

The best minds in brain science

Combining clinical and basic research strengths, the **INSTITUTES OF BRAIN SCIENCE (IOBS) AT FUDAN UNIVERSITY** in Shanghai has pioneered neuroscience innovation set to bring significant social benefit.

Just as brain research has gone through dramatic changes in the past decade, the Institutes of Brain Science (IOBS) at Fudan University has undergone rapid transformation since its inauguration on Fudan's medical campus in 2006. After the State Key Laboratory of Medical Neurobiology (SKLab) added its might in 2010, the combined IOBS/SKLab has strengthened its distinctive role in boldly driving interdisciplinary research and bench-to-bed translation — all supported by Fudan's rapid growth as a comprehensive university.

Committed to deepening understanding of brain functions and accelerating the development of novel therapies for major nervous system disorders, IOBS/SKLab takes on cutting-edge research to learn the basic principles of sensory neurobiology, define the mechanism of higher cognitive functions, and develop next-generation treatment for major brain disorders.

Its researchers have made breakthroughs ranging from improved understanding about reward processing, to technology for vision restoration, positioning itself as one of the most influential brain

science research institutions in China.

Signalling change

The molecular mechanisms underlying drug addiction has long intrigued Lan Ma, the current director of the IOBS/SKLab. Working with the group of another IOBS/SKLab researcher, Ping Zheng, Ma has recently unveiled the signalling pathways for morphine-induced behavioural sensitization. Combining optogenetics, electrophysiology, and cell type-specific RNA sequencing, Ma and her colleagues also revealed how morphine assembles heterogeneous interneurons in prefrontal cortex, and disinhibits pyramidal neurons while enhancing reward. Ma's team also showed neuronal cells and circuits that store cocaine reward memory and associated contextual information. For her outstanding achievements, Ma was recently elected to the Chinese Academy of Sciences (CAS).

IOBS/SKLab has also opened frontiers on fear memory by exploring how neurons form functional connections. Its researcher, Yongchun Yu, has shown how transplantation of immature inhibitory interneurons in



Lan Ma (left), director of IOBS and SKLab; Xiongli Yang (right), founding director of IOBS/SKLab and chairman of IOBS Academic Committee



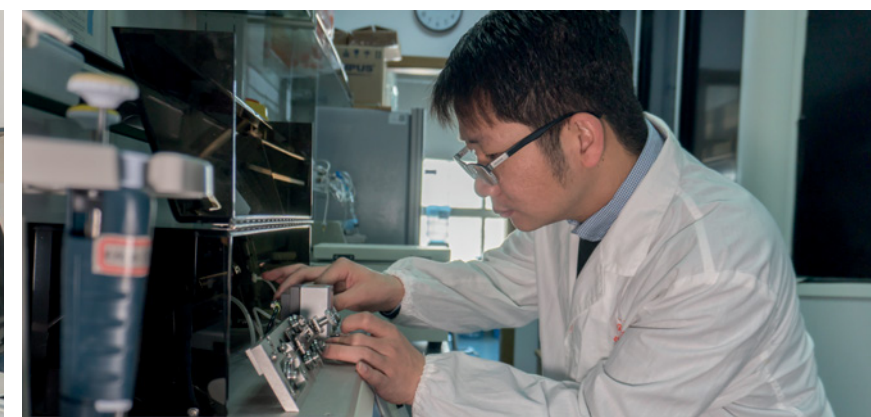
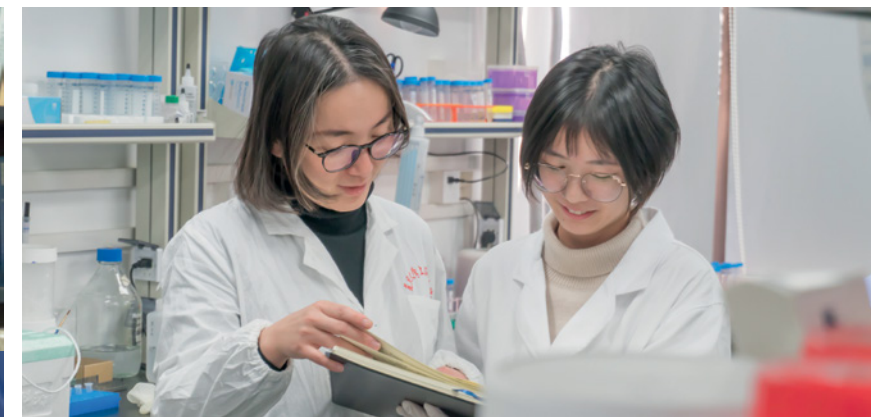
adult mice erased their fear memory, shedding light on a new strategy for preventing pathological fear.

Zhengang Yang, who joined the IOBS/SKLab in 2007, focuses on the mechanisms regulating division and differentiation of neural stem cells, and brain repair after injury. In his 2018 *Nature* paper, coauthored with colleagues, new evidence was found for the absence of neurogenesis in the adult human hippocampus. During the first year of life, recruitment of young neurons to the hippocampus decreases rapidly. This counters the common belief that new neurons continue to be generated in the dentate gyrus of the adult hippocampus, a region critical in learning and memory.

A nanowire-based retinal prosthesis study on mice sheds light on vision restoration. Jiayi

Zhang developed artificial photoreceptors based on gold nanoparticle-decorated titanium nanowire arrays, mirroring photoreceptors in human retina and their functions. Zhang joined IOBS/SKLab in 2012 to become part of the vision research team led by Xiongli Yang, a neuroscientist and CAS member. Their device restores visual responses in blind mice, bringing potential treatment for patients with retinal degenerative diseases.

Blood-brain barrier defects and cerebrovascular dysfunction drive pathology of neurodegenerative diseases such as stroke and Alzheimer's disease (AD). Bingqiao Zhao's work at IOBS/SKLab singles out an enzyme which maintains blood-brain barrier integrity and cerebrovascular function, presenting unprecedented therapeutic opportunities for stroke and AD patients.



Chemotherapy-induced peripheral neuropathy often results in neuropathic pain. Yuqiu Zhang and her team discovered an antibody for its potential treatment, targeting a cytokine which mediates neuron-glia interactions and neuronal hyperexcitability.

Co-creating a bright future

Collaboration between neuroscientists and clinicians is integral to the IOBS/SKLab. "Working in different fields, our PIs utilize interdisciplinary approaches, and integrate basic studies with clinical issues," said Xiongli Yang, the founding director of IOBS/SKLab.

The IOBS/SKLab has integrated more than 60 research groups on brain-related research from Fudan's affiliated hospitals, as well as the Schools of Life Science, Medicine, and Pharmacy by providing extramural support

and making joint appointments. With top-ranked clinical departments in neurosurgery, neurology, ophthalmology, psychiatry, and hand surgery, the joint efforts have allowed the IOBS/SKLab to expand its basic research strength to clinical studies.

The multi-disciplinary approaches, including innovative imaging technologies, genetics, molecular biology, new methods of electrophysiological recording, and next-generation sequencing and bioinformatic analyses, also allow IOBS/SKLab researchers to use advanced technologies to explore the working principles of the brain. Aiming to build advanced technical platforms for brain research, IOBS/SKLab has set up a support team to run core facilities, providing high-quality technical services.

These efforts have attracted

neuroscientists worldwide to become PIs at the IOBS/SKLab, including Thomas Behnisch, from Germany, and Nashat Abumaria, from Jordan. Several other talented members have recently joined the IOBS/SKLab team, including Miao He from the Cold Spring Harbor Laboratory in USA, Yunli Xie from the Institute of Molecular Biotechnology in Austria, and Ying Zhu from Yale University School of Medicine. IOBS/SKLab plans to recruit more talent at different levels from across the world.

Brain research has now become a key discipline under Fudan University's 'World-Class University Construction Program'. Generous funding support from the Shanghai municipal government has seen the launch of a RMB 800-million project in 2018 for brain-inspired technologies and applications,

MILESTONES AT IOBS/SKLAB

- An international team of 69 talented PIs, including two members of the Chinese Academy of Sciences

- Between 2005-2019, IOBS investigators published more than one thousand research papers and reviews in peer-recognized international journals

- Enrolled more than 500 graduate and doctoral students in neurobiology, pharmacology, biophysics, and neurology

- State-of-the-art core facilities include: In vivo and high-resolution imaging facility, platforms for behavioural neuroscience, functional MRI for small animals, single cell genomics



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