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## Jen Schaefer's 2021 Induction Ceremony Address: "Astrocytes, Allostasis and the Liberal Arts"

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## PBK 2021 address

Hello everyone. Congratulations on the great work you have done here at CSB/SJU and on your nomination to Phi Beta Kappa.

My name is Jen Schaefer. I'm a professor and the Biology department chair, and I direct the neuroscience minor at CSB/SJU.

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I'm a neuroscientist and physiologist. More specifically, I'm a trained electrophysiologist. I perform patch clamp and extracellular recordings, I use a light activated cation channel-- called channelrhodopsin-- to activate neurons, and I measure muscle responses using GCaMP--a Ca-activated fluorescent protein. Sounds sciency, right? You might be wondering what this has to do with our nation's leading liberal arts and sciences honor society.

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I'm certain I would have done none of those things without a liberal arts and sciences background. I'm equally certain that the field of neuroscience, itself, would not exist if not for the values, principles, and skills of the liberal arts and sciences.

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- First, the liberal arts and sciences teach us about interconnectedness.
    - biology, chemistry, physics, but also math, computer science, psychology, and --importantly-- philosophy, make the field of neuroscience. Current problems in neuroscience like spinal cord injury, Alzheimer's disease, and deep brain stimulation are most effectively approached by teams of biologists, psychologists, physicists, chemists, mathematicians--and **ethicists**.

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- Second, the liberal arts and sciences train us to dig deeper into underlying mechanisms.
    - Our bodies and brains function because molecules function to build cells, which function to build tissues that form organs. Organ functions are coordinated in systems such as the respiratory and cardiovascular systems. Molecule, cell, tissue, and organ functional mechanisms ultimately produce body function in a series of **cause & effect events** that create our thoughts and behaviors and maintain our bodily functions. Dysfunction in even a small molecule leads to dysfunction in cells, tissues, organs, and--eventually--brain and body function.
    - I tell my students that "it's not magic, it's dominoes".

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- **The liberal arts and sciences teach us how to make predictions and problem-solve, and the value of evidence-based conclusions and actions.**

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- Last, but not least, the liberal arts and sciences help us develop creativity and appreciate beauty.
    - The "father" of neuroscience, Santiago Ramon y Cajal famously stained parts of the brain and drew, by hand, the structures that he saw in his microscope, often combining views from multiple slides into a single sketch, such as the drawing seen in my Zoom background. Based on his drawings, he deduced that the nervous system is composed of the **individual, discrete cells** that we now call neurons. He used his drawings to make predictions about how those neurons might be arranged into the circuits that produce brain function. In doing so, he opened the door

for the explosion in understanding of brain function that has taken place in the subsequent 100 years. He shared the 1906 Nobel Prize in Physiology or Medicine in recognition of the impact of his work. Ramon y Cajal's original passion, importantly, was art. He only enrolled in medical school at the wish of his father. It was his background in art that allowed him to make beautifully exquisite drawings of brain structures and to deduce brain organization from those depictions.

- Similarly, a 2008 paper found that Nobel Laureates in the sciences were more likely to have arts hobbies than National Academy members, and Academy members were more likely to have art-related pastimes than the US public.
- Today, advancement in the field of neuroscience relies on creativity in experimental design and tool development, and in data communication and analysis. The data sets that we are now capable of compiling contain hugely complicated genetic, anatomical, and functional data that require new modes of visual and graphic representation to understand and to communicate to other scientists and the general public.

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What does this have to do with all of you? Before I answer, I would like you to take a moment to consider how and why you are sitting here now, a new PBK member. What brought you here? Why did you pursue the path that you have taken thus far?

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I once sat in your seat—I was at a PBK induction, soon to graduate from a small Minnesota liberal arts college. My answer to this question, at that time, was that academics were a refuge for me. Home was turbulent, I was shy, my economic options were limited. But, I had always been good at school. It was the best tool I had to expand my world and future, and I felt safe there. That's not to say it had always been easy, but it was a place of refuge from other things.

The liberal arts and sciences did, as expected, help me build my future and expand my world. I received grants and scholarships that enabled me to attend my undergraduate liberal arts college where I then took classes that hugely impacted my personal growth—classes with titles like Environmental History, World Full of Women, God and Suffering, Saving Wild Places, and Ceramics. I graduated, and lived and worked in Arizona, Iowa, and South Korea. I met some of my closest friends while I was at my small college—they were from all over the country and graduated with diverse majors including economics, dance, theater, computer science, and English. They are now an attorney, a dance professional, a treasury manager, and an MBA head of Amazon Fire Sales in Europe (that's the theater major).

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But, it turns out that I have increasingly experienced something that wasn't obvious to me when I sat in your seat. Education, and especially the liberal arts and sciences, are sneaky. They masquerade as a benefit to one's self (which they are). But it turns out that education and the liberal arts and sciences are really a **responsibility and a challenge**.

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You see, when we approach the world from a liberal arts and sciences perspective, we are able to see

- Not only the interconnectedness of disciplines, but also the interconnectedness of people and societies.
  - Brain function is the result of the simultaneous activity of hundreds of thousands of neurons, all interconnected and communicating. But, it turns out that another set of cells, called glial cells, which we used to ignore as boring cells that mostly “filled the spaces”, are critically important for brain function. For example, Astrocytes, a type of glial cell that we long thought of as a

supporting player in brain function, help to form and maintain the blood brain barrier and to regulate levels of chemicals called neurotransmitters—levels that when altered lead to psychiatric disorders.

- Teams of scientists are more likely to make discoveries and advancements when composed of individuals with not only different expertise, but also diverse life experiences and cultures because diverse teams are more likely to examine problems from multiple perspectives, to see connections between seemingly unconnected observations, and to identify gaps in data.
- Likewise, social groups, families, and societies, emerge from the interconnectedness of people, each with multiple roles and connections. These groups are harmed when any one of the participants or connections is dysfunctional—even the “lowly astrocytes” of the world—and we risk dysfunction when we under-value individuals who seem different from us or whose value we have not yet investigated.

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- When we approach the world from a liberal arts and sciences perspective, we are challenged to dig deeper into mechanisms—the how and the why of what is happening around us.
    - Like I tell my students, it’s not magic, it’s dominoes. Brain function, personality, emotion, behavior, and disease arise from diffusion of ions like Na and K across cell membranes and diffusion of chemicals with names like glutamate and acetylcholine between millions of cells. We must examine the underlying mechanisms if we want to understand behavior or disorders.
    - Similarly, the liberal arts and sciences help us to examine the dominoes of economics, history, healthcare, politics, law, education, housing, and entertainment that built and maintain our societal structures of racism, power, and privilege. We must examine the dominoes before we can begin the difficult work of reassembling structures that better support justice and well-being for all.

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- When we approach the world from a liberal arts and sciences perspective, we utilize **evidence-based conclusions** to determine our actions
    - in the field of neuroscience, we evaluate data about cellular function, pharmaceuticals, and brain imaging in order to make predictions about how the brain works and how we can treat psychiatric conditions.
    - We have seen this same process of evidence-based decision making in action over the past year as scientists, medical professionals, educators, restaurant and retail workers, and families had to work with real-time evidence about COVID risks and spread to make decisions for themselves and their communities.
    - We can use this same type of evidence-based decision-making to develop policies that reduce the impacts of climate change and increase equity in health care.

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- Last, but not least, the liberal arts and sciences challenge us to **creatively** find new approaches for improving and adding beauty to our corners of the world.

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I would like to leave you with two principles of physiology and neuroscience: Emergence and Homeostasis.

First) Emergence: The sum is greater than the total of its parts, just as cognition and behavior are the sum of each of the billions of proteins, ions, and cells hidden within the brain. Each of us and each way of knowing has value

and we achieve greater outcomes together. We see this in improved clinical outcomes when socioeconomic, emotional, and biological considerations are coordinated; We see it when initiatives that bring **all** members of a community to the table are more successful and enduring than those developed by a single group.

Second) Homeostasis: Homeostasis is a foundational principle in physiology, first described in the late 1800s. Homeostasis describes events, coordinated by the brain, that maintain a **steady state**. A common analogy is the thermostat in your home that, when temperature changes, activates heating or cooling to return your home to the set temperature. Similarly, your brain coordinates responses that maintain blood pressure, body temperature, blood oxygen, and other variables, at set levels for body function.

But, more recently, science has recognized a related principle called “allostasis”, first described in 1988. Allostasis builds on the idea of homeostasis but recognizes that sometimes the “set” point will actually be changed, usually by the brain, **to a new level**, in anticipation of a changing environment or threat. In other words, the body achieves stability through change.

For example, in a study that fascinates me for its choice in model organism, armadillos were exposed to cold environmental temperatures. In response, they increased, and sustained, their “set” body temperature by a few degrees. Exactly what this means for body function, and even the definition of allostasis, are still in dispute. Allostasis is commonly used to describe **problematic** changes that occur during chronic stress--that shrink neurons, decrease immune function, and raise blood pressure. All bad. On the other hand, allostatic changes in set point can **help** us to navigate anticipated environmental conditions. For example, the set point for body fat increases in animals prior to migration or hibernation. Body temperature set point increases during infection, making us less hospitable to viruses and bacteria.

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As a student of the liberal arts and sciences, you are equipped to enact allostasis in the world around you, to achieve stability in our communities through change. The challenge for you is to **positively alter set points** rather than maintaining the status quo or creating a negative change. We have a **responsibility** to use our educational privilege and skills—such as evidence-based problem-solving, interdisciplinarity, and creativity-- to move the needle and improve our corners of the world, be it in our families, workplaces, social groups, or communities.

Challenge yourself and those around you to think critically, to examine underlying mechanisms, to be attentive to interconnectedness, and to value diverse roles and contributions, including your own. Each of you is capable of great things, but don't lose sight of the purpose, which, ultimately, is to strengthen the interconnected humanity that emerges from the mechanistic dominoes of our daily actions.

Thank you and, again, congratulations on your induction to Phi Beta Kappa. We are proud of you and the work that you have done, and we are happy to have this opportunity to recognize your accomplishments.