

## Patent Rights and Licensing

Moderator: Dr. Ashley Stevens  
Panelists: Thomas Meyers, Esq.  
Prof. Michael Meurer

### **Prof. Michael Baram:**

This panel will discuss intellectual property – the patent incentive, patentability issues, licensing, and litigation-related matters. It will be moderated by Dr. Ashley Stevens, the Director of the Office of Technology Transfer at Boston University. Ashley has multiple degrees, including a doctorate in physical chemistry from Oxford University. He has worked in the biotech industry for a number of years, mostly with startup companies and academic research organizations such as the Dana Farber Cancer Institute, where he was also Director of Technology Transfer. Ashley was instrumental in the startup and operations of firms such as Biotechnica International, and started his career at Procter & Gamble. He serves on a number of scientific advisory boards and is known for his work on early-stage technology evaluation and industry-university strategic alliances. He is also a mentor to many of us here at the law school.

### **Dr. Ashley Stevens:**

Thank you. Professor Yarmush gave us a very nice segue into this session.<sup>[1]</sup> A good way of telling when trends are going from the fringes into the mainstream is to read the Sunday cartoons. For example, it was in 1991 or 1992, when the Internet was just getting started and you started seeing cartoons about email, you knew that this was going to be very important and was starting to take off. I wish I had brought with me a cartoon that ran about a month ago in the Sunday Boston Globe in which a grade school teacher has got little kids sitting on the ground around her. The teacher is saying, “Class, today’s lesson on ‘sharing’ has been cancelled and will be replaced with a lesson titled ‘Intellectual Property Protection.’” Clearly, as we move more and more into a knowledge-based economy, intellectual property protection is becoming more and more important.

To put this session on intellectual property protection into perspective, clearly in these high-tech fields intellectual property protection is critical to investment. Rufus King talked about good technology, but he didn’t say exactly what that meant.<sup>[2]</sup> I think he meant two things. Obviously, the technology has to work. Second, it has to be protected.

Second, I observe that the medical devices industry, as Professor Yarmush observed, is a litigious industry.<sup>[3]</sup> If you look at the financials of the major device companies, not every year but periodically, you will see blips of ten- to hundred- million dollar settlements of patent infringement litigation.

I think intellectual property in this industry presents particular challenges. It is unlike pharmaceuticals, where you go through a ten-year development and regulatory approval process, and then sell that drug until the day its patent expires, at which time you will hand it over gracefully to the generic companies. The medical device industry tends to be an industry of relatively short product life cycles. You need to get your intellectual property in place while it still has value. The final challenge that you face is that there are two patent systems worldwide. The U.S. patent system operates on a first to invent basis; the worldwide system is first to file. Since the device industry is a worldwide industry, it is particularly challenging to get your products out there and protected on a worldwide basis. With that, I will introduce the first speaker.

Thomas Meyers is a partner at Testa, Hurwitz & Thibault and a member of their Intellectual Property Practice Group. He focuses on advising clients in all areas of intellectual property law with particular emphasis on biotechnology and chemical patent prosecution, licensing, interference and opposition. He received his B.S. from the University of Illinois in 1982, and his J.D. from Northwestern in 1991.

**Thomas Meyers:**

Thank you. I want to pick up where the last panel left off by telling a story about a panel I sat on about a year and a half ago at the organization that does continuing education for lawyers in Massachusetts, the MCLE. They had an all-day patent course that was attended by about fifty percent lawyers and fifty percent non-lawyers. The course was designed to teach us about the basic nuts-and-bolts of patenting in different areas such as biotechnology, chemistry, electrical engineering, and software. There were about one hundred to one hundred and fifty people attending. We had a wonderful program set up, with a district court judge making the keynote speech at lunch. In the afternoon, there were a number of satellite programs. I was on the panel of the only biotech program on the menu that people could choose from. Of the 150 people in attendance, a total of six showed up for the biotech panel. Three of them were from my firm. One of the people who attended was a head hunter who thought that the panel was on artificial intelligence. She was looking for software engineers to be patent lawyers.

The reason I tell this story now is that today we have a program dedicated solely to biotech, and about 150 people signed up for today's program. I only see one or two people from my firm. I think that gives you a comparison to gauge the interest in biotechnology and that supports what we see in our practice.

We represent a number of biotech companies and biomaterials companies. Over the last year or year and a half, we've seen more interest in patenting. We use patenting to gauge the amount of money that is going into biotechnology. The increase has been encouraging for all of us who have been wondering what we were going to do, or whether we would be doing software patents for the rest of our lives, or whether we were going to have enough biotechnology work. I think the answer is that there is an upswing in the biotech industry. What I want to talk about today is how people in the biotech industry generally protect their investments, and then I want to focus specifically on biomaterials.

What are the kinds of things that people are trying to patent these days? Why do they want patents in the first place? What are some of the pitfalls that people run into in trying to obtain protection for their intellectual property? Most of the people here today are not patent lawyers, and I have been in an audience where a patent lawyer gets up and spends twenty minutes on the minutiae of § 102 of the Patent Act,<sup>[4]</sup> which is boring. I do want to mention two key points for people who are not patent lawyers.

First, a patent does not give you the right to do anything except sue people who are infringing the patent. The patent is a right to exclude others from making, using, selling, offering for sale, or importing that which is claimed in the patent. Keep in mind that a patent does not give you the right to do anything, it just gives you the right to prevent other people from doing things. Second, it is the patent's claims that count. The claim is analogous to the deed on your real property that says that the property extends so far to the North, so far to the East, the West. Your patent claims define the limits of the intellectual property right that you want to exclude other people from. We will talk a little bit about why that is important when we get into more of the details from this particular area.

What are people trying to patent in the area of biomaterials? It is divided into two sub-areas. One sub-area is biotech devices or medical devices. I am not going to spend a lot of time

talking about medical devices, but that group includes things like stents, catheters, and other things that surgeons and physicians use in treating illness. These are examples of medical devices, and medical devices have been around a long time. They are really a different animal than biomaterials. Economically, it is an actual product that you are selling. Typically, a little tweak here or there will take you outside someone else's patent protection. While there is a lot of patent activity going on in this area, medical device patents are not really going to be the focus of my comments today.

My comments will be more geared towards the area that was addressed by the first panel – biomaterials and the interplay between biomaterials and genomics. This is really a hot, new area in biotech right now. We are getting more calls from genomics companies or people interested in genomics patents. Second only to the calls on genomics, are calls of people who are interested in organ regeneration, repair, and reconstruction. There is some interplay between the two but what I want to focus on is the former, the biomaterials, bioengineering aspects of biotechnology.

What are people trying to patent? We have seen patents on scaffoldings and matrices to grow new tissue or to repair damaged tissue. There are two aspects of matrices, cellular and acellular, and the one you use will depend on whether you want the body to seed the matrix itself or whether you have seeded that matrix *ex vivo*. You want to put it in as a scaffolding to grow new tissue, the scaffolding being sort of an architecture around which you want to grow, for example, a new kidney or a new bladder.

People are trying to patent the artificial organs themselves. This leads to some of the problems that I will discuss in a few moments in terms of enforceability and for what you can get patents (or get paid, for that matter). People are trying to patent methods of repairing damaged tissue and methods for replacing dysfunctional organs. By dysfunctional organs, I mean an organ that is there and working, however it is not producing the right enzymes. An example would be a pancreas that is not producing insulin. This sort of dovetails with the gene therapy area that has been in the press lately, but has not shown the promise that we had hoped for a few years ago.

People have also attempted, and received, patents on growth factors. Instead of trying to repair tissue that is damaged, or instead of replacing an organ that is not working very well, people are trying to inject growth factors and get the body to turn itself around. A patient might be missing a kidney, and there may be a growth factor that can be injected that will grow a kidney. While it is never that simple, and no one has been able to develop something like this, people have had some success in the area of bone regeneration and cardiac regeneration using growth factors, at least in the laboratory.

What good are patents in this area? Why do people want patents? Clients call us wanting to patent some idea. We often have to stand back and ask if they really want a patent for what they have said they want a patent on. How is this patent going to protect this business? What is it going to do for their company? Are they going to be able to get economic value out of it?

These are some of the issues that we think about when analyzing the economic value from patents. First, we work with a lot of startup companies. I think for startup companies, the economic value is that patents help create the illusion of value that you need to attract funding. Venture capitalists, in our experience, are typically impressed with somebody who comes in and says that he has forty-two patents. We perform due diligence often on companies that our clients are thinking about investing in. Sometimes, we look at those forty-two patents and find out that only two of them really relate to the business. The rest of them are either on the fringes, do not exist anymore, or maybe the company never paid the right fees. However, just having the

patents attracts investment and notice. If a company has forty-two patents on an artificial kidney, it must be doing something right.

Second, patents keep people out of your space. Patents create a barrier to entry so that you can develop your technology in the quiet of your laboratory, without having to worry about people bothering your product market. As an analogy, think of learning how to shoot free throws in a situation where there are all kinds of people coming onto the court and waving their hands in your face. If you had the patent on that court, nobody can come in, and you can learn to shoot free throws in privacy (and learn to do it quite well).

Third, obtaining an economic advantage in the marketplace is very competitive right now. It is a crowded field, especially in the area of biomaterials. Everybody wants to get in. You want to carve out a niche for yourself, not only to give yourself time to develop the products that you want to develop, but also in the economy going forward. Who are your customers going to be? Who are you going to eventually sell to? Even biotech companies should be thinking about these questions. Eventually biotech companies are going to come up with products, and they will have to get revenues, and there may no longer be a royalty stream. You will look at licensing and hooking up with big pharmaceutical companies. It may be a while, but the trend is going that way, especially in the pharmacogenomics areas that are cropping up. We are seeing a lot of activity not only on the venture capital side, but also on the patent side, which to us is a good economic indicator.

It is still a good idea if you are starting a company to call it [organsareus.com](http://organsareus.com) because you will get some investment just by doing that. But it is not so important as it was. Compare the billions of dollars flowing into the IT companies and hundreds of millions into the biotech companies. However, the biotech companies are on the upswing. Hopefully we will be back to the situation, like not too long ago, where there was substantial interest in biotech. We will be able to fulfill the promise this time of coming up with some actual products, and actual methods, that will service the medical industry and promote biotech better. Getting patents is not just a way for lawyers to make money. That is my response to Dr. Yarmush. <sup>[5]</sup>

What are the pitfalls in this area? I can spend the next hour talking about all of the bad things that can happen to you, but I only have an additional seven minutes. I will try to streamline the pitfalls. However, I think that the pitfalls in this particular area are different than they are in other areas, even biotechnology. The principle reason for the differences is the medical activity exemption, which occurs when a doctor performs a medical procedure on a patient and in doing so infringes a method patent. The doctor is still an infringer. The common misconception is that the doctor has not infringed, but the doctor has. There is no remedy for that infringement under the Patent Act.

For example, take a company that invents and patents many wonderful method patents. One patented method is replacing a defective heart, and comprises of the steps of removing the defective heart and replacing it with a good heart. The patent might not be worth much because if a doctor performs that medical procedure, he or she is infringing your patent but there are no damages. You can not stop the doctor with an injunction, but you cannot get attorney's fees if you sue the doctor. These are the remedies that you normally get against another for patent infringement.

To clarify, when you have a patent, and you think somebody is infringing that patent, typically you want to sue them. You want to say to them: "Stop. Stop doing what you're doing." That is an injunction. But when you say: "Hey! I could have made the six hundred million dollars you made off your infringing product and I want that money back from you," that is asking for damages. Typically, you would go in and ask for your attorney's fees as well. You want the other side to pay your lawyers.

You cannot get either of those remedies when you are dealing with doctors and related health care organizations. You cannot sue the doctor. You cannot sue the HMO. You cannot sue the doctor's employer. This is a problem. You should think about these problems when you are considering which type of patents you want.

The medical activity exemption does not get doctors out of infringement of device patents, however. If I have a patent on the artificial heart, the doctor is not infringing my method patent by performing the procedure, but has infringed my artificial heart patent, and he or she is on the hook for that. This is one thing you do when trying to get around the exemption.

The exemption exists because we as a society have decided that we want to promote treatment of sick people, and we want to give medical doctors an opportunity to heal people if that opportunity is available. The National Institute of Health thinks the exemption is great, and I do not completely disagree with them. However, we still want to promote technology. I like to tell people that the patent system is the only business right which is specifically enumerated in the U.S. Constitution, which gives the Congress the right to establish the patent system.<sup>[6]</sup> Congress responded by saying, "alright, we'll give you this exclusive right to your invention for a period of years so you can keep people out of your space, attract investment, and get all the value from your invention for a period of years. However, in exchange you have to tell us everything. You must disclose everything to the public." The purpose of disclosure is to promote technology and push technology forward. We have a desire to push technology further. We want people to develop artificial organs. We want people to develop ways to repair damaged tissue. Yet at the same time we want people to have treatment available to them when they have a problem. The exemption was the compromise.

Similar problems exist with enforceability. How do you enforce a patent to a medical procedure, to a method? How do you enforce a patent that claims an artificial kidney? What do you do? Do you go after the person with the artificial kidney? That is not going to look good. It is bad public relations if you sue the poor kidney recipient who would have died without the procedure. Do you sue the doctor who used the kidney? Take ten doctors and their combined net worth is probably not enough to make it worthwhile. So, you cannot sue the doctor. What do you do?

You look to the manufacturer. You still want your method patents. You still want your device patents, but you look for infringement damages from the manufacturer. You look for inducement to infringe. You look for contributory infringement. You are telling the manufacturer of the artificial heart (while this is an absurd example it is easy to visualize) that you gave this artificial heart to this doctor to put in this person. You, the manufacturer, knew that there was only one purpose for an artificial heart – to replace the damaged heart. Thus, you induced that person to infringe. You, the manufacturer, contributed to the doctor's infringement. Therefore you are on the hook, and we want damages from you. We would want an injunction to stop you from doing what you are doing – making the artificial heart. Those enforceability problems, I think, are unique in this area, because you have public relations problems (you cannot go after the direct infringer sometimes), and you have to build your patent portfolio, or your intellectual property estate, around those concerns. You still try to get value out of it.

This is where patent lawyers come in. Patent lawyers work with you trying to derive the economic value from your business plan going forward, and figuring where you want to go, and how you are going to protect your assets in the future.

A couple of additional thoughts. It is almost always necessary that a company, especially a start-up, have multiple patents to protect whatever the company sees as its business focus. You need multiple patents because other companies can design around your patent

claims, and they will figure out a better way to do it that does not infringe your patent. Take for example the polymerase chain reaction (“PCR”) patents. PCR was a revolution in biotechnology in the late 1980’s. Originally, there were three, but I think it is now up to seven or eight. They keep getting more to try to keep extending the protection. More than one patent is almost always necessary. You want to view the intellectual property landscape as a fence around your real property. It is a brick fence and there are always holes in the fence, and you want to keep putting bricks in the holes to keep people out until you get a solid fence. People hardly ever achieve that, but that is the aim. Second, you want to consider alternatives to traditional patenting. Alternatives may be cheaper and could provide, in some cases, better protection for your business.

I can think of two ways that people have traditionally used alternatives to patenting to provide protection. First, companies used disposables. A number of our clients’ business models revolve around a big fancy machine. You basically give the machine away, and then you patent the disposables necessary for the machine. You charge people an arm and a leg for the disposable. Now that a customer has the big fancy machine, they have to buy the disposables from your company. This is a good alternative to the straightforward patenting strategy one typically thinks of first.

Second, you consider design patents when you are talking about device-work, medical device work, even biological devices. Here, you patent the way something works. This is useful if there is really no other way to do it that is compatible with the procedure that you are performing, or the procedure that people will be performing. Design patents, which are typically considered not worthwhile, can go a long way in protecting you. You have to be a little creative in today’s landscape because there are so many competitors out there. It is such a crowded field and people are litigious and smart. Few twenty year olds are designing medical devices. However, there are a lot of thirty-five and forty year olds, who have experience, and who can come up with something maybe in an hour or two to design around what you think is your cornerstone technology. You must keep pushing forward. You must be creative and think of multiple ways to protect your technology. The protection is out there, and the patent system is an important cog in that machine.

I will leave you with that thought. Thank you.

**Dr. Ashley Stevens:**

Thank you, Tom. Our next speaker is Michael Meurer, who joined the faculty of the Boston University School of Law last fall. Before that, he taught law at the University of Buffalo, and economics at Duke University. He has both a J.D. and a Ph.D. in Economics from the University of Minnesota. He spent a year at Yale Law School as an Olin Faculty Fellow and a year at AT&T Bell Labs as a Post-Doctoral Fellow. At Boston University he teaches in the areas of intellectual property law, antitrust, and law and economics.

**Professor Michael Meurer:**

Thanks, Ashley. Dean Cass this morning told us that he was interested in biomaterials because of the potential for hair regeneration. I share that interest, and I think that I probably share his knowledge of biomaterials. That might sound discouraging, but I think I do have something interesting and useful to tell you. Instead of talking about the future of biomaterials, I want to talk about the recent past of related fields; namely the impact that patents have had on the biotech and pharmaceutical industries. The first question I want to talk about is the ethical issues that relate to the pursuit of patents and the impact that it has had on the biotech industry. Second, I want to talk about organizational forms in biotech and the essential need for

collaboration between different kinds of organizational forms. I will discuss the impact that patents have had at universities, small firms, and big firms, and how the three interrelate. Finally, I want to talk about biotech patent litigation history.

In terms of ethical issues, the market incentive that is created by the pursuit of patents does not really create new ethical problems but it may aggravate problems that already exist. You need to pay attention to two kinds of problems: first, you have look at issues of informed consent. Second, you want to look at the impact of pursuit of patents on the culture of science. With regard to informed consent there are a couple of topics, actually many topics, that I think are important here, but there are specifically two that I want to tell you about right now. The first one is well represented by the case of *Moore v. Regents of California*,<sup>[7]</sup> which is famous in first-year property classes and from an episode of *L.A. Law*. It is a case that had to do with harvesting of cells from a patient without that patient's knowledge. The cell line ended up being turned into a valuable patent right. The second topic that I want to talk about is experimentation designed to refine patented technology. In the medical area there are questions of informed consent intertwined with questions of patent law.

The *Moore* case involved a patient suffering from hairy-cell leukemia. His spleen cells were harvested and cultured, which produced the Mo cell line. The cell line was patented, and those patent rights ended up yielding fifteen million dollars for Sandoz Pharmaceutical Corporation, and there is an estimated three billion dollars worth of drugs that followed from it.

The California Supreme Court considered the issue of whether or not Moore had a property right to the cells that were excised from his body. He brought a conversion action against the researchers that were involved, but the California Supreme Court declined to find that Moore enjoyed a property right to the cell line. Alternatively, though, he was able to succeed in a tort claim, claiming that the doctors had not informed him fully of the nature of the procedure, specifically, that they had not informed him that the cell line was potentially useful for biomedical research.

Informed consent issues are prominent with regard to biomaterials derived from embryonic stem-cell research. The NIH has recently come out with guidelines that talk about what kind of informed consent is required in that area.<sup>[8]</sup> There is danger that researchers who are looking for attractive target cells to start cell lines, leading to patents and other kinds of valuable commercial property, will overlook the need to obtain informed consent from patients. So, be on guard. Make sure that your clients or your people are complying with informed consent requirements in this area.

The other potential problem arises from Section 102(b) of the Patent Act.<sup>[9]</sup> That section gives rise to something called the statutory bar, which says that you must apply for a patent pretty quickly if you take steps to commercialize or publicize an invention; you could end up invalidating your patent because of that activity. Specifically, one common kind of problem is public use. We want to make sure that public use does not create a danger of detrimental reliance by third parties who see some kind of technology they think is in the public domain and then start to use it. We cut some slack to inventors though by including an experimental use exemption within that doctrine. There was a case involving an orthodontist who experimented with a dental appliance and the Federal Circuit applauded the orthodontist for his efforts to maintain the secrecy of the appliance.<sup>[10]</sup> Unfortunately, the secrecy extended to his patients; they were not informed that an experimental device had been implanted in their mouths. The statutory bar creates an incentive to keep the information secret, but you have to pay attention to your ethical obligations; obligations which could turn into legal problems as well as ethical

problems.

Besides concern about informed consent, you should also think about the implications of the pursuit of patents for your relationships with the academic community. Smart managers in the pharmaceutical industry and especially biotech firms are aware of the importance of bridges with the academic community. Many scientists chafe under concerns about trade secrecy and restrictions on academic publication in a commercial setting. Companies suffer if they depart too much from the academic organizational model of science because they might lose their best scientific employees. Besides problems from too much secrecy, biotech firms should also be mindful of the dangers of trade secret infringement. There was a case in which a journal referee allegedly stole information and used it in a patent application.<sup>[11]</sup> So once again, my message is simply be aware these dangers are out there, and they may be exacerbated by the pursuit of patent rights.

I will now move to the second topic. Collaboration is very important in many biotech fields and probably will be important in biomaterials. Collaboration occurs between universities, start-ups or small biotech firms, and large pharmaceutical firms. I want to comment on the motivation of these different parties when it comes to patents and commercialization of biotech inventions. First, there are technology transfer offices in universities. Actually, I will have more to tell you about descriptive details about how technology transfer offices work, and the role of patents in universities. First, there are just a few comments I want to make.

I want to report some empirical work that describes the behavior of technology transfer offices, and reveals a keen interest in biotech collaboration. Research indicates that technology transfer officers think that only about twelve percent of the technology that they license is ready for commercialization.<sup>[12]</sup> Most of what they license not only is not ready to be commercialized but it requires on-going cooperation by faculty if there's any hope really of ever commercializing the technology.<sup>[13]</sup> Universities are willing to work with companies to achieve that goal. Technology transfer officers indicate that royalty maximization and diffusion of technology are their two primary goals in managing university technology transfer.

They also indicate that in about eighty percent of these licenses there is some kind of profit-sharing arrangement. Many of them include output- or sales-based royalties, but also equity stakes are becoming increasingly common. One motivation for profit-sharing is to align the incentives of the university and the university-based inventor with the licensee and focus all the parties on the goal of commercialization of the technology.

There are a lot of difficult issues faced by start-ups with regard to commercializing their patented technology. The basic problem, I suppose, is that patent licenses that they derive from universities or from other sources transfer certain patented information disclosures that are made in patent grants. But, anybody with experience in the field knows that know-how is very important, and it is difficult to get the know-how transferred. Trade secret licenses are possible. But, really the key in a lot of biotech firms is moving people around, because tacit knowledge can't be communicated very easily any other way. So what you find is that you end up with not only this formal licensing relationship between start-ups and universities, but you see faculty moving back and forth to start-ups. If you are advising the start-up and you are looking at these talented scientists that are moving in and may soon be moving out of the company, you have to be concerned about whether they will go and work for one of your competitors, or whether they will take trade secrets with them when they go.

So a word of advice to attorneys that are thinking about this issue is that you have to make sure that you negotiate something that will be satisfactory to both sides. A difficult issue, but something that is central in planning employment relationships in these start-up companies,

is the high degree of mobility of people with special talents. In fact, empirical researchers comment that star scientists play a key role in the success of start-ups. Extensive research by Zucker and Darby shows that the rate of new product introduction is critically related to the presence of a star academic researcher in a biotech company.<sup>[14]</sup> They also find that geographic proximity to the university where the stars reside is important to the success of the small biotech firms. Beyond that, you want to maintain a kind of culture of science within your start-up. It makes it more attractive to the stars. They have their chance to publish and they view the start-up as being more credible if it seems like it is not too distant from the community of academic science.

I have one last point looking in the other direction. So far I have spoken about the relationship between start-ups and universities. I have less to say, but it is also very important to pay attention to the relationships between start-ups and large firms, pharmaceutical companies.

Financing over the '80s and the '90s for biotech firms has been extremely volatile.<sup>[15]</sup> There have been good days but there have also been bad days. It does not look like the financing history of the dot-coms. An alternative to going out and raising your own capital is striking up some kind of alliance. It is very common to have alliances between biotech firms and the pharmaceutical firms. When start-ups contemplate such alliances, they should think about questions like: "Who's going to control patent litigation? What kind of know-how transfers are going to be made from the small firm to the big firm?" And can you maintain your academic culture within your small firm, even though many of the big companies are skeptical about allowing publication? You want to continue with academic publications because you want to impress your financiers, and you want to keep your academic researchers happy.

There is a fair amount of empirical evidence that says that there are some big pharmaceutical companies that have gotten the message and there are some that have not. Some have a pretty sophisticated research organization that seems to emulate the model of academic science, and other research groups and pharmaceutical companies are more constrained. The empirical evidence shows that there is a high value to pharmaceutical companies of having co-authorship links with people in academic science.<sup>[16]</sup> There is an indication that the research productivity difference is thirty to forty percent. It is higher in companies that maintain close relationships with the academic community. The value of that close relationship is that you are better able to recognize upstream development and you are going to see new research opportunities earlier. In order to create a kind of an academic science culture within these large corporations, you need to take the chances that some of the lawyers in the pharmaceutical companies have been counseling against. You need to let your researchers publish, you need to let them attend academic conferences, and you need to reward them based on their standing in the academic community. The companies that have done that, as well as establish the co-authorship links, are the ones that appear to have been the most successful in terms of moving new products to market and success in terms of research productivity.

The last thing to consider is the point that I made before with small firms, that if you want to establish an academic culture within your large firm, you are going to face the same kinds of problems of, or heightened problems of, employee mobility: concern about departure of key employees and the possibility that they will take trade secrets with them.

The final topic that I want to talk about is patent litigation in the biotech world. The message here is fairly simple. First of all, frequency of litigation and the cost of litigation for biotech patents is very high. Drug and health patents are litigated more than any other kind of technology. There is one empirical study that showed that six lawsuits are spawned by every

100 corporate biotech patents.<sup>[17]</sup> There is also research that shows that most of the start-up companies are spending a comparable amount on legal costs to what they are spending on research.<sup>[18]</sup> So this is a very big concern for start-up companies.

A second issue is that the market surrounding litigation is becoming more sophisticated. You will find that there are financial products available that allow investors to buy into ownership of patents for the purpose of funding litigation and you will find that there is also a nascent patent enforcement insurance market developing; an indication of the great costs involved and the significance of the litigation in this area. Significantly, the research agendas in small biotech companies are influenced by these litigation costs. There is empirical evidence that the smaller start-ups with less financial resources direct their research in such a way that they avoid fields crowded with many patents and fields that are likely to generate a lot of litigation.<sup>[19]</sup>

The final comment that I want to make, something that is a particularly significant issue when you are talking about collaboration between a firm and a university, specifically a state university, is that recent cases involving the Eleventh Amendment<sup>[20]</sup> have made it difficult to challenge the validity of a patent held by a state university.<sup>[21]</sup> Firms that normally insist on patent ownership might let a state university retain patent rights. On the other hand, when you are looking to enforce patent rights, you might have to worry about infringement by laboratories in state universities. The university might be sheltered, and they're the deep pockets, the organization that you would like to name as plaintiff -- you'll end up though, choosing the university researcher as a target, and you may be able to sue the individual researcher to stop them from infringing on your patented technology. As Thomas Meyers said a few minutes ago, that might not be the best move in terms of public relations. The last thing I'll say is keep an eye on legislation that is pending. Congress may try to react to this issue; it is an important consideration since state universities will be the source of a lot of biomaterials patents.

### **Dr. Ashley Stevens:**

Thank you very much Michael. I'm going to talk on four topics briefly. First, I'll talk about the Bayh-Dole Act,<sup>[22]</sup> which started universities out in the patenting business. Second, I'll talk a little bit about universities' approach to patenting; third, about their approach to licensing; and finally, then their approach to start-ups.

I'll start with a little history. I won't go back a million B.C., but I'll go back to 1945. During the Second World War, the government had intervened in the creation of science for the first time. The Manhattan Project, the Penicillin Project, and the microwave radar projects had proven that the government could direct science and produce results. This led to Vannevar Bush and his Endless Frontiers Report,<sup>[23]</sup> which resulted in the growth of the government-funded, peer-reviewed system that has driven the development of science since the Second World War. Now, it turned out that that move had some side effects. Government was funding the science, therefore government owned the results of the science. Fast-forward to 1965 or so, and a situation occurred at the University of Wisconsin concerning 5-fluorouracil (5FU), still a major drug in cancer chemotherapy today. Most of the research had been funded by a drug company and the government had put in, on final examination, minimal funding. Yet the government asserted that they owned the entire rights to 5FU, and that they had policies of non-exclusively licensing technologies. This resulted in a "Chinese Wall" between academic and industrial science, when research was said to be "contaminated" by federal funding.

Fast-forward again to 1978. This was a time when there were severe concerns about US industrial competitiveness, fears about European and Japanese economic supremacy, and the government was looking for ways to enhance US economic competitiveness, and they found that cases like 5FU had isolated academic research from industrial application. One of the solutions was to change the ownership rules of academic intellectual property. They looked for ways to reverse this and so the Bayh-Dole Act, a bipartisan bill sponsored by Senators Birch Bayh (D, Indiana) and Robert Dole (R, Kansas), was born. They found in 1978 that the government owned 28,000 patents and had been successful in licensing only four percent of them. Part of the reason was philosophical – they had this philosophy of only non-exclusively licensing patents. Another part was a practical one. As Michael said, and I firmly believe, for successful translation of academic science, the inventor has to stay involved with the project. So in the pre-Bayh-Dole era, you had the government in Washington through the NTIS owning the patent and the universities controlling access to the researcher. The two just did not get together. The Bayh-Dole Act was passed and it removed a number of things. It removed restrictions on exclusivity. Initially there was a partial removal; soon afterwards, all restrictions on exclusivity were removed. It allowed universities to elect title to patents if they wanted to. If you look at U.S. patents, in about three to four percent of them, you will see the first paragraph after the abstract says that this invention was funded in part by a contract from the government and the government may have certain rights in it. That meant it was an academic patent funded by a grant.

The government retained a nonexclusive license for its own use. It required the product sold in the U.S. be manufactured in the U.S., so the US economy would benefit; the invention couldn't be made with government funding and shipped overseas for cheap manufacture, rather the U.S. manufacturing sector would benefit. It required that universities share the income with the inventor to provide an incentive to participate in the process. Putting, I might say, US academics in a class where their only peer group is Germany – where there are laws that require firms to share with employees profits from their patents.

Finally, there was a walk-in provision whereby if the government felt that the patents weren't being managed in the public interest, they could grant compulsory licenses. This issue was tested very thoroughly in the case of *Johns Hopkins v. CellPro*, where after a protracted debate, Harold Varmus decided to enforce Johns Hopkins's patent against CellPro.<sup>[24]</sup> Johns Hopkins sued CellPro for infringement of their basic patents on CD34. CellPro lost thoroughly in court, and then as a final attempt applied to the NIH for a compulsory license; Varmus declined it, and CellPro promptly shut down.

The Bayh-Dole Act was passed in 1980. It wasn't the only structural change taking place at that time. There were several other important changes – a series of court cases that extended patents to living organisms: *Chakrabarty* extending it to microorganisms,<sup>[25]</sup> *Ex parte Hibberd* extending it to plants,<sup>[26]</sup> and the Leder patent extending patent protection to animals.<sup>[27]</sup> A critical factor was the establishment of the Court of Appeals for the Federal Circuit which created a uniform national court of appeal on patent matters. There were changes on the financial side as well – changes in the Prudent Man rules of investment and reduction in capital gains taxes which stimulated the development of the venture capital industry that Rufus King documented so dramatically earlier today.<sup>[28]</sup>

The result has been that universities have participated, and been major contributors, to the growth of a number of industries – clearly, the biotechnology industry. You can also look at the growth of the Internet and see that all aspects of the Internet were incubated in the academic

sector, developed initially in the defense sector, and later moving under the control of the NSF and into the university sector. This year's survey from the Association of University Technology Managers shows that the universities, teaching hospitals and independent research institutes collectively received royalty income last year of \$800 million, which sounds like an awful lot. But when you start thinking about it, universities, which typically receive 2-5% royalties on sales under their licenses are receiving this much, what is the total economic impact on the country? You can see that there is probably \$25-30 billion in commercial activity and 250,000 jobs in the economy today that are direct consequences of academic technology.

Next, I'll talk a little about universities' patenting activity. First, universities look upon patents as protectors of academic freedom, not as inhibitors of it. After all, the whole essence of a patent is that it allows you to publish your ideas while retaining your intellectual property position in them. Therefore, we encourage researchers, if they think their research has commercial potential, to patent it so that they can go on and be good academics, publish and collaborate and not feel obliged to keep their knowledge to themselves. Next, I would say that universities recognize that their technology is embryonic in nature. I wish that twelve percent of my inventions were immediately ready for prime time. They almost universally require some development. A study out of the University of California a number years ago showed that UC doesn't start to realize significant revenue from a license until it's been in existence for eight years. Certainly, you can look at some sectors where that term is even longer. Gene therapy, which is in the news so much today, is an example. It was in 1986, fourteen years ago, that French Anderson and Steve Rosenberg started their work; still there is not an approved gene therapy product, although there are some now in Phase III. Our own experience with Serogen was that immunotherapeutics took seventeen years for the first product, ONTAK, to get to the marketplace, although certainly it is selling well now. Given both the embryonic nature and the long lead time, a lot of what universities do in their patenting strategies is targeted cost containment, minimizing expenditures and maximizing protection while you try to get the technology assessed and evaluated so that you can see what its potential is going to be.

We love provisional patent applications, which arrived in 1995. They have been a godsend to universities. Generally, when we have been able to contact the researcher or he contacted us before the initial publication came out, we use the PCT system to stake out foreign protection. Then there is that terrible eighteen month deadline down the road for national phase entry. I would say that in general, universities will not enter national phase overseas without a licensee in place to reimburse the costs.

Going on to how universities look at licensing, I would say that we generally do license. Often companies come to us and ask us to assign the patents to them. I would say that there is a great resistance to that.

To pick up on Michael Meurer's point on state universities, there are certain restraints on states. However, there are equal restraints on states in licensing. For example, you cannot bind states to arbitration, which many licensing agreements require. A number of state universities have set up a research foundation that is independent as 501(c)(3) corporations and not part of the state which owns the patents. These foundations may not have those protections that a state itself would.

One of the biggest concerns of a university is that most licenses tend to be exclusive, in which the university gives up control of its technology completely. Therefore, the university is very concerned about due diligence – making sure that the licensee is going to put a serious effort into developing the technology. A lot of negotiations that take place involve due diligence, and the ultimate arbiter of due diligence is annual minimum royalties kicking in quite early to ensure that the technology has significant value to the licensee and that they are prepared

to make \$10,000, \$25,000 or \$50,000 payments each year to keep their rights. We do acknowledge that as the technology leaves the university, its potential is great but its proof is limited. Therefore, perhaps the present value is not great. We will therefore share in the risk of the value of technology proving out either by taking an equity stake in the company if the company is at the appropriate stage or through a series of milestone payments in which, as the technology is proven out, we receive cash payments from the licensee reflecting this increase. Then, in terms of the value that is being contributed up front, since most of these inventions have been funded by grants, which we have no obligation to repay, the need for reimbursement of sunk costs is generally limited to the costs of patenting.

I'll make a couple of observations specific to the medical device area. Boston University has twice gone through cycles in which we licensed a medical device patent to a mid-size device manufacturer, which a few years down the road, was acquired by a large device company. The development project we had with the original licensee didn't meet the development criteria of the large company, and the license was terminated. So we got back a device which was well-prototyped, had good animal data, and had issued patents. We have been successful in licensing these to young start-up companies that were delighted with the well-developed technology that we were able to give them and were able to do an attractive deal. Medical device patents have an enduring value.

On the issue of university-sponsored start-ups, there is a spectrum of involvement with the university. The involvement can be nonexistent. At most universities, faculty members have the right to consult one day a week with third parties. He or she could dedicate that day to helping found a company to develop one of his or her ideas. We might know very little about it. The next level of involvement is where the invention has been disclosed to the university and the university has licensed it and taken an equity stake in the licensee. Some universities have the ability to invest and then even go to levels of involvement like incubation and even participating in the development phase. Boston University has a very prominent activity in that area through our Photonics Center, where we have a very active program of incubating both companies that come to us from the outside and companies that are spawned from our own technology. <sup>[29]</sup>

I'll conclude by saying a little about the Community Technology Fund, which I am part of. It's a fairly unusual organization in academia. We do four things for the University. First of all, we advise the managers of the University's endowment on investing a small part of the endowment in venture capital limited partnerships. Second, we manage a venture capital pool of uncertain value. On December 31, we were about \$35 million dollars, but with all the current biotech and high-tech IPOs, I'm not sure what the value of our fund will be at the end of this quarter. We invest directly in early stage companies – biotech and information technologies (both those that come from Boston University and those that have no involvement in Boston University). The third function we have is taking a proactive role in starting companies. A faculty member can come to us and say that he wants to start a company in this area, but doesn't have the necessary resources. Finally, we do technology transfer. We represent both campuses of the University and in a somewhat unusual move, we also represent our affiliated teaching hospital, Boston University Medical Center.

We're very proud of one of our spin-out companies, a company called Sequenom, founded on technology developed by Charles Cantor of Boston University and Hubert Koster of the University of Hamburg. This is a unique trans-Atlantic collaboration. This company has just gone public, and is developing technology for high-throughput genotyping of individuals' DNA. This company went public late last month, and is currently valued at about \$1 billion.

This concludes my remarks. We have about five or ten minutes to take questions.

## **Question and Answer Session**

### **Audience Member:**

On the topic of academic patenting, will there be a problem with relatively new statutory development that would allow the public to reach into federally funded research under the Freedom of Information Act including non-profit funding?

### **Dr. Ashley Stevens:**

I think you would be able to claim confidential treatment for proprietary information under FOIA.

### **Dr. Martin Yarmush:**

I wanted to comment on the slides addressing the academic nature of companies I think there are as many cases of failures of companies following that model as successes, meaning that if you have an academic star as opposed to an academic center, sometimes it doesn't work just because of those things. I think in those cases it's a good thing gone bad, where placement has become too academic. I think the nature of the successes have been where there has been a natural balance between industrial goals as well as the academic culture. The other thing I just wanted to make a point about involves universities versus health centers. I come from the MGH, and they're very interested in licensing and patenting. However, the mandate there is really that if the physician has something that's useful for the patient population, it's their obligation to get that out there for all patients and the only vehicle is really through industrial development. That sounds nice and if it works out that way, it's great.

I have a problem with universities and the Bayh-Dole Act, where basically the goal is not so much to get it out there for the patient population. There is an equal and opposite drive to make money for the university, which puts it into a different framework. If it's commercializable and can make a lot of money, we go forward with it. But in the case of the health center, it's more an issue of will it help the patients. I would like to hear a comment from a resident university technology transfer officer to see if they see a difference between the two.

### **Dr. Ashley Stevens:**

No, I don't think we do. I think that if we want the invention to be commercialized, it needs to be patented and protected. I think the universities have a legitimate right to participate and share in that income. As I remarked earlier, typically 95% of the benefit goes to the commercial partner and 5% if you're lucky goes back to the university.

### **Dr. Martin Yarmush:**

But I am willing to change the Bayh-Dole Act and say that universities own nothing. They contributed nothing to the invention at all. It was funded by the government, it was worked on by myself and colleagues. What did the University do besides providing rent, which is paid for by overhead? I realize that we have to tag the obligation on somebody out there, but I'm not sure that universities are the ones I would have given it to.

### **Prof. Michael Meurer:**

I agree with the comment. I don't want to oversell the academic model for research in industry. What I observed based on these studies was the correlation – I admit that the studies don't establish a causal relationship. There is a lot of anecdotal evidence, a lot of indirect evidence that suggests that it's very important to stay in touch with academic science and promoting this academic model within corporations is a good start at doing that. But I certainly

agree that you can't forget that ultimately you've got to roll products out, and appropriate standards need to be put into place to accomplish that. There are these twin goals and certainly some of the pharmaceutical companies have failed to maintain incentives to product development in striving to put the academic model into place.

**Dr. Ashley Stevens:**

I think what I hear you saying is an argument I hear a lot from faculty, which is "I did this. This is my invention. What did the university do?" I think the answer is the university had the wisdom to hire you, it had the wisdom to provide you with your laboratory, it may have had the wisdom to supply you with start-up funding. I don't think the university would make any claim to an invention that you made in your garage or your cellar with funds that you raised independently such as through the SBIR program, which is certainly feasible. But when the invention is made in the mainstream of your academic practice, then you made a deal when you joined the university. You signed an assignment agreement which said that in return for a risk-free share of X percent of the income, I assign you the rights. A deal is a deal.

**Steven Bauer:**

If I can give three comparative models and you can see between Harvard and MIT as examples. I'm not so familiar with BU, but you can see the real difference between them in this sense. MIT owns the patents coming out of its research. But the media lab model is different compared to the MIT model. MIT generally can grant exclusive licenses because it's from its technology, except for the information coming out of the media lab. The media lab has a model that's a communist versus a capitalist model. The Media Lab model is anybody who invests in the Media Lab gets access to all the technology non-exclusively. I've been told that it's sad in that the Media Lab gets all this great technology, but there isn't a lot of technology spinning out of the Media Lab. That's because no one can get exclusive rights. You compare that to the rest of MIT and the entrepreneurial entity that it is, and it's because they can grant exclusive rights. Similarly, at Harvard, you have a good comparison of the model. In that instance, my understanding is that Harvard owns all patents or technology that are health-care related. For some reason, Harvard doesn't own in the first instance technology that comes out of non-health-related areas. You see big differences in that area in terms of the technology being spun off. When the university doesn't own it, the researcher is going to have to pay the patent application cost himself. Where you're doing fundamental research, you're not going to see a technology come out five years from now and you're publishing, no faculty member is going to spend \$15,000 of his or her own money to get a patent now that might have value five years from now. The university is willing to pay \$15,000 for the patent now, put it away in its portfolio, allow the researcher to continue researching for the next five years, and then when the technology is developed, there is going to be some profit or royalty availability. There will be a patent there to take advantage of.

**Dr. Martin Yarmush:**

The alternative that I would like to see is not so much to exclude the others, but where the people who fund it own the patents. So if I want to assign rights to the company that's out there, I'm probably violating some major issues, but that's the way I see the entire system being funneled or fueled by industry who paid for it and gets the patent. They will be more likely to fund research in the future to get more patents.

**Dr. Ashley Stevens:**

That exists today. If a company funds research, a standard component of a sponsored research agreement is an exclusive option to an exclusive license. The reason that we do it that way is that universities do their research for cost. We don't make a profit on the research. We ask what the direct costs of doing the research are, what the indirect costs are, and that's what we charge people. If you go to somebody like Arthur D. Little, or SRI, they don't charge costs. Yes, they will give you the results so that you can own the patent, but they will charge you the cost of the research and a profit margin on top. Universities don't do it that way. We charge cost and the profit comes from the income from licensing to the sponsor, if the technology is successful. But the company that has funded the research has exclusive access to the results of the research.

**Dr. Martin Yarmush:**

But one way that you could do that is by funneling in a separate overhead for those people who actually want to own the patents. In other words, you get your profits through doubling your overhead and then the company can own the profit. I think that would be the most robust method of funding research in the long run. It's an alternative.

**Audience Member:**

Regarding the intellectual property of biomaterials, it's been my experience that with virtually all smaller companies and to a greater extent most larger companies as well, very few companies are willing to use or even try to develop newer biomaterials in a medical device because it complicates the path tremendously. From a regulatory perspective, you have to qualify the new material and then, assuming that you are able to do that, you have to then get the device approved. There is also additional time that's involved so that it makes the deal quite a bit more risky. Academic research aside, I'm wondering what are some of the issues specifically related to industry regarding the use of some of these newer, more novel biomaterials closer to the biological materials and how are they going to impact industry needs?

**Thomas Meyers:**

I don't know whether I agree with the question with respect to the move to get approval as a rate-limiting step. I'm not sure that that has a big impact on industry. It has somewhat of an impact, but I'm not sure that it has as big an impact as you suggest.

**Audience Member:**

But if you don't get something approved, you can't market it.

**Thomas Meyers:**

It's true that if you don't get something approved, then you've got a problem down stream. But I don't think that impacts the decisions that companies are making, at least from what we see in the short term. They're always thinking about that in the backs of their minds. We will be hearing from people later this afternoon who might have more direct data, but I don't see, with the companies that we work with, that being a step that stops them from incorporating biomaterials into the devices that they're working with.

**Audience Member:**

New materials – non-existing materials. One of the best cases is how long it's taken us to develop an FDA database of approved materials. This has been going on for three decades, and we still don't have a good one.

**Thomas Meyers:**

There aren't a lot that you can look at and say that this is something that we can get approval for without a fight. I don't do any FDA law, so I can't comment on the statistics. What I can comment on from a patent point of view is that it's not stopping people from pursuing patents. It's not stopping people from doing research. When somebody comes up with an idea, they are not saying that because it's going to be a long road on the way to approval, they're going to discard it.

**Audience Member:**

On the medical device side? I think it's different from the biotech side. One of the fundamental differences between the medical device industry and the biotech industry is the time-lines. Medical devices have a much shorter time to market than a biotech or a drug product.

**Thomas Meyers:**

That's right, because there is that database for approvals on the medical device side that doesn't exist on the biotech side, but on the biotech side I don't see it as a major impediment for the people that we work with.

**Audience Member:**

I would agree that it might not be an impediment on the biotech side, but I think it is an impediment on the device side.

**Thomas Meyers:**

I would agree.

**Dr. Ashley Stevens:**

You heard what Josh Tolkoﬀ said earlier this morning. It has been the breast implant litigation that's done it. When Dow Chemical can be sued for the activities of an independent joint venture company that it's set up, that puts a severe chill over all novel biomedical materials. I think Congress has started a trend and addressed this. I forget what the legislation providing an exemption is, but it's still providing a chill.

**Audience Member:**

I think that's an excellent example, because today all but two suppliers of medical-grade silicones have been driven out of the marketplace. Even in suppliers of other biomaterials, oftentimes they are asking for \$1 billion indemnification before they will allow you to use their materials. If you're a small company, that's just not a possibility.

**Dr. Ashley Stevens:**

I would like to thank the Panelists and wish you a good lunch.

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[1] See Joyce Wong et al., *Advances in Biomaterials & Devices, & Their Financing*, 6 B.U. J. SCI. & TECH. L. 2, ¶¶ 26-41 (2000).

[2] See *id.* ¶ 66.

[3] *See id.* ¶ 93.

[4] 35 U.S.C. § 102 (1994).

[5] *See* Wong et al., *supra* note 1, ¶ 93.

[6] *See* U.S. CONST. art. I, § 8, cl. 8.

[7] *Moore v. Regents of California*, 793 P.2d 479 (Cal. 1990).

[8] *See NIH Director's Statement on Research Using Stem Cells -12/1/99* (last modified Dec. 1, 1999) <<http://www.nih.gov/news/stemcell/draftguidelines.htm>>.

[9] *See* 35 U.S.C. § 102(b) (1994)

[10] *TP Labs. v. Prof'l Positioners, Inc.*, 724 F.2d 965, 972 (Fed. Cir. 1984).

[11] *Solarex Corp. v. Arco Solar, Inc.*, 870 F.2d 642 (Fed. Cir. 1989).

[12] *See* RICHARD JENSEN & MARIE THURSBY, PROOFS AND PROTOTYPES FOR SALE: THE TALE OF UNIVERSITY LICENSING 5 (National Bureau of Econ. Research Working Paper No. 6698, 1998).

[13] *See id.* at 6 (“For 71% of the inventions licensed, respondents claim successful commercialization requires cooperation by the faculty inventor and the licensee in further development.”).

[14] *See* Lynne G. Zucker et. al., *Geographically Localized Knowledge: Spillovers or Markets?* 36 ECON. INQUIRY 65 (1998).

[15] *See* JOSH LERNER & ROBERT P. MERGES, THE CONTROL OF STRATEGIC ALLIANCES: AN EMPIRICAL ANALYSIS OF BIOTECHNOLOGY COLLABORATIONS 3-4 (National Bureau of Econ. Research Working Paper No. 6014, 1997).

[16] *See* IAIN COCKBURN & REBECCA HENDERSON, PUBLIC-PRIVATE INTERACTION AND THE PRODUCTIVITY OF PHARMACEUTICAL RESEARCH 2-3 (National Bureau of Economic Research Working Paper No. 6018, 1997) (“[Close contact] to the community of open science is a key factor in driving a firm’s ability to recognize and use upstream developments, and . . . it has a large impact on research productivity.”).

[17] *See* Josh Lerner, *The Importance of Trade Secrecy: Evidence from Civil Litigation*, paper presented to the Conference on the Economics of Intellectual Property Rights, ICARE Institute, University of Venice, Italy (October 6-8, 1994).

[18] *See* JEAN O. LANJOUW & MARK SCHANKERMAN, STYLIZED FACTS OF PATENT LITIGATION: VALUE, SCOPE AND OWNERSHIP 3 (National Bureau of Economic Research Working Paper No. 6297, 1997) (noting that crowded fields and new fields of technology generate more patent litigation); JEAN O. LANJOUW & JOSH LERNER, THE ENFORCEMENT OF INTELLECTUAL PROPERTY RIGHTS: A SURVEY OF THE EMPIRICAL LITERATURE 13 (National Bureau of Economic Research Working Paper No. 6292, 1997) (correlating number of times that a patent is cited in future applications to the value of the patent and noting that innovative technology patents are cited with increased frequency).

[19] See Josh Lerner, *Patenting in the Shadow of Competitors*, 38 J. L. & ECON. 463, 465 (1995) (“[P]atenting behavior of firms varies with litigation costs . . . . When high-litigation-cost firms do patent in subclasses in which rival biotechnology firms have already patented, they tend to choose less crowded subclasses.”).

[20] “The Judicial power of the United States shall not be construed to extend to any suit in law or equity, commenced or prosecuted against one of the United States by Citizens of another State, or by citizens or Subjects of any Foreign State.” U.S. CONST. amend. XI.

[21] See, e.g., *Florida Prepaid Postsecondary Educ. Expense Bd. v. College Sav. Bank*, 527 U.S. 627, 640 (1999) (invalidating Patent Remedy Act, which abrogated States’ sovereign immunity to patent infringement suits, on Fourteenth Amendment grounds); Robert G. Bone, *From Property to Contract: The Eleventh Amendment & University-Private Sector Intellectual Property Relationships* (2000) (unpublished manuscript, on file with author).

[22] Pub. L. No. 96-517, 94 Stat. 3015 (codified at 35 U.S.C. §§ 301-07 (1994)).

[23] See VANNEVAR BUSH, *SCIENCE, THE ENDLESS FRONTIER: A REPORT TO THE PRESIDENT ON A PROGRAM FOR POSTWAR SCIENTIFIC RESEARCH* (1945).

[24] See *John Hopkins v. CellPro*, 152 F.3d 1342 (Fed. Cir. 1998).

[25] See *Diamond v. Chakrabarty*, 447 U.S. 303 (1980).

[26] See *Ex parte Hibberd*, 227 U.S.P.Q. (BNA) 443 (Bd. Pat. App. & Int. 1985).

[27] U.S. Patent No. 5,925,803.

[28] See Wong et al., *supra* note 1, ¶¶ 62-72.

[29] See *The PHOTONICS CENTER at BOSTON UNIVERSITY* (last modified Sept. 14, 1998) <<http://www.bu.edu/photronics/>>.