



# The University of Chicago and Affiliated Laboratories: Powerful Partners in Transformative Science

## ARGONNE, FERMILAB, MARINE BIOLOGICAL LABORATORY AND THE UNIVERSITY OF CHICAGO DISCOVERIES THAT CHANGED THE WORLD



### Measured the speed of light.

Precision optical experiments by physicist Albert A. Michelson led to measurements of the speed of light and support for Einstein's theory of relativity. In 1907, Michelson became the first scientist from the United States to win the Nobel Prize. (University of Chicago, 1907)



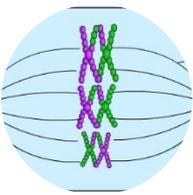
### Established the role chromosomes play in heredity.

Thomas Hunt Morgan established that the hereditary material is located on the chromosomes, conducting his research at Columbia University and at the MBL. In 1933, Morgan received the first Nobel Prize in Physiology or Medicine to be awarded in the field of genetics. (Marine Biological Laboratory, 1906-1912)



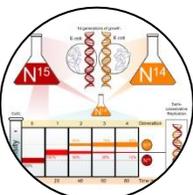
### Conducted the first controlled, self-sustaining nuclear chain reaction.

The modern nuclear age began when Nobel laureate Enrico Fermi and his colleagues conducted the first controlled, self-sustaining nuclear chain reaction on December 2, 1942, on the University of Chicago campus. (University of Chicago: 1942)



### Proved that chromosomes are moved in a dividing cell by the spindle.

Shinya Inoué, a pioneer in the microscopic imaging of live cells, confirmed the existence of the mitotic spindle, the dynamic structure that segregates chromosomes in the dividing cell. (Marine Biological Laboratory, 1953)



### Proved the hypothesis of semi-conservative replication of DNA.

Just a year after the discovery of the structure of the DNA double helix, Matthew Meselson (a graduate student) and Franklin Stahl (a postdoctoral fellow) conceived the experiment to prove the hypothesis of semi-conservative replication of DNA. Frequently called "the most beautiful experiment in biology," the Meselson-Stahl experiment was published in 1958. (Marine Biological Laboratory, 1954)





### **Revolutionized archaeology and paleontology with carbon-14 dating.**

The discovery that ancient organic materials could be dated based on the abundance of an isotope of carbon—called carbon-14 dating—has had revolutionary implications for archaeology and paleontology. Chemist Willard F. Libby won the Nobel Prize for this work in 1960. (University of Chicago, 1960)



### **Produced revolutionary particle accelerator applications, including cancer treatment and drug development.**

From blueprint to construction, scientists and engineers at Fermilab and Argonne develop particle accelerators to produce the beams needed to take research in many areas of science to the next level. The Tevatron particle collider, the Advanced Photon Source and the proton accelerator at the Loma Linda Medical Center are just a few of the particle accelerators that Fermilab and Argonne have designed and built over the years, and the two labs have collaborated with laboratories around the world on additional machines. More than 30,000 particle accelerators are in operation around the world, serving medicine, industry, energy, the environment, national security, and discovery science. As accelerator science and technology continue to advance, so too will their benefits to society. (Fermi National Accelerator Laboratory, Argonne National Laboratory, 1967-present)



### **Discovered cyclin, a family of proteins that regulate the cell cycle.**

Tim Hunt, Joan Ruderman, and collaborators made the discovery during post-MBL course research while studying clam and sea urchin eggs. Hunt was awarded the Nobel Prize in Physiology or Medicine for the discovery in 2001. (Marine Biological Laboratory, 1979-1982)



### **Discovered the top and bottom quarks and the tau neutrino.**

In 1977 Fermilab scientists discovered the bottom quark, an essential ingredient in the theoretical framework called the Standard Model. In 1995, the Tevatron's colliding detector experiments at CDF and DZero discovered the top quark, the last undiscovered quark of the six predicted to exist by current scientific theory. In July 2000, the DONUT collaboration announced the first direct observation of the tau neutrino. (Fermi National Accelerator Laboratory, 1977, 1995, 2000)



### **Discovered kinesin, a class of motor proteins, in the axoplasm of squid.**

Ronald Vale, Michael Sheetz, and collaborators discovered kinesin, a class of motor proteins that move cargo within cells, using new video-imaging technology invented at the MBL. (Marine Biological Laboratory, 1984)



### **Developed the GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) fuel-cycle model.**

GREET is the world-wide standard for evaluating the energy and emission impacts of advanced vehicle technologies and new transportation fuels over their entire fuel cycle "wells to wheels" and the complete vehicle cycle from mining initial raw materials through end-of-life vehicle disposal. (Argonne National Laboratory, 1996)





**Invented “near-frictionless carbon,” an ultra-hard coating many times slicker than Teflon.**

Using Argonne’s Leadership Computing Facility, scientist Sanket Deshmukh discovered a phenomenon that had never been observed before— a completely new mechanism for superlubricity, a state in which friction essentially disappears. A reduction in friction translates directly into higher engine efficiency, better and quieter performance, less wear, longer lifespans and lower maintenance costs. This new coating has applications for a wide range of industries including automotive, aerospace and transportation. (Argonne National Laboratory, 1997)



**Discovered evolutionary link between fish and land animals.**

In 2006, paleontologist Neil Shubin discovered fossils of Tiktaalik roseae, the missing evolutionary link between fish and the first animals that waddled out of water onto land 375 million years ago. Shubin’s key discovery advanced evolutionary biology, and his best-selling book and television series sparked popular interest in the subject. (University of Chicago, 2006)



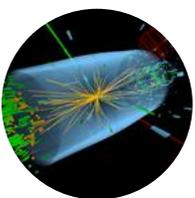
**Invented the process for growing the world’s smoothest diamond films.**

These ultra-smooth diamond films represented a generational leap in diamond wafer technology that brought the surface roughness of diamond films to levels comparable to electronic grade silicon wafers; opening up new possibilities for the application of diamond into a wide variety of electronic and biomedical devices. Argonne licensed multiple U.S. Patents related to the discovery to a local company, and subsequently, diamond films have become an effective engineering material for industrial, medical and semiconductor applications. (Argonne National Laboratory, 2009)



**Invented the cathode material for the battery in the Chevy Volt, which in 2011 became the first mass-produced plug-in hybrid electric car.**

The battery's chemistry is based in part on a revolutionary breakthrough pioneered by Argonne scientists. The new development helps the Volt's battery — a lithium-ion design similar to those in your cell phone or laptop — last longer, run more safely and perform better than other batteries on the market. (Argonne National Laboratory, 2011)



**Contributed to the discovery of the Higgs boson.**

On July 4, 2012, scientists of the ATLAS and CMS experiments at the Large Hadron Collider announced the discovery of the Higgs boson. Fermilab, Argonne and the University of Chicago were heavily involved in both the construction of the LHC and its experiments as well as the data analysis that led to the discovery. (Fermi National Acceleratory Laboratory, Argonne National Laboratory, The University of Chicago 2012)

