Collaboration between engineering and the life sciences: Influence of surface attachment on the biologic properties of proteins

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Collaborative research between the basic sciences and engineering is critically important to the ability of academia to answer future societal challenges. Despite the importance of fostering collaboration between scientists and engineers, there can sometimes be institutional or interpersonal roadblocks that limit successful collaborations. I have been fortunate to work as part of a successful collaborative team since 2006, and in this white paper, I will offer my personal narrative of collaboration as an example of what I think makes a strong collaboration between engineers and scientists.

I joined the faculty in the Department of Civil Engineering in January 2006 and almost immediately, I contacted Dr. Jason Bartz in the Department of Medical Microbiology and Immunology at the Creighton University School of Medicine. I had read some articles describing work investigating the environmental behavior of the prion protein, which is the infectious agent for a group of diseased called prion diseases. Prion diseases, or transmissible spongiform encephalopathies, are fatal, neurodegenerative diseases that include bovine spongiform encephalopathy also called Mad Cow Disease; scrapie, a prion disease of sheep and goats, and chronic wasting disease, which affects deer, elk and moose.

In particular, scrapie and chronic wasting disease have been shown to be transmitted in the environment, although at the time we began our collaboration, very little was known about the fate of the prion protein in the environment. Jason was very responsive, and almost immediately, we began to collaborate on experiments to investigate the environmental behavior of the prion protein. In looking back at the start of this collaboration, I believe that something that lead to our success was that in the beginning, we kept the research question very simple.

To illustrate this point, one of our first questions was 'What is the most environmentally-relevant form of the prion protein?" To answer this question, we incubated prion-infected brain homogenate at one of two different temperatures that simulated either a carcass decomposition environment (37°C) or ambient temperatures (22°C) and then collected samples at pre-determined time points ranging from 0 hr to 1 month.

To answer our question regarding prion conformation as a function of time, we exposed the brain homogenate to antibodies that response to a particular

epitope on the protein. If that portion of the protein was degraded, the antibody would not bind, and we would not 'see' that portion of the protein. By keeping our question simple, we were able to learn the terminology and techniques of the other discipline, and we also successfully answered our question. A more complex or complicated question might be important to answer, but with initial collaboration, I would encourage keeping it simple.

As any collaboration progresses, you learn more about the discipline and language of your collaborator, and begin to work together to pose questions. I feel this is another trait of successful collaborations – they raise questions that may not have been ever thought of by an individual working in a single discipline. Also, the answers to these questions many times requires the knowledge of people from disparate disciplines. To illustrate this point, as our collaboration progressed, we began to formulate research questions together.

Once such question was "Does attachment to soil influence the biologic properties of the prion protein? Biologic properties such as infectivity and replication are a function of protein conformation and protein conformation can be influenced by attachment to surfaces. To investigate this question, we attached prions to various types of soils or soil minerals and then evaluated their ability to replicate using *in vitro* and *in vivo* techniques. Our collaborative work allowed us to develop a conceptual model of prion disease transmission that encompasses both environmental behavior and passage into and within the host animal (Saunders et al. 2012). This linked environmental and biologic model would not have been possible without our collaborative research relationship.

Over the past eight years of our collaborative research, I have learned what contributes to a positive collaborative relationship. First – working collaboratively requires that you take the time to understand each other's language and respect each other's expertise. I would suggest that meeting in person on a regular basis is very important to establish a positive collaborative relationship.

Also, you must begin to read the literature outside your discipline to learn more about the terminology and work being done in the discipline of your collaborator. This takes a significant investment of time, but I find that this is a critical component to working together. Second, a collaborative research relationship requires trust between individuals. Collaboration means that you will share ideas, resources, equipment, and student advising activities, often without knowing ultimately what benefit or products may arise from this work. This requires a leap of faith and a commitment to the long-term collaborative relationship.

Institutions can do things to incentivize and support collaborative research. Administrators must recognize that initiating a collaborative relationship is time-intensive and may have a longer return period for funding and publications when compared with single discipline research.

Similarly, collaborative research will often be published in journals outside your discipline area. There must be an understanding and appreciation of this work and its contribution both to your

own discipline as well as other disciplines. This is important for faculty going through the promotion and tenure process. Institutions can also have policies and programs in place to allow faculty from outside your institution to serve as student committee members or co-chairs. Institutions could also give credit to faculty for advising students in another department or outside your institution.

References

Saunders, S.E.; Bartz, J.C.; and Bartelt-Hunt, S.L. (2012). Soil-Mediated Prion Transmission: Is Local Soil Type a Key Determinant of Prion Disease Incidence? *Chemosphere*, 87(7): 661-667