⁷ there is little reason to expect that simply abandoning patenting in these areas will solve the delay and barrier problems created by the use of MTAs. In the event that gene sequence patenting is disallowed, many firms and academics would stop the disclosure process and much of the related subject matter would fall into the domain of trade secret law and MTAs, as in the case of patent ineligible ESTs.

It is critical that lawmakers look to these facts and weigh them heavily when considering the wisdom of stripping the genetics industry of its patenting ability. As a middle-of-the-road solution, lawmakers may implement mitigating measures, such as march-in rights and a statutory experimentation defense. Implementing such measures will help avoid the rare scenarios where an individual entity fails to properly develop a given area of subject matter or is using awarded patent rights to squelch basic experimental research. Congress may implement these measures as fail-safes, while at the same time preserving the positive aspects of the current patent regime which act to stimulate large sums of private investment in the biotechnology and genetics industry, leading to new life-saving technologies.

337. See Bayh-Dole Act, Pub. L. No. 96-517, 94 Stat. 3019 (1980) (codified as amended at 35 U.S.C. §§ 200–212 (2006)).