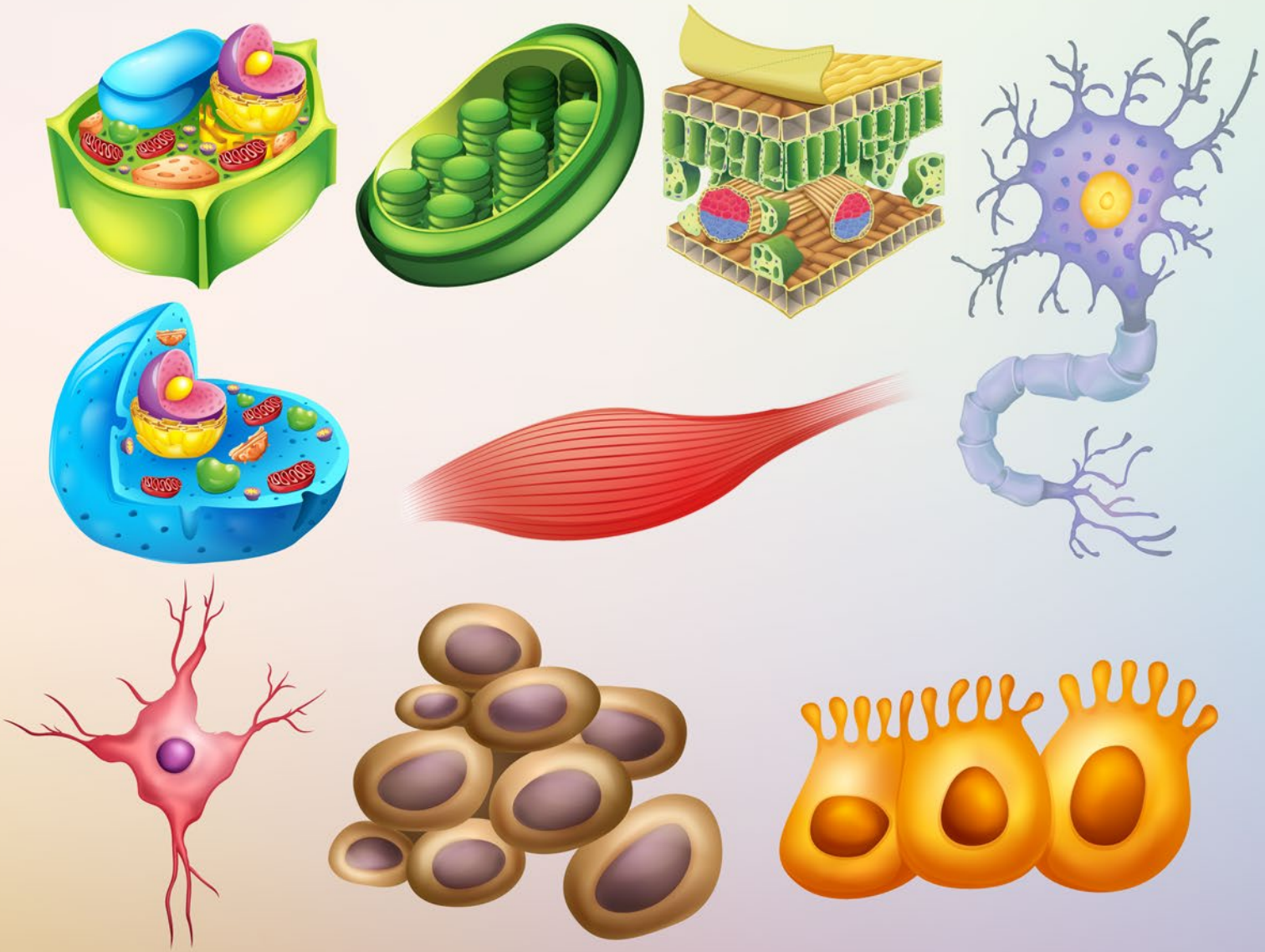
Driving Innovation in Cell Biology Education: The Cell Biology Education Consortium

Professor Lori Hensley and
Professor Nathan Reyna



Scientia

DRIVING INNOVATION IN CELL BIOLOGY EDUCATION: THE CELL BIOLOGY EDUCATION CONSORTIUM

Cell biology is the foundation of several branches of science and medicine. An education in cell biology theory and techniques gives students the grounding to pursue careers in healthcare, research, and the pharmaceutical industry, as well as providing a background in ethics, science communication and critical thinking. Unfortunately, undergraduate-level education in cell biology is often prescriptive and limited. The Cell Biology Education Consortium, founded by **Professors Lori Hensley** and **Nathan Reyna** from Jacksonville State and Ouachita Baptist Universities, respectively, offers a novel approach in which students engage in authentic research and provides extensive resources to support learning.

Cells and Cell Biology

Cells are the basic structural and functional units of all living organisms. Some organisms, like bacteria, are made up of just a single cell, whereas other organisms, such as mammals, consist of a huge number of cells working together in a cooperative group. Cell biology is the study of the structure and function of cells – from general characteristics and functions shared by all cells to unique and highly specialised attributes seen in particular cell types.

Cell biology is a key component of modern science and medicine, with many conditions, such as diabetes, cancer, and neurodegenerative conditions, all being caused by underlying cellular dysfunction. Cell biologists work to uncover the underlying mechanisms of these conditions as well as to investigate treatment options. Cell biology is a critical stage in the drug discovery and development pipeline; by understanding how cells respond to substances, researchers can design drugs to target disease-causing processes as well as improve the efficacy of existing treatments. A new and exciting area in cell biology is the advance of personalised and regenerative medicine – understanding how stem cells could be used to repair lost or severely damaged tissues which are currently untreatable.

Future Cell Biologists

Cell biology is the foundation of many scientific disciplines, including biological, pharmaceutical, and medical sciences. Cell biology education provides students with a broad range of skills applicable to various fields. By studying cell biology, students gain knowledge and skills to help them succeed in a variety of careers, for example, in academic research, the pharmaceutical industry, biotechnology firms, healthcare and medicine, science communication, and more.

In addition to direct benefits to academic and medical progress, education in cell biology gives students the knowledge and critical thinking skills to understand and evaluate scientific claims and make informed decisions. By understanding emerging technologies such as stem cell research and genetic engineering, students are able to consider the ethics of these and other new technologies. Scientific education promotes critical thinking, problem-solving, and data analysis. It encourages students to ask questions, and highlights the importance of basing opinions and statements on validated facts and critically analysing the source and quality of information. These skills are valuable not just in scientific settings but in everyday life.

The Cell Biology Education Consortium

Most university-level cell biology classes include a laboratory-based component that runs once a week for two to three hours. Making the most of this valuable teaching time can be difficult as it is nearly impossible to have large groups of students all gather around a piece of equipment so the instructor can demonstrate the techniques necessary for each experiment. This can be even harder at less well-funded institutions or primarily undergraduate institutions which don't have graduate students to support faculty as teaching assistants.

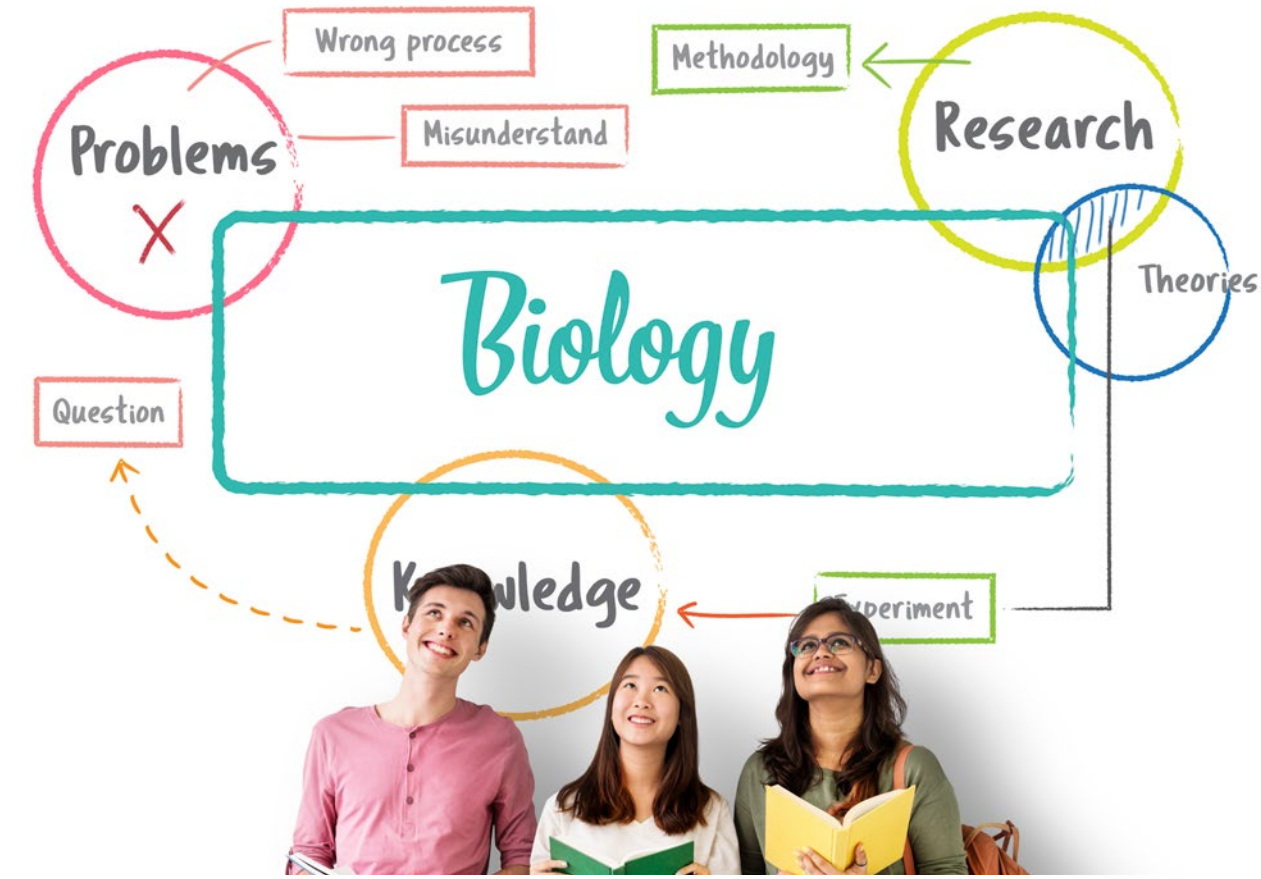
To address this issue, Professors Lori Hensley and Nathan Reyna from Jacksonville State and Ouachita Baptist Universities, respectively, founded the Cell Biology Education Consortium (CBEC). CBEC is funded by the National Science Foundation and takes a novel and experiential approach to learning about cell biology. The researchers have developed an extensive set of resources known as 'Cell Blocks', which can be used in a mix-and-match way to allow students to engage with and answer authentic research questions.

A Cell Block typically contains both video and written step-by-step instructions as well as a pre-laboratory assignment to help students familiarise themselves with techniques and information before coming to the laboratory session. Cell Blocks may also contain best practice notes, teaching tips, and an assessment component. The use of video protocols reduces the need for faculty staff to spend a significant portion of laboratory time, ensuring that all students have been able to observe the techniques, and pre-laboratory assignments help students feel confident in their understanding before the laboratory sessions.

For example, in the initial course-based undergraduate research experience (CURE) on cancer biology, students were asked to answer the overarching question, 'How do potential therapeutic compounds affect hallmark behaviours of cancer cells?'. To address this question, students examined the effects of a chosen compound on a type of cancer cell's ability to survive and reproduce. Based on the results of these experiments and analysis of the published literature, students then chose a protein they believed may be produced at different levels in the cells treated with the compound compared to untreated cells. They then performed a laboratory test to analyse the amount of protein the cells produced.

The modular design and standardised content of CBEC Cell Blocks make them easy to use within different settings, in particular allowing students at traditionally underfunded or under-resourced institutions to gain hands-on experience in cell biology techniques. CBEC has proved to be immensely popular with both students and educators around the globe; CBEC faculty and students have developed and shared 45 Cell Blocks to date. CBEC currently has 235 registered faculty members from 168 institutions; this has led to over 800 students being able to use CBEC material in the classroom and laboratory.

As well as being used directly within educational institutions, CBEC content is available for anyone with an interest in learning about and engaging with cell biology. The first Cell Block video was posted on YouTube in late 2019, and in less than three years, the channel has had an impressive 34,000 total views. In 2022 alone, over 700 hours of content has been watched despite the average video only being five minutes long. Almost 200 students from nineteen universities who had taken part in CBEC Cell Blocks were given the valuable opportunity to share their research and interact with hundreds of other scientists through a research symposium organised by CBEC faculty and hosted on Twitter.



In addition to providing and sharing Cell Block content, CBEC also provides funding for equipment and supplies to academics setting up cell biology projects. Funding aims to be equitable, with efforts made to fund applicants from minority serving institutions, first-generation college students, and those from community or technical colleges.

Cell Biology Education in a Changing World

The flexible modular nature of the Cell Blocks lent itself to virtual teaching during the COVID-19 pandemic and the resulting shutdowns of universities. The CBEC team helped disseminate information between members on ways to transition to virtual learning and minimise education disruption, as well as continuing to support student learning and research. Cell Blocks shifted from traditional laboratory-based learning to a focus on data analysis and computational skills, which better allowed for virtual learning and research projects. This led to over 200 students across five institutions being able to continue their education and conduct meaningful research during the COVID-19 pandemic. This innovative and collaborative approach to education in unique times led to the publication of several papers in academic journals with the aim of highlighting the methods used by CBEC to support and guide other educators.

During the pandemic, a CBEC faculty member developed a Spanish language version of some CBEC content to use at their institution in Puerto Rico, enabling students there to continue to participate in cell biology education and research despite pandemic-enforced closures. This content continued to be vital to students in Puerto Rico during hurricane- and infrastructure-based closures in 2022.

The flexible design of Cell Blocks and the community focus of CBEC have helped the consortium thrive in both in-person and online educational settings. In providing support and resources to both traditionally underrepresented educational settings and those looking to provide the highest standards of education, CBEC has pioneered novel approaches to developing our future generation of scientists.

The CBEC recently received new National Science Foundation funding for the Cell Biology Education Consortium: Path to Publication. Publishing research can be challenging at undergraduate institutions where high faculty teaching responsibilities and student mentoring are priorities. The new ‘CBEC Path to Publication’ grant will help faculty build their curriculum vitae and allow undergraduate students and faculty to become published authors in a recognised scientific journal. This will be accomplished by leveraging the power of their collaborative network to create a triage-style system that will help faculty prepare single-figure manuscripts from their data in partnership with microPublication Biology. This will help faculty build their curriculum vitae and allow undergraduate students and faculty to become published authors in a recognised scientific journal. The single-figure publication approach is a creative way to maximise the dissemination of undergraduate research and can serve as a model for other disciplines.

Meet the Researchers

Professor Lori Hensley
Department of Biology
Jacksonville State University
Alabama, AL
USA

Having received a PhD from the University of Tennessee, Professor Lori Hensley is now the Head of the Department of Biology at Jacksonville State University. She has supervised over 150 undergraduate research students, with several groups of students being selected for the prestigious Undergraduate Research Posters on the Hill event. Her research focus is on using compounds from the Cannabis plant as potential therapeutics for aggressive paediatric cancers with low survival rates. In addition, Professor Hensley is a strong advocate for student learning and believes the best learning opportunities come through doing real science. Alongside her academic position and commitment to student learning, Professor Hensley is currently Co-Chair of the Department Head Council and a member of the Academic Affairs Leadership committee.

CONTACT

E: lhensley@jsu.edu
W: https://www.jsu.edu/biology/faculty/hensley/index.html

Professor Nathan Reyna
Department of Biology
Ouachita Baptist University
Arkansas, AR
USA

Professor Nathan Reyna received his PhD from the University of Arkansas and has gone on to become a Professor at Ouachita Baptist University. His research focuses on understanding how biologically inspired nanostructures provide a support structure for neuron growth and development, and the use of synthetic biology techniques to examine bioinformatically-identified regulatory genetic sequences. Alongside his research, Professor Reyna is passionate about increasing access to science and incorporating opportunities for cell biology learning and research into the undergraduate classroom. As part of this work, he has provided professional development events for high school students and teachers, including an annual bioinformatics workshop. In 2021, he received the inaugural award for Innovation in Education from the American Society for Cell Biology.

CONTACT

E: reynan@obu.edu
W: https://obu.edu/directory/reynan.php

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