Interdisciplinary teams from Genomics and SynBio, two biotechnology companies incubated by Academia Sinica

# LAYING FOUNDATIONS FOR DISCOVERY

Taiwan's leading academic institution, ACADEMIA SINICA, stands for research excellence, social responsibility and talent incubation.

**As Taiwan's leading** government-funded research institute, Academia Sinica (AS) has spearheaded numerous fundamental and interdisciplinary research initiatives to address diverse challenges in Taiwan and beyond. Its key objectives, outlined by its president, James Liao, are to achieve global recognition, fulfil social responsibilities, and attract and cultivate top talent. These objectives are embedded in the diverse research programmes at AS, spanning life sciences, mathematics and physical sciences, as well as humanities and social sciences.

**Integrating biological sciences**

Life sciences has dominated AS's extensive research success, especially in the field of precision medicine, which develops treatment based on a person's genetic, environmental and lifestyle factors. Translational applications of precision medicine in cancer, infectious diseases, regenerative medicine, neurodegenerative diseases, and genetic anomalies are grounded in a strong tradition of fundamental biological research, ranging from biochemistry, molecular biology, cell biology to evolutionary biology.

An example of AS's translational biomedical research is the study of dengue virus, which causes pain, fever, and can be lethal. By identifying a novel mechanism behind how this mosquito-borne virus invades the body, the study contributed to the development of effective vaccines. Efforts are also made to develop vaccines for other viruses.

To enhance these efforts, AS has conducted a large-scale genomics study, aiming to elucidate genotypes of the Taiwanese population. With the help of artificial intelligence (AI) and data science, findings underpinned epigenetic studies on obesity and cancer. There are also breakthroughs in improving the precision of immunotherapy and clarifying the role of gut microbiota.

Vaccine development, protein modification, and structure-based drug discovery, all use sophisticated chemical biology tools, including glycan arrays, bio-imaging, designer molecular probes and nanomaterials.

Meanwhile, research on metabolic biochemistry and synthetic biology has contributed to new antibiotics, biofuels, and other bioactive molecules, as well as to improving immunotherapy and carbon dioxide fixation methods. Strong support for chemical synthesis and derivatization of biomolecules has also advanced integrated research on glycobiology, host-microbe interaction, immunity, and neurosciences.

AS neuroscientists have prioritized efforts on the mechanisms and therapeutic strategies for neurodevelopmental and neurodegenerative diseases, such as Alzheimer's. Their multidisciplinary research approach involves iPS technology, based on induced pluripotent stem cells, molecular and imaging techniques, and glycol-chemistry employing organic compounds. These have led to breakthroughs including finding new roles for glia-neuron interactions in development and diseases, and elucidating novel signals and circuits underlying sensory responses such as pain and hunger.

**Engineering a better future**

Improving social wellbeing is also integral to physical science research at AS. Committed to the UN's sustainable development goals, AS is driving research on carbon reduction. Its scientists have combined biological and chemical approaches for carbon dioxide conversion, developed synthetic and artificial photosynthesis, and investigated novel approaches for methane utilization, hydrogen production, and energy storage. AS's sustainability focus also includes global climate modelling, air-quality monitoring, analyzing health and environmental changes caused by climate change, and developing renewable energy and resilient agriculture.

This work is facilitated by AI and data science at AS. Aside from applications in public health, precision medicine, and air pollution, studies on architectures and algorithms to optimize AI performance also have implications in structural biology, music production, natural language and knowledge processing.

Given Taiwan's location in an earthquake zone, AS geoscientists have conducted long-term monitoring of seismic activities in the region. Measurements of crustal deformation using dense arrays have improved analysis of local seismic hazards potential, contributing to better preparation for earthquakes. AS has also collaborated with other institutions to study the subduction tectonics.

Collaboration is also vital for astronomical and astrophysical studies at AS. Notably, AS's participation in the Event Horizon Telescope (EHT) project has led to capturing the first direct evidence of a supermassive black hole at the heart of a distant galaxy. Advanced instruments and data processing methodologies developed at AS have also enabled astronomical observations.

AS also spearheads the development of micro- and nano-scale imaging technologies. Their electron, X-ray, and super-resolution imaging technologies, along with the cryo-electron microscopy are essential for biological and nanoscience research.

Using these advanced technologies, AS has piloted numerous theoretical and experimental studies on advanced materials, including two-dimensional materials, energy materials, quantum materials, and material analysis techniques. These studies, along with cross-institutional projects on materials science, have contributed to Taiwan's position as a hub for semiconductor fabrication.

**Building world-leading infrastructure**

Aiming to integrate biotech innovation with commercialization efforts in drug development, AS, with government support, has established a biotechnology research park. Combining top talent and infrastructure, the park will incubate start-ups to initiate drugs, reagents, vaccines, and new therapeutic modalities. A biotechnology incubation centre within the park will facilitate technology transfer of research results for commercialization.

Furthermore, to leverage regional research capabilities and enhance local strengths, AS is building its southern campus, focusing on precision agricultural biotechnology, advanced materials, and sustainability. "We promote scientific discoveries and practical solutions to key global problems — with an eye on pioneering research to create actionable knowledge based on fundamental principles," says Liao. ■

https://www.sinica.edu.tw/en

## FOSTERING INTERNATIONAL EXCHANGE

A vibrant hub for pursuing advanced education in cutting-edge fields, AS launched the Taiwan International Graduate Programme (TIGP@AS) in 2002. Its diverse, open and stimulating research environment welcomes international talent to pursue their research in Taiwan:

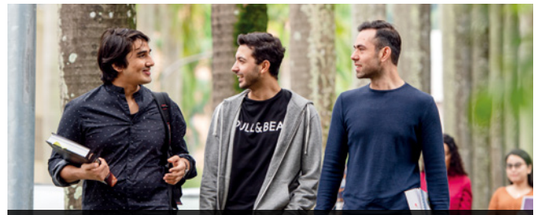
- Language of instruction: English
- **12** programmes spanning chemical biology, precision medicine, neurobiology, biodiversity, molecular biology, advanced materials, nanotechnology, artificial intelligence and Earth sciences
- Student: **604** enrolled Ph.D. students, including **421** international students from more than **40** countries

**ACADEMIA SINICA BY NUMBERS**

- **3** research divisions
- **32** research institutes and interdisciplinary research centres
- About **800** principal investigators
- Around **8,000** employees, including graduate students and postdocs

A student from Academia Sinica's Taiwan International Graduate Program operating a confocal microscope

Model of a magma reservoir from the Tatun Volcano Group in northern Taiwan



Academia Sinica offers a diverse and open environment for international students



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