Remarks for the 2008 DBBS PhD Graduate Celebration

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Ralph, John, Honored Graduates, DBBS Faculty, financially relieved parents, relaxed relatives, friends, and envious members of future DBBS Graduating classes. Good afternoon, and congratulations to you all.

When I say congratulations, I don't mean it simply in the general celebratory sense of having strived and achieved an important educational goal. You new graduates and the 34 prior years and 990 PhDs who have graduated from the Division of Biology and Biomedical Sciences at Washington University in St. Louis have obtained a doctor of philosophy degree in one of the finest inter-disciplinary, collaborative programs in biomedical research and education that has ever existed. Your faculties are among the most distinguished members of cutting edge research in some of the most highly competitive areas of biology and biomedicine, and as you are well aware they have been extremely successful in their enterprises. As a result, you as students working in this environment with these faculty have both benefited and contributed. So congratulations all around are in order.

A splendid example of your stellar intellectual environment is the paper that Ralph published in the first issue of SCIENCE for 2008, with 50 other colleagues from 7 countries: a genomic analysis of the moss, *p.patens*,

that illuminated one of the most important events in the history of the earth, the conquest of land by plants.

The interdisciplinarity of the programs you were offered are unique resources to this University. The 12 graduate programs of predoctoral training are broad enough to cover the entire range of dynamic fields in biology and biomedicine. Yet as pioneering as they were when the program was created in the mid-70's, your faculty recognized that the future course of science is unpredictable, and that new programs merging ever broader approaches to the biological sciences were needed. From that realization emerged the current 8 special emphasis pathway programs. Just reading the topics that they have allowed you students to be exposed to is inspirational to an alum of the Medical Campus. The pathway in human pathobiology alone separates you from the thousands of 21st century biology and biomedical PhDs who are obliged to think of translational research without having the foggiest idea of how pathology informs the curious mind as to what features of normal physiology we do not yet understand.

Of course, given my own career emphases I am as drawn to the Cognitive, computational and systems neuroscience pathway, as I am to the imaging sciences pathway, and as I once was temporarily drawn to the Life Sciences entrepreneurship pathway. I have no doubts that this dynamic program will continue to evolve, extending didactic pseudopodia deeper into the problems of society.

In my view, we must help science move beyond what we have learned from the human genome project to what we don't yet understand: how do the challenges of the environment expose gaps in our understanding of vulnerabilities or resiliencies to disease? Environmental Biology and Disease could train our bioengineers to develop environmental biosensors while extending the power of our social scientists to understand how to help society avoid diets of big Macs and sugar-laden cola drinks.

There is another big problem I see in the distance, in part prompted by the attention given to genomic markers of disease vulnerability in a society for whom public health measures are invisible. Public health is based on the premise that society faces common problems that can be minimized if we agree to support improvements in our shared environments like clean water, reducing environmental pollution, and protecting a safe food supply. The social problem we may face is how to maintain the support for those public problems if individuals who pay to have their genome sequenced become obsessed with their own future disease vulnerabilities and the steps they may be able to take to compensate. The fascination with recreational genomics has both legal, psychological and ethical implications—few yet based on evidence of the benefits of knowing versus not-knowing, at least for now.

So believe me then when I say it is indeed a special pleasure to participate in your program's celebration and to add my small increment to the growing traditions of the DBBS graduate program. Before becoming a Trustee of the University, my only visits to the hilltop campus were to audit a course of differential calculus during my internship year to make up a deficit in my undergraduate education.

Ralph mentioned in his introduction that I had been the Editor-in-Chief at SCIENCE between 1995 and 2000. When they were doing the search, the AAAS set aside a goodly sum of money in case the new Editor wanted to move to Washington, DC, the home of the Association and the home of SCIENCE. Having lived in DC at least 3 times before, I knew I would prefer to live in San Diego. So it happened that when 2 of my News Editors, Ellis Rubenstein and John Benditt came to me with a new idea, I had some funds to invest to get it started. Their new idea was to launch a new online-only journal for graduate students, post-docs and new faculty, that we called Science's Next Wave.

At the March, 2008, meeting of the Board of Trustees, the Research-Graduate Affairs Committee heard from Dean Robert Thach, that when he first began his post as Dean of the Graduate School of Arts & Sciences in 1993, doctoral education in the US was facing public criticisms and graduate student unrest. There were 3 main problems recognized. The first 2—limited and unreliable financial support and long times to degree—have been directly confronted with decreased attrition, increased

student morale and faster degree completion. The third factor—uncertainty in the academic job market—was and is a real world issue.

In 1995, when I started at SCIENCE, the scientific community was in one of its lesser funding crises, but there was growing recognition, well before the concept of a doubling for the NIH budget had gained traction, that all the new scientists we were training might not be able to find jobs in the academic setting to continue to work as they had as students or post-docs. Industrial jobs were still regarded as disloyalty to the academic system and as a less than professional alternative. The concept behind SCIENCE's Next Wave was to offer a resource in which alternative employment opportunities for better or for worse could be shared among those contemplating whether they were on the right path for themselves.

In addition to the professional journalists who staffed the journal online in Washington, campus correspondents were sought who could tell others what was going-on on their campuses, which seminar speakers were coming up, who were the good mentors and the not-so-good mentors. Soon we had lots of accomplished and high achieving individuals volunteer to write of their own reasons for leaving strict academic science for pursuits in many other highly worthwhile opportunities, and not just in the United States but globally.

When the money I had to invest in this enterprise was running out, Ellis was able to get subscriber support from graduate schools all across the

US to make the information available to their students. This support then lead internationally to national subscriptions for most of the NATO countries, Canada, Mexico, several countries of South America, China, Japan, Australia, and Southeast Asia. The value brought to their students was confirmed when in year three, all these supporters with few exceptions renewed their campus-wide and nation-wide subscriptions. In 2006, after more than ten years of operations, SCIENCE's Next Wave merged with another ongoing AAAS student member benefit, namely a listing of job opportunities, fellowships and other sources of special training funds. The combined operation, now called "Careers.org" , represents a very popular web site for those nearing the end of their current career phase and contemplating what to do next.

It was this background I had in mind when Ralph asked me to do this talk and why I gave it the provocative title 'so now what'? At that time, Careers was doing a weekly series of excerpts from an excellent book "Mastering your PhD: Success in the Doctoral Years and Beyond" written by Patricia Gosling, a senior writer for Novartis in Germany and Bart Noordam, a Professor of Physics in the Netherlands. The series of excerpts, appearing once a month since October,2006, has covered such topics as "Preparing for your Post-PhD. Career", "Dealing with Difficult Colleagues", "Writing Your Doctoral Thesis", "Making the Most of a Scientific Conference", "Dealing with Setbacks" (in your research) , and "Mentors, Leadership and Community". In my view, the latter choice is perhaps one of the most critical decisions you will make in selecting where and with whom you will do your next phase of career development,

but knowing where to get the useful advice in that decision could perhaps now be done more easily, given the resources at Science's Careers.

Science's Careers is the most comprehensive source of science-related employment opportunities, funding announcements, and career-development articles on the Web. Scientists and engineers in academia, industry, and government come to Science's Careers.org to find jobs and then return again and again to gain the skills they need to land jobs and build their careers.

There are more than 4000 information-packed articles about science careers accessible, and in any given week, in excess of 2000 jobs in their jobs database. There are some 600 current fellowships and grants listed on GrantsNet at this web portal--most of them awards from private sources that you won't find listed on the Web sites of the National Institutes of Health or the National Science Foundation… and all of it is free.

When I looked back through the list of the previous 34 years of graduates from this PhD program, I can see that many of your predecessors have ventured outside of the strict academic research lab pathway, as the seminars held this afternoon have made clear. It is said that less than 50%

of graduate students have firm job commitments 3 months before they graduate. While I won't ask for a show of hands from those already interested in career alternatives I will just mention a few paths that turn up frequently, and now you will know where to find them:

Consulting/Publishing
Technical Writing
Science Journalism
Science Publishing
Broadcast Journalism
Venture Capital
Biotech Investment Analysis
Business Development
Entrepreneur
Business Consulting
Regulatory Affairs
Patent Agent
Clinical Trial Affairs
Technology Transfer
Corporate Communications
Sales and Marketing
Head Hunter
Science Education Policy
Science Policy
Res. Funding Administrator
Govern. Res. Progr. Manager
Information . Service's Entrepreneur

As I said, you may not be interested in any of those options now, but if and when you are, for whatever reason, you'll know where to find those and some of the new opportunities that may have arisen. Science PhDs can contribute to science in many important ways beyond doing original research in the same way that JDs contribute without practicing law or MDs contribute without practicing medicine.

Let me now conclude with some brief remarks on two *facets* of the scientific life, some small residue of which you may find useful as you move forth along your future career's development.

The two facets are 1) Zadig's (ZAHDEEG's) Method, or the insightful power of the curious observer, and 2) the recognition that there will be many roles you will be called upon to play in the greater community of scientists.

ZAHDEEG's Method is likely not well known to you , at least not by that name, so let me clarify. ZAHDEEG was an heroic character in a fable of Voltaire, written in the mid-eighteenth century. He was endowed with marvelous powers of observation and reasoning. In one example, consider this description of his analysis of a horse he has never seen:

> "In the lanes of this wood, I observed the marks of a horse's shoes, all at equal distances. This must be a horse I said to myself that gallops excellently. The dust on the trees in a narrow road that was but 7 feet wide was a little brushed off, at the distance of 3 feet and a half from the middle of the road. The horse, said I, has a tail 3 feet and a half long, which being whisked to the right and left has swept away the dust. I observed under the trees that formed an arbor 5 feet in height, that the leaves of the branches had newly fallen; from whence I inferred that the horse had touched them and that he must therefore be 5 feet high...."

It is perhaps interesting for your scientific appreciation, that this passage was drawn from an earlier sixteenth-century collection of stories about the travels of the three sons of the king of Serendippo, a book which had prompted the term "serendipity" . .. and in fact I found this entire description by accident while reading a book of essays by the late English Social Psychiatrist Michael Sheppard while once preparing myself to debate the enhanced value of Biological Psychiatry over Psychoanalysis.

Zadig's method was well known and appreciated by T.H. Huxley, who termed it "retrospective prophecy", and concluded in an essay on the subject that:

"The rigorous application of Zadig's logic to the results of accurate and long-continued observation has founded all those sciences which have been termed historical (archaeology, paleontology, astronomy, geology).

It is also the basis of what medical students are taught when they obtain histories of patient complaints and try to draw from these details the physical origins of their problems.

Zadig's logic was also much appreciated by one Professor Joseph Bell, a nineteenth century Scottish surgeon who was said to possess the ability to diagnose people as they came in the door of his clinic. Bell was the professor and mentor of Arthur Conan Doyle who later incorporated and somewhat exaggerated these analytico-synthetic skills into Detective

Sherlock Holmes whose classic powers of observation should be well known to you.

Zadig's logic will apply to every problem you encounter as you go forward into the world of experimental science when you sense a question and ask yourself how did this come to be this way? It will be a skill that will do you well when you ask, if it happened to emerge this way, then if I ask this question in a new experiment, it should then reveal this result.

... And it will apply especially when you do the properly framed experiment, with many of the right controls, and the results reveal themselves to be totally the opposite of your prediction. It is then that you will need the keenest powers of retrospective prophecy to move ahead because now surely you have an important problem worth pursuing.

It may be clear from this tale that the powers of good teachers have enormous formative powers on receptive students, and you have experienced this in your training here. It is one of the many roles you will play in renewing the graduate educational system that has shaped you thus far. For in science, as in much of life, knowledge of facts and a desire to discover new facts is not enough—

One also has a duty to the larger scientific community to help the system survive. There is an ancient Chinese proverb that holds "When you drink from the stream, remember the spring"-- remember where the system of your education here arose-- from the energies and support of your mentors and fellow students.

The essence of this view was well expressed by one of my favorite intellectual icons in shaping the American world of science after world war II, namely Vannevar Bush. In July 1945, in his report to President Truman, entitled “Science, The Endless Frontier “ , Bush wrote that basic research was: "the pacemaker of technological progress” and "New products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science!"

Bush recommended the creation of what eventually became in 1950 the National Science Foundation (NSF), intended to cement the ties between academic science, industry and the military which had been forged during the war.] Bush almost single-handedly led the conversion of the academic scientific community from its contributions to the war effort into a peacetime in which Science was to be the endless frontier for the good of the public. Among other achievements, he also

accurately predicted computerized information handling, hypertext, and desktop computers.

In his book of essays "Science is not Enough", Bush wrote:

"The process by which the boundaries of knowledge are advanced, and the structure of organized science is built, is a complex process indeed. It corresponds fairly well with the exploitation of a difficult quarry for its building materials and the fitting of these into an edifice...

"... the edifice (organized science) itself has a remarkable property, for its form is predestined by the laws of logic and the nature of human reasoning.

It is almost as though it had once existed, and its building blocks had then been scattered, hidden and buried, each with its unique form retained, so that it would fit only in its own peculiar position, with the concomitant limitation that blocks cannot be found or recognized until the building of the structure has progressed to the point where their position and form reveals itself to the discerning eye of the talented worker in the quarry."

Bush went on in this short essay to describe the nature of the workers; I will mention a few you will recognize:

Those content to dig away, unearth odd blocks, pile them up for others to view and caring not whether they fit in now;

Those who watch carefully until some industrious group digs out a particularly ornamental block, whereupon they fit it into the structure with much gusto and bow to the crowd;

...groups who do not dig at all but spend their time arguing about the placement and fit of earlier additions;

..those who sit by and give advice, and those who just sit.

On the other hand there are those (scientists) of rare vision who can grasp well in advance just the block that is needed to advance construction rapidly and can tell by some subtle sense (perhaps Zadig's logic) where it will be found. For each of these master-workers there will be many who chip and delve industriously... with little grasp of what it is all about but (who) nevertheless make the great steps possible.

There are those who can give the structure meaning, can trace its evolution, and describe the glories that are to be to inspire those who work and enjoy.

There are also those old men, whose days of vigorous building are done; they have built a wall here and there, and lived long in the edifice and learned to love it, and who have even grasped a suggestion of its ultimate meaning, and who sit in the shade and encourage the young workers."

DBBS Graduates of 2008, as you go forth to seek your fields of exploration, remember well those who have guided your way here. Renew your commitment to the long-term survival of the scientific edifice of knowledge. May you have the satisfaction of many discoveries of your own before the time comes when it is your turn to celebrate a graduating class.

In closing, I offer you this final thought—think about the bigger issues; connect with other people. Think about what it means to have a scientifically trained voice, and use it. Use it.

My very best wishes for your success.