PREPARED STATEMENT OF

JEFFREY P. KUSHAN

ON BEHALF OF

THE
BIOTECHNOLOGY INDUSTRY ORGANIZATION

ON

"Stifling or Stimulating - The Role of Gene Patents in Research and Genetic Testing"

Before the Committee on the Judiciary
Subcommittee on Courts, the Internet, and Intellectual Property

OCTOBER 30, 2007

BIOTECHNOLOGY INDUSTRY ORGANIZATION
1201 MARYLAND AVENUE SW, SUITE 900
WASHINGTON, D.C. 20024
(202) 962-9200
www.bio.org

Overview

The Biotechnology Industry Organization (BIO) appreciates the opportunity to provide the views of its members on the role of DNA-based inventions in research and innovation. In general, BIO believes that the patent system has proven to be an effective stimulus for developing and bringing to market a wide range of innovations that have delivered innumerable benefits to patients and consumers.

The biotechnology industry today is a thriving, competitive, and dynamic industry. A significant reason for this is the availability of comprehensive and effective patent protection, including for inventions based on nucleic acids. Nucleic acid patents enable start up companies, universities, as well as established companies, to justify the significant investments – whether on the order of millions or hundreds of millions of dollars – that are necessary to discover, develop, bring to market and support products and services based on these nucleic acid inventions.

BIO does not believe issues exist that justify legislation to modify the patent system with regard to nucleic acid inventions. Like any other industry, commercial conflicts can arise regarding use of patented technology. The presence of occasional patent conflicts, or the need to resolve them (including through litigation), does not signal a need for legislative reform. Rather, it is a signal that there is a healthy degree of competition in this sector. And, the benefits delivered by the R&D investments of biotechnology companies far outweighs the incidental costs of resolving these patent disputes.

Background on BIO and the Biotechnology Industry

BIO represents over 1,100 companies, universities and research institutions that use biotechnology to research and develop cutting edge healthcare, agricultural, industrial and environmental products and applications. As of December 31, 2005, there were over 1,400 biotechnology companies established and doing business in the United States, 329 of which were publicly held, having an aggregate market capitalization of over $410 billion. The biotechnology industry has mushroomed since 1992, with U.S. health-care biotech revenues increasing from $8 billion in 1992 to $50.7 billion in 2005. BIO members directly employ more than 1.2 million people, and biotechnology companies can be found in every state of the Union. More than 80 percent of BIO members are small businesses.

The biotechnology industry is one of the most research-intensive industries in the world. In 2005 alone, biotechnology companies spent nearly $20 billion in R&D. Since its inception, the biotechnology industry has raised more than $100 billion in private investment. These investments are paying off. There are more than 400 new drug products and vaccines on the market or in development. These products are now improving, and will continue to improve, the lives of millions of Americans, and offer hope for cures for a wide range of illnesses. Advances in agricultural biotechnology have already had a profound impact on the world's capacity to feed itself, dramatically improving yields of crops while decreasing dependence on chemical pesticides. Industrial biotechnology is affecting numerous sectors of the economy, and is presenting a realistic alternative through biofuel production.

The key to success of the biotechnology industry – across of all its sectors – is a business model that is based on taking significant risks to develop products based on innovation. Specifically, the biotechnology business model is based on making significant investments (often hundreds of millions of dollars) in early stage research and development with the hope that some of these investments and efforts will yield a commercial product. This model has worked despite the fact that it is lengthy (often taking more than a decade) and that most biotechnology R&D investments and efforts do not result in a commercial product reaching the market. It is only by pushing boundaries of science and taking these risks that breakthrough inventions are discovered and converted into commercially viable products and services.

The biotechnology business model requires an environment that, as much as possible, eliminates unpredictability in the commercial sector. One important factor in this environment is the guarantee of patent exclusivity. Specifically, by ensuring that the products or services that may eventually be marketed can be protected from unauthorized copying and use, companies can justify taking risks and making significant R&D investments. Introducing unpredictability by changing the availability of patent rights, or the conditions in which patent rights can be asserted, will adversely affect business environment that is so crucial to supporting innovation in the biotechnology sector.

Patents and the Biotechnology Industry

The biotechnology industry can attribute its current success to two seminal events in 1980; namely, the landmark Supreme Court decision of *Diamond v. Chakrabary*, 447 U.S. 303 (1980), in which the Supreme Court confirmed that key forms of biotechnology inventions including biological materials and living organisms can be patented; and by the passage of the Bayh-Dole Act, which allowed for the efficient transfer of patents on inventions arising from federally-funded research into the private sector.

Patents in the life sciences sector protect the type of products and processes that are integral to companies doing business in the biotech sector. By enabling these companies to prevent the unauthorized use of the patented technology, companies can justify pursuing their research and development efforts. Indeed, it is the guarantee of securing and using rights in the future that companies rely to justify making investments in R&D today.

To illustrate the role of patents in the typical biotechnology venture, consider the following example. A researcher, typically in a university laboratory, discovers a gene which is expressed only by a particular type of cancer cell. This discovery can result in a variety of distinct research and development initiatives – ranging from diagnostic tools for detecting the presence of the gene or its expression product in test samples taken from patients, to therapeutic agents that selectively kill cells that express the gene or inhibit the expression of the gene. As soon as practical after the discovery of the gene and its practical value, patent applications must be

filed. Filing the application early ensures that the researcher or its sponsor (a university or startup biotechnology company) can secure rights in the inventions that derive from the discovery, and permits the researcher to publish the results.

The patents based on this early application will be used to justify the investment of millions of dollars into development of these diagnostic and therapeutic agents. Translating this initial discovery into a tangible products can take more than a decade and hundreds of millions of dollars. The exclusivity that patents issued from this early application is what investors will rely upon to provide funding for development of products, and will be a key factor affecting the decision of a larger company to work with the startup company or university that owns the patent to do clinical development of products based on the discovery. Of course, the road to development from this point is long and torturous, has a significant likelihood of failure, and is fraught with other commercial setbacks. However, the faith that the discovery will help improve the lives of patients, and the confidence that patent rights will protect products that are developed, propel the transfer of technology and research and development work that follows.

Patents in the Field of Genomics

The topic of this hearing is "gene patents." Conceptually, this is a misnomer. Patents are not granted on "genes" per se, but on nucleic acid sequences that have a practical application. Genes as they exist in nature cannot be patented. Instead, patents can be secured for discrete nucleic acid sequences that are made after conducting research on genetic information.

Significant advances over the past two decades in research tools, such as the polymerase chain reaction (PCR), gene sequencing technology, and sophisticated computers and analytical tools, coupled with significant public and private investments, have produced a wealth of genomic information and tools for analyzing that information. By performing genomic research, scientists can discover and characterize genes and their functions, and then conduct research to decipher how to exploit the genomic information to produce useful products and services.

Two significant aims of genomic research have been to (i) identify sequences corresponding to proteins that regulate cellular activities, and (ii) to identify "abnormal" sequences and link these sequences to disease states. Once deduced, the "function" or "role" of a gene can provide the basis for developing a practical application of a nucleic acid sequence derived from that gene. This nucleic acid having a practical application – such as whether to enable commercial production of a desired protein the nucleic acid encodes or to provide the basis of a clinical diagnostic tool – is the threshold that must be achieved in order for a nucleic acid to have a practical application, and thus be "useful" in a patent sense. *See*, *In re Brana*, 51 F.3d 1560 (Fed. Cir. 1992).

A nucleic acid (i.e., a discrete nucleotide sequence), like any other type of chemical compound, is eligible to be patented if it is new, useful, and not obvious. A patent may be granted giving rights in the nucleic acid invention only if it is adequately described in a patent application. This public disclosure is the principle public benefit of the patent system – in exchange for disclosing their invention in a

scientifically meaningful way, inventors are awarded a finite period of exclusive rights in the invention that is patented.

Over the patent 20 years, the Congress, the Patent and Trademark Office (PTO) and the courts have been ensuring that this bargain is a good one for the American public. For example, in 1995, Congress changed the term of patents to run 20 years from the date patents are filed, rather than 17 years from the date patents are granted. As a consequence, the fixed period of exclusive rights is now more certain, and in many cases, is shorter, than it had been before 1995. Then, in 1999, the Congress enacted changes to the patent system that require publication of patent applications 18 months after they have been filed. This means that the public gets their part of the bargain – a meaningful public disclosure of the invention – regardless of whether the patent applicant emerges with any rights.

The PTO, almost from the dawn of the biotechnology industry, has been focused on granting high quality patent grants. In 1988, barely years after the first wave of biotechnology applications had been filed, the PTO formed a special new group to focus on examination of biotechnology applications, aggressively devoting resources to accurate examination of biotechnology applications. This group has since grown to more than 485 examiners today, more than 80% of which have advanced degrees, including more than 385 examiners with Ph.D's. This is by far the most technologically advanced and competent group of patent examiners in the PTO today.

A critical threshold for any invention to be patented is that it is new. In the field of biotechnology, this raises two issues. First, to be eligible to be patented, the invention must be claimed in a form that distinguishes it from the form it is found in nature. A nucleic acid patent, thus, cannot be issued with claims that define nucleotide sequences that are indistinguishable from the form in which the nucleic acid exist in nature (e.g., in a human chromosome). A nucleic acid patent, thus, must be limited to a specific nucleotide sequence that does not occur in that form in nature. Second, there is extensive information that has been published regarding genetic sequences. To be patentable, the claim must be distinct from any nucleotide sequence that has been reported in the literature. If the claim covers nucleic acid sequences that are already known from earlier experimental work, the patent should not issue, or if it is, will likely be held invalid.

Other patentability criteria operate to limit the scope of patent rights in the field of nucleic acids. The PTO has aggressively applied these patentability criteria in examining biotechnology applications for more than 25 years. In fact, the PTO has promulgated several sets of guidelines that set forth aggressive examination standards aimed specifically at biotechnology patent applications, such as those claiming nucleic acid inventions.

In 1995, and again in 2001, the PTO issued guidelines relating to the "utility" standard of 35 U.S.C. §101. See, e.g., *Utility Examination Guidelines,* 66 Fed.Reg. 1092 (Jan. 5, 2001). Under these guidelines, the PTO has demanded applicants identify a specific, substantial and credible utility for their inventions. This

disclosure must appear in the patent application, which is filed shortly after an invention is made. The guidelines do not permit an applicant to simply guess about what a nucleic acid might be useful for – they require the disclosure to be supported by a scientifically credible basis of support. The PTO has supplemented these guidelines with training materials that illustrate how to apply the standards properly. See, **http://www.uspto.gov/web/offices/pac/dapp/mpep_examguide.html**.

In 2001, the PTO issued guidelines on application of the "written description" requirement of 35 U.S.C. §112, first paragraph. See, *Guidelines for Examination of Patent Applications Under the 35 U.S.C. 112, P1, "Written Description" Requirement*, 66 Fed. Reg. 1099 (2001). As applied by the PTO, the guidelines require applicants to provide a comprehensive written description of what they perceive their invention to be as of the filing date of the patent. The guidelines, in particular, direct examiners to conduct a critical review of whether broad claims, such claims to broad class of related nucleic acids, are adequately supported by the patent disclosure. For example, the guidelines direct examiners to question whether a representative number of nucleic acids covered by a broad "genus" claim are described in the patent application, or whether the applicant has shown that there is a common structural relationship between the sequences and a function shared by all the nucleic acids in the genus. *Id* at 1106. Again, the PTO followed the guidelines with training materials that provide examples of commonly encountered scenarios, with clear guidance on when to impose rejections. See, **http://www.uspto.gov/web/offices/pac/dapp/mpep_examguide.html**.

These PTO efforts have been aided by a series of decisions of the Supreme Court and the Federal Circuit over the past two decades.

As noted above, the principles of broad eligibility for patents on living organisms and materials derived from them has been affirmed by the Supreme Court in *Chakrabarty*, and was again confirmed in 2001 by the Supreme Court in *J.E.M. Ag. Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc.*, 534 U.S. 124 (2001) (holding non-naturally occurring plants eligible to be patented under utility patents).

A series of decisions of the Court of Appeals for the Federal Circuit have both laid the foundation for the PTO guidelines, and affirmed the legitimacy of these guidelines.

- In *In re Wands*, 858 F.2d 731 (Fed. Cir. 1988) the Federal Circuit set forth a practical guide for applying the "enablement" requirement of 35 U.S.C. §112, first paragraph. This requirement demands that an applicant provide a disclosure that enables a person skilled in the field of the invention to practice the full scope of the claimed invention. As the court explained, unpredictability in the field of the invention, which is common in the field of biotechnology, often demands a more comprehensive disclosure. The so-called "Wands factors" are a central focus of the PTO examination process in the biotechnology area. See, e.g., MPEP 2164.01(a).

- The principles in the PTO utility guidelines were affirmed by the Federal Circuit in 2005 in the case of *In re Fisher*, 421 F.3d 1365 (Fed. Cir. 2005). *Fisher* specifically addressed the patentability of expressed sequence tags, which are short nucleic acids produced incidental to the

expression of a gene in a cell. EST sequences correspond to at least part of a gene that encodes a protein, and thus have some value in conducting research to discover a gene or a protein encoded by the gene. The Federal Circuit, largely affirming the rationale of the PTO which had rejected claims under §101 in the case, held that this mere potential for use in discovering a gene was not sufficient to satisfy the specific and substantial utility requirements of §101, which were the focus of the PTO guidelines. In particular, the court observed that labeling the invention as a "research" tool or not was not helpful to the analysis, stating:

> [a]n assessment that focuses on whether an invention is useful only in a research setting thus does not address whether the invention is in fact "useful" in a patent sense. [The PTO] must distinguish between inventions that have a specifically identified substantial utility and inventions whose asserted utility requires further research to identify or reasonably confirm.

Fisher at 1372. Instead, the court emphasized that the patent applicant must identify in the patent application a utility that (i) is specific to the claimed invention, rather than being generally applicable to all molecules in the class of the invention, and (ii) must be substantial, in that it provides "real world value" (i.e., that "one skilled in the art can use a claimed discovery in a manner which provides some immediate benefit to the public."). The court then held that claims based on the EST sequences described in the application were not sufficient under §101. The Federal Circuit specifically observed that the "…PTO's standards for assessing whether a claimed invention has a specific and substantial utility comport with this court's interpretation of the utility requirement of § 101." *Id*.

- The Federal Circuit has also found the PTO's guidelines concerning the written description requirement to be consistent with the requirements of this section of the patent law. See, Enzo Biochem v. Gen-Probe, 323 F.3d 956, 964 (Fed. Cir. 2002) ("We are persuaded by the Guidelines on this point and adopt the PTO's applicable standard for determining compliance with the written description requirement"); see also, *University of Rochester v. Pharmacia*, 375 F.3d 1303 (Fed. Cir. 2004).

The efforts of the PTO, and the decisions of the Federal Courts, have ensured that patents on nucleic acids that are issued or asserted today are valid, reflect a true inventive contribution, and provide a balanced set of rights for innovators relative to the public at large. In simple terms, given the rigor of examination of patent applications in this sector and the stringent legal standards governing patent eligibility and claim scope, there is no basis for any criticism of the quality of patents issuing that claim nucleic acids or other biotechnology inventions.

Nucleic Acid Patents Are Used In Different Ways by the Biotechnology Industry

Some have identified concerns with "gene patents" and offered solutions that would, as a practical matter, eliminate the possibility of obtaining patents on nucleic acids. Before addressing the merits of those concerns, it is important to appreciate the far-ranging impact such a proposal would have on the biotechnology industry.

Patents on a specified nucleotide sequence give rights to prevent the unauthorized making or use of the nucleotide sequence. This right can be applied

in a variety of commercial settings. One use is to incorporate the sequence into a host cell, and use it to produce a protein encoded by that sequence. Another application is to use the sequence to screen samples from patients to detect the presence in the sample of the sequence, which might indicate that the person being tested has a condition that justifies further investigation or treatment. Other uses of the sequence can be envisioned, each having some distinct final outcome (e.g., a product that incorporates the sequence, a product made via use of the sequence, information that provides clinical diagnostic value, a therapy based on interfering with expression of a gene). The same type of patent rights are implicated in each application – patent rights in a discrete nucleotide sequence.

As such, a patent on a nucleic acid has significant commercial value because the single patent can support a variety of distinct commercial applications ranging from producing a new drug product to a new diagnostic agent. Consider the case of a company that has developed a protein that is useful for treating a disorder. This company will use the nucleic acid patent to control which companies, if any, may be authorized to manufacture the protein. If the protein is identical to a protein that occurs in nature, patent rights in the protein may be limited or non-existent. The nucleic acid rights, by contrast, provide practical value by enabling the innovator to control the commercial production of the protein. Without protection for the nucleic acid embodiment of the invention, there may be no exclusivity available that could justify investment in developing the therapeutic product.

Legislation Altering Patent Rights in Nucleic Acid Inventions Would Harm the Biotechnology Industry and Be Inconsistent With WTO Standards

Prohibiting the issuance of patents on nucleic acids would fundamentally disrupt expectations that were set for the industry nearly 30 years ago in *Chakrabarty*. The capacity of a biotechnology company to secure comprehensive commercial protection against free-riding on its investments and efforts has been a crucial factor contributing to the success of the biotechnology industry. Biotechnology companies for nearly three decades have used patents to secure this commercial protection, and count on it in a critical fashion to guide their business development and investment decisions. In a setting where hundreds of millions of dollars of investment must precede the commercial launch of a product, eliminating or even limiting patent protection for a commercially important aspect of the product (i.e., nucleic acids) would be severely disruptive and harm long-settled expectations.

Legislation prohibiting the issuance of nucleic acid patent claims, or limiting use of patents on nucleic acids, also would place the United States out of compliance with its international obligations. For example, under the World Trade Organization Agreement on Trade Related Aspects of Intellectual Property Rights (WTO TRIPS Agreement), WTO members may not exclude protection for specific categories of inventions, such as nucleic acids, or limit their "enjoyment" (i.e., the ability of the owners of those patents to use them). Doing so would run counter to obligations of the United States under Article 27.1, which prohibits discrimination

in the availability or enjoyment (i.e., use) of patents and patent rights, based on the field of technology of the invention.

Legislation is Unnecessary

Three different types of concerns have been raised regarding gene patents. None of these concerns merits legislative action, in the view of BIO.

One concern that has been voiced is that the existence of patents on nucleic acids is preventing academic research from being conducted. This perspective is inconsistent with the experiences of BIO and its members. An important historical aspect of the biotechnology industry is its close affiliation with the academic scientific community – particularly professors in universities and in other public research institutions. This relationship is built upon shared principles, such as a desire to advance scientific understanding through both basic and applied research, publication of scientific advances and sharing of information regarding research results.

This concern is based, in part, on fears of an increased frequency of patent infringement assertions by biotechnology companies against universities and other public research institutions following the decision in *Madey v. Duke University*, 307 F.3d 1351 (Fed. Cir. 2002). Most working in this field recognize that unique circumstances were presented by the *Madey* case, in which patent rights in a machine were entangled in a broader dispute between Duke University and an ex-employee. These circumstances are unlikely to be viewed as a harbinger of a new

wave of patent litigation by biotechnology companies against universities. And, since 2002, there has not been a significant increase in patent infringement actions against university researchers. Certainly, if a university researcher is being supported by a commercial competitor of a patent owner to develop a competing product that infringes a patent, that researcher may become part of a broader landscape of commercial disputes between the companies. But, concerns that basic research will face significant new obstacles from patent litigation patent are unfounded and not borne out by experience, either from before or after the *Madey* decision.

A similar theoretical concern has been expressed that the number of patents issued in the field of biotechnology will create an overall impediment to the performance of research or in the development of products. The so-called "anticommons" effect, as hypothesized by Drs. Heller and Eisenberg, *Science*, vol. 280, (May 1998), was that the "overpatenting" of biotechnology inventions would stifle research and development in the biotechnology sector. Nearly a decade later, the conflicts hypothesized about in the paper have not materialized. Instead, research and development activities, both in the public and private sectors, has continued to enjoy vigorous growth. A summary of the paper and experiences since it was published is provided as Attachment C to this testimony.

Another concern that has been voiced is that gene patents are impeding the delivery of clinical diagnostic services. Examples have been identified of disputes between companies that own patents on nucleic acids and entities attempting to

perform clinical testing for gene-linked diseases. The fact that only one or two disputes of this type have been identified despite the fact that thousands of patents have been issued relating to nucleic acids, in one sense, confirms that the vast majority of gene patents do not create significant impediments to performing clinical diagnostic testing.

Finally, concerns have been expressed that patent rights in nucleic acids will confer rights to control use of genetic information, including by individuals. Patents give rights only in the making, using, selling, offering for sale or importation into the United States of what is patented. In the case of a patent on a nucleic acid, this means that the patent can be used vis-à-vis entities that make or use the nucleic acid that has been patented. Dissemination and use of information about the nucleic acid is part of the bargain of the patent system -- patent rights in a nucleic acid cannot be used to stop use of the dissemination or use of information *per se*.

The granting of valid patent rights, in response to investments and innovative activity, gives the innovator a certain degree of discretion to pursue and exploit the patent rights. To the extent that the business model pursued by a company is impractical, the market should and will respond to address the shortcomings of that business model. It should also be kept in mind that patent rights are inherently limited; they give the owner of the patent the right to prevent others from using the patented invention without authorization. Patents do not convey positive rights to perform diagnostic testing, impose impractical or unlawful conditions (through contract or otherwise), or to waive compliance with laws

governing competition or the regulation of human diagnostic products. Patents only provide the right to prevent others from using the patented invention.

From a broader perspective, BIO submits that granting patents in exchange for public disclosure of inventions – including for nucleic acid inventions that are new, useful, non-obvious and adequately disclosed – reflects sound public policy. The benefits after nearly 30 years of experience cannot be contested – more than a thousand companies, employing more than a million highly skilled people, and producing hundreds of life-saving and life-changing products and services. Indeed, the biotechnology industry is proof that the patent system is working as it should – promoting billions of dollars of investments in crucially important research and development, generating millions of jobs, and delivering new hope to patients and consumers.

Conclusion

The U.S. patent system allows for broad subject matter eligibility. This system has served this country well over the past thirty years. Everyday, new innovative products enter the market place, and every day, a new discovery is made in biotechnology. The House Subcommittee is to be commended for undertaking this examination of the role of gene, nucleic acid based system. In BIO's view, altering the legal standards of eligibility for gene based inventions, or limiting the ability of innovators to use gene patents, would seriously harm the biotechnology industry. BIO appreciates the opportunity to provide insight into the role of gene based

patents in the growth of the biotech industry and to describe the nature of the industry and its contributions to the improvement of the human condition.

Attachments

A. Biotechnology Industry Facts

B. Ted Buckley, *The Myth of the Anticommons* (May 31, 2007)

C. BIO Position on Research use Exemption

D. BIO FAQ on Gene Patents

Biotechnology Industry Organization
1201 Maryland Avenue, SW
Suite 900
Washington, DC 20024-2149

Close Window

Biotechnology Industry Facts

- The biotechnology industry originated in the 1970s, based largely on a new recombinant DNA technique whose details were published in 1973 by Stanley Cohen of Stanford University and Herbert Boyer of the University of California, San Francisco. Recombinant DNA is a method of making proteins-such as human insulin and other therapies-in cultured cells under controlled manufacturing conditions. Boyer went on to co-found Genentech, which today is biotechnology's largest company by market capitalization.

- Biotechnology has created more than 200 new therapies and vaccines, including products to treat cancer, diabetes, HIV/AIDS and autoimmune disorders.

- There are more than 400 biotech drug products and vaccines currently in clinical trials targeting more than 200 diseases, including various cancers, Alzheimer's disease, heart disease, diabetes, multiple sclerosis, AIDS and arthritis.

- Biotechnology is responsible for hundreds of medical diagnostic tests that keep the blood supply safe from the AIDS virus and detect other conditions early enough to be successfully treated. Home pregnancy tests are also biotechnology diagnostic products.

- Consumers are enjoying biotechnology foods such as papaya, soybeans and corn. Biopesticides and other agricultural products also are being used to improve our food supply and to reduce our dependence on conventional chemical pesticides.

- Environmental biotechnology products make it possible to clean up hazardous waste more efficiently by harnessing pollution-eating microbes without the use of caustic chemicals.

- Industrial biotechnology applications have led to cleaner processes that produce less waste and use less energy and water in such industrial sectors as chemicals, pulp and paper, textiles, food, energy, and metals and minerals. For example, most laundry detergents produced in the United States contain biotechnology-based enzymes.

- DNA fingerprinting, a biotech process, has dramatically improved criminal investigation and forensic medicine, as well as afforded significant advances in anthropology and wildlife management.

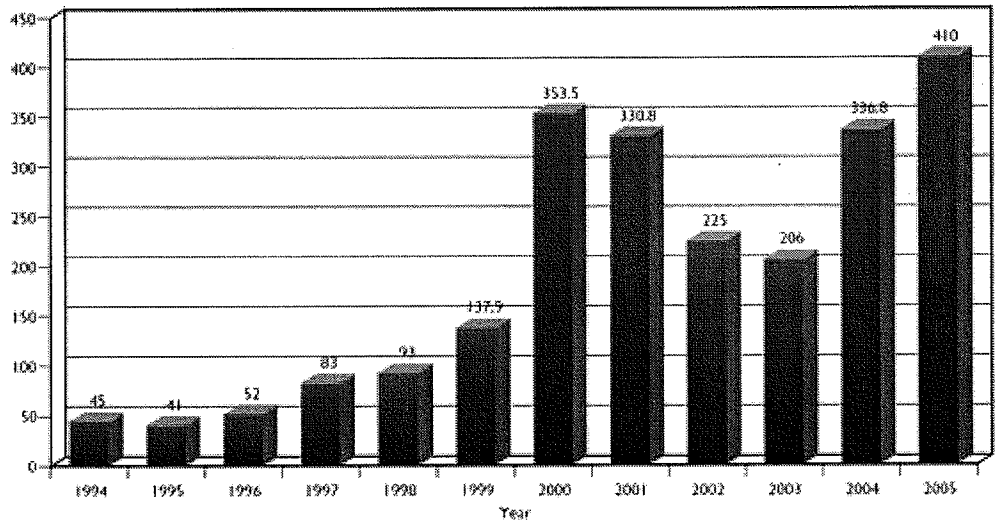
- The biotech industry is regulated by the U.S. Food and Drug Administration (FDA), the Environmental Protection Agency (EPA) and the Department of Agriculture (USDA).

- As of Dec. 31, 2005, there were 1,415 biotechnology companies in the United States, of which 329 were publicly held.

- Market capitalization, the total value of publicly traded biotech companies (U.S.) at market prices, was $410 billion as of Dec. 31, 2005.

- The biotechnology industry has mushroomed since 1992, with U.S. health-care biotech revenues increasing from $8 billion in 1992 to $50.7 billion in 2005.
- Biotechnology is one of the most research-intensive industries in the world. The U.S. biotech industry spent $19.8 billion on research and development in 2005.
- The top five biotech companies invested an average of $130,000 per employee in R&D in 2005.
- In 1982, recombinant human insulin became the first biotech therapy to earn FDA approval. The product was developed by Genentech and Eli Lilly and Co.
- Corporate partnering has been critical to biotech success. In 2005, biotech companies signed 564 new agreements with pharmaceutical firms and 354 with fellow biotechs, according to BioWorld.
- Most biotechnology companies are young companies developing their first products and depend on investor capital for survival. Biotechnology attracted more than $20 billion in financing in 2005 and has raised more than $100 billion since 2000.
- The biosciences-including not just biotechnology but all life sciences activities-employed 1.2 million people in the United States in 2004 and generated an additional 5.8 million related jobs.
- The average annual wage of U.S. bioscience workers was $65,775 in 2004, more than $26,000 greater than the average private sector annual wage.
- Bioethanol-made from crop wastes using biotech enzymes-could meet a quarter of U.S. energy needs by 2025.
- The Biotechnology Industry Organization (BIO) was founded in 1993 to represent biotechnology companies at the local, state, federal and international levels. As of December 2006, BIO's membership consisted of more than 1,100 biotechnology companies, academic centers, state and local associations and related enterprises.

Market Capitalization, 1994-2005*



* Amounts are in U.S. dollars in billions
Sources:

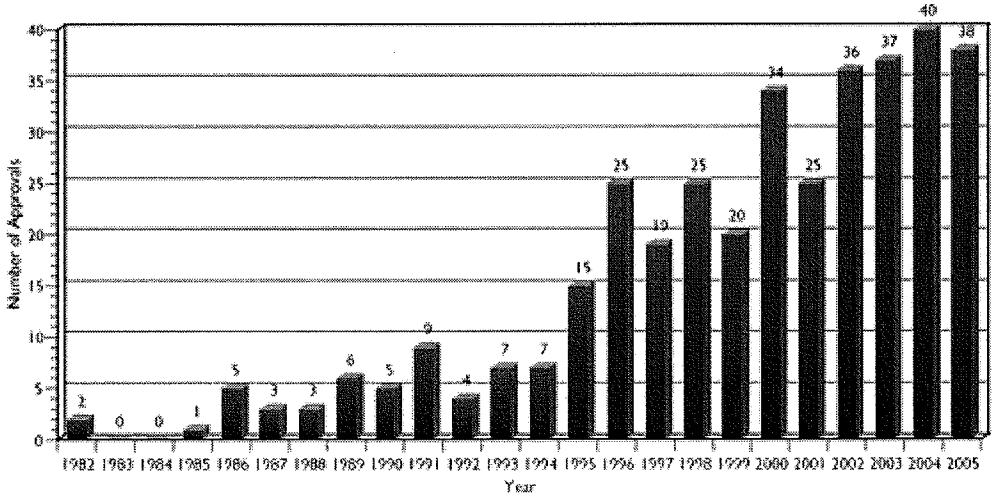
Ernst & Young LLP
BioWorld

U.S. Biotech Industry Statistics: 1994-2005*

Year	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994
Sales	32.1	28.1	28.4	24.3	21.4	19.3	16.1	14.5	13	10.8	9.3	7.7
Revenues	50.7	43.8	39.2	29.6	29.6	26.7	22.3	20.2	17.4	14.6	12.7	11.2
R&D Expense	19.8	19.6	17.9	20.5	15.7	14.2	10.7	10.6	9.0	7.9	7.7	7.0
Net Loss	4.1	6.8	5.4	9.4	4.6	5.6	4.4	4.1	4.5	4.6	4.1	3.6
No. of Public Companies	329	331	314	318	342	339	300	316	317	294	260	265
No. of Companies	1,415	1,346	1,473	1,466	1,457	1,379	1,273	1,311	1,274	1,287	1,308	1,311

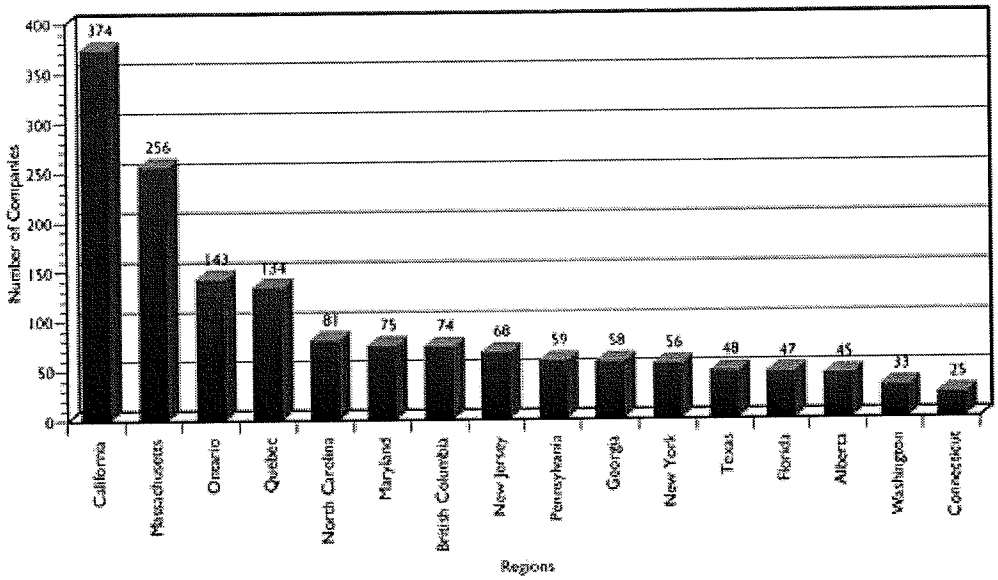
*Amounts are U.S. dollars in billions.
Source:
Ernst & Young LLP, annual biotechnology industry reports, 1995–2006. Financial data based primarily on fiscal-year financial statements of publicly traded companies.

New Biotech Drug and Vaccine Approvals/ New Indication Approvals by Year



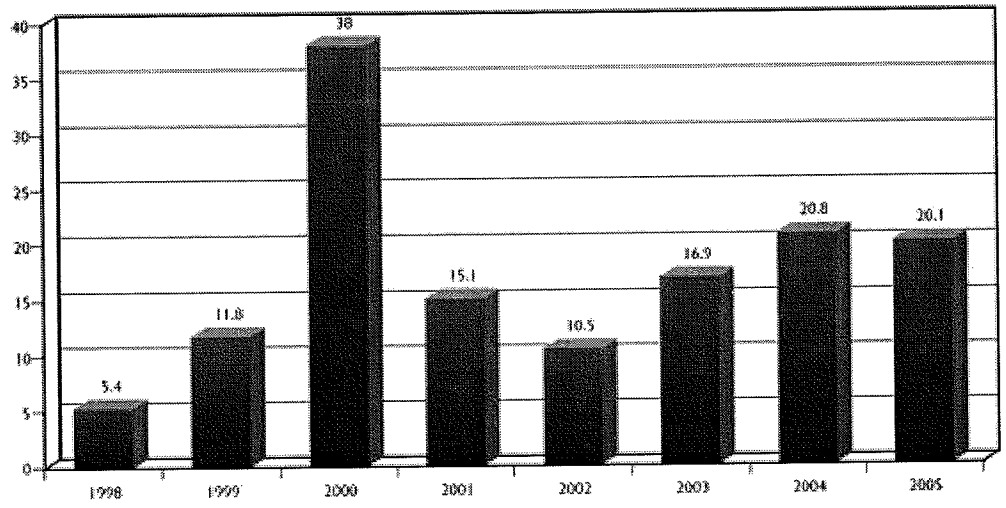
Source:
BIO

North American Biotech Companies by State and Province



Source:
Ernst & Young LLP

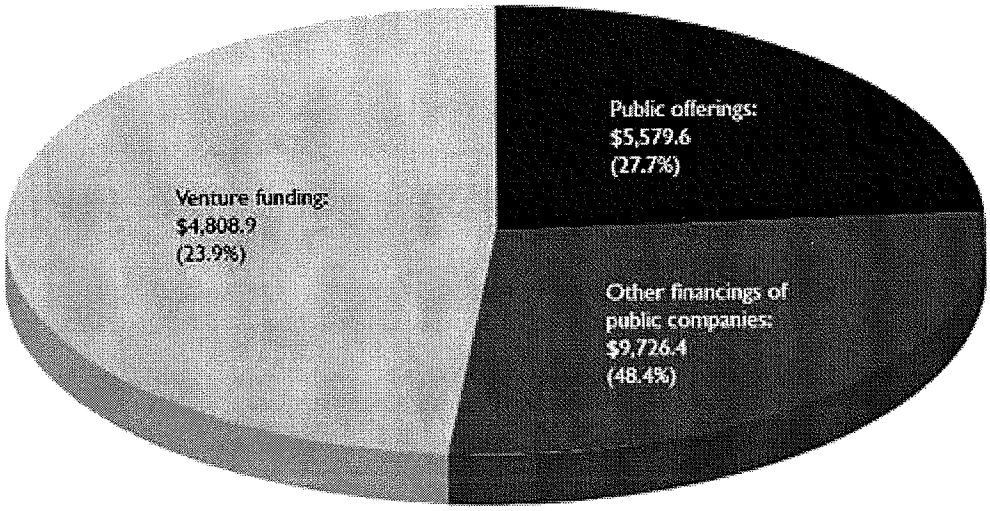
Total Financing, 1998-2005 (in billions of U.S. dollars)



Source:
BioWorld

Biotech Industry Financing, 2005

Total: $20,114.9 Million
(all figures in millions)



Source:
BioWorld

Close Window

BIO
BIOTECHNOLOGY
INDUSTRY ORGANIZATION

The Myth of the Anticommons

Ted Buckley, Ph.D.
BIO Director of Economic Policy
May 31, 2007

Executive Summary:

The theory called the *tragedy of the anticommons* was put forth in 1998 and claimed that over-patenting of research in the field of biotechnology was hindering research and development of new innovative treatments. Although no empirical evidence was cited, the theory quickly gained traction.

This paper examines the theory from both a theoretical and empirical basis. From a theoretical perspective, we find that the geographical interpretation that has been implied is too limited.

On the empirical side, rather than finding an industry unable to continue to find innovative therapies due to a patent thicket, we find an industry that is actively engaged in discovering and inventing innovative therapies. Specifically, we find that:

1. Since 1998 R&D of publicly traded biotech companies has increased over 60%.
2. From 1995 – 2005 the amount of venture capital funding for biotechnology companies has increase 300%.
3. Employment has increased by 21% since 1998.
4. Annual original INDs received by the FDA, while steady for a number of years, has shown a sharp increase in 2004 and 2005.
5. The number of biological compounds entering preclinical trials in 2005 was 37% higher than the number entering trials in 1998.
6. None of the academics surveyed reported abandoning a line of research due to patents on knowledge inputs.

Thus, we conclude that there is neither theoretical support nor empirical evidence to support the idea of the *tragedy of the anticommons*.

1201 Maryland Avenue, SW • Suite 900 • Washington, DC 20024-2149 • 202.962.9200 • Fax 202.488.6301 • www.bio.org

BIOTECHNOLOGY INDUSTRY ORGANIZATION

Myth of the Anticommons:

I. Introduction:

In 1998 Heller and Eisenberg put forth an idea in a paper that suggested that over-patenting was threatening innovation in the biotechnology industry.[1] The idea was called the *tragedy of the anticommons*. The theory posited that, because of the excess number of patents in the biotechnology arena, innovation would be stifled due to an inability to conduct research without patent infringement. Although no empirical evidence was cited, the idea quickly gained a good deal of attention and traction.

This paper examines the theory of the anticommons from both a theoretical and empirical perspective. The paper finds that the theoretical construct, upon which the theory of anticommons is based, is too simplistic to adequately characterize the biotechnology world. Further, though a number of metrics are examined, none of the metrics empirically support the idea that there is over-patenting in the biotechnology industry.

The paper is arranged as follows. Section one contains a brief overview of the economics of patents. Section two provides an overview of the theory of the *tragedy of the anticommons*. Section three discusses the theoretical shortcomings of the theoretical construct. Section four examines the empirical evidence. A brief conclusion follows.

II. Overview of the Economics of Patents:[2]

The idea underpinning the US Patent system is the balance between giving incentives to inventors and giving society broad access to innovation. Abraham Lincoln may have put it best when he said, "The Patent System added the fuel of interest to the fire of genius." On one hand inventors need to be rewarded for the time and effort that they have put into their inventions. Thus, society grants patents to inventors which bestow a property right to the individual inventor. The invention belongs to the inventor and can not be copied or used without the permission of the inventor. The result of this exclusive ownership is that the price of the invention that is able to be charged is higher than it would be in a competitive market, and therefore, the inventor makes a higher profit for the invention that has been patented.

The ability to charge the higher price for their innovative products provides the innovators with an incentive to develop innovative products. Without the incentive

---

[1] Heller, M.A. and Eisenberg, R.S. "Can Patents Deter Innovations? The Anticommons in Biomedical Research." *Science* Vol **280**. 1 May 1998.

[2] The discussion presented in the paper is a simplified overview of the patent system in order to facilitate an examination of whether there is evidence of the *tragedy of the anticommons.* Please refer to http://www.bio.org/ip/primer/main.asp for a fuller discussion of the U.S. patent system.

provided by the patent, the pace of innovation would slow because inventors would not be rewarded as much for the time, effort and risk that it took to develop the innovation. Indeed, intellectual property protection has been found to be a significant determinant of economic growth.[3]

The patent system is especially important to the biotechnology industry.[4] Each biopharmaceutical that is brought to market requires on average $1.2 billion in research and development. The cost is high for a number of reasons. The reasons include the number of failures that occur along the way. For every biopharmaceutical that is brought to market, there are approximately10,000 failed attempts. In addition, the time to go through clinical development and regulatory approval to market for the biopharmaceutical is 97.7 months on average.[5, 6] Finally, the cost of the clinical trials is quite high and has risen substantially in the past decade. On average the cost of research and development rose 7.5% above the annual rate of inflation during the 1990s, the latest years for which figures are available.[7] Patents granted on a biotechnological innovation allow the inventors to recoup the research and development costs which have been invested.

III. Overview of the Anticommons Argument:

As has been discussed, patents are central to the development of innovative therapies in the biotechnology industry. However, in 1998 an idea was put forth that suggested that patents, instead of encouraging innovation, had the potential to actually stifle innovation in the biotechnology industry. This stifling of innovation was called the *tragedy of the anticommons*.[8] The authors posit that innovation may be stifled if there are too many owners who may exclude others from a scarce resource. Specifically, if there are too many patent holders of upstream technology, they may inhibit downstream innovation because of transaction costs and strategic behaviors. Imagine that a biotechnology

---

[3] Gould, D. M. and Gruben W. C. "The role of intellectual property rights in economic growth." *Journal of Development Economics* Vol **48** (1996) 323 – 350.

[4] See for example, Cohen, W, M., Nelson R. R. and Walsh, J. P. "Protecting their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (Or Not)." NBER Working Paper 7552. February 2000.

[5] DiMasi, Joseph A. and Henry G. Grabowski. "The Cost of Biopharmaceutical R&D: Is Biotech Different?" *Managerial and Decision Economics*. Forthcoming.

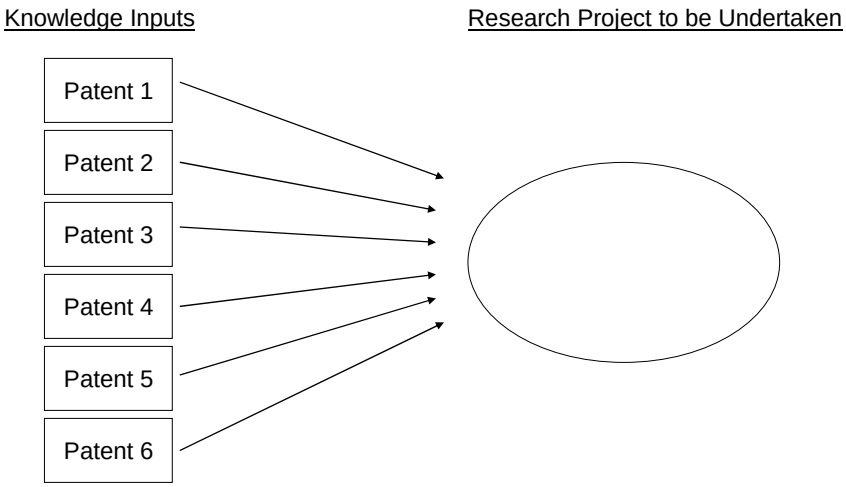
[6] Note: This does not include pre-clinical time of development.

[7] DiMasi, J. A., Hansen, R. W. and Grabowski, H. G. "The price of innovation: new estimates of drug development costs." *Journal of Health Economics* 22 (2003).

[8] Heller, M. A. and Eisenberg, R. S. "Can Patents Deter Innovations? The Anticommons in Biomedical Research." *Science* Vol **280**. 1 May 1998.

company seeks to do research in a particular area to bring an innovative therapy to market and that in order to do research in this area the company must use a set of knowledge inputs. Further, suppose that each of the knowledge inputs has been patented by a different company. In order for the biotechnology company to proceed with the research, it must first receive permission from each of the patent holders to use the patent holder's knowledge input for its research.

Figure 1:



In this case the company would need to obtain permission from 6 different parties before it could undertake the research project

Getting permission may take considerable time and may require considerable money. Thus, the research to bring an innovative therapy to market may be delayed, may cost more or may not take place if the company can not obtain permission from all of the upstream patent holders. In this scenario one patent holder in the set of knowledge inputs could suppress the research by not granting permission for the biotechnology company to use its patented input.

IV. Theoretical Shortcomings of the Anticommons:

The theory outlined above is appealing for its simple elegance. However, the simplicity of the argument is one of its short comings. An implicit part of the argument is that there is a scarcity to the biological commons akin to a geographical scarcity. Indeed, in responding to Heller's and Einsberg's call for a formal economic model to be developed,

Buchanan and Yoon developed an economic model and illustrated it geometrically.[9] Further, in another paper that discusses the *tragedy of the anticommons* Scherer states, "The problem is analogous to conditions on the Rhine River during the 18th Century. Over the 85-kilometer stretch between Mainz and Koblenz in 1780, there were nine toll stations…"[10] The result of the excessive number of tolls was a significantly lower amount of traffic on the river.

The geographic analogy is appealing but is flawed when applied to the biotechnology industry. In the examples above, there is a single starting point and a single ending point. In addition in the Rhine River analogy there is only one route from the starting point to the ending point. However, the "geography" in the biopharmaceutical world is much more complex than geography that is described in the world of the anticommons. In biotechnology world there are many starting points and many routes that will lead to the desired ending point, which in this case is an innovative therapy. In applying the "geography" of the biopharmaceutical world to the Rhine River analogy, imagine that a shipper wants to transport good from Mainz to Koblenz but is faced with having to go through nine toll stations on the river. Whereas in the 18th century, the shipper had no other option but to traverse the river, in the 21st century biotechnology world, the shipper has alternative routes, such as roads, rail or air. Thus, the shipper can reach the desired ending point by going around the river tolls.[11]

The idea of going around a toll is well known in the biopharmaceutical industry, as well as other industries, and is called inventing around a patent. An illustrative example is the class of pharmaceuticals called statins, which are medicines designed to lower blood cholesterol levels. In this case, the desired endpoint is a lower blood cholesterol level. According to the geographical example above, there is only one route to the desired endpoint and thus, one would expect only one statin to be on the market. However, there are more than five statin products on the market presently. The statins are but one class among many therapeutic classes of pharmaceuticals in which there are two or more products. There are multiple products in clinical testing for the treatment of breast cancer that utilize a variety of mechanisms of action. Some of these products' mechanisms of action overlap with the mechanisms of action utilized by other products.[12] Likewise, there are multiple products being developed for the treatment of chronic myeloid

---

[9] Buchanan, J. M. and Yoon, Y. J. "Symmetric Tragedies: Commons and Anticommons." *Journal of Law and Economics* Vol. **43**, No. **1**. (April 2000).

[10] Scherer, F. M. "The Economics of Human Gene Patents." *Academic Medicine* Vol. **77**, No. **12** (December 2002) Part 2, p. 1363.

[11] Epstein, R. A. and Kuhlik, B. N. "Is there a Biomedical Anticommons?" *Regulation* Summer 2004.

[12] Waltz, Emily. "GlaxoSmithKline Cancer Drug Threatens Herceptin Market." Nature Biotechnology Vol. 23, No. 12. December 2005.

leukemia.[13] Therefore, one can conclude that the geography of the biopharmaceutical world is much richer and more complex than the geography posited by the world of the anticommons.

V. Empirical and Experiential Evidence and the Anticommons:

While the discussion above showed that the geographical assumption of the anticommons theory is too limited, that does not demonstrate that the *tragedy of the anticommons* is not occurring. We can not categorically prove that there is no *tragedy of the anticommons*. To do so would require an examination of a world without patents that does not exist. However, we are able to examine the world as it is and determine what evidence, if any, exists for over-patenting. If over-patenting were occurring in the biotechnology industry, one would expect that fewer innovative therapies would be brought to market. However, given that the timeline to bring a product to market is approximately 12 years from time of patent, it is likely too soon to examine number of innovative therapies for evidence of the anticommons. Therefore, we examine the inputs that produce the innovative therapies. That is, we examine the amount of research and development that is occurring, the result of that research and development and the experience of companies and researchers in the industry. If the *tragedy of the anticommons* is occurring, one would expect the following:

1. The amount of research and development would decline
2. *Ceteris paribus* fewer potential innovative therapies would be tested
3. Companies and researchers would clamor for a public policy remedy

We examine each of these in turn.

1. The amount of research and development would decline

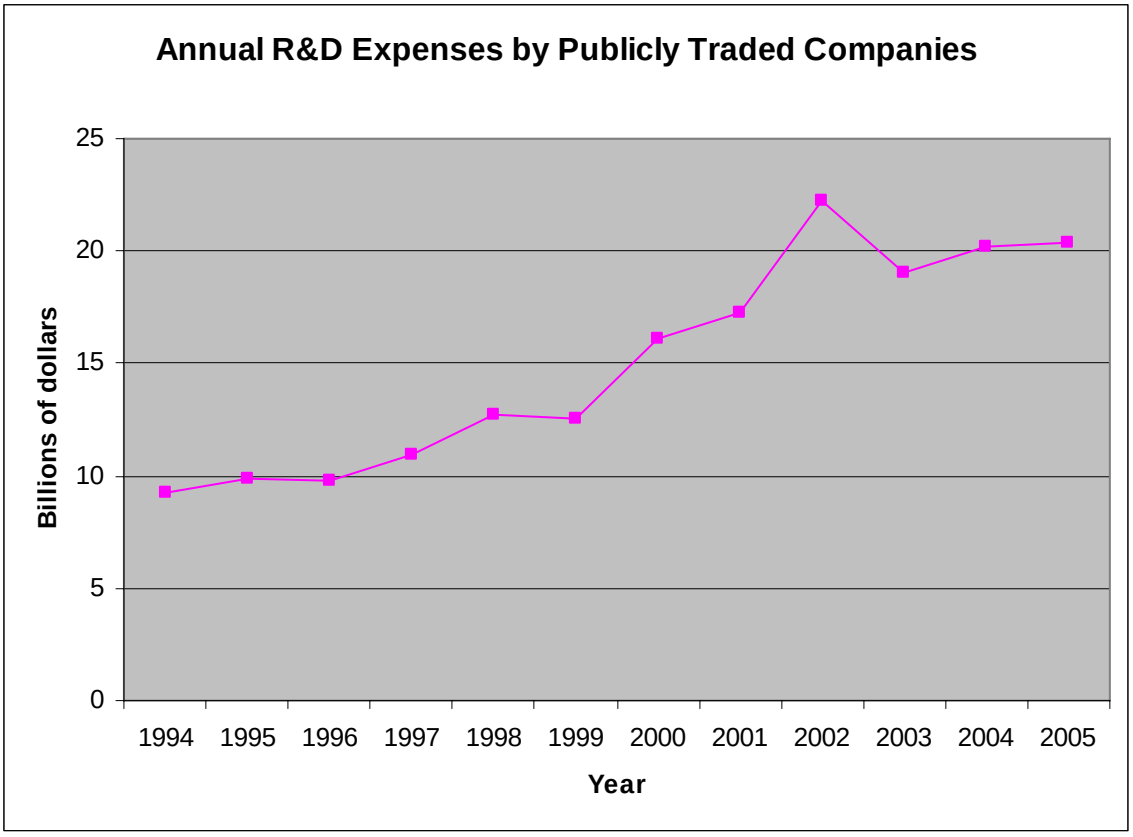
Recent R&D History:

Companies will spend research and development dollars until the point at which it is no longer profitable for them to do so. From a more formal economic stand point, companies will spend until the expected marginal benefit of the research and development (e.g., the expected revenue derived from the research and development) equals the expected marginal cost of the research and development. The idea of the anticommons is that upstream knowledge inputs, which would be used in developing innovative therapies, have been "over-patented" and thus research in these areas is difficult, if not impossible, to do without engaging in patent infringement. The practical effect of this over-patenting is to make research and development more difficult (e.g., costly) to undertake. Thus, one would expect that because the research has become more costly, the amount of research and development undertaken by biotechnology firms

[13] Hampton, Tracy. "Looking Beyond Imatinib." JAMA Vol. 295, No. 4. January 25, 2006.

would decrease. However, if one examines the amount spent on biotechnology research and development, the evidence does not indicate that *tragedy of the anticommons* is occurring.

Figure 2:



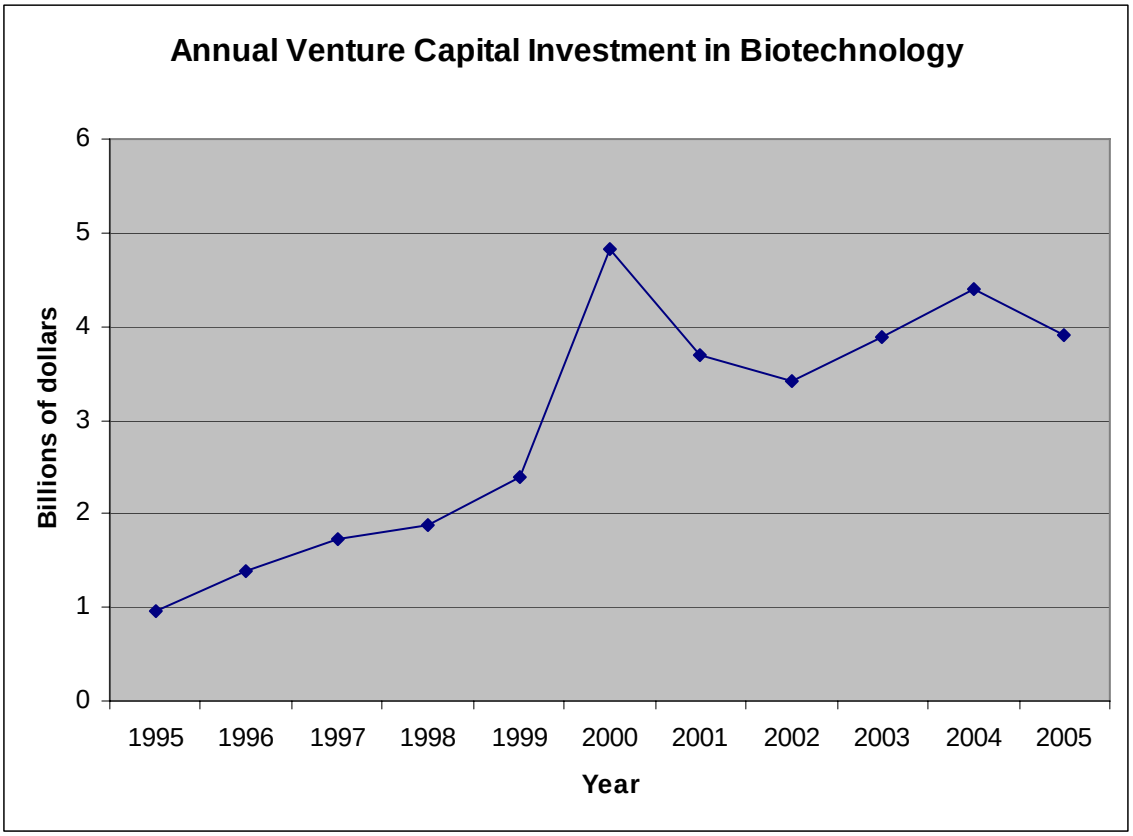
Sources: Ernst & Young LLP, annual biotechnology industry reports, 1993–2006. Financial data based primarily on fiscal-year financial statements of publicly traded companies; constant 2005 dollars.

Figure 2 indicates that the amount of research and development by publicly traded companies in the biotechnology arena has grown substantially over the past decade. Indeed, since 1998 when the *tragedy of the anticommons* was posited, R&D has increased by over 60%.[14]

[14] However, one could argue that perhaps the cost of doing research and development has actually decreased during the time period. If the costs decreased at a faster rate than the cost increase associated with the *tragedy of the anticommons*, one could argue that the investment in research and development would therefore increase. However, according to DiMasi, the cost of research and development of innovative therapies has increased at a rate of 7.5% over and above the cost of inflation during the 1990s. DiMasi J. A., Hansen, R. W. and Grabowski H. G. "The price of innovation: new estimates of drug development costs." *Journal of Health Economics* 22 (2003).

While figure 1 focuses on publicly traded companies, privately held biotechnology companies play a pivotal role in the biotechnology industry.[15] Much of the funding for these companies comes from the venture capital (VC) community. If companies were unable to perform research and development due to the presence of the anticommons, one would expect the VC investment in biotechnology to dry up.

Figure 3:



Source: National Venture Capital Association; constant 2005 dollars

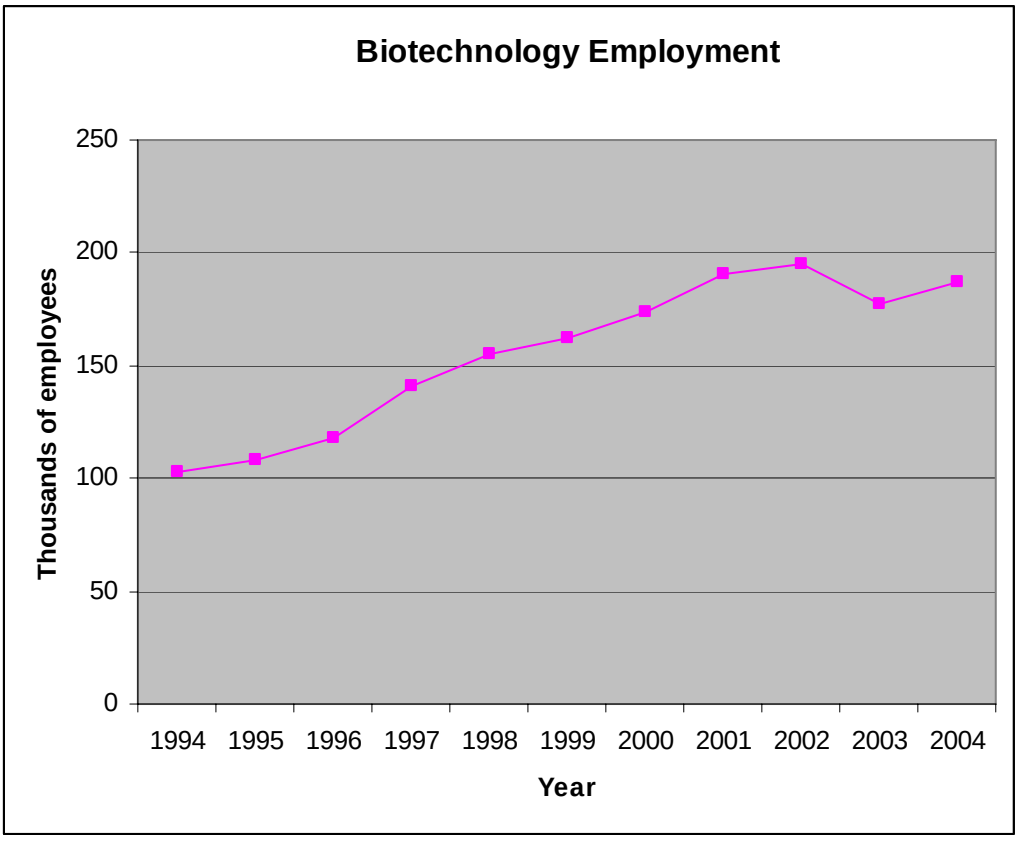
Figure 3 shows that the amount of VC has increased substantially in the past decade. In 2005 the amount of VC funding was almost $4 billion, up 300% from 1995.

Another aspect of research is the number of personnel. If the industry were experiencing a significant slow down due to the *tragedy of the anticommons* and the inability to pursue research on innovative therapies, one would expect that the difficulties of the industry

[15] Indeed, according to figures in Ernst and Young's Beyond Borders 2006 three quarters of the U.S. biotechnology companies in 2005 were privately held.

would be reflected in a decrease in the number of industry employees. However, biotechnology employment has risen over the past decade.

Figure 4:



Sources: Ernst & Young LLP, annual biotechnology industry reports, 1993–2005.

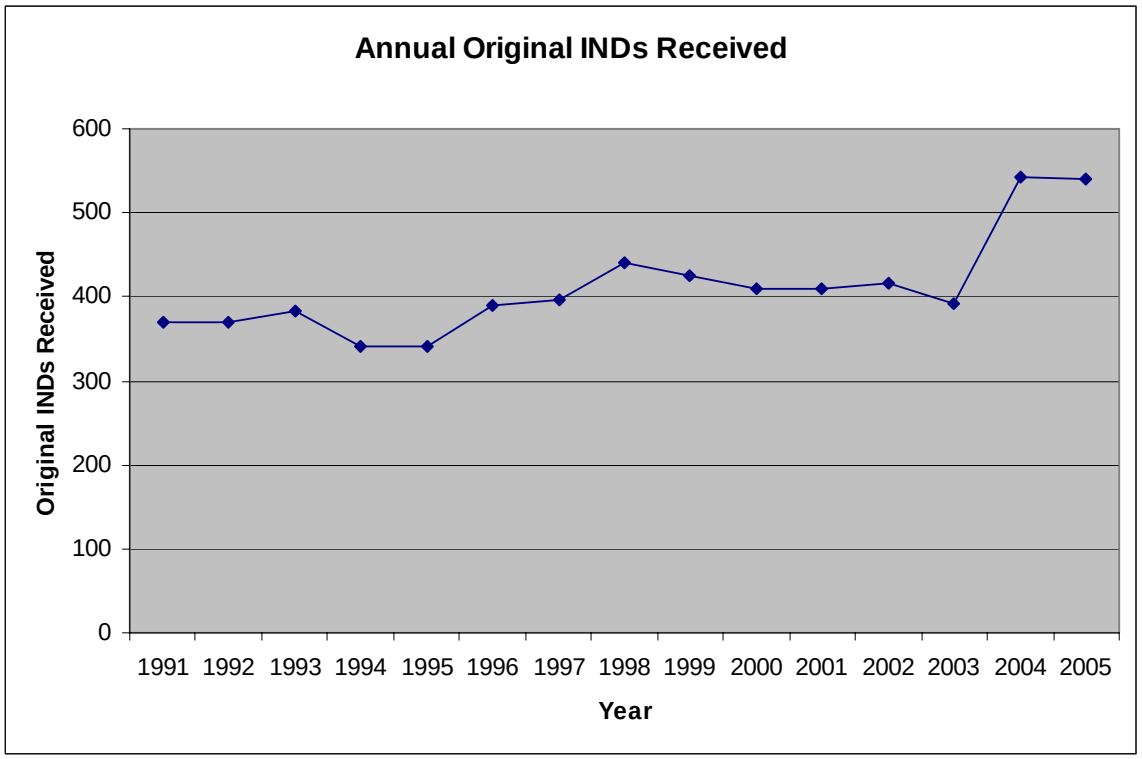
Since 1998, the number of employees has increased by 21%. Thus, instead of seeing what one would expect if an industry were experiencing the *tragedy of the anticommons* – lower research and development and with it falling employment – one observes an industry which is increasing research and development levels and increasing employment.

2. *Ceteris paribus* fewer potential innovative therapies would be tested

If the *tragedy of the anticommons* were occurring one would expect that the R&D that was being undertaken would be less efficient. That is, because so many of the knowledge inputs had patents that needed to be licensed or invented around, the research projects would take longer or the research projects would be abandoned altogether. As a result of the increased difficulty of doing research, the number of innovative therapies would decrease. However, given the long lead time that it takes to research and develop an innovative therapy and bring it to market, approximately 12 years, it may be too early to see evidence of the *tragedy of the anticommons*. Therefore, we examine the number of

annual Investigational New Drug (IND) submissions, which would be affected in a similar way. Because of the shorter timeframe, if the *tragedy of the anticommons* were occurring, one would expect the number to have decreased.[16]

Figure 5:



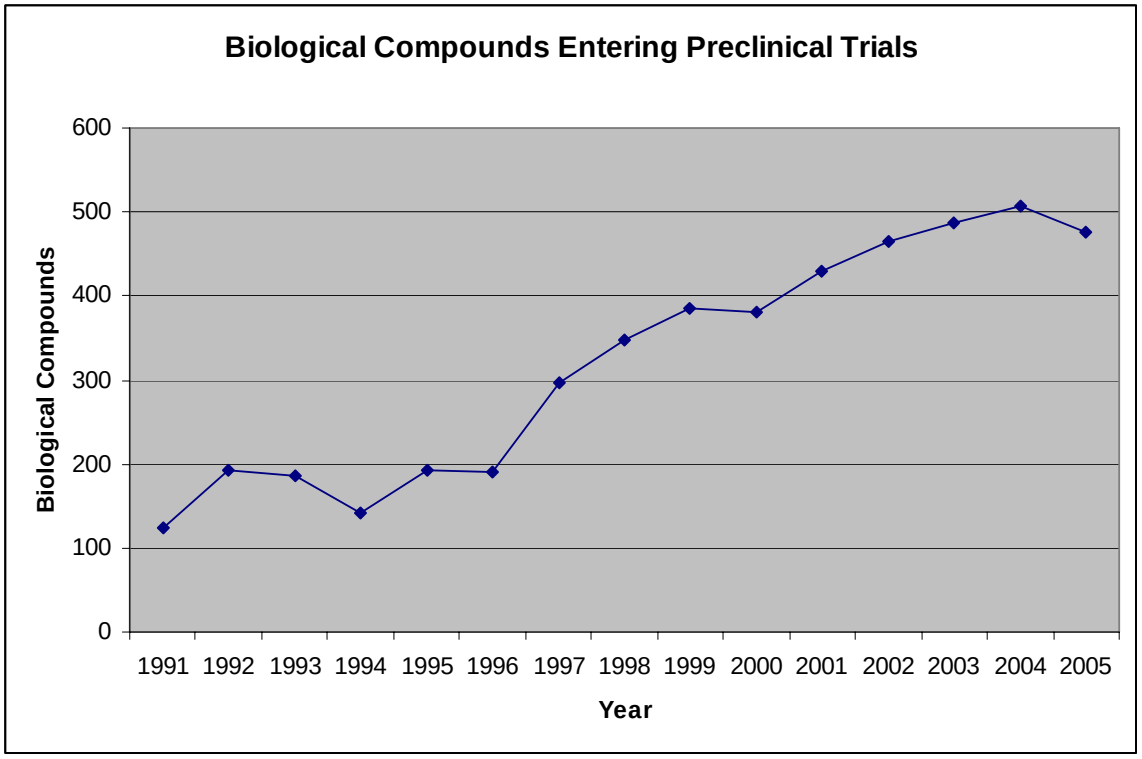
Source: FDA, Parexel's Bio/Pharmaceutical R&D Statistical Sourcebook 2006/2007

One would expect the number of INDs to drop if the *tragedy of the anticommons* were occurring. One finds a relatively stable number of INDs being originated annually from 1991 – 1998, the seven year time period before the *tragedy of the anticommons* was posited, and a relatively stable number of INDs being originated from 1998 – 2003. However, there is a sharp increase in the number of original INDs received in 2004 and 2005. These years are precisely the time period when one would expect a decrease if over-patenting were starting to occur in 1998. One would expect a decrease in INDs approximately six to seven years after the phenomenon began to occur because pre-clinical testing (that is the time from a drug being patented until it reaches the IND stage) takes on average between 3 – 6 years. If there were an anticommons problem, it would take 3 – 6 years to manifest.

[16] Because biotechnological inputs are used for the development of both small molecule therapies and therapeutic biologics, we examine both in turn.

Next, we examine the number of biological compounds that enter preclinical testing on an annual basis.

Figure 6:



Source: Pharmaprojects, Informa Healthcare

Rather than finding a decrease in the number of biological compounds entering preclinical trials, we find there has been a substantial increase in the number of biological compounds entering preclinical trials both before and after 1998. While the percentage growth has dropped from the 1991 – 1998 to the 1998 – 2005 time periods, in 2005 there were still more than 37% more compounds entering preclinical trials every year than were entering in 1998. This finding is inconsistent with research being stifled or hampered as one would expect to find if the *tragedy of the anticommons* were occurring.

3. Companies and researchers would clamor for a public policy remedy

A substantial number of members of the Biotechnology Industry Organization (BIO), the trade association for the biotechnology industry, are companies who depend on the ability to research and develop innovative therapies. Thus, if there were a *tragedy of the anticommons*, one would expect that BIO would be clamoring for a public policy remedy especially patent reform. However, rather than implying that there is a *tragedy of the anticommons* which is impeding research, BIO's position implies that the patent system encourages innovation. That is, the patent system is not hindering innovation, but rather,

the patent system is allowing companies to engage in research and development of innovative therapies.[17]

The *tragedy of the anticommons* focuses specifically on the patenting of upstream research. However, BIO's position specifically supports the patenting of "novel and useful nucleotide sequences..." BIO also supports patenting research tools which, like nucleotide sequences, are akin to the knowledge inputs that the *tragedy of the anticommons* discusses. Further, BIO's position fundamentally opposes the notion that patents on this broad array of biotechnology inventions are hindering innovation. BIO says unequivocally that it supports patenting of these types of inventions. In addition, it affirms that intellectual property rights are a prerequisite for the commercial success of these companies and for future innovation in these knowledge inputs.

While the discussion above focuses on companies and shows no evidence of the anticommons, one may argue that perhaps the *tragedy of the anticommons* is affecting academic researchers rather than companies. The National Academy of Sciences commissioned a study to examine the issue.[18] Walsh *et al* surveyed 414 academic researchers from universities, non-profits and government labs to examine whether their research had been impacted by patents. The authors found that only 1% of the academic respondents stated that they had experienced delays on their projects of more than a month due to patents on knowledge inputs. None of the academics reported abandoning a line of research due to patents on knowledge inputs.

Thus, neither biotechnology companies nor academic researchers are claiming to be adversely affecting by the patenting that is occurring in the biotechnology arena. Indeed, none of the academic researchers surveyed have abandoned research because of patent issues. Further, biotechnology companies have stated not only are patents not hurting them, but on the contrary the ability to patent is a prerequisite for commercial success.

We find no evidence of a *tragedy of the anticommons* either among companies or among the researchers who work in academic, non-profit or governmental settings.

VI. Conclusion:

The *tragedy of the anticommons* is an elegant and compelling theory. The theory claims, that instead of encouraging innovation as patents have been found to do in the biopharmaceutical industry, the patenting that has been occurring in the 1990s has the potential to hinder innovation. However, as has been discussed, the theoretical construct of the anticommons world is too simplistic to describe the world of biotechnology. We

[17] BIO's Principles for Patent Reform Approved March 29, 2004 Board IP Standing Committee.

[18] Walsh, J. P., Cho, C. and Cohen, W. M. "View from the Bench: Patents and Material Transfers." *Science* Vol **309**. 23 September 2005.

acknowledge that we can not categorically state that there is no *tragedy of the anticommons*. To do so would require an examination of a world without patents that does not exist. However, we are able to examine the world as it is and determine what evidence there exists for over-patenting. Indeed, if over-patenting were occurring, the outcome of this over-patenting would be "fewer useful products for improving human health."[19] Because of the long development time of innovative therapeutic products, we inspect the inputs of those products. The first input is R&D. If there were a *tragedy of the anticommons,* one would expect that the amount of R&D would decline because of the increased difficulty of undertaking research. Yet, we find the exact opposite. R&D in both the publicly traded and privately held biotechnology companies is increasing. Further, we find that the number of people employed in the industry is increasing over time. Next, we inspect the pipelines of biopharmaceutical industry. If the research were becoming more difficult, one would expect that the number of innovative therapies in testing would be decreasing. Rather, we find the opposite. We find that the pipeline of both chemically and biologically based innovative therapies is expanding. Thus, the information that we examine paints a picture of an industry that is growing in terms of research and development with an increasing number of products in the pipeline. The argument could be made that perhaps researchers – either those in industry or in academia - are encountering problems that are not reflected in the R&D figures or in the numbers associated with the product development pipeline. However, the biotechnology industry is strongly supportive of the patent system and contends that it encourages innovation. Thus, industry is not supportive of the idea that over-patenting is occurring and hindering its ability to bring innovative therapies to the marketplace. Further, none of the academic researchers surveyed by Walsh *et al* abandoned their line of research due to patents on knowledge inputs. Therefore, we conclude, based on both empirical and experiential evidence, that there is no support for the idea that a *tragedy of the anticommons* is occurring in the biotechnology industry.

[19] Heller, M. A. and Eisenberg, R. S. "Can Patents Deter Innovations? The Anticommons in Biomedical Research." *Science* Vol **280**. 1 May 1998.

BIO
BIOTECHNOLOGY
INDUSTRY ORGANIZATION

Biotechnology Industry Organization On Research Use Exemptions July 28, 2005

Overview

In exchange for complete disclosure of an invention, a patent grants the right to exclude others from using the invention for a limited time. This time-tested contract is the cornerstone of technological progress in a free economy, as it provides incentive to research and invent while society gains access to the eventual products and knowledge. Nowhere is this more evident than in the biotechnology industry. Biotechnology offers enormous hope for curing intractable diseases and meeting many of the world's environmental and agricultural challenges, thereby improving the health and well being of people today and for generations to come.

The current intellectual property system in the United States has been instrumental in creating the biotechnology industry and sustaining biotechnology companies. By protecting inventions that are essential to the development of biotechnological products, the patent system's time-limited protection spurs investment into the research and development of technological products, particularly biotechnology products. It is common for a biotechnology company to expend hundreds of millions of dollars and work for more than a decade before it reaps its first dollar of product revenue. The risks are great, and few companies actually succeed in their quest to get products approved by regulatory authorities. Without strong, predictable, comprehensive and enforceable patent protection, it is unlikely that investors would risk their capital or resources to fund biotechnology endeavors. Through patent protection for the molecules that serve as modern biotechnology's foundation (proteins and nucleic acids) the biotech community can invest in the R&D needed to bring these important and innovative healthcare products to market.

BIO members are dedicated to translating cutting-edge technologies into products for use in healthcare, agriculture and the environment to benefit humanity. BIO recognizes the importance of the tools being used in modern biotechnological research, including those used in the private and public sector to decipher the human genome and other genomes. BIO supports the ability of developers of innovative research tools to obtain patents on their discoveries. BIO also supports the rights of developers to use intellectual property

rights to succeed commercially so that investment in needed innovation will continue and society will reap the benefits.

Through their close relationship with the research and academic communities, both public and private, BIO members are dedicated to promoting the larger objectives of scientific progress against disease and famine.

Research Use Exemptions

Exemptions from patent enforcement are rare in U.S. patent law. However, there are two types of existing exemptions that are of importance to BIO members.

One exemption is the judicially created research-use exemption. This narrow exemption permits making and using a patented invention to better understand **that** invention. It provides that it is not an act of infringement to make and use a patented invention if the use is limited to research or experimentation and the user does not obtain any commercial advantage or benefit.

The courts have interpreted this exemption narrowly. In *Madey v. Duke*[1], the Court of Appeals for the Federal Circuit held that activities that could be construed to have a business-related objective (e.g., publishable research to further a university's prestige, image, & ability to bring in grant money) are considered to be outside the scope of a research use exemption. Thus, academic researchers may be outside the scope of exemption if their activities further the interests of their institutions, such as attracting researchers or securing research grants. As a practical matter however, a patent owner will generally not enforce his patent against a researcher if the research activities in question do not damage the patent owner's commercial interests.

A second type of research exemption is included in the Hatch-Waxman Act of 1984[2]. This exemption allows making and using a patented pharmaceutical compound or device to collect data for submission to a U.S. Government regulatory agency (typically for a generic drug manufacturer to submit to the FDA). This "safe harbor" is intended for individuals or entities making and using patented materials for uses "reasonably related" to the development and submission of information to the government. In *Merck v. Integra*[3], the Supreme Court held that a certain amount of experimentation using a patented invention falls within the "safe harbor" provision of the Hatch-Waxman Act as long as the experimentation is reasonably related to the development and submission of data for the government regulatory agency. At the same time the Court held that not all experimentation falls within the safe harbor.

BIO believes that taken together, existing practice[4] and law[5] [6]pertaining to research use of patented inventions is appropriate and provides the appropriate balance between product development and research.

---

[1] John M.J. Madey, Plaintiff-Appellant, v. Duke University, Defendant-Appellee., 307 F.3d 1351; 2002 U.S. App. LEXIS 20823; 64 U.S.P.Q.2D (BNA) 1737

[2] PL 98-417

[3]Integra Lifesciences I, Ltd. and The Burnham Institute, Plaintiffs-Cross Appellants, and Telios Pharmaceuticals, Inc., Plaintiff-Appellee, v. Merck KGaA, Defendant-Appellant, and The Scripps Research Institute and Dr. David A. Cheresh, Defendants. 331 F.3d 860; 2003 U.S. App. LEXIS 11335; 66 U.S.P.Q.2D (BNA) 1865

[4] Existing material transfer and licensing practices.

[5] *Merck v. Integra*

[6] *Madey v. Duke*

Gene Patenting FAQ's

What is a patent?

A patent is an agreement between the government and an inventor whereby, in exchange for the inventor's complete disclosure of the invention, the government gives the inventor the right to exclude others from using the invention in certain ways. The property right granted is quite different from what we typically think of when we own land or other real property. A patent does not provide the right to make, use, offer for sale, sell or import, but the right to stop others from making, using, offering for sale, selling or importing the invention.

Can living things be patented?

Some, but not all, living things. The United States Patent and Trademark Office, PTO (the agency charged with granting patents) enforces strict standards, set by Congress, on what can be patented. Like any invention or discovery, a living thing must be "new", non-obvious, and useful in order to be patented. More importantly, living organisms under consideration for patenting cannot be those that occur or exist in nature "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title." 35 USC 101. One cannot obtain a patent on just any living creature, such as a mouse, because mice have been around for a long time. If, through manipulation of genes, someone makes a kind of mouse that never existed before, however, then that kind of mouse might be patentable.

For example:

- **Microbes**

  As long ago as 1873, Louis Pasteur received a US patent for yeast "free from organic germs or disease." With the growth of genetic engineering in the late 1970's, the patentability of living organisms was re-examined, and confirmed. A landmark case involved Ananda Chakrabarty's invention of a new bacterium genetically engineered to degrade crude oil. In 1980, the US Supreme Court clearly stated that new microorganisms not found in nature, such as Chakrabarty's bacterium, were patentable. Chakrabarty received a patent in 1981 (US Pat. No. 4,259,444). In its Chakrabarty decision, the US Supreme Court stated that "anything under the sun that is made by the hand of man" is patentable subject matter. Therefore, if a product of nature is new, useful and nonobvious, it can be patented if it has been fashioned by humans.

- **Plants**

In 1930, the US Congress (Congress) passed the Plant Patent Act, which specifically provides patent protection for newly invented plants that are asexually reproduced. In 1970, Congress provided similar protection for newly invented sexually reproduced plants.

- **Animals**

In the 1980s, the question of whether multicellular animals could be patented was examined. The key case involved a new kind of "polyploid" oyster that had an extra set of chromosomes. This new, sterile oyster was edible all year round because it did not devote body weight to reproduction during the breeding season. The PTO found that such organisms were in fact new but this particular type of oyster was determined to be obvious, and thus into patent was allowed. Nonetheless, the polyploid oyster paved the way for the patenting of other nonnaturally occurring animals. In 1988, Philip Leder and Timothy Stewart were granted a patent on transgenic nonhuman mammals (U.S. Pat. No. 4,736,866) that covered the so-called Harvard mouse, which was genetically engineered to be a model for the study of cancer. The PTO does not allow anyone to patent a human being under any circumstances. A 1987 PTO memo issued by Donald J. Quigg, Assistant Secretary of Commerce and Commissioner of Patents and Trademarks, states, "A claim directed to or including within its scope a human being will not be considered to be patentable subject matter." Accordingly, since 1987, the PTO has rejected any application that encompasses a human being.

- **Natural Compounds**

Natural compounds, such as a human protein or the chemical that gives strawberries their distinctive flavor, are not themselves "living," but do occur in nature. Thus, they are new, and can be patented, only if, they are somehow removed from the setting in which they naturally occur (*isolated*). Therefore, a compound that is *purified* away from a strawberry, or a protein that is *purified* away from the human body can be patented *in its purified state* (provided that, the purified, e.g., protein or compound, also meet the other requirements for patentability, as well). Such a patent would not cover the chemical while in the strawberry or the protein while in the person. Such a patent would not cover the strawberry or the person. The USPTO does not allow anyone to patent a human.

What is a gene?

A gene is the fundamental physical and functional unit of heredity. It is made up of tightly coiled threads or polymers of deoxyribonucleic acid (DNA). DNA is an informational molecule and is made up of four distinct nucleotides: deoxyadenosine (A), deoxyguanosine (G), deoxythymidine (T), and deoxycytidine (C). It is the nonrandom order of these individual "bases" that results in DNA being an

informational molecule. However, in and of itself, DNA has no functional property. It is a chemical that, when placed in an appropriate environment, will direct the synthesis of particular and specific proteins, which make up the structural components of cells, tissues and enzymes (molecules that are essential for biochemical reactions). Organisms, from single-celled protozoans to far more complex human beings, are made up of cells containing DNA and associated protein molecules. The DNA is organized into structures called chromosomes, which encode all the information necessary for building and maintaining the organism. A DNA molecule may contain one or more genes, each of which is a specific sequence of nucleotide bases. It is the specific sequence of these bases that provides the exact genetic instructions that give an organism its unique traits.

Can genes be patented?

Isolated and *purified* genes are patentable inventions if they meet the patentability requirements of Title 35 (including being novel, nonobvious, adequately described and useful). It is difficult to identify genes and even after we recognize them, it is very difficult to isolate them and put this information to use.

Gene and nucleic acid-based patents have helped attract the biotechnology and pharmaceutical industry's interest in the development of gene-based therapeutics, diagnostics and processes. For example, the isolated and characterized gene associated with a certain type of breast cancer, Her-2, was patented after years and millions of dollars spent in its identification, isolation and characterization. This discovery and the patents protecting its various aspects, enabled companies to develop therapeutics and diagnostics for breast cancer.

Are patents granted on an individual's genes?

No. Patents do not provide any rights to a person or to the genes in his or her body. Instead, patents are granted on *isolated* genes and gene products that have real-world applicability. That is, the patents cover genes and gene products that could be obtained from any person, for example, from a blood sample. Genes are not unique to an individual. Two unrelated people with brown hair may have the same gene that causes their respective locks to be brown. Or two women may have the same mutant gene that makes them susceptible to breast cancer. In that sense, a gene is generic and could be obtained from any number of people who posses that gene. (What makes an individual unique is the collection of genes that make up their DNA). As previously mentioned, patents may also cover genes of microbes as well as genes from animals and plants.

When considering the patentability of nucleic acids, which are the building blocks of genes, one must take into account the nature of the object for which protection is being sought. A nucleic acid, regardless of its source, is chemically indistinguishable from any other nucleic acid. While its sequence of bases may change, there is no *a priori* means of

establishing its source. Human DNA is no different, at least chemically, from that of a bacterium.

If one were presented with a nucleic acid, its sequence could be chemically characterized, and any protein that it might encode could be determined. However, it would not be possible to ascertain what species the DNA came from. In fact, DNA as an isolated molecule does not exist within living cells. It is always associated with various other molecules, such as proteins, sugars and fats. It is well established that subject matter that is a product of nature is not eligible for patent protection. However, isolated nucleic acids do not exist in nature.

How will the patents on DNAs, RNAs, and their correlates help society?

Gene and nucleic acid-based patents have helped attract the biotechnology industry's interest (and the pharmaceutical industry's interest) in the development of gene-based therapeutics, diagnostics and processes. Many, if not most, human diseases have their roots in our genes. More than 4,000 diseases are suspected to stem from mutated genes inherited from one or both parents. As of April 2000, 1,792 individual genes had been linked to disease, including common disorders such as heart disease and many cancers. In addition, discovery of new genes holds promise for new treatments, diagnostics, predictive tests, and agricultural and environmental innovations. However, in most cases, these discoveries will not be further developed if they are not patent protected.

Without patents, these discoveries will remain just that, discoveries sitting on laboratory shelves, and society will miss out on the public benefit that could have come from such discoveries. Without the ability to protect core biotech inventions such as DNAs, RNAs (ribose in place of deoxyribose, uracil (U) in place of thymine (T)) and their correlates, the prospect of investing in biotech is so risky that investors will choose other industries and technologies in which to invest. The road to putting a biotech product on the market is long (10 to 14 years) and expensive (hundreds of millions of dollars) and, that, only a small percentage (one out of 1,000) of biotech products ever make it to clinical trials and, of those, an even smaller number (one in five) ever make it to the market. These odds are astronomical, and patents provide the investor with an assurance that if anyone benefits from the research, it will be the party that took the risk to invest in that research. Without patents on biotech inventions, investing in biotech would be akin to a donation rather than an investment and investors will choose other industries and technologies in which to invest. The lack of availability of patents for biotech inventions will be detrimental, not just to the growth of, but also to the survival of, the biotechnology industry.
