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Belonging in Biology: Working through Pedagogical Partnership for Social Justice in STEM

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BELONGING IN BIOLOGY: WORKING THROUGH PEDAGOGICAL PARTNERSHIP FOR SOCIAL JUSTICE IN STEM

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With a passion for social justice and a hope to make courses more inclusive for students, I participated in the newly created Community Learning and Inclusivity Partnership (CLIP) at Emmanuel College in Massachusetts. I was assigned to observe the foundational class for the biology majors, Introduction to Cellular and Molecular Biology. Students who are hoping to graduate with a degree in chemistry with certification from the American Chemical Society (ACS) are also required to take this course. I am a Counseling and Health Psychology major and double minor in Education and Criminology and Criminal Justice, so I was able to draw on my experiences in these areas in my work in an area that is often not very welcoming to a diversity of students.

In my first meeting with my faculty partner, we set up goals for our partnership: helping the students retain course content, assessing how the students are engaging with the material, and talking about diversity in STEM and other challenging topics surrounding discrimination. Each week would consist of me observing the class, then meeting with the professor, and also meeting with our partnership guide, Nandeeta Bala, who is an experienced student partner from Vassar College. This experience not only provided me with the opportunity to observe a STEM class through the lens of a psychology major, but it also let me use my perspective as a person of color at a predominately white institution (PWI) to inform my conversations with my faculty partner. The overall partnership provided me with the opportunity to analyze the curriculum and how it could be more inclusive while constructively critiquing the teacher and how she interacts with the students.

Participating in the partnership provided me with better insight into what goes into a curriculum and how professors have to balance teaching the content required for the course and engaging the students all while adjusting to teaching during a global pandemic. As a person of color observing a course in the science department, I was also able to see how the curriculum could be more racially inclusive and better prepare students intending to attend medical school. I also enjoyed working with someone who was also a person of color because they understood how Black Indigenous People of Color (BIPOC) students feel as the minority in a field that often does not respect or understand the culture of people who look like them. Partnership can benefit professors through allowing them to adjust how they teach their course as they are teaching it, rather than waiting until course evaluations at the end of the semester, when it is too late. Many professors across all disciplines could benefit from having a student partner who can talk with them about how to make their class more conducive to learning.

Retention and the Transition from Online to In-person Learning

Because the class that my faculty partner and I focused is foundational, it is important for the students, who are primarily first-years, to retain the content so that they are better prepared for

the upper-level classes (i.e. Microbiology, Endocrinology, Immunology, and Cancer Biology). However, most of these students had to balance the adjustment from high school to college learning while also readjusting to learning in-person after learning online. Professors at Stanford University and Harvard University conducted a study with primarily undergraduate students prior to the COVID-19 pandemic; their results suggested that taking a course online "reduces student success and progress in college" (Bettinger et al., 2017). Research since the onset of the pandemic has revealed other challenges of online learning, and we saw some of these play out in Introduction to Cellular and Molecular Biology.

While the students struggled on the first test, they learned what study skills worked for them and what resources aligned with how they best learn, such as using the class tutors. Because this class is fairly large, there are more tutors who can be accessed by the students; the tutors have taken the class previously so they are familiar with the content and how the professor teaches it. However, the most popular resource was the practice exams that the professor provided. They covered the content that would be on the test, and students also became familiar with the wording of the questions and the depth of the answers that were expected of them. My partnership work showed me first hand how demanding being a student in the STEM field is; they are expected to retain a lot of information in a short period of time. Outside of the classroom, a mentorship within the Biology Department was started; upperclassmen who were majoring in biology, but in a variety of concentrations, were mentoring first-year students whose intended major was also biology. Not only did these mentorships allows first-year students to get academic help, but the upperclassmen could also provide advice that they wished they had known as a first-year student. The relationships fostered between the students created a stronger community within the Biology Department. This in turn made not only BIPOC students, but all undergraduate students looking into or majoring in biology, feel like they belong.

In terms of the class overall, the professor taught the content in multiple ways to accommodate different learning styles. For students who learn best auditorily, she posted lectures that were required for the following class; attached were quizzes on said lecture so that students would see if they truly understood the content. Her teaching style consisted primarily of lecturing coupled with a presentation. However, in the 1 hour and fifteen minute class, students tended to zone out. Therefore, I recommended that she incorporate more technology into her learning, so that the content is broken up and it helps the students pay more attention. At the end of our meetings, my faculty partner provided me with specifics to look for in the class that I would be observing for that week. The majority of what I paid attention to related to student engagement, the pace of teaching the content, how the drawings on the board impacted students' engagement compared to the lectures, and group interactions. Per my suggestion, she also incorporated videos in the lecture for sections covering translation, transcription, and splicing. I have found through many years of being a student that having visually appealing presentations can contribute to having more engaged students in the classroom. For students who learn visually, she included graphics and diagrams in the lesson, when warranted. This was included in lessons on Frederick Griffith's experiment, prokaryotes, and eukaryotes. Education is meant to and should be interactive; students should have an active role in their own learning.

Additionally, educational institutions should provide better mental health resources for students, especially during a global pandemic. As a current sophomore in college, I experienced the

transition from high school to freshman year during the pandemic; however, the environment in which I did so was different from the environment that the current freshman entered college. The second half of my senior year was online, but the majority of my high school academics were conducted in person. However, for this year's freshman class, almost half of their high school experience was either a hybrid of online and in-person learning or entirely online. My CLIP experience has shown me that professors genuinely want to make their classes better for the students who they are teaching. If nothing else, these past couple years have shown that educators, as well as the education system as a whole, has a lot of room to grow in terms of creating a more inclusive environment for students and preparing them academically and culturally for entering a diverse world. This experience has also emphasized how much of a student's success depends on the student themselves and their own drive. Especially in college, many students tend to burn out very quickly. For many of them, this semester was the first time in at least a year that all of their classes have been in person, which is an adjustment in itself. Therefore, it is important for professors to see, global pandemic or not, that a lot is expected of students, that they are people at the end of the day, and they have their emotional and mental limits.

Offering my perspective and recommendations to my faculty partner as a consultant allowed me to have an impact in the classroom. There still remains an unspoken hierarchy in the classroom in which the professor is 'above,' so to speak, and the students are 'beneath'; in other words, students do not tell professors how to teach. However, being a student consultant helps break down the hierarchy and hopes to make professors more approachable to their students, not just when the student signs up for office hours. This opportunity also allowed me to have a different experience and perspective from when I am a student enrolled in a course; I got to be a student in a classroom without having the pressure of needing to absorb any of the content in preparation for an exam.

Engagement in the Classroom

A key component of retaining information is engaging with the content and participating in class. Throughout the lesson, the professor periodically included trivia questions that related to the previous content through an app called Poll Everywhere. Even before joining the partnership, Poll Everywhere was, and continues to be, a widely-used app across many majors within the science department whether it is psychology or biology. It allows students a quicker assessment as to if they understood the content as it was being taught rather than having to wait until the exam to see if they truly understood said content. This could prove to be particularly beneficial for biology students because there is a lot of heavy content that they have to remember in a short period of time. Using this technology provided the professor with the opportunity to gauge if the students understood the content. She continued to ask how the student arrived at the answer. Although getting the answer is important, how they arrived at it is even more so because they can apply those skills to the exam. Also, it demonstrates that they truly understood the question vs. guessing or being told the answer.

My faculty partner also incorporated homework connections into the classroom; this is where the students answered a question that was in their homework packet. They could see how the content

applied to the homework, which in turn reflected what would be on the exam. It also allowed the students to get a little ahead on their packets, which are quite thorough. This form of homework was an avenue in which collaboration enters the classroom, along with study groups that students were encouraged to create outside of class. The professor also posted the presentation slides before class with blanks to write additional information. I found this beneficial for students who may have had difficulty paying attention in class or needed to go over the content themselves while watching the lecture prior to attending class.

In my first semester of sophomore year, I took Crime and Justice for my Criminology minor, where I was required to watch pre-recorded lectures that covered larger concepts prior to attending class that day. This way, the professor could answer any clarifying questions about the lecture as well as teach minor details and any outstanding content that we needed to know for exams. In my Recent Moral Issues course, which fulfilled my philosophy requirement to graduate, it was recommended that we read the section of the textbook that related to the issue or theory that would be taught in the upcoming class. Although it was not required, it proved to be beneficial as it was easier to understand the content because I already learned it once. My faculty partner and I have discussed that because most of the students in her course are first-years, and they may be struggling with the transition academically from high school to college, it is even more important for them to adjust quickly, especially because they are interested in being in STEM, which has a more demanding workload compared to other majors. This is indicative of the negative connotation behind the course that she is teaching; it is widely known as the 'weed-out' class because it has an abnormal drop-out rate. In the semester where I observed her course, approximately five students dropped out of the course, which was more than normal. Finding engaging ways to teach the required content can help to retain students within the major, which was one of her long-term hopes for the academic year.

Prior to the coronavirus pandemic, teachers were using technology as a medium to teach their content. Whether it is providing elementary school students with iPads to watch Schoolhouse Rock to learn about the Bill of Rights or recommending middle school students to watch Khan Academy videos to help with math, students of all ages learn to become familiar with technology and view it as an effective tool for learning. A survey conducted by Pew Research Center found that 92 percent of the teachers said that the Internet has a "major impact on their ability to access content, resources, and materials for their teaching" (2013). Inside of the classroom, 43 percent of the same teachers report either themselves or their students using computers in the classroom or to complete assignments. Because of the pandemic, assignments like worksheets or research papers that would have previously been submitted in person transitioned to online platforms like Canvas or Blackboard. This has made it easier on professors when grading because all student work is already all in one place, and it is environmentally friendly as it saves paper. However, there are some caveats that come with allowing technology to enter the classroom such as students getting distracted on other sites or classes; the accountability is strictly on the student to pay attention in class as there are no deterrences that are evident in a middle or high school classroom (i.e. taking an individual's phone away). Distractions such as these were evident in the classroom that I observed. While some people had Airpods during class, others were looking ahead toward slides that were not yet covered or looking at another class entirely. This impacted their learning overall: some students asked clarifying questions on what was just covered as they were not paying attention, and this caused confusion among the other students.

Oftentimes, the class before an exam serves as the review session; students to ask any questions that they may have had about the unit. As an alternative, students who tend to ask a lot of clarifying questions throughout the class could write them on an index card and then give it to the teacher at the end of class. Prior to the next class, the professor can look them over and see any overlapping concepts that seemed to confuse most of their students. Then, at the next class but before teaching any new content, the professor could clarify the more complicated concepts that the majority of the students did not understand. In the second semester of my freshman year, I took Physiological Bases of Behavior, which was required for the Psychology major. Although the class was taught online through Zoom, the professor was able to create an ungraded assignment where students could submit any questions that they had about the lecture and she would go over them in the next class. More generally, in terms of engagement, I have found through CLIP that the students' energy is often dependent on that of the professor. As an education minor, I have taken courses that are designed to prepare students to become well-rounded teachers. In these courses, we are shown examples of how teachers create inclusive classrooms and environments where students enjoy learning, even if the student is not particularly fond of the subject being taught.

Incorporating Diversity, Equity, and Inclusion into the Curriculum

At a PWI such as Emmanuel, it is crucial that the curriculum reflects the populations that it is serving; in STEM classes specifically, when scientists from historically excluded and marginalized communities often go unrecognized, it is a professor's responsibility to give them said credit. In the first class, session of Introduction to Cellular and Molecular Biology, the professor showed pictures of seven scientists, and asked the students to find the commonality—all of them were white men. She then transitioned into a *New York Times* article about James Watson, a founder of modern genetics, and his previous remarks concerning race. Watson made the unfounded claim that black people are genetically less intelligent than their white counterparts. This was the foundation for a larger discussion about the lack of racial and gender representation in the STEM field. According to a report by United Nations Children's Fund (UNICEF), women comprise about 40 percent of the STEM workforce across 68 countries (2020). Racial diversity within the STEM field is not much better compared to gender diversity; according to Pew Research Center, black people comprise 7 percent of STEM workers, Hispanics have 6 percent, and Asians hold 10 percent (2018). In another class, where the professor was teaching DNA replication, she incorporated a discussion about Rosalind Franklin, who was the first to photograph DNA. James Watson and Francis Crick took the photographs without her permission, included it in their research, and did not give her the credit.

I was pleasantly surprised to see these topics covered in an introductory biology class, and I wish such topics were discussed more and further. For example, in both of the aforementioned discussions, students came to the general consensus that there should be more diversity in the STEM field and BIPOC scientists should get more credit for their work. However, it was very rudimentary and did not go below the surface. The professor argued that fixing the institutionalized racism that is deeply ingrained in the STEM field is not as easy as it sounds and encouraged the students to think deeply about the flawed system that they will be a part of. Prior

to the class, I had not heard of Rosalind Franklin, but was acutely aware of the lack of diversity within the STEM field, as my brother is interested in pursuing engineering. In other STEM classes, students are assigned Scientist Spotlights, where they choose and research a scientist, both their personal life and their research. In Physiological Bases of Behavior, the professor gave this assignment, but it was relating specifically to neuroscientists. Some of the neuroscientists included Ben Carson, May-Britt Moser, Ivan Pavlov, and Rita Levi-Montalcini; the provided list had both gender and racial representation. Education has failed continuously in highlighting BIPOC voices and creating a space for BIPOC students to feel seen in the lessons they are learning.

As a black person who has gone to PWIs all my life, I have experienced first hand what a Eurocentric curriculum looks like. In English classes, I read books written by white authors with white characters. In history, it was often taught from the perspective of a white savior complex; in the rare case that black people were brought into the classroom, it was only for Black History Month. This creates not only a narrow view of black history, but of American history as a whole. Since the murder of George Floyd and the re-emergence of the Black Lives Matter movement, BIPOC students across the nation have expressed the need for curricula to have equal and accurate representation across all disciplines and all levels of education, from elementary school to higher education. Having such curricula would not only contribute to BIPOC students feeling seen inside of the classroom, but it would also allow for students to have a broader worldview. For those who are interested in attending medical school, they should be able to understand the cultures of the individuals they would be treating.

The student consultants from the previous semester's CLIP program sent out a survey in the middle of the semester to the students to assess how the semester had been going for them: if the way the professor was currently teaching was effective and what could be improved moving forward. Similarly, in my cohort, the student consultants sent out their own version of the survey to the students in the class they were observing. In my survey, I asked students the following questions: 1.) to rate how the class had been going for them, 2.) how the transition from online to in-person learning had been for them, 3.) how the professor can help with said adjustment, 4.) if the student feels as though they are retaining the information from the lecture, 5.) what resources they have used for the class, 6.) if they have anything outside of school that has prevented them from using any of the aforementioned resources, 7.) how the most recent test went for them and to mention any topics they were unsure about, 8.) if they feel as though the class is being inclusive, 9.) what topics they would be interested in learning about that would make the class more inclusive and other ways the class as a whole could be more inclusive and accessible to them as a student. Responses indicated that some wanted to learn more about the scientists who did not get recognition for their work because of injustices like racism.

When I brought this to the professor, I also inquired what other topics could be covered, such as Henrietta Lacks and how black people are discriminated against by medical professionals. To provide context, Henrietta Lacks was an black woman who was a patient of The John Hopkins Hospital. Her cancer cells were unique because they would double while other cells would die (*The legacy*, n.d.). After her death, her family received no compensation from the companies that used and profited from her cells; they also refused to ask her family for consent prior to revealing her name, giving her medical records to the media, and publishing her cell's genome online

(2020). Because students who are interested in attending medical school are required to take this foundational biology class, I believe that it is important for them to get a well-rounded scope of the patients that they would be treating and understand the historical context of the medical field and their fragmented relationships with communities of color and the LGBTQ+ community. Through my conversations with my faculty partner about further incorporating more BIPOC voices into the curriculum, my recommendations pertained more to the higher-level classes such as Cancer Biology and Healthcare Ethics.

Developing an Integrated Biology and Chemistry Course and its Implementation at a University

Later in the semester, my role transitioned from observing the class to finding research on how to best integrate the biology, chemistry, and math classes so that students can understand earlier on how the foundational classes (i.e. Genetics, Organic Chemistry) connect to the concentration classes (i.e. Chemistry of Fire and Explosives, Anatomy and Physiology) in their major. A student who is majoring in Chemistry with a concentration in Forensic Science is required to take two semesters of Calculus and two semesters of General Physics. Similarly, students on the pre-med track are also required to take physics. In my meetings with the professor, we discussed how students often have to make the connections between the relevance of the foundational classes to the upper-level classes in said upper-level classes rather than in the foundational classes. Many of my friends have majors within the STEM field whether it is Forensic Chemistry or Biology with a Health Science or Neuroscience concentration. In both the biology and chemistry departments, they would like to see how to apply the content they are learning inside the classroom to possible career fields. Since some biology and chemistry students have to take a physics class regardless, they have expressed the desire to have one specifically relating chemistry and medicine.

I have observed first hand how demanding the work can be, so I was able to convey the student experience to my faculty partner. There are certain skills that are expected of STEM students—specifically memorization. For instance, students majoring in Biology with a Health Sciences concentration are required to take two semesters of Anatomy and Physiology with a lab. In this course, students have practicals in which they are expected to memorize the anatomical structures of the different organ systems as well as explain its function. The practical itself consists of 52 questions, and students are given 40 minutes to complete it. When studying for the practical, students are expected to teach themselves as a way of studying using the provided resources, which included detailed slides (see photos 1 through 4) and realistic human models. As a reference, the words in red are the ones students are expected to memorize.

Photo 1 (provided by a student):

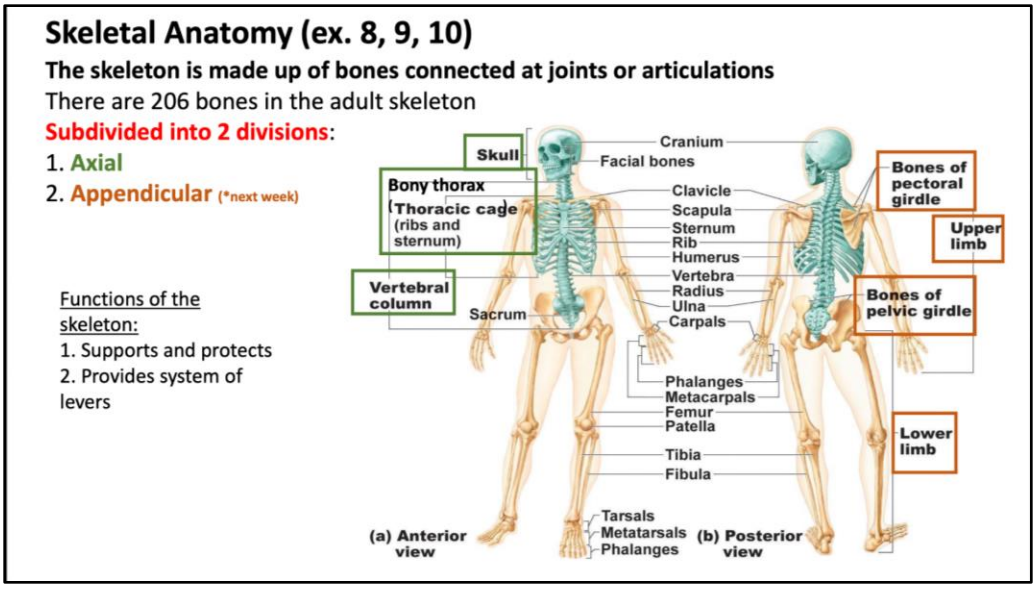


Photo 2 (provided by a student):

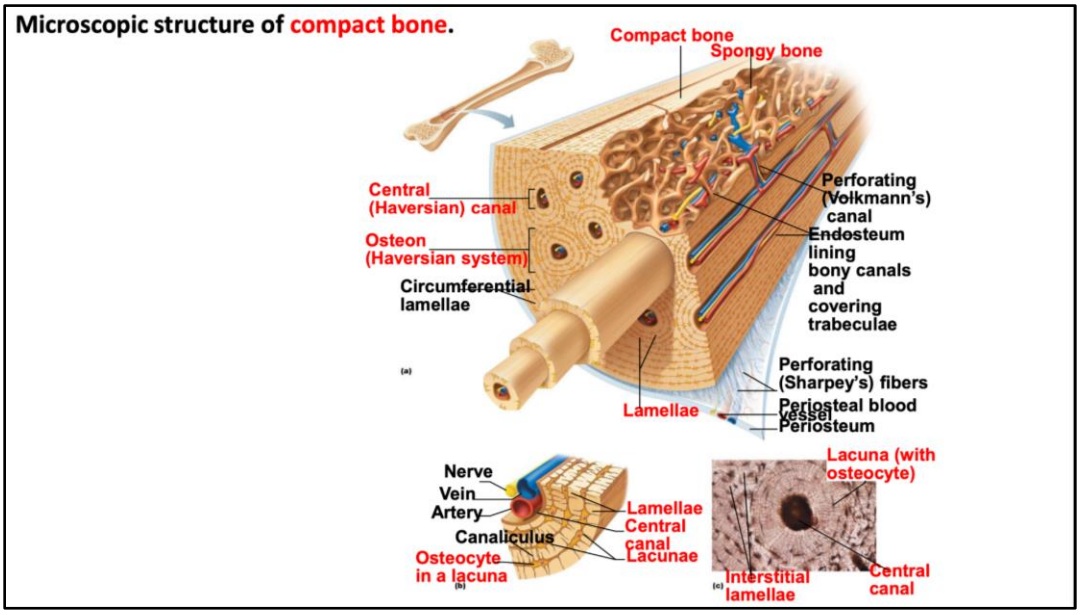


Photo 3 (provided by a student):

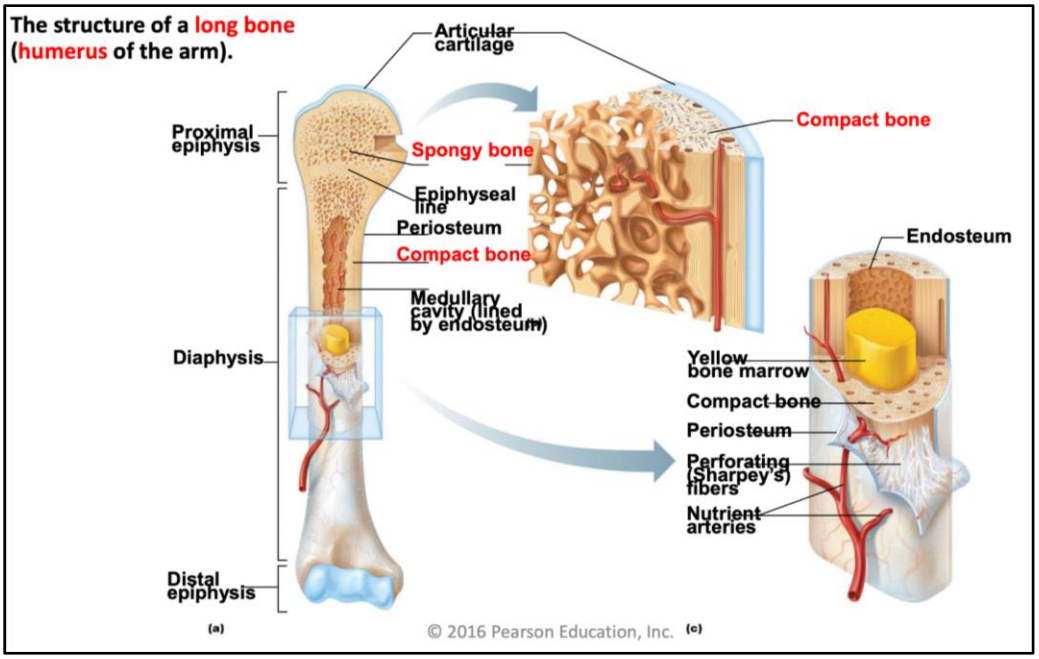
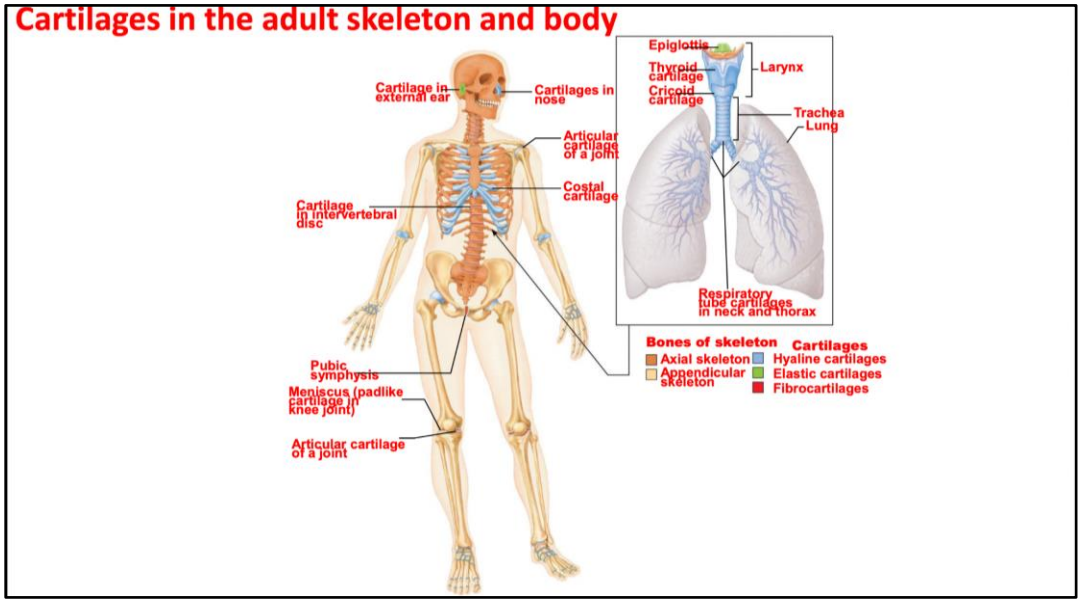


Photo 4 (provided by a student):



As a response to our discussion about the lack of connection between the biology and chemistry courses, my faculty partner requested that I do further research into integrated biology and chemistry courses at other colleges and universities. Through my research, I found that it is not a new concept in higher education. Institutions such as the University of Delaware and Boston University have implemented courses that combine multiple disciplines within STEM. This is one aspect of what the National Academy of Sciences are calling “New Biology,” which is defined as the integration or reintegration of many subdisciplines of science such as biology,

physics, chemistry, computer science, engineering, and math to best equip students to "tackle a broad range of scientific and societal problems" (2017). In the model demonstrated by the University of Delaware, students who are enrolled in the biology class are automatically enrolled in the corresponding chemistry course. The course would target first-year undergraduate students and is taught in the form of lectures and labs for both disciplines, a studio for the biology section, and a workshop for the chemistry section; all courses overlap in terms of content. For example, in the studio, they are given assignments that are connected to their laboratory course. During the lab section, the students are divided into two subsections; one section will complete the biology lab while the other performs the chemistry lab. When the lab meets a second time during the week, the two subsections would switch. In the workshop, students are introduced to chemistry concepts before it is discussed in the lecture. Not only does this course strengthen collaboration and communication skills, specifically in the labs, but it exposes students to other disciplines while displaying the connections between them (2008).

One of the many benefits to the integrated classrooms is that students are able to see the intersections of various fields within STEM; many of the skills required for biology and chemistry can be applied to engineering in the form of biochemical engineering. This course also allows for students to learn and comprehend how the content can be applied both inside the classroom, but through various methods, as well outside of the classroom. Emmanuel College could benefit from such a course so that students could better see the content flow in both their lectures and lab sections.

Conclusion

CLIP provided me with a better perspective of how much professors think about teaching, made me more aware of the burnout that students (not just those in the STEM field) experience, and showed me how much the global pandemic impacted higher education. Outside of the CLIP program, I hope to help the Education Department in better preparing students to teach in diverse schools and help BIPOC undergraduate students feel as though they belong in the department. The student consultants presented our experiences at the college's second Belonging in Biology Summit. This experience inspired me to talk with faculty in the Education Department to start a Belonging in Education Summit. Especially at PWIs where BIPOC students are already in the minority, statistically speaking, they will also be the minority in their respective major and minor. It is important for them to feel as though they belong in their respective major because they will be entering a field that may not be welcoming or is biased and discriminatory towards people who look like them. Empowering them in higher education will provide them with a confidence that they can carry to their workplace, so that they can help make that space more welcoming to those who come after them.

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