

Carissa Krane, PhD, Associate Professor, Biology

Response to “The Humanities and What Matters”

I also want to thank Pat Johnson for the invitation to participate as a panelist for this Humanities Symposium. While mindful that this is a Symposium on the Humanities, with my remarks, I will take you into enemy territory. Yes, I’m going to talk ‘science’. I will focus my talk on ways in which the goals and pursuits of scientists exploring and discovering the natural and physical world through the scientific method are shared with scholars in the humanities who seek to understand how we as humans interact with and experience the world around us. My hope is to add to the discussion of “What Matters”. The essence of my thoughts on this matter are this: The scientific method is a powerful tool for delivering answers to important questions of “how” and “what”. But it is a clumsy tool at best for answering equally important fundamental questions of “why”. It is only through the linking of knowledge and understanding across disciplines that we can create a truly useful common ground work of explanation and meaning.

Today marks the 10th anniversary of the release of the first completed draft sequences of the human genome. With much negotiation, the publically funded Human Genome Project, and Celera Genomics, a privately funded company--both racing to be the first to “complete” the genome --- agreed to jointly declare success in completing draft sequences of the genome and to publicly release on the same date, the results of their research. In addition to generating the complete sequence of the human genome, the goals of the human genome project involved the sequencing of the genomes of other organisms, the development of the technology to efficiently and cost effectively complete the sequencing effort, the generation of the computational tools required to analyze the enormous amount of data collected, and the development of an ethical, legal and social issues plan for how the data would be used. Analysis of the draft sequence revealed unanticipated results. Prior to the availability of the sequence of the human genome, the total number of genes in the human genome was estimated to be between 35,000 and >100,000. That number decreased to only 30-40,000 predicted protein coding genes once the genome sequence was analyzed. Compare this number with ~13,700 protein coding genes in *Drosophila melanogaster*, the fruit fly, 19,000 genes in the microscopic roundworm *C. elegans*, or 25,000 genes in the flowering plant *Arabidopsis thaliana*.

How could *Homo sapiens*, humans, with our exceptional abilities and complexities, have only 2X the number of genes as a microscopic roundworm? Further genomic comparisons with more closely related primates, showed that the nucleotide sequence of chimpanzees and humans differ by only

1.23% or approximately 35 million positions out of the 3.2 billion nucleotide pairs which make up our genomes. Today, 10 years after that first draft release, the estimate of the number of distinct protein coding genes has been further reduced to ~21,000. Of these, approximately 2/3 of our proteins have counterparts or orthologs in other mammals. Through observation, discovery and experimentation, we now know that it is not through the total number of genes that we garner our complex functionality, but rather through specialized regulatory mechanisms such as alternative gene splicing that we can differentially express many more proteins than we have genes. We are also beginning to understand how it is that environmental influences can cause epigenetic changes at the molecular level which can make us susceptible to certain types of disease. Scientists have also begun to better understand how the society and culture in which we live contribute to human biology. For example, the types and proportion of microbes that colonize and inhabit our gastrointestinal tract and our skin are partly determined based on the geographical location and culture in which we live. In fact, the number of microbes present in and on our bodies out number our human cells 10:1 making each and every one of us more microbe than human. Thus, given our abundantly shared genome, biological similarity with seemingly unrelated organisms, and chronic occupation by mutualistic microbes, what really makes us “Human”? What matters?

This is where I think the humanities and the natural sciences are likely to find some common ground. As humans, we are naturally curious. We, from very early on in our lives, individually and collectively pursue knowledge, and seek understanding of the world around us through experimentation and experiences. For those present in this room, it is partly in our individual, academic or professional choice of approach towards understanding that we categorize ourselves as being from the humanities, or the arts, or the sciences. In doing so we may confound the acceptance of the common pursuits we share.

The scientific method, as stated by David Edwards, Professor of Biomedical Engineering at Harvard University, and author of the book “Artscience: Creativity in the Post-Google Generation”, is, quote, “a process of thought that is guided by quantification, is analytical, deductive, conditional on problem definition, is “true” in that it is repeatable, is expressive of nature in its simplicity, a basis for technology and industry.” End quote. The scientific method allows us to rigorously and systematically pursue the answer to questions. It requires creativity, imagination, and logic, as well as analytical, quantitative, and critical thinking skills. The answers gained through scientific experimentation, exploration and discovery, help to frame who we are as humans in so far as it helps us to better understand the natural world around us, thus satisfying the part of us that wants to know and

understand. Science does a good job of answering the questions of “how” or “what”, but it is not at all well suited to answering the fundamental question of “why”. It is the humanities which can help students thoughtfully reflect on possible answers for the “why” questions for which no answer is known and no experiment can test. Thus, as UD does so well, it is through the combination of the commonality as well as the uniqueness of intellectual and creative pursuits in the humanities, arts and sciences, that the education of the whole person, the human person, can be achieved.

Therefore, I agree with Dean Benson with regard for the need and utility of interdisciplinary pursuits of knowledge as we continue to evolve an enriching environment for learning, creativity, reflection, discovery, and exploration. However, in order to fully embrace the power of the humanities—to understand what it means to be human, what we as humans value, what we care about, and what matters to us, or as previously stated, interest in human concern from the inside, we must also pursue a systematic and scientific understanding of the natural world, our evolutionary history—our genetic similarities with fruit flies and round worms—as well as our unique capacities as humans to follow our curiosity, to pursue knowledge for the sake of knowing, and to accept our responsibilities as obligate stewards to use our knowledge to improve the human condition and care for the natural world which sustains us. Thus it is through our understanding and appreciation of this integration that we learn sympathy.

I will conclude with a quote from E.O. Wilson, Harvard Professor, Sociobiologist, and Pulitzer Prize winning author who wrote about the intersection between the humanities and the sciences in his book entitled, “Consilience, the Unity of Knowledge”. There, he credits William Whewell, who, in 1840 first defined consilience as “the jumping together of knowledge by the linking of facts and fact based theory across disciplines to create a common ground work of explanation.” Wilson writes, “A balanced perspective cannot be acquired by studying disciplines in pieces but through pursuit of the consilience among them. Such unification will come hard.Intellectually it rings true, and it gratifies impulses that rise from the admirable side of human nature. To the extent that the gaps between the great branches of learning can be narrowed, diversity and depth of knowledge will increase. They will do so because of, not despite the underlying cohesion achieved. The enterprise is important for yet another reason. It gives ultimate purpose to intellect.”