2020

ANNUAL REPORT

CHEN TIANQIAO & CHRISSY
INSTITUTE

Founders' Letter

While, like many, we found 2020 challenging at times, we were also struck by the opportunity it presented. The rise of Zoom meetings and conferences, for example, meant much more access for those who might not otherwise have been able to engage with the global scientific community. As we start moving back towards some semblance of normalcy, we will endeavor to carry some of these lessons with us.

2020 saw the continued expansion of the Chen Institute's ecosystem. In October last year, we opened the first Chen Frontier Lab for Brain Science in Shanghai on Huashan Hospital's new Hongqiao campus. The Frontier Lab supports cutting-edge research and explores how it can be practically applied to real-world situations. Its early priorities will center around sleep and dreams, the brain-machine interface, digital medicine and cognitive assessment, diagnosis and interventions.

Late last year, we were excited to see the scientists and researchers starting to move into the Chen Neuroscience Research Building at Caltech. Designed around our shared values, the building is the home for neuroscience at Caltech. It facilitates easy collaboration and interdisciplinary thinking which we hope will lead to exciting new scientific breakthroughs.

We hope you enjoy reviewing the achievements of last year and thank you for your continued support.

Tianqiao Chen   Chrissy Luo

Our Vision

Improving the human experience by understanding how our brains perceive, learn and interact with the world.

Supporting brain research which is focused on:

- Understanding the sensation-perception mechanisms and related systems of memory, attention, learning and expectations.
- Advancing discoveries and applications that minimize the negative and enhance the positive impact of perceptions.

We believe that the ability to shape and refine perception will help us better understand our world, be it through more targeted therapies to alleviate negative psychological states such as depression or seamless brain-machine interfaces to enhance the utilization of mental capacity and capabilities.

Focus

Supporting fundamental research into brain function and how perceptions are formed

We are committed to bringing together the world's most talented researchers to investigate the complex interactions governing sensation, perception and cognition. We have three core areas

Brain Discovery

Understanding the brain at the fundamental level of individual neurons and synapses. We support research that will deepen our understanding of how the brain gathers, organizes and retains information, and translates perceptions into thoughts, emotions, decisions, actions and memories.

Brain Treatment

We seek to translate improved understanding of brain mechanisms and processes into break-throughs in the treatment of physical and psychological suffering such as mental disorders and neurodegenerative diseases.

Brain Development

An acute understanding of fundamental brain processes will allow us to perfect the brain-machine interface, use technologies such as augmented reality or virtual reality to improve neurorehabilitation and inform the next generation of artificial intelligence.

BUILDING AN ECOSYSTEM

Tianqiao and Chrissy Chen Institute for Neuroscience at Caltech

The Tianqiao and Chrissy Chen Institute for Neuroscience at Caltech, founded in 2016, brings together a cross-disciplinary team of scientists and engineers to investigate one of today's greatest challenges and opportunities: understanding the brain and how it works. Together, these researchers are probing the most sophisticated biological and chemical computing machine and advancing the most promising ideas from that work.

Read more on Caltech's Website >

The Chen Neuroscience Research Building at Caltech

Described as a new gateway building, the Chen Neuroscience Research Building is the home for neuroscience at Caltech. The building brings together all of the disparate groups across the university who are focused on the brain under one, beautifully designed roof.

Caltech president Thomas F. Rosenbaum, Sonja and William Davidow Presidential Chair and professor of physics, described it as having "state-of-the-art laboratories but also very human gathering spaces," as well as "skylights and gardens where serendipitous scientific encounters can launch new collaborations and reveal unexpected research directions."
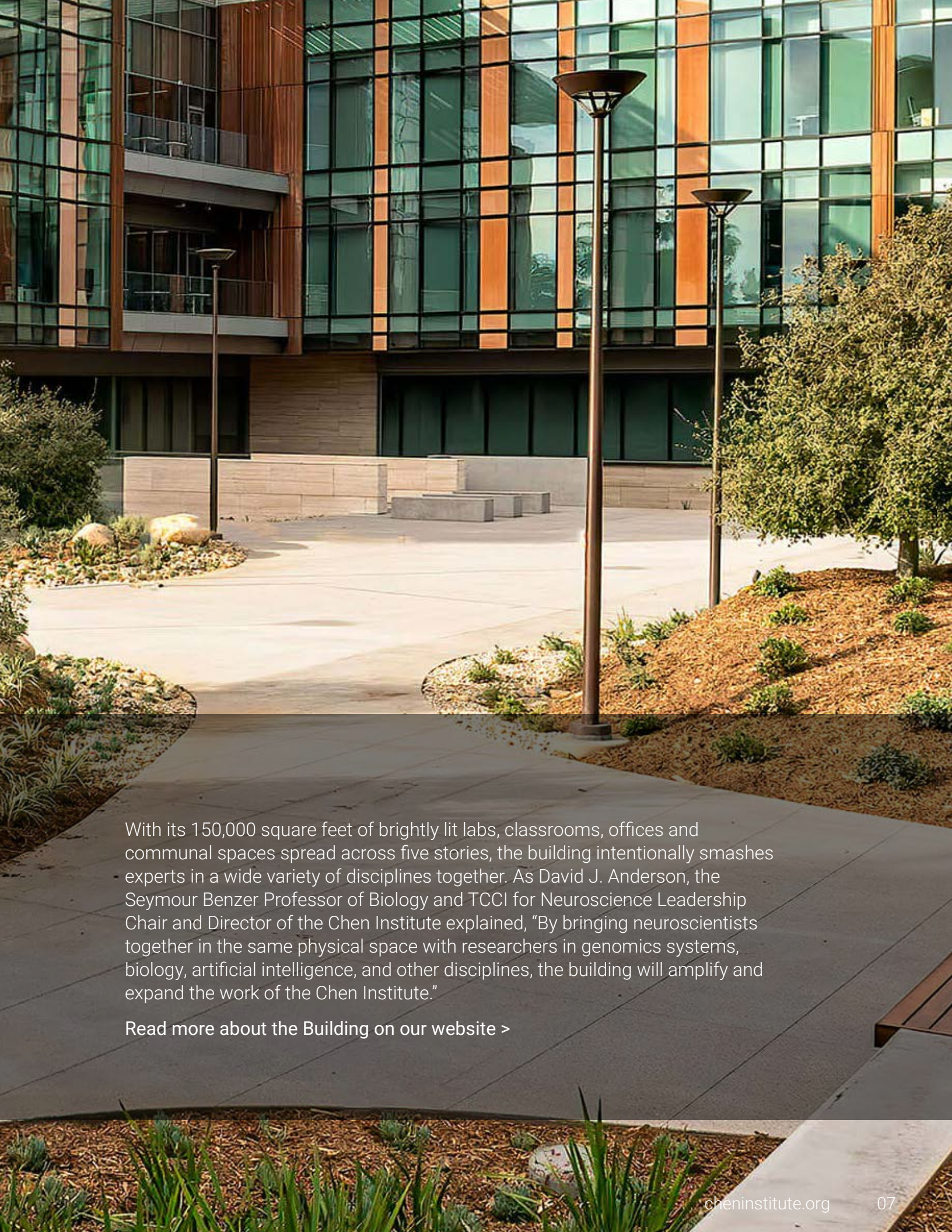
With its 150,000 square feet of brightly lit labs, classrooms, offices and communal spaces spread across five stories, the building intentionally smashes experts in a wide variety of disciplines together. As David J. Anderson, the Seymour Benzer Professor of Biology and TCCI for Neuroscience Leadership Chair and Director of the Chen Institute explained, "By bringing neuroscientists together in the same physical space with researchers in genomics systems, biology, artificial intelligence, and other disciplines, the building will amplify and expand the work of the Chen Institute."

Read more about the Building on our website >

TCCI Opens First "Chen Frontier Lab for Brain Research"

In a major step for our RMB 500 million commitment to support brain science research in China, we opened the first Chen Frontier Lab for Brain Research in October 2020. The lab is situated on the Huashan Hospital Hongqiao Campus, a large-scale neuroscience medical center, near Shanghai. It seeks to achieve accomplishments in four dimensions: scientific research, talent development, standards formulation and industry research.

With a particular focus on Sleep and Dreams, the Brain-Machine Interface, Digital Medicine and Cognitive Assessment, Diagnosis & Intervention, the Frontier Lab prioritizes interdisciplinary collaboration and the translation of fundamental research into practical products and applications. It is open to all scientists in China and abroad and gives them complete academic freedom to pursue unique, cutting-edge research.

Read more about the Chen Frontier Lab >

SUPPORTING OUR COMMUNITY DURING THE PANDEMIC

During the challenges presented by the pandemic in 2020, we felt it was more important than ever to support our community of teaching hospitals, universities and community organizations so we donated over $10 million in unrestricted funds to the organizations below.

David Anderson

Seymour Benzer Professor of Biology, Tianqiao and Chrissy Chen Institute for Neuroscience Leadership Chair and Director, and Howard Hughes Medical Institute Investigator

PRINCIPAL INVESTIGATORS

Ralph Adolphs

Director of the Caltech Brain Imaging Center, Bren Professor of psychology, neuroscience and biology and Allen V. C. Davis and Lenabelle Davis Leadership Chair

Richard Andersen

James G. Boswell Professor of Neuroscience and T&C Chen Brain-Machine Interface Center Leadership Chair and Director

Liang Chen, MD
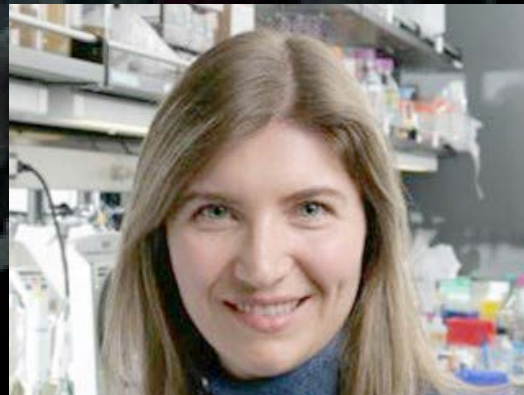
Professor of Neurosurgery at Huashan Hospital
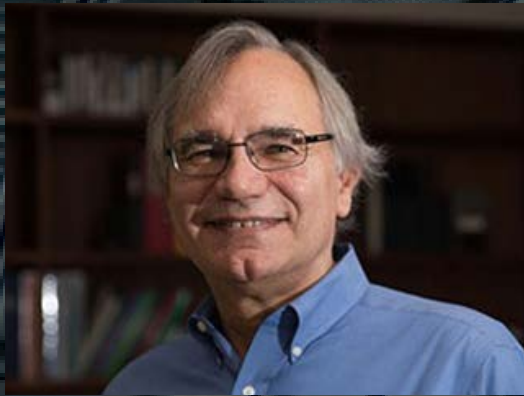
Colin Camerer

Robert Kirby Professor of Behavioral Economics and T&C Chen Center for Social and Decision Neuroscience Leadership Chair and Director

Viviana Gradinaru

Director of the Center for Molecular and Cellular Neuroscience, professor of neuroscience and biological engineering and Heritage Medical Research Institute Investigator

Yanyan Huang, MD

Professor, Deputy Director of Geriatrics Department at Huashan Hospital

Yu Huan, MD

Associate Professor of Neurology Department at Huashan Hospital, Fudan University; Executive Director of Sleep and Wake Disorders Center at Fudan University, TCCI Investigator – Sleep

Zhili Huang, PhD Mentor, MD

Head of the Department of Pharmacology, Shanghai Medical School, Fudan University; President of Chinese Sleep Research Society

Chunbo Li, PhD Mentor, MD

Vice President, Shanghai Mental Health Center; Vice President, Institute of Psychology and Behavioral Science, Shanghai Jiao Tong University, Professor of Psychiatry and Neuroscience
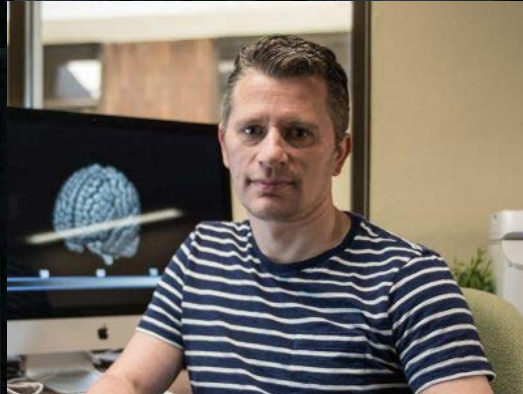
Carlos Lois

Director of the Chen Center for Neuroscience Education

Dean Mobbs

Chen Scholar and Assistant Professor of Cognitive Neuroscience

Ying Mao, PhD Mentor, MD

President of Huashan Hospital, Director of the Tianqiao and Chrissy Chen Institute for Translational Research

Yuki Oka

Chen Scholar and Assistant Professor of Biology

Tiger H. Tao

Professor, Shanghai Institute of Microsystems and Information Technology (SIMIT), Chinese Academy of Sciences; Founding Director, 2020 X-Lab, SIMIT; Deputy Director, State Key Laboratory of Transducer Technology

Zhi Yang, MD

Professor, Shanghai Mental Health Center; Professor, Institute of Psychological and Behavioral Sciences, Shanghai Jiao Tong University

Doris Tsao

Professor of Biology, Howard Hughes Medical Institute Investigator and T&C Chen Center for Systems Neuroscience Leadership Chair and Director

Tifei Yuan

Professor, Shanghai Mental Health Center

Liangfu Zhou, PhD Mentor

Vice Chairman of Translational Research, Academician of Chinese Academy of Engineering, Director of Neurosurgery Department of Huashan Hospital

Wei Zhu, MD

Professor of Neurosurgery at Huashan Hospital

Recognition

Congratulations to the many TCCI-affiliated scientists and researchers who were recognized for their hard work and ingenuity in 2020.

Professor Viviana Gradinaru Wins Two Awards

In February, Viviana Gradinaru, Professor of Neuroscience and Biological Engineering, was named one of the recipients of the Vilcek Foundation Prize for Creative Promise in Biomedical Science, an award recognizing exceptional early to mid-career, immigrant biomedical scientists. Gradinaru is an HMRI Investigator and Director of the Center for Molecular and Cellular Neuroscience at TCCI for Neuroscience at Caltech.

Later in the year, Gradinaru was presented with a Young Investigator Award by The Society for Neuroscience. This award recognizes the outstanding achievements and contributions by a young neuroscientist who has demonstrated scholarly independence.
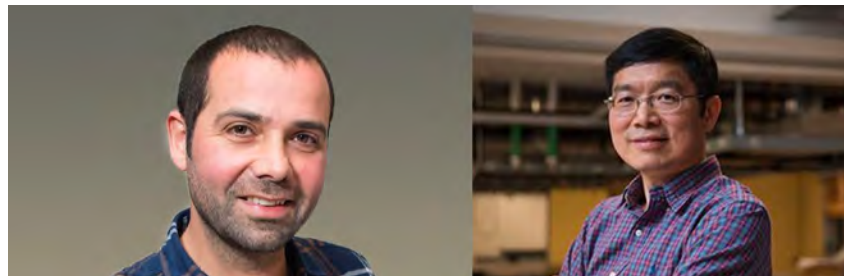
Two Caltech Faculty Awarded NIH BRAIN Grants

In December, two TCCI-affiliated researchers at Caltech received funding for neuroscience projects from the NIH's Brain Initiative. Joe Parker, Assistant Professor of Biology and Biological Engineering, is studying the brain circuits that control behavioral interactions between animals and Lihong Wang, Bren Professor of Medical Engineering and Electrical Engineering is developing next-generation tools for imaging the brain with high resolution.

Professor Magdalena Zernicka-Goetz Received NIH Director's Pioneer Award

In October Magdalena Zernicka-Goetz, Bren Professor of Biology and Biological Engineering received an NIH Director's Pioneer Award for her work studying the processes that guide early embryonic development. The award "challenges investigators at all career levels to pursue new research and develop groundbreaking, high-impact approaches to a broad area of biomedical, behavioral, or social science".

Professor Mao Ying's Team Wins 2020 China Neuroscience Major Progress Award

Professor Mao Ying, Director of the Tianqiao and Chrissy Chen Institute for Brain Health and Dean of Huashan Hospital, and his team received a 2020 China Neuroscience Major Progress Award recognizing their work published in the journal Nature Neuroscience in May titled "Assessing the depth of language processing in patients with disorders of consciousness." The research was done in collaboration with a team from the Wang Liping Research Institute and the Center for Excellence in Brain Science and Intelligence Technology at the Chinese Academy of Sciences.

Two TCCI-affiliated Faculty Members at Caltech Receive Sloan Research Fellowship

Yuki Oka, assistant professor of biology and Chen Scholar and Joseph Parker, assistant professor of biology and biological engineering were among four Caltech Faculty Members to receive prestigious Sloan Research Fellowships in February which "seek to stimulate fundamental research by early career scientists and scholars of outstanding promise."

Doris Tsao, inducted to the National Academy of Sciences

In April, Doris Tsao, Professor of Biology, Howard Hughes Medical Institute investigator, and director and leadership chair of the T&C Chen Center for Systems Neuroscience, was one of two Caltech faculty members inducted into the National Academy of Sciences. Membership in the academy is considered one of the highest honors a scientist can receive.

Recognition

2020 RESEARCH GRANTS

The Tianqiao and Chrissy Chen Institute for Neuroscience offers seed funding to allow Caltech faculty to develop new directions of neuroscience research, leveraging the Institute's interdisciplinary and collaborative environment. This funding allows faculty to pursue highly innovative projects that are often considered too 'risky' by more traditional funding sources and generate "proof of concept" data.

DIRECTOR'S AWARD

Awarded to Professor Joseph Kirschvink

"Biophysics of a Possible Magnetite-based Geomagnetic Sensory System in the Planarian, Dugesia dorotocephala."

Although many migratory and homing organisms are known to have a geomagnetic sensory system, the ultrastructure of the sensory cells involved in geomagnetic field transduction remains unknown. Kirschvink will conduct a series of behavioral, anatomical and biophysical experiments to isolate the magnetosensory cells of the D. dorotocephala, to characterize their structure and biophysical properties, and to use these insights to constrain possible models of magneto-transduction.

Awarded the Professor Kai Zinn

"Efficient enzymatic coupling of antibodies and receptors to oligonucleotides for neuroscience and cell biology applications."

The Zinn Lab has recently developed methods to covalently attach high-affinity binding proteins to oligonucleotides in a one-step reaction. They are using these binding proteins/enzymes to label antibodies and biotinylated cell surface proteins with specific oligonucleotides. These protein-oligonucleotide complexes may have many applications in neuroscience, cell biology, and molecular biology.

T&C CHEN CENTER FOR SYSTEMS NEUROSCIENCE AWARDS

Awarded to Professor John Allman

"Diffusion imaging of an Elephant Brain"

In this project, Allman will investigate the micro-anatomy and connections of the brain of a rare completely intact elephant brain with ex-vivo structural and diffusion MR imaging, which will then be compared with histological sections from the same specimen.

Awarded to Assistant Professor Scott Cushing and Assistant Professor Elizabeth Hong

"Low Power, Entangled, Two Photon Microscope for Live Imaging in Neuroscience"

Two-photon imaging techniques have accelerated progress in biology and neuroscience by allowing deep imaging of live samples. However, the two-photon absorption cross section is significantly lower than that of a one-photon process, requiring the use of high-peak intensity pulsed laser sources. The high peak intensity leads to instantaneous tissue damage as well as long term heating and warping of the sample. This project will examine the use of entangled photons to perform two-photon imaging at equivalent signal levels to a classical pulsed laser, but at a million times lower peak intensity and a thousand times lower average power.

Awarded to Professor Anima Anandkumar

"Understanding the role of feedback in vision"

Feedback is a ubiquitous, anatomical feature of the brain but its function remains largely unknown. Visual neuroscience has been dominated by work on feedforward transformations, raising the critical question: what is the role of feedback in visual computation? This project will pursue the hypothesis that feedback serves to implement a generative model of the visual world, incorporating priors that make it possible to resolve visual ambiguity.

Caltech Research Grants

Awarded to Professor Markus Meister and Professor Yisong Yue

"Transformator Scientiae: Expert-Guided Neural Knowledge Extraction from Brain Science Corpora"

This project aims to create a computational engine that can extract knowledge from scientific literature, and aid in the direction of future research in brain science. There is great need for a system that exploits the ever-expanding scale of scientific knowledge at a scope inaccessible for any single human participant. This is the domain of computational learning machines. Such a system would be invaluable in guiding scientists, who could make informed decisions rapidly in a way that might require months if one wanted to query a large team of human experts.

Awarded to Professor Alexander Varshavsky

"Experimental Approaches to Verifying the Fragment Generation (FG) Hypothesis About the Cause/Function of Sleep."

This project seeks to verify, in detail, specific predictions of the fragment generation (FG) hypothesis about the cause/function of sleep. The molecular-level cause of sleep is still unknown. The FG hypothesis was proposed in 2012. By now, this hypothesis has become more detailed with inclusion of additional, specific ideas. These verifiable propositions will be examined.

T&C CHEN CENTER FOR SOCIAL AND DECISION NEUROSCIENCE AWARDS

Awarded to Professor Antonio Rangel

"Changes in the neurocomputational basis of human simple choice with extensive experience and training: initial exploratory studies"

The goal of this project is to carry out extensive piloting of the feasibility of studying how the neurocomputational basis of simple choices changes with extensive experience using fMRI and long-term human subjects. The data and results generated by this pilot project will be used as the basis for an NIH RO1 application to fund a full, larger study.

T&C CHEN BRAIN-MACHINE INTERFACE CENTER AWARDS

4 supplemental grants were awarded to existing BMI projects.

Professor Azita Emami

"System-on-Chip for Machine Learning Based BMI"

Professor Julia Greer

"Stimuli responsive micro-architected materials: enabling long term neural recording"

Professor Markus Meister

"Electrode Pooling: A Method to Boost the Yield of Multi Neuron Recordings"

Professor Mikhail Shapiro

"Feasibility of a Human Ultrasonic Brain-Machine Interface"

Caltech Research Grants

2020 CHEN GRADUATE INNOVATOR GRANTS

Annie Erickson, Chen Graduate Fellow, and Tarun Sharma, Dickinson lab

"Sensorimotor computation underlying praying mantis predatory strike"

Shannon Esswein, Bjorkman lab

"Evaluating temporal proteomics of Zika virus infection in neural progenitor cells using bioorthogonal non-canonical amino acid tagging"

Han Kim, Chen Graduate Fellow, Parker lab

"Investigating the reafferent chemosensory effects of an innate behavior"

Sangjun Lee, Oka lab

"Investigating the neural basis of need-free appetite"

Zsofia Torok, Lois lab

"The role of sleep in birdsong maintenance"

SUPPORTING THE COMMUNITY

Since its inception, the Chen Institute has supported neuroscience conferences and events around the world because we believe that some of the best ideas can be sparked when scientists and researchers have an opportunity to step out of their day-to-day routine, hear about the latest scientific theories and connect with others in the field.

In 2020, in addition to supporting global conferences, we invited anyone organizing scientific meetings focused on the brain and mind to apply for funding and we have plans to further extend our efforts in 2021.

Learn More >

The 12th FENS Forum of Neuroscience

We were happy to support the 12th FENS Forum of Neuroscience which took place online July 11-15, 2020. Specifically, we supported Jan Born's plenary lecture on "Sleep's Role on Memory Consolidation."

Neuromatch Academy 2020

In 2020, we got involved with the innovative Neuromatch Academy for the first time. This online school for Computational Neuroscience took place online place July 13-31. TCCI specifically helped participants in the course by supporting 15 Teaching Assistants in China.

The 43rd Annual Meeting of the Japanese Neuroscience Society

he Chen Institute was proud to support the plenary lecture of Dr. Giulio Tononi (University of Wisconsin, USA). We also supported "Interplay Between Theory and Experiment in Decision Neuroscience," a symposium organized by Dr. Naoshige Uchida which featured Naoshige Uchida (Harvard University, USA), Will Dabney (DeepMind, UK), Christine Constatinople (New York University, USA) and Paul Glimcher (New York University, USA)

Brain Innovation Days

The Chen Institute supported Brain Innovations Days, a virtual event sponsored by the European Brain Council and beLean.net in October. The event reflects our belief that the best way to make progress is to break down siloes and bring together scientists, policy makers and the private sector to focus on innovative ways to advance brain science.

Cognitive Impairment Science Week in Shanghai, China

The Tianqiao Chen Institute for Brain Health (TCIBH), together with the Shanghai Municipal Health Commission, the Science and Technology Commission and the Health Promotion Center organized a Cognitive Impairment Science Week from September 21-27. The goal of the week was to educate people about the importance of brain health, raise public awareness of cognitive impairment and the application of new technologies in the field of cognitive impairment services.

ANS2020 Conference and AGM

In December last year we were pleased to support the annual Australasian Neursocience Society meeting which was held online. Specifically, we enjoyed supporting a rapid-fire series of three-minute thesis presentations done by PhD students. The session was chaired by Mr. Amr Abdeen, the ANS Student Representative.

SUPPORTING THE COMMUNITY

GOING DEEP

The Neuroscience of Stock Markets

5 June 2020

Can technology borrowed from biological studies reveal the ways in which gender and other factors influence how humans choose? Colin Camerer takes us behind the scenes, describing how he gains a deeper understanding of decision-making behaviors by looking inside the brain as choices are made.

Colin Camerer is the Robert Kirby Professor of Behavioral Economics and the T&C Chen Center for Social and Decision Neuroscience Leadership Chair and Director at Caltech.

Listen on Caltech's site >

Clear Contrast: Q&A with Mikhail Shapiro, Ph.D

15 September 2020

One of the most challenging aspects of studying the brain is that it's so hard to access within living organisms. Mikhail G. Shapiro, PhD, TCCI-affiliated Professor of Chemical Engineering and HMRI Investigator was recently interviewed by the Dana Foundation about his team's recent discovery of an "erasable" contrast agent which makes it easier to study brain function.

Read more on the Dana Foundation website >

RESEARCH
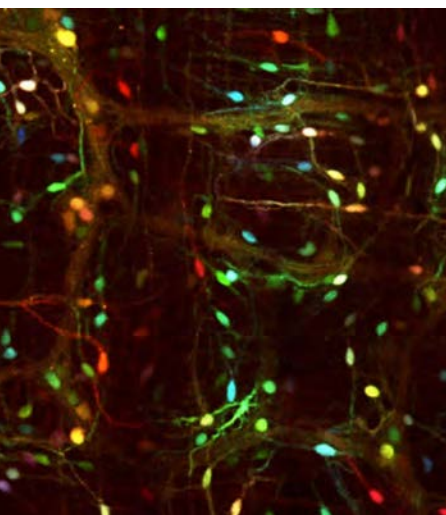
Biomarker for Parkinson's Disease May Originate in the Gut

17 February 2020

Researchers in the lab of Viviana Gradinaru, professor of neuroscience and biological engineering, HMRI Investigator and director of the Center for Molecular and Cellular Neuroscience at TCCI for Neuroscience at Caltech, may have discovered a link between neurons in the gut and Parkinson's Disease, a debilitating neurodegenerative disorder, impairing the motor functions of millions of elderly people worldwide.

Read more on Caltech's site >
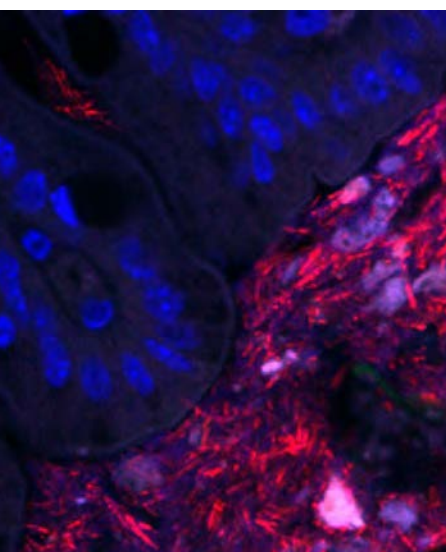
Mapping Bacterial Neighborhoods in the Gut

10 March 2020

The microscopic populations of bacteria in our intestines are, in some ways, just like us: They live in communities, eat, work, reproduce, and eventually die. Some live in harmony with our bodies but others don't, putting us at increased risk for a variety of diseases. Now, Caltech researchers in the laboratory of Sarkis Mazmanian, Luis B. and Nelly Soux Professor of Microbiology, HMRI Investigator and TCCI-affiliated faculty member have discovered that a certain species of bacteria behaves differently depending on where in the gut it takes up residence.

Read more on Caltech's website >

Watch and Learn: Study Shows How Brain Gains Knowledge Through Observation

20 March 2020

It has long been the belief that there are two types of observational learning: imitation and emulation. Research led by Caroline Charpentier, a postdoctoral scholar in neuroscience at Caltech, now shows how the brain chooses between the two neural systems responsible for each of these kinds of learning. The study, which appeared in the journal Neuron, reveals for the first time how the brain chooses which strategy to employ when faced with an observational learning task.

Read more on Caltech's website >

Research

An Invisible Threat: Fear and Anxiety in the Era of the Coronavirus

6 April 2020

Dean Mobbs, assistant professor of cognitive neuroscience and Chen Scholar at Caltech explains the brain circuitry that is causing many of us to feel heightened anxiety during the coronavirus pandemic. He calls the coronavirus an "invisible threat" and says that it causes us to seek out information on media sites about how to prevent it, but that this can lead to information overload and make us anxious.

Read more on Caltech's site >

High-Throughput Method Speeds Discovery of Improved Vectors For Gene Delivery To Diverse Brain Cell Types

20 April 2020

For decades, scientists have studied how to repurpose viruses to deliver therapeutics for treating disease and tools for studying cells. Researchers in the lab of Viviana Gradinaru, professor of neuroscience and biological engineering, HMRI investigator, and director of the Center for Molecular and Cellular Neuroscience at TCCI for Neuroscience at Caltech, have now developed a method to rapidly and efficiently identify designer adeno-associated virus (AAV) variants that can deliver to specific types of cells in mice, enabling scientists to choose a virus based on research or clinical needs.

Read more on Caltech's website >
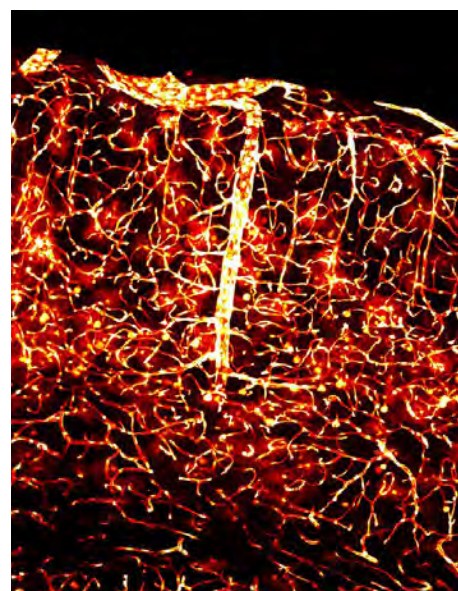
Understanding Congenital Heart Defects, One Chicken at a Time

4 May 2020

Approximately 10 percent of infants are born with a congenital heart defect, with one of the most common being persistent truncus arteriosus—a hole in the heart. New research conducted in the Caltech laboratory of Marianne Bronner, Albert Billings Ruddock Professor of Biology and director of the Beckman Institute uses chicken embryos as a model organism, to discover the genetic pathways that certain stem cells utilize to properly form heart tissues. The research appeared in a paper in the journal Developmental Cell on May 4.

Read more on Caltech's website >
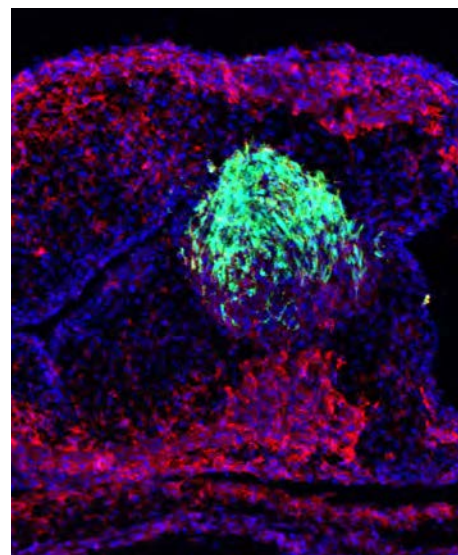
New Ultrafast Camera Takes 70 Trillion Pictures Per Second

4 May 2020

A new camera developed in the lab of Lihong Wang, Bren Professor of Medical Engineering and Electrical Engineering in the Andrew and Peggy Cherng Department of Medical Engineering, is capable of taking as many as 70 trillion frames per second. That is fast enough to see waves of light traveling and the fluorescent decay of molecules. Exciting applications for life sciences and other fields. Wang is affiliated with TCCI.

Read more on Caltech's site >
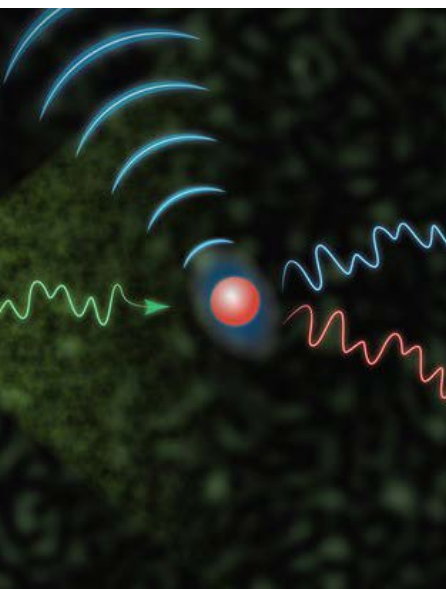
Seeing through opaque media

11 May 2020

Caltech researchers have developed a technique combining fluores-cence and ultrasound to peer through opaque media, such as biological tissue. Changhuei Yang, Thomas G. Myers Professor of Electrical Engineering, Bioengineering, and Medical Engineering, and senior author of a paper about the technique says they hope this method will one day be deployed to extend the operating depth of fluorescence microscopy and help image fluorescent labeled cells deep inside living animals.

Read more on Caltech's site >
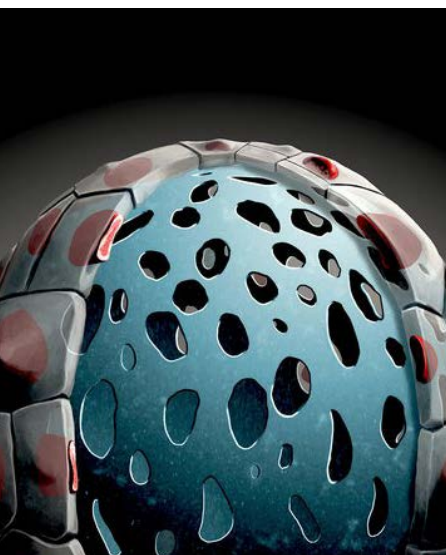
New Insights into Early Embryonic Development

12 May 2020

Caltech researchers have new insights into the embryo's architecture and the structures that enable proper development at a very early stage. The research was done in the laboratory of Magdalena Zernicka-Goetz, Bren Professor of Biology and Biological Engineering and affiliated faculty member with the Tianqiao and Chrissy Chen Institute for Neuroscience. A paper describing the study appeared in the May 6 issue of the journal Nature.

Read more on Caltech's site >

Can Patients in a Vegetative State Understand Language?

27 May 2020

Professor Mao Ying, Director of the Tianqiao Chen Institute for Brain Health, and other members of the Chinese Academy of Sciences Institute of Neurology published the paper "Assessing the Depth of Language Processing in Patients with Disorders of Consciousness" online in Nature Neuroscience on May 25.

The study used high-density EEG and innovatively applied a hearing paradigm based on Chinese semantic understanding to the detection of residual consciousness and prediction of awakening in patients with consciousness disorders.

Read the paper on Nature Neuroscience >

Social Science in the Time of COVID: A Conversation with Ralph Adolphs

29 May 2020

Ralph Adolphs, Caltech's Bren Professor of Psychology, Neuroscience, and Biology, usually conducts research on human volunteers at the Caltech Brain Imaging Center to try to understand how the fundamental biology of the brain, as revealed through neural activity, produces the breadth of human feelings, abilities, and social behaviors. After stay-at-home orders kept human subjects out of his lab, Adolphs worked with colleagues to craft a long-term online study to examine how the pandemic influenced people's emotions, attitudes, and biases.

Read more on Caltech's website >
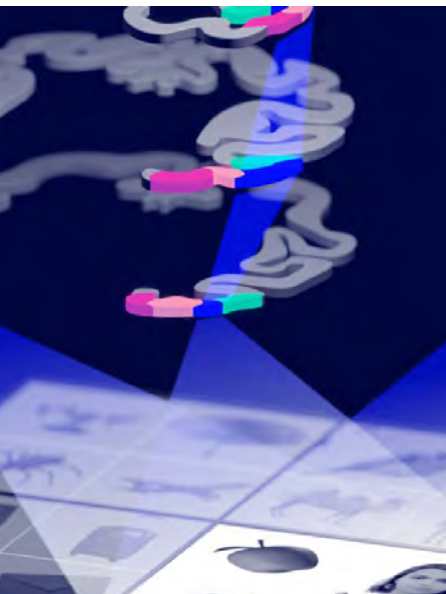
Faces, Bodies, Spiders, and Radios: How the Brain Represents Visual Objects

4 June 2020

The reduction of an object to its fundamental characteristics is an example of a technique known as principal component analysis. Researchers in the lab of Doris Tsao, professor of biology, director of the Tianqiao and Chrissy Chen Center for Systems Neuroscience and holder of its leadership chair, and HHMI Investigator published a paper in the journal Nature on June 3 about combining tools from machine learning and neuroscience to discover that the brain uses a mathematical system to organize visual objects according to their principal components.

Read more on Caltech's website >
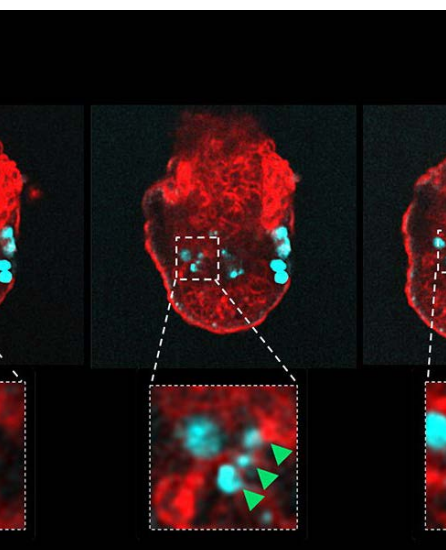
How Young Embryos Conduct Quality Control

12 June 2020

The first few days of embryonic development are critical for determining the failure or success of a pregnancy. Using mouse embryos, scientists in the lab of Magdalena Zernicka-Goetz, Caltech's Bren Professor of Biology and Biological Engineering, have discovered that embryos are able to rid themselves of abnormal cells just before and soon after implantation into the uterus, thereby keeping the whole embryo healthy. The research appeared in Nature Communications on June 11.

Read more on Caltech's site >

"Where are My Keys?" and Other Memory-Based Choices Probed in the Brain

25 June 2020

While memory retrieval has been the subject of countless animal studies and other neuroimaging work in humans, exactly how the process works—and how we make decisions based on memories—has remained unclear. In a new study published in the June 26 issue of the journal Science, a collaborative team of neuroscientists from Caltech and Cedars-Sinai Medical Center has identified different sets of individual neurons responsible for memory-based decision-making. Ralph Adolphs, Caltech's Bren Professor of Psychology, Neuroscience, and Biology; director of the Caltech Brain Imaging Center; and an affiliated faculty member of TCCI for Neuroscience at Caltech was part of the collaboration.

Read more on Caltech's website >

Machine Learning Helps Robot Swarms Coordinate

13 July 2020

Engineers at Caltech have designed a new data-driven method to control the movement of multiple robots through cluttered, unmapped spaces, so they do not run into one another. To overcome key challenges, Soon-Jo Chung, Bren Professor of Aerospace, and Yisong Yue, professor of computing and mathematical sciences and TCCI-affiliated faculty member, developed a multi-robot motion-planning algorithm and "Neural-Swarm," a swarm-tracking controller augmented to learn complex aerodynamic interactions in close-proximity flight.

Read more on Caltech's website >
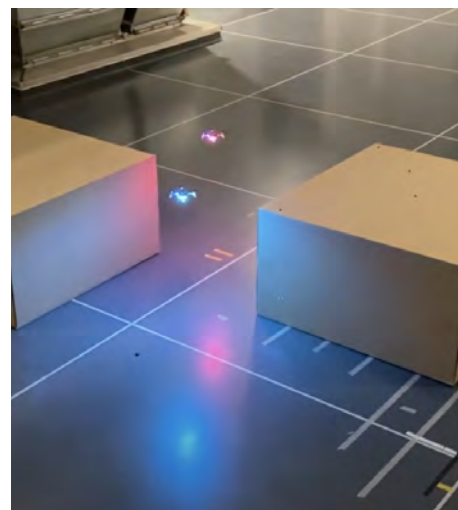
Molecular "Tails" Are Secret Ingredient for Gene Activation in Humans, Yeast, and Other Organisms

14 July 2020

In a paper appearing in the July 15 issue of Molecular Cell, the team, which includes Paul Sternberg, Bren Professor of Biology, TCCI-affiliated faculty member and graduate student Porfirio Quintero Cadena, shows that the enzyme RNA polymerase is biologically tailored to match different types of DNA through the addition of a tail of amino acids (amino acids being the building blocks of proteins and enzymes) whose length correlates with the length of the DNA the enzyme works with. The longer the DNA, the longer the amino acid tail.

Read more on Caltech's Website >
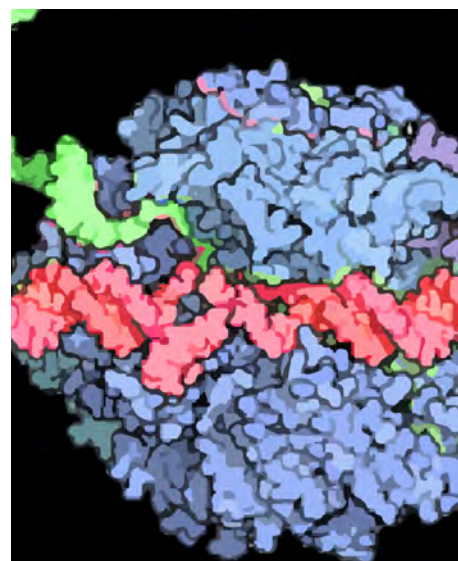
Imaging enzyme activity with ultrasound

16 July 2020

For years, Caltech's Mikhail Shapiro, a TCCI-affiliated faculty member, has been working to extend ultrasound imaging into the microscopic realm. Now, with a new breakthrough based on genetic engineering, he is making it possible for researchers to use ultrasound to watch enzymes at work within cells. In a new paper appearing in the journal Nature Chemical Biology, Shapiro and lead authors Anupama Lakshmanan and Zhiyang Jin, and their fellow researchers, describe how they have harnessed the genes for a protein that helps bacteria float in water to create a microscopic ultrasound marker that indicates when certain enzymes are active inside cells.

Read more on Caltech's website >
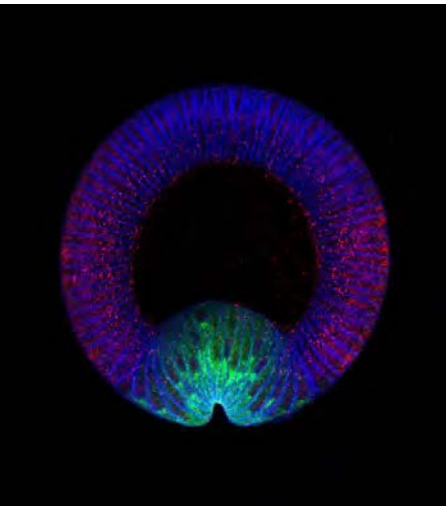
Decoding the language of cellular messaging

17 July 2020

Individual cells in our bodies communicate with each other by sending tailored "letters"—not with paper and pen, but in the form of proteins called ligands. Researchers in the laboratory of Professor of Biology Angelike Stathopoulos, a TCCI-affiliated researcher, who study how to decode the language of ligands to understand cellular communication have now discovered new insights into how cells use one particular ligand to coordinate embryonic development. A paper describing the study appeared in the journal Current Biology on July 1.

Read more on Caltech's website >

Risks of Cognitive Impairment Linked to Sleep Characteristics and Cerebrospinal Fluid Biomarkers

23 July 2020

Researchers in the labs of Professor Yu Jintai within at Fudan University-affiliated Huashan Hospital and Professor Tan Lan at Qingdao University have discovered that sleepiness during the day, insufficient sleep or too much sleep at night can affect the levels of cerebrospinal fluid indicators of amyloid deposition in female patients and thus increase the risk of cognitive impairment. The TCCI-supported study was published in the July 2020 issue of "Alzheimer's & Dementia"

Read the report >

Research

Famous Economics Experiment Reproduced Thousands of Times

3 August 2020

Now, nearly 60 years later, Caltech economists, led by Colin Camerer, the Robert Kirby Professor of Behavioral Economics and director of the T&C Chen Center for Social and Decision Neuroscience in TCCI for Neuroscience at Caltech, have analyzed data from 2,000 repetitions of an experiment from researchers around the world that tests the phenomenon of ideal pricing resulting from the laws of supply and demand, to demonstrate for the first time that the work of Nobel Laureate Vernon Smith, Charlie Plott, and others is reproducible on large scales. The research was published August 3 in the journal Nature Human Behaviour.

Read more on Caltech's Website >

Merkin Institute Catalyzes COVID-19 Research at Caltech

4 August 2020

In August, several TCCI for Neuroscience faculty members at Caltech received grants from the Merkin Institute for Translational Research to study different aspects of COVID-19. Dean Mobbs, assistant professor of cognitive neuroscience and Chen Scholar; Cindy Hagan, research assistant professor of neuroscience; and Ralph Adolphs, Bren Professor of Psychology, Neuroscience, and Biology, and director of the Caltech Brain Imaging Center, led projects to understand the impact of stress and isolation.

Read more on Caltech's website >

Earlier Help for Anorexia

13 August 2020

The most life-threatening of all psychiatric disorders is anorexia nervosa, affecting about one percent of Americans. The eating disorder typically emerges in adolescence and is characterized by low body-mass index and an intense fear of weight gain. TCCI-affiliated neuroscientist Cindy Hagan at Caltech is searching for detectable differences in brain structure and function that could help doctors identify early warning signs of the disorder, and help patients sustain or regain health.

Read more on Caltech's website >

As Pandemic Progressed, People's Perceived Risks Went Up

16 September 2020

In the first week of the coronavirus pandemic, people living in the United States underestimated their chances of catching the virus, or of getting seriously ill from the virus, according to a recently published Caltech-led study done by Toby Wise, a visiting postdoctoral scholar at Caltech and Dean Mobbs, assistant professor of cognitive neuroscience at Caltech and a Chen Scholar, appeared in the journal Royal Society Open Science. As time passed however, those same people became more worried about their personal risk, and, as a result, began to increase protective behaviors such as washing hands and social distancing.

Read more on Caltech's website >

How Fear Persists in the Mouse Brain

17 September 2020

After a sudden fright, it's common to remain alert for another threat. A team working in the Caltech lab of David Anderson, Seymour Benzer Professor of Biology, HHMI Investigator and Director and Leadership Chair of TCCI for Neuroscience, discovered that the neural mechanisms in mice that are responsible are located in a center of the brain that was thought to be much more evolutionarily primitive and reflexive. Their results were published in the journal Nature.

Read more on Caltech's website >

Research

Unlocking the Mysteries of Brain Chemistry with New Dopamine Sensors

18 September 2020

Research from Viviana Gradinaru, Director of the Center for Molecular and Cellular Neuroscience, is cited in this article about dLight1, a dopamine sensor developed by Lin Tian and her team at UC Davis Health, which detects this hormone which is released by neurons to send signals to other nerve cells. When combined with advanced microscopy, the sensors provide high-resolution, real-time imaging of the spatial and temporal release of dopamine in live animals. Tian recently succeeded in expanding the color spectrum of the dLight1 sensor which means researchers will be able to detect and monitor different information processing activities in the brain.

Read more on SciTechDaily >
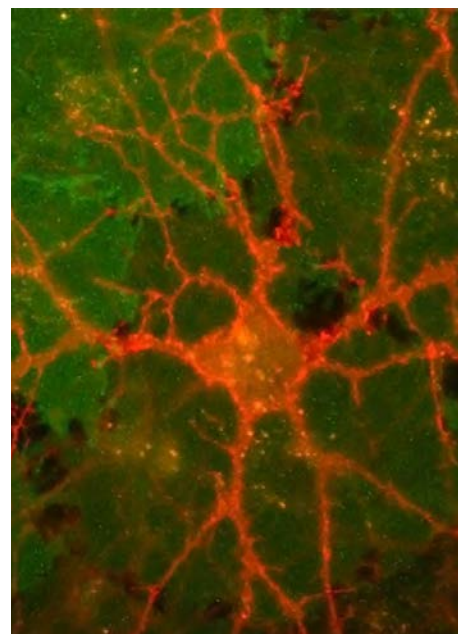
Professor Ying Mao Introduces New Technology for Epilepsy Treatment in Journal Nature, Biomedical Engineering

28 September 2020

Professor Ying Mao, Director of the Tianqiao Chen Institute for Brain Health, and Professor Cong Li from the School of Pharmacy at Fu-dan University, published a paper titled "An electric-field-responsive paramagnetic contrast agent enhances the visualization of epileptic foci in mouse models of drug-resistant epilepsy" in the journal Nature Biomedical Engineering. The paper introduces a class of probes which may increase the probability of detecting seizure foci in patients and help study of epilepsy.

Read the article on Journal Nature >

nature
biomedical
engineering

Microcavity arrays for the standardization of organoid culture
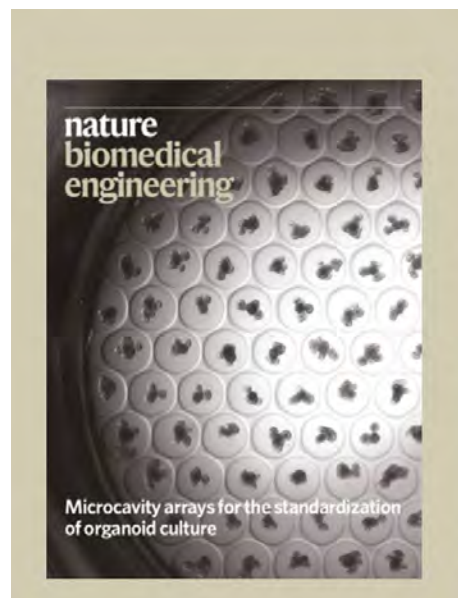
How Aggression Leads to More Aggression

1 October 2020

Like a champion fighter gaining confidence after each win, a male mouse that prevails in aggressive encounters against other male mice will become even more aggressive in future encounters. A team of Caltech researchers in the lab of David Anderson, Seymour Benzer Professor of Biology, Director and Leadership Chair, TCCI for Neuroscience and HHMI Investigator have discovered that the hard-wired neural circuits governing aggression in mice are strengthened following their victories in aggressive encounters, and they have identified a learning mechanism operating in the hypothalamus—a brain region traditionally viewed as the source of instincts, rather than learning.

Read more on Caltech's Website >

The Brain Quenches Thirst in Different Ways

14 October 2020

After eating a bag of salty potato chips, you probably feel thirsty. And after a long period of exercise, you also probably feel thirsty. However, these two types of thirst are not the same. Caltech researchers in the laboratory of Yuki Oka, professor of biology and Chen Scholar, have discovered unique populations of neurons in the mouse brain that separately drive these different types of thirst. Their paper on the topic appeared in the journal Nature on October 14.

Read more on Caltech's website >

Research

The Effect of Ventral Globus Pallidus on Arousal and Motivational Behavior

14 October 2020

TCCI researcher and President of the Chinese Sleep Research Society, Professor Huang Zhili's research group at Huashan Hospital recently published research focused on the effect of ventral globus pallidus on wakefulness and motivational behaviors in the journal "Molecular Psychiatry." The paper, entitled "Ventral pallidal GABAergic neurons control wakefulness associated with motivation through the ventral tegmental pathway" is the first time the journal has published a basic research paper on sleep.

Read the paper on the Molecular Psychiatry website >

Researchers Find Gene to be Key Regulator of Progranulin Expression; Modifies the risk of Multiple Neurodegenerative Diseases

21 October 2020

Professor Yu Jintai from Fudan University-affiliated Huashan Hospital and his research team recently published a major discovery in the journal Science Advances. In research supported by TCCI, the team discovered that the FAM171A2 gene is a key regulator of progranulin (PGRN) expression in cerebrospinal fluid and can reduce the risk of multiple neurodegenerative diseases.

Read the paper on Science Advances website >

How Stem Cells Choose their Careers

26 October 2020

Stem cells are cells that have not yet chosen whether they'll become a neuron or a white blood cell.

Researchers in the lab of Marianne Bronner, Albert Billings Ruddock Professor of Biology and Biological Engineering at Caltech, have been focused on a population of stem cells called the neural crest which have the ability to differentiate into heart muscle, parts of the facial skeleton, and other tissue types. Using chick embryos, a team of researchers in this lab have discovered how a gene called Hmga1 helps the formation of neural crest cells in the early embryo. A paper describing this research appeared in the journal eLife.

Read more on Caltech's website >
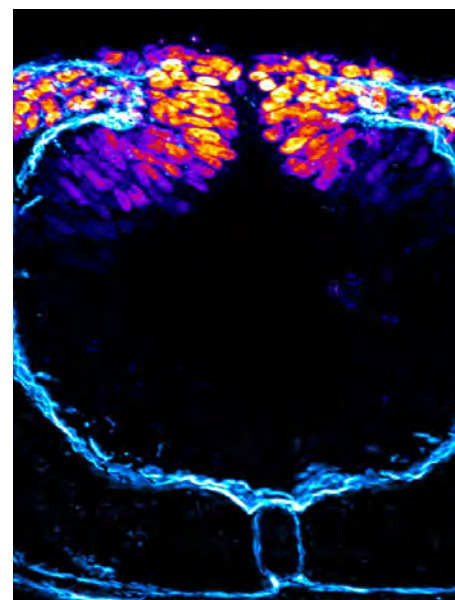
Hibernation: Translating Insights from Nature into Manned Deep Space Exploration

14 December 2020

During long manned spaceflight missions, crew will spend long periods in a spacecraft with closed-loop life-support systems. Professor Tifei Yuan, a Tianqiao Chen Institute for Brain Health project lead and PI at Shanghai Mental Health Center published a paper in the journal Cambridge Philosophical Society's Biological Reviews which examines the neural circuits of hibernating and non-hibernating animals to understand the neurobiological mechanisms of natural hibernation and human sleep.

Read the paper online >

Love and Hate in the Mouse Brain

23 December 2020

Mounting behavior, that awkward thrusting motion dogs sometimes do, is usually associated with sexual arousal in animals, but this is not always the case. New research by Caltech neuroscientists who explored the motivations behind mounting behavior in mice finds that sometimes there is a thin line between love and hate (or anger) in the mouse brain. The research, which appeared in the journal Nature, was conducted in the lab of David Anderson, Seymour Benzer Professor of Biology, Director and Leadership Chair, TCCI for Neuroscience and HHMI Investigator.

Read more on Caltech's Website >

Research

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