Frozen Facility

The above image shows 3-D reconstructions of cardiac intercellular gap-junction channels and needle complexes that were isolated from Salmonella bacteria. The molecular reconstructions are arranged on a background containing raw image data of the needle complex as well as processed crystallographic data from the gap junction sample.

The biological sciences involve many hypotheticals, equations, and deductions. But having the ability to actually view biological specimens with their own eyes allows researchers to make connections and better understand the complex science of life. Northwestern's Cryo-Electron Microscopy (Cryo-EM) Facility gives researchers a unique glimpse into molecular structures. In this facility, researchers can peer inside of a molecule to see what makes it work.

Such an up-close look is made possible by the JEOL 3200FS field-emission electron microscope, which is the heart and soul of the core facility. The facility also has a smaller electron microscope, the JEOL 1400, used to prescreen samples.

“The CryoEM allows us to image biological samples at scales from entire cells and organelles to single molecules, sometimes at atomic resolution,” says facility director Vinzenz Unger, molecular biosciences. “Exploiting this versatility and factoring in very exciting recent technological advances, CryoEM is poised to become a key technology for the advancement of life sciences in the ‘post-omics’ era.”

Unger uses the facility for his research to understand how cellular processes function at the molecular level. In particular, he is focused on problems ranging from the transport of simple ions such as copper, to understanding how cells change the shape of their membranes, to the molecular basis of synaptic scaffolding. In many cases, using the high-powered microscope led to “a-ha!” moments in his own work.

“By using cutting-edge technology,” he says, “we can see what nobody else has yet seen. We can go where no one has gone before.”

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Jona Testifies at Congressional Hearing

Kemi Jona, education and social policy, testified before a Congressional committee in Washington, D.C., on January 8 to share his expertise on industry partnerships for STEM (science, technology, engineering and mathematics). The hearing for the Committee on Science, Space and Technology's subcommittee on research and technology focused on “Private Sector Initiatives That Engage Students in STEM.”

Jona directs the Office of STEM Education Partnerships (OSEP) at Northwestern, which develops liaisons with schools and industry partners for innovative initiatives in STEM education.

“...Frozen Facility continued

Unlike Northwestern’s Biological Imaging Facility—which has tools to image an array of samples, such as fixed cells or polymers at lower resolutions—the CryoEM Facility is dedicated to high-resolution imaging of biological and other soft materials. Its microscopes are so sensitive that commonly used chemicals used for preserving samples to do lower resolution work would contaminate the instruments to the point where high-resolution work would no longer be possible. Even the facility’s space in the basement of Silverman Hall was renovated with the instruments’ sensitivity in mind: the room is soundproof with a stabilized temperature and humidity control. Workers installed a 7,000-pound granite slab that supports the large microscope, isolating it from the vibrations in the building.

The “cryo” part of cryo-electron microscopy refers to the necessity of rapidly freezing specimens before viewing them under the microscope. By first freezing the samples, biological activity is ceased but structure is preserved, allowing the specimen to become stabilized in a lifelike state. To prepare samples, the facility provides a Cryoplunge instrument, which flash freezes samples in aqueous solutions. From there, no further processing is needed. The sample can be observed without having been stained or fixed in any way, showing it in its native environment.

Despite rapid technological advances since its purchase four years ago, the JEOL 3200FS remains a state-of-the-art instrument. Notably, before the CryoEM Facility opened in September, there were no other similar microscopes in Illinois. The current setup provides a much-needed resource that Unger hopes will be used by other institutions in the area, including the University of Illinois-Chicago and University of Chicago.

“We are the only CryoEM facility for Chicago and the greater Chicago area,” Unger says. “No doubt, having this instrument and keeping abreast with more recent technological improvements to the instrumentation increase Northwestern’s standing in the local community and will allow researchers to make unprecedented advances in the life sciences.”

In order to prepare users to handle the equipment, facility manager Jonathan Remis trains interested parties. “Training is free,” he says. “But we only train people with a serious commitment to continue using the facility.” To ensure this commitment, trainees are required to pay for and reserve 15 hours of time on the microscope after training. Remis also provides support ranging from specimen development, preparation, imaging, and structure determination.

“Northwestern has a training mission,” Unger adds. “We want to empower researchers through training in the facility, so they can take this expertise back to their labs.”

For more information about the CryoEM Facility, visit www.facilities.research.northwestern.edu/browse-facilities/cryoem-facility.