UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF NEW YORK

ASSOCIATION FOR MOLECULAR PATHOLOGY; AMERICAN COLLEGE OF MEDICAL GENETICS; AMERICAN SOCIETY FOR CLINICAL PATHOLOGY; COLLEGE OF AMERICAN PATHOLOGISTS; HAIG KAZAZIAN, MD; ARUPA GANGULY, PhD; WENDY CHUNG, MD, PhD; HARRY OSTRER, MD; DAVID LEDBETTER, PhD; STEPHEN WARREN, PhD; ELLEN MATLOFF, M.S.; ELSA REICH, M.S.; BREAST CANCER ACTION; BOSTON WOMEN'S HEALTH BOOK COLLECTIVE; LISBETH CERIANI; RUNI LIMARY; GENAE GIRARD; PATRICE FORTUNE; VICKY THOMASON; KATHLEEN RAKER, Plaintiffs, v. UNITED STATES PATENT AND TRADEMARK OFFICE; MYRIAD GENETICS; LORRIS BETZ, ROGER BOYER, JACK BRITTAIN, ARNOLD B. COMBE, RAYMOND GESTELAND, JAMES U. JENSEN, JOHN KENDALL MORRIS, THOMAS PARKS, DAVID W. PERSHING, and MICHAEL K. YOUNG, in their official capacity as Directors of the University of Utah Research Foundation, Defendants	Civil Action No. 09-4515 (RWS) ECF Case **DECLARATION OF FIONA E. MURRAY, Ph.D.**

I, FIONA E. MURRAY, Ph.D., certify under penalty of perjury that the following is true and correct:

1. I am an Associate Professor of Management of Technological Innovation and Entrepreneurship at the Massachusetts Institute of Technology (MIT) as well as an Affiliated Professor in the Harvard-MIT Division of Health Science and Technology.

2. I submit this declaration in support of Plaintiffs in the above-captioned case.

3. I received both my Bachelor's and Master's degrees in Chemistry from the University of Oxford in 1989 and 1990, respectively. I received a Ph.D. in Applied Sciences from the Harvard University School of Engineering and Applied Sciences in 1996.
4. My research focuses on the study of science commercialization, the organization of scientific research and the role of science in national competitiveness. I have studied how growing economic incentives, particularly intellectual property (IP), influence the rate and direction of scientific progress, particularly in the areas of genomics, stem cells and mouse genetics. I have authored and published articles on my research in numerous journals including *Science*, the *New England Journal of Medicine*, *Nature Biotechnology*, *Research Policy*, *Organization Science* and the *Journal of Economic Behavior & Organization*. A complete list of my professional credentials and publications is contained in my curriculum vitae, attached as Exhibit 1.
5. In 2005, I was awarded a grant to research the impact of gene patenting on scientific progress and commercialization. My empirical research in this area demonstrates that gene patents -more precisely patents that claim human protein-encoding nucleotide sequences- decrease the long-run production of public genetic knowledge as measured by citations to related gene publications. This general trend is exacerbated in situations when patents are broad in scope, privately owned, or where the patented genes are closely linked to human disease, and especially cancer. All of these conditions are relevant to the patents held by Myriad Genetics that are the subject of this case.

GENE PATENT LANDSCAPE

6. Gene patents have been the subject of considerable debate for many years. In 2005, to provide more empirical data on this topic, my colleague Kyle Jensen and I published an

article in *Science* documenting the patent landscape of the human genome. Using a precise algorithm based on bioinformatics methods, we identified *all* patents that claimed human nucleotide sequences (as listed using the REFSEQ language) in the claims and physically mapped the gene-oriented IP rights to specific locations along the human genome. Our results revealed that **4382** of the **23,688** genes listed in the National Center for Biotechnology Information's gene database, or nearly **20% of human genes**, are explicitly claimed (for some use or another) as United States intellectual property. The article in which these results were published is attached as Exhibit 2.

EFFECTS OF GENE PATENTS ON LONG-RUN SUPPLY OF PUBLIC KNOWLEDGE

7. Building on the results of the 2005 paper, my colleague Kenneth Huang and I devised a study to gauge the influence of gene patenting on the long-run supply of public knowledge. Our starting point for this analysis was to identify and examine human gene patent-paper pairs. These are cases where a gene sequence is disclosed both in the claims of a gene patent and also discussed in a related publication by a related set of authors..
8. In accordance with U.S. patent law, a purported inventor who wishes to patent an invention must file a patent application no later than one year after publishing the invention. The patent application process often takes over two years. Consequently, in cases of gene patent-paper pairs, there is typically a three- to four-year lag between the publication of a paper on a gene sequence and the issuance of a patent disclosing the sequence of that gene.
9. During this lag period of three or four years, the not-yet-patented information is essentially part of the public knowledge stream. Follow-on researchers are entitled to treat the information as such. This means the follow-on researcher who relies upon the

information typically is obligated to do no more than acknowledge the original author with a citation in any follow-on work. In other words, in the period prior to the patent grant, genetic knowledge is disclosed in a paper and contributions to future public knowledge stream building on that paper accumulate in an institutional setting characterized by public norms and practices.

10. Once a patent is granted, the patent owner may legally provide, restrict, or prohibit access to any researcher seeking to build upon the patentee's contribution. Any follow-on accumulation of knowledge takes place in the shadow of formal legal private property.
11. By comparing the difference in gene patent paper citations in the pre- and post-grant period for those affected by the patent grant to the same difference for unaffected gene paper citations, we can evaluate the precise impact of the change.
12. From the human gene patents identified in the 2005 patent landscape documentation, my colleague and I identified 1279 patent-paper pairs: instances in which a gene sequence was disclosed in both the publication and claims of the gene patent. The 1279 pairs we analyzed disclose 2637 human gene sequences in publications and correspond to 11% of the known human genes as defined by NCBI. We then studied follow-on research published during both the pre- and post-patent grant periods for each gene patent-paper pair – as captured by publication citations.
13. We hypothesized that the grant of a gene patent would negatively impact the rate of follow-on publications.
14. We also hypothesized the degree to which a gene patent would negatively impact the rate of follow-on publication would depend upon a number of factors, including: 1) the breadth of the patent granted over the knowledge claimed; 2) whether the patent is

assigned to a private sector compared to the public sector; and 3) the applicability of the knowledge claimed (the more useful the knowledge associated with the patent – for example, where the gene sequence is directly correlated with a common disease – the more the patent would deter follow-on publications.)

15. We took an empirical approach to testing these hypotheses. We used publication citations to each gene paper (i.e. peer-reviewed publications citing the focal paper) as a proxy for follow-on public knowledge accumulation. The full details of our methodology and variables used in our analysis are disclosed in our publication of the study, attached as Exhibit 3.

KEY RESULTS

16. The study results supported our hypothesis. We found that the negative impact of patent grant on the future public knowledge production, as measured by the annual rate of forward citations to the paired paper, was 17%. A more stringent interpretation of the results showed a 5% decline in the expected rate of citations. This more stringent interpretation suggests that follow-on genetic researchers forego about one in ten research projects (or more precisely research publications) because of the causal impact of the gene patent grant.
17. Our results additionally showed that the negative impact of a gene patent grant on follow-on publications was worse when the patent assignee was from the private sector compared to the public sector (a 6%-9% decline as compared with 0%-3% for academic patents).

18. Our results also showed that patent scope and strength had a modest, but statistically significant, impact on the degree to which a gene patent grant had a negative impact on follow-on publications.

19. Our results additionally showed that the negative effect of patents on follow-on public knowledge production is greatest for genes closely linked to human diseases. While we would expect that gene papers on disease-related genes would be more highly cited, our methodology allowed us to distinguish between this "levels" effect and the effect of a gene patents grant on annual citations. Only disease genes listed in the Online Mendelian Inheritance in Man (OMIM) database were found to have a significant 8% reduction in forward citations. In looking only at cancer genes, the effect was even more pronounced: the sample of proven cancer genes sees a negative impact of 11% as compared with 4% in the non-cancer sample.

CONCLUSION

20. Based on my expertise in studying the effects of gene patents on the stream of public knowledge and in particular on the results of the 2009 empirical study described above, it is my opinion that the Myriad patents at issue in the instant lawsuit are likely to have negatively impacted the accumulation of public knowledge of the BRCA1 and BRCA2 genes by between 5 and 10%. The negative impact of the patents at issue is exacerbated by the fact that Myriad Genetics is an assignee from the private sector, the patents in question are exceedingly broad, and the genes at issue are cancer genes.

I declare, pursuant to 28 U.S.C. § 1746, under penalty of perjury under the laws of the United States, that the foregoing is true and correct to the best of my knowledge and belief.

Fiona E. Murray

Executed on January 19, 2010