Port-a-Patch used for teaching undergraduate students in ion channel electrophysiology at Loyola University

Loyola University New Orleans is a private Liberal Arts College in New Orleans, Louisiana. Loyola is committed to preparing science majors for careers in STEM and medical disciplines, and to promoting scientific literacy among all students. Key to this success is Loyola's robust undergraduate research program, which affords students invaluable opportunities to gain hands-on research experience.

Student Interest in pre-health studies

Since a large proportion of Loyola STEM students show interest in pre-health studies, giving them opportunities for cutting-edge interdisciplinary research would improve their preparation for careers in biomedical fields. Dr. Armin Kargol and Dr. Kimberlee Mix, leading their respective laboratories in Cellular Biophysics and Molecular Biology, have been providing students with opportunities to gain hands on experience in ion channel electrophysiology and in studies of the molecular biology of arthritis.

Funding project helps students

In 2016 they were awarded a $112k grant from the Louisiana Board of Regents Support Fund Enhancement Subprogram for the project titled "From the cell membrane to the nucleus: enhancing laboratory experience and collaborative research projects for pre-health undergraduates in biology and physics". The purpose of the project is to enhance preparation of Loyola students for careers in the health sciences by integrating biomedical research methods into teaching and research programs.

This funding enabled the purchase of two instruments, the Nanion Port-a-Patch and the Lonza Nucleofector device. Together, these instruments have created an "experimental pipeline," that will enable students to modify ion channel receptors

and nuclear factors by site-directed mutagenesis, transfect the altered genes into relevant cells, and study the functional impact of these changes at the level of electrophysiology and gene expression.

A student working with Dr. Kargol is using Nanion's Port-a-Patch

Opportunities for students

Importantly, these biomedical research techniques are being integrated into existing teaching labs in physics and biology, and students will have opportunities to engage in interdisciplinary projects in introductory and advanced courses. These two instruments provide an efficient method to study properties of different ion channels and nuclear factors, and they will augment traditional, more labor-intensive techniques that are currently in place at Loyola. The Nucleofector device will improve the expression rate of transgenes in mammalian cells and the Port-a-Patch will facilitate a variety of electrophysiological experiments to be conducted by undergraduate students. These devices will also be integrated into research projects led by Dr. Kargol and Dr. Mix.

Dr. Kimberlee Mix

Assistant Professor of Biological Sciences at Loyola University New Orleans
Department of Biological Sciences

Dr. Kimberlee Mix's research projects

Research in Dr. Mix's lab is aimed at elucidating the transcriptional mechanisms driving synovial hyperplasia and cartilage degradation in order to devise innovative strategies to prevent tissue erosion and preserve joint function in arthritis. The orphan nuclear receptor NR4A2 is currently being studied as a novel therapeutic target and the transcriptional mechanisms of this receptor will be investigated with the Nucleofector device.

Dr. Armin Kargol's research projects

Research in Dr. Kargol's lab concentrates on improving our understanding of ion channel gating and developing new methods of regulating this process for research or therapeutic purposes. In Dr. Kargol's lab the novel application of magnetically driven multiferroic nanoparticles for the purpose of nano-electrostimulation of voltage-sensing biological macromolecules, such as voltage-gated ion channels in cell membranes, is investigated. Another project involves the study of the effect of cholesterol content in cellular membranes on the function of ion channels. Human nutrition is known to impact the lipid composition of cell membranes, including the formation of lipid rafts. Because of their intimate contact, protein-lipid interactions can significantly affect ion channel function. By examining the interplay between membrane

components such as cholesterol and embedded ion channel function, the role of nutrition can be elucidated.

Dr. Armin Kargol

Professor of Physics, Rev. James C. Carter, S.J., Distinguished Professor in Experimental Physics, Department Chair

Patch Clamp Technology is established in Dr. Kargol's group

Loyola is a primarily undergraduate institution and almost all scientific research is conducted by faculty and undergraduate students. The limiting factor to productivity and student engagement is the amount of time required to train students with no prior lab experience. Since modern experimental techniques often require significant background knowledge and practical skills, the faculty mentoring undergraduate researchers must balance training time with the amount of time that the students can and should devote to research.

The best example is the patch-clamping technique in Dr. Kargol's lab. Its success depends to a large degree on the skills of the operator and it takes over a year to train an undergraduate student on the current manual rig. The Port-a-Patch is a compact patch-clamping system. It is an excellent compromise between versatility, ease of use, and cost. It allows all types of measurements that are typically done on large manual rigs, in some aspects exceeding their capabilities, while being entirely automated, thus increasing lab throughput and reducing the training time from months or years to a few weeks.

Dr. Kargol teaches how to use the Port-a-Patch

Dr. Kargol about the Port-a-Patch:

"Nanion's Port-a-Patch is an excellent instrument for research labs working with undergraduate students. Manual patch-clamping methods depend to a large extend on the skills of the operator. They require long training periods. For a typical undergraduate student it takes over a year to learn patch-clamping. Port-a-Patch reduces that time to only weeks and the most difficult part is to understand the software that controls the instrument. This allows undergraduate students to actively participate in real research projects."

The educational aim for students

The educational aim of this project is to enhance pre-health pedagogy by embedding state-of-the-art biomedical research methods into introductory and advanced biology and physics courses. In upper level physics and biology courses, such as Advanced Physics Lab, Cellular Biophysics, Molecular Genetics, students will engage in inquiry-based experiments with the Port-a-Patch and Nucleofector devices to investigate problems related to human health and disease. These courses will include new experiments focused on membrane

Nanion's Port-a-Patch

The Port-a-Patch is a miniaturized patch clamp system supporting giga-seal recordings from one cell at a time. It offers fast and easy access to high quality patch clamp data with only minimal training. Not only a powerful research tool but also ideal for educational purposes and quick tests of cells and ion channels.

Using the Port-a-Patch® is straightforward and easy – the user simply adds solutions and cells onto the disposable recording chip, where a cell is automatically captured and sealed by suction using a computer controlled pump. Supported recording modes are the whole cell, perforated patch and cell attached configuration.

potential and the properties of ion channels while transfection experiments and discussions of genetic therapies will be incorporated into the Molecular Genetics Lab. Experimental data generated in these courses will in turn be analyzed and discussed by students in introductory biology and physics courses (BioInquiry, Cells and Heredity, Intro Mechanics/Intro EM, Physics for Life Sciences).

The Advantage for Medical School Training

Exposure to experimental data and analysis methods early in the pre-health curricula will allow students to sharpen their critical thinking and analytical skills and provide them with a framework for scientific investigation that will be further developed in upper level courses.

Emphasizing the importance of scientific literacy and quantitative research methods as an integral part of the medical professions will enable students to make relevant connections between their science courses and their chosen career path.

Dr. Kargol students: Understanding and analyzing ion channel functions

Student Training on the Port-a-Patch: First Step towards Medical School Education

When the Port-a-Patch was installed in Dr. Kargol's lab in October 2016, undergraduate students that trained on manual patch-clamp rigs for months were able to successfully record whole-cell ionic currents after only a few hours of training. Another important aspect is that the Port-a-Patch uses the same HEKA Patchmaster software that has been in use in Dr. Kargol's lab. That made the transition to the new equipment much easier. Undergraduate researchers are already beginning to work on specific research questions. This is a very exciting time for Loyola biophysics and molecular biology students.

Dr. Kargol and his students: Practical teaching lessions in Electrophysiology

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