Review Article
Volume 12:3, 2023

Molecular Biology: Open Access

ISSN: 2168-9547 Open Access

Molecular Mechanisms of Disease Prepare a Modern Workforce with Biochemistry

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Abstract

In biochemistry, especially at a research-intensive institution, setting an example and supporting the department's goals are essential components of leadership. At UNL, faculty members had a clear expectation of this: leadership that had been in the trenches and understood the specifics of the interrelated academic missions. Being merely a unit administrator cannot be considered academic leadership in a department with a strong emphasis on research. Maintaining a robust research program with undergraduate and graduate students and leading by example was essential to the development of biochemistry (e.g., see references). Supporting the educational mission and fostering teamwork. It also required proactive discussions with the deans and upper university administration, as well as ongoing engagement with the faculty, staff, and students. Meeting the requirements and achieving the faculty's vision with the assistance of the university's resources was like balancing on marbles. Biochemistry, biophysical chemistry, metabolic biochemistry, plant biochemistry, and systems biology and biochemical informatics were the primary areas in which significant faculty appointments were made following the first academic program review.

Keywords: Biochemistry • Molecular biology • Teaching • Learning • Primary research • Stem education

Introduction

The first obstacle was persuading the "traditionalists" that teaching biochemistry and molecular biology for the same way as they were taught would not prepare a modern workforce with a biochemistry education at its core. With retirements, a portion of this initial challenge was eliminated. Identifying strategic needs within the unit that combined to advance both research and teaching was the second obstacle. This challenge reminded me of being the conductor of an orchestra, where the whole is more important than the sum of its parts. The outcome would be catastrophic if the violins and brass were not in sync. This became the priority whenever there were issues with the percussion or woodwinds that needed to be fixed. As an office seat, I didn't have to guide the personnel at the same time, similar to a guide, needed to lay out the climate to accomplish ideal joint effort and mix among the current and recently selected workforce, expert and specialized staff, and understudies. In addition, this challenge was mindful of linking biochemistry-related research programs with other programs for greater impact and strength. It was additionally aware of the changing essence of current organic chemistry and sub-atomic science to be more quantitative, particularly with the rise of high-all through information and frameworks science. Making biochemistry a true academic home for nearly undergraduate majors was the final and crucial challenge. Because of this, the curriculum had to be carefully reevaluated, and practices were set up so that students were involved and guided as they progressed through the program over four years. Building a faculty that valued teaching and learning in addition to basic research in biochemistry and molecular biology was also necessary for this. A broad understanding of how research that improved teaching and learning, the creation of novel pedagogical tools, and fundamental research that generated new knowledge interact was the outcome.

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Received: 01 March, 2023, Manuscript No: MBL-23-95127; **Editor assigned:** 02 March, 2023, PreQC No: P-95127; **Reviewed:** 14 March, 2023, QC No: Q-95127; **Revised:** 20 March, 2023, Manuscript No: R-95127; **Published:** 27 March, 2023, DOI: 10.37421/2168-9547.2023.12.374

Literature Review

The climate that was laid out north of a 10-year time span was one of comprehensive greatness and one that permitted the smartest plans to approach and be examined and refined with many being carried out. Plant biochemistry, metabolic biochemistry, biomedical biochemistry, biophysical chemistry, and biochemical informatics were all advanced by research programs staffed by highly skilled graduate students and postdoctoral research fellows during this same time period. The establishment of a graduate training program in Molecular Mechanisms of Disease, supported by the National Institutes of Health, was one important outcome of this excellence. A landscape needed to advance the training of students for both established and emerging career paths was created by the breadth of research and shifts in teaching culture.

Innovation, teamwork, and leadership Leadership in any academic department necessitates more than just maintaining the status quo and steering the unit. Like a director and their symphony, scholarly initiative requires an unmistakable comprehension of the group, the proportions of progress, and how that fills the vision. Fundamental to biochemistry is the excitement of fundamental research and the generation of new knowledge. The hallways and seminar rooms, where experimental planning, data sharing, and lively discussions take place, are filled with the hum of ongoing research programs. Graduate and undergraduate students in the laboratories and classrooms become part of the fabric because they are part of a biochemistry department that is not affiliated with a medical school. In this way, they acquire the necessary foundations for the career paths they choose [1].

Discussion

At that time, it became crucial to make significant progress in teaching and learning biochemistry. As previously mentioned, during this time period, the department's culture incorporated basic research that generated new knowledge and research that advanced teaching and the creation of novel pedagogical tools. During this period, the four-year educational program had been adjusted to incorporate organic chemistry courses in every scholarly year, subsequently making a scholastic home for the college understudies. There were increased efforts to get as many students as possible involved in basic research lab work in biochemistry and the larger molecular life sciences across the campus. Faculty members received internal and external grants to improve biochemistry teaching and learning in conjunction with these efforts; these grants received the same high level of recognition as those supporting basic research. These efforts came

at the same time that a solid graduate program was strengthened to put more emphasis on the variety of career paths. All of this took place in a setting that was influenced by the faculty and benefited from internal team building. The results have been amazing, with faculty engaging in both research and teaching and, more specifically, a sense of excitement connecting the two. In addition to grants for instruction and learning, four faculty members received CAREER grants from the National Science Foundation. As essential components of a cutting-edge research program, outreach and education are required for these grants. I'm still convinced that these awards were successful in large part due to the department's established culture of inclusive excellence, which places equal importance on research and teaching [2].

The Department of Biochemistry received the 2019 University-wide Departmental Teaching Award as one of the President's Faculty Excellence Awards as the university celebrated its 25th year and the 150th anniversary of its founding. Through faculty involvement and creativity, the pedagogical excellence tradition was specifically acknowledged by the University of Nebraska system. Innovative educational programs in the department that place an emphasis on critical thinking, experimental testing, molecular and computational modeling, and excellence in basic research in redox biochemistry, biophysical chemistry, metabolic biochemistry, plant biochemistry, systems biology, and biochemical informatics received praise. A number of high-impact career paths resulted from the department's transformation of biochemistry education and development of lifelong learners. The common thread that created synergy and strength was the linkage between basic research that generated new knowledge and research that advanced teaching and the development of novel pedagogical tools.

Program, critical thinking, and the significance of scientific discourse the modernization of the undergraduate biochemistry curriculum to meet 21st-century career paths, as is the case in many programs across the country, has made critical thinking an expectation for students. Presenting a body of information in conjunction with asking where it came from and how it advanced the field is now the norm in the biochemistry department at UNL. The biochemistry program has been altered to cover all four years, as previously stated. Faculty leadership and grants from the National Science Foundation, the National Institutes of Health, and the Kelly Fund, an internal philanthropic fund that supports advancements in teaching and learning, have all contributed to these modifications to the undergraduate biochemistry curriculum. The fundamentals are taught with a high degree of student engagement in current research trends, which serves as an important backdrop for enhancing the learning process's interest and applicability [3].

The ASBMB accreditation core concepts (energy is required by and transformed in biological systems) are introduced to students as early as freshman year. Function and regulation are determined by macromolecular structure; storage and movement of information are dynamic and interactive; and discovery necessitates clear communication, quantitative analysis, and objective measurement) simultaneously with their initial biology, math, and chemistry courses. Understudy learning is evaluated through on-line idea inventories. Using the tools of scientific discourse, students write a position abstract to support or oppose statements made on a product that claim to be scientifically or clinically proven. Last but not least, they produce a brief scientific paper based on suggested core concept topics that requires proficiency with PubMed, learning to write in their own words, and citations of at least three primary works in the Journal of Biological Chemistry format. These efforts are incorporated into discussions about college planning and skills, goal setting, working in a research laboratory, comprehending the significance of teamwork in education, and career paths.

Biochemistry sophomores are introduced to the crucial nature of biochemical data, specifically how it is generated, interpreted, and presented in a scientific publication. This is done as the course of study for biochemistry students progresses. More writing and the integration of the analyzed data with other related works complete these efforts. The class has a maximum of 24 students, and each student works on their own or in groups of four. Even though this method is time-consuming, there is a lot of discussion and a clear appreciation for scientific teamwork. Students who take this course before taking the year-long biochemistry sequence perform better, according to our experience [4].

A two-semester comprehensive biochemistry sequence has evolved from a traditional lecture format to one that combines experiential learning and traditional lectures during the third year of study. The difficulty has been delivering this biochemistry sequence to 300-350 students, 70-80 of whom are majoring in biochemistry. Faculty who instruct in this sequence have led efforts to create interactive learning modules that enable students to visualize biomolecular structures by utilizing dynamic 3D printed models. As of now, three designated learning targets connected with DNA and RNA structure, record factor-DNA communications, and DNA supercoiling elements have been created and joined by evaluation devices to measure understudy learning in an enormous homeroom setting. In terms of their capacity to comprehend and relate molecular structures to biochemical functions, students had normalized learning gains. Students are able to comprehend macromolecular structure-function relationships and observe molecular dynamics and interactions thanks to the developed technologies, which are significant.

To enhance learning in this biochemistry sequence, I am absolutely certain that additional innovative teaching technologies along these lines will be developed. The Cell Collective is an additional, highly innovative platform created by professors of biochemistry. It uses computational modules to provide students with hands-on experience in a variety of subjects, such as cellular respiration and the lac operon's molecular dynamics. Students are able to work in small groups to comprehend intricate biochemical processes thanks to these efforts, which break down the barriers that typically exist in large classroom settings. In biochemistry, the junior/senior laboratory sequence has been modernized and is now directly connected to ongoing fundamental research in faculty members' labs. Students are well-prepared for advanced training in biophysical chemistry and structural biology that includes hands-on experience with programs like PyMOL as they gain a broad understanding of basic biochemical concepts. The subsequent efforts are coordinated with group presentations, problem-solving, and literature reviews [5].

Biochemistry students complete a capstone course in Advanced Topics in Biochemistry as seniors. This course covers a variety of topics, including Metabolons and Metabolic Flux, the biochemistry of starvation and obesity, Trace Metals in Redox Homeostasis, and Plant Metabolic Engineering. These 24-person classes feature group discussions that culminate in the writing of a sophisticated scientific paper and presentations. This class emphasizes scientific discourse, with active discussions addressing the possibility of data discord between different experimental approaches. One instructor conducts peer review of student manuscripts, which results in a compilation of papers published in the student journal Advances in Biochemistry, which is distributed to the class and stored in the department's archives. This course is graded using rubrics that are the same for each section, despite the fact that the instructors' topic areas vary.

The Department of Biochemistry at UNL has top-tier research programs that spend between $9 and 10 million annually on research. The majority of these programs are externally supported by grants from the National Institutes of Health, National Science Foundation, USDA, Department of Energy, and private foundations like the American Heart Association and Michael J. Fox Foundation. Undergraduate Creative Activities and Research Experiences (UCARE), a university-wide undergraduate research program that supports students for two semesters or a summer, complements this research strength. Gifts from Union Bank and Trust and the Pepsi Quasi Endowment contribute some money to UCARE. The workplace of the Agribusiness Exploration Division (ARD) likewise upholds scholastic and summer research encounters for college understudies. Students in UCARE and ARD must find a research mentor and write a peer-reviewed research proposal. In natural chemistry, extra undergrad research understudies are upheld during the scholarly year and summer by assets from individual examination awards. These students are guided through research standard operating procedures, biosafety, conduct codes, ethical research expectations, selecting the appropriate graduate program, and application assistance for graduate schools [6].

Conclusion

The laboratory of the Department of Biochemistry is home to more than fifty undergraduate research students at any given time. In addition, the molecular life science laboratory is home to an additional undergraduate biochemistry students from the departments of psychology and food science and technology in addition to chemical and biomolecular engineering and chemistry. It is critical to bring up that large numbers of these understudies start working in an exploration research facility in their rookie and sophomore years and go on through graduation. Two university-wide research fairs feature juried poster presentations, which are open to all undergraduate research students. The ASBMB Annual Undergraduate Research Symposium is just one of many national venues where many of these students present their work. Notwithstanding these undergrad research programs, the college has various Exploration Experience for Undergrad (REU)

programs that are coordinated to understudies outside the college for research-escalated encounters in the mid-year. There are programs in Virology, Molecular Plant-Microbe Interactions, Redox Biology, and Biomedical Engineering for students who are interested in biochemistry.

Acknowledgement

None.

Conflict of Interest

None.

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How to cite this article: Black, Paul. “Molecular Mechanisms of Disease Prepare a Modern Workforce with Biochemistry.” *Mol Bio* 12 (2023): 371.