The Hebrew University of Jerusalem has launched the new Edmond and Lily Safra Center for Brain Sciences, which aspires to revolutionize current neuroscience research. The Center will bring together a powerful interdisciplinary team of top scientists to explore the relationships between gene function, brain neuronal circuits, and behavior. This collaboration will have profound implications for our ability to understand and treat neurological and psychiatric disorders. The Center will contribute to worldwide progress in brain science and establish the Hebrew University as one of the world’s leading neuroscience centers. With outstanding faculty recruits, world-renowned scientists, talented students, state-of-the-art equipment, and modern new facilities, the Center, together with established neuroscientists at the Hebrew university will have a leading role in generating powerful intellectual home for cutting-edge brain research.

INTRODUCTION

Background

The field of neuroscience is thriving as new research techniques allow scientists to make remarkable discoveries about the brain. Advances in brain imaging methods have yielded detailed images of the working brain and sophisticated tools have allowed scientists to analyze the brain on the molecular, cellular and neural levels. The emerging picture of the human brain is one the most exciting developments of the century. A deeper understanding of brain function has important implications for diverse fields, from science and art to philosophy, law and medicine. In the last decade, neuroscience research has produced innovative new treatments for disease, super-fast computers, and intelligent machines. In future years, a greater insight into the functions of the brain will be crucial to our understanding of the human organism and sophisticated medicine. The new Edmond and Lily Center for Brain Sciences (ELSC) will be housed in a new building on the Edmond J. Safra campus. In addition to established scientists of the Hebrew university, 15 new brain scientists will be recruited in the course of the next ten years to join the ELSC. Faculty will be located both in the new building and across the Hebrew University’s three campuses. Within the Center itself, a core facilities unit will provide state-of-the-art research equipment that will be available to the entire faculty. Housing the modern equipment in a central location will encourage interaction among colleagues in many faculties, ranging from Humanities to Medicine.
Neuroscience at the Hebrew University

The Hebrew University, Israel's first and foremost university, is consistently rated as the top Israeli university in international surveys, and its alumni and faculty have been awarded a total of six Nobel Prizes. Neuroscience research has been one of the most successful domains of activity at the Hebrew University. Researchers in brain science have achieved international recognition for their accomplishments in many areas, including cellular, molecular and circuit functions, learning and movement control, computational and theoretical neuroscience, and human perception. Currently, research in neuroscience at the Hebrew University is spread across three campuses: the Edmond J. Safra campus (Faculty of Science), the Ein Kerem campus (Faculty of Medicine), and the Mount Scopus campus (Faculty of Social Sciences). Hebrew University researchers are proud of their collaborations, which extend across disciplines and research groups. In addition, Hebrew University neuroscientists often collaborate internationally, ensuring the fast integration of advances in the field and a seamless exchange of ideas on a greater scale. The neuroscience graduate students at Hebrew University are among the most talented in Israel. The undergraduate Cognitive Science program, the graduate programs in Neurobiology, and the Ph.D. program in Rationality provide the Hebrew University with a powerful research force. In addition, the Interdisciplinary Center for Neural Computation (ICNC) runs an internationally recognized Ph.D. program in computational neuroscience. The program accepts top science students and provides them with rigorous training in a broad range of disciplines, from anatomy and physiology to computer science, physics, and cognitive sciences.

GOALS OF THE CENTER

The Edmond and Lily Safra Center for Brain Sciences

The new Edmond and Lily Safra Center for Brain Sciences will build upon the Hebrew University's existing framework for neuroscience research—namely, collaborative multidisciplinary research conducted by world-renowned faculty and talented students—and will provide the intellectual and physical environment in which breakthroughs in neuroscience can take place. The missions of the center are:

a. To study neuronal basis of perception, cognition and behavior, targeting on neuronal circuits level and bridging molecular-cellular levels on the one hand, and brain states and behavior on the other.

b. To advance our understanding of the system-level neuronal malfunctions associated with brain disorders and contribute to the development of new therapeutic approaches for diseases like neurodegeneration, brain injuries, perceptual and motor deficits.

c. To build upon the unique strength of the Hebrew University as a leading academic institute in a broad range of fields relevant to brain sciences and its excellent track record for multidisciplinary research and education in neuroscience.

d. To bring together interdisciplinary teams of top scientists and provide them with modern facilities, equipment, and research funds that will enable them to carry out pioneering research in ELSC's areas of investigation.

e. To promote interdisciplinary neuroscience studies and research across the university through true collaborations with other departments, research centers, and teaching programs, aspiring together to raise the level of achievements of the university in brain sciences.

f. To train a new generation of interdisciplinary neuroscientists through research and an advanced graduate program.
g. To bring the knowledge and significance of brain research to the community in Israel and abroad.

**SCIENTIFIC PROGRAM: OUTLINE**

The Center will incorporate several unique features. First and foremost, the Center will focus on cross-level inquiry, in which research groups spanning molecular, cellular, circuit and behavioral levels will work in close proximity, interact closely, and share common goals. While this mode of research is rare in other neuroscience institutes, it is crucial to advancing our understanding of the brain. The Center will also be an open research entity with dynamic links with other Institutes, Centers, and research groups within the Hebrew University, both in specific neuroscience-related areas as well as in Medicine, Physics, Chemistry, Engineering, and Psychology. Research groups will share technical skills and common facilities, mainly via the Core Research Facilities unit. In addition, space in individual laboratories will be minimized in favor of larger common spaces such as joint offices, seminar rooms and gathering places. Furthermore, the Center will offer flexible resources such as seed money for pioneering, cross-disciplinary research and lab space for relevant research ventures by non-Center faculty. The Center will engage in the highest quality interdisciplinary teaching in neuroscience. In particular, the Center will oversee graduate programs in neuroscience and strengthen existing programs such as the ICNC's Computational Neuroscience program and the Neurobiology and Behavior program. The Center's unique graduate program will provide researchers with a pool of creative and talented students who have been trained in the quantitative and technical skills required for modern brain research. Generous fellowships for postdoctoral studies both at the Center and abroad will be awarded to outstanding graduate students for training and research in high priority areas. This unconventional investment in the future is crucial for meeting the Center's long-term faculty recruitment goals. In addition, funding will be set aside to encourage active visiting faculty and exchange programs. This allocation will ensure that the Center remains informed about the latest developments in the field and realizes its potential of becoming an internationally renowned hub for innovative research. The administrative, fiscal, and academic independence of the Center will help attract the finest researchers, ensuring its continued excellence in research and education.

**Scientific Research at the Center**

Research at the new Center will focus on five broad areas of inquiry, each differing in the level of investigation and associated research tools but all aimed at uncovering the mechanisms by which the brain generates behavior and cognition. Research ranges from the level of genes, molecules and single neurons, to research examining advanced behaviors such as thinking, decision-making and emotions. In between, teams of scientists conduct studies of neuronal circuits (groups of interconnected neurons) and of interconnected brain areas and structures, which contain many neuronal circuits acting in coordination. Specific behaviors, such as a sensations and movements, emerge when many neuronal circuits act in coordination. Teams of experts in computational neuroscience apply theoretical approaches and use experimental data to test and construct theoretical models of the brain. These models are critical because they make specific sets of predictions about the brain that can then be tested in experimental settings. The five divisions below are largely conceptual and do not entail administrative boundaries between the groups. What makes the new Center unique is not only the cutting-edge research within each topic, but the interaction and communication between these areas of research. For example, experiments on neuronal circuits will inform research at the level of single neurons, motor function, cognitive neuroscience, and computational neuroscience. Since a deeper understanding of the brain requires a knowledge of its working at all levels?from the single molecule up to higher-order emergent properties like consciousness?what is truly needed is a comprehensive scientific program that unifies research approaches.
1. Molecular and Cellular Mechanisms

Research groups in this area will study the properties of molecules and neurons to better understand how they generate structures and function. Researchers in molecular genetics will examine how the information contained in genes affects neuronal connections and functional interactions between neurons. A greater knowledge of how genes, molecules and neurons form specialized neuronal structures (such as synaptic connections between neurons), as well as a greater knowledge of how these structures operate in the neuronal circuit, is critical to our understanding of brain function, both in health and disease. These research groups will also work together to develop new cellular and molecular tools that will allow them to improve future studies of neuronal circuits in the living brain. Importantly, research in this area will contribute to the uncovering of cellular mechanisms at work in normal and pathological cases such as epilepsy, spinal cord injury and tremors. The Center plans **two new appointments** in these areas.

2. Neuronal Circuits - Structure, Plasticity and Development

Scientists are only just beginning to understand the incredible dynamic and plastic nature of the brain. For example, in the brain of a blind person, the area that is normally dedicated to vision will not go to waste; rather, it may be dedicated to another function such as audition. Research in this area will examine the plasticity, structure, and development of neuronal circuits. How are new neuronal processes integrated into existing circuitry, and what is the process by which new neurons formed? How are neuronal circuits modulated by chemicals and hormones in the brain? A deeper understanding of brain plasticity will have important applications for cognition, learning and disease. Researchers will use molecular genetic, electrophysiological and modern imaging techniques, including two-photon microscopy and tools that allow stimulation of specific cells in pursuit of answers to these fundamental problems. Research groups will also quantitatively characterize the neuronal circuits and how they are anatomically connected to each other. It is anticipated that work in this area will revolutionize traditional brain anatomy. The development of novel electronic and electro-optic probes and interfaces for the brain is growing rapidly and holds great promise. This research will be the nucleus for fruitful collaborations between the Center and the recently established School of Engineering and Center for Nanotechnology at the Hebrew University.

3. Neuronal Basis of Sensory, Motor, and Cognitive Functions

Studies of neuronal circuits often focus on their interactions at a cellular level. Within a larger framework, however, neuronal circuits cause complete behaviors, such as feeling a sensation or generating an action. Researchers in this area will study how neurons and neuronal circuits interact in sensory, motor and cognitive functions. For example, researchers will examine the learning and control of movements as well as reward-based behavioral decisions. These groups also focus on the clinical applications of their research, such as Deep Brain Stimulation as a treatment for Parkinson’s disease and other psychological and psychiatric disorders, and Brain Machine Interfaces as a therapy for severe motor deficits. Other groups will investigate neuronal circuits underlying sensory processing (auditory, olfactory, and visual) using a variety of physiological, optical and behavioral tools. The emergence of powerful molecular genetic tools calls for a substantial investment in the study of neuronal circuits of rodents and simpler animals, using modern multi-electrode arrays, telemetry, two-photon imaging, and molecular genetic tools, combined with novel and quantitative behavioral paradigms.

4. Cognitive Neuroscience

Cognitive neuroscience will be a core area of activity that bridges the gap between animals studies and studies of human perception and cognition. The research will cover perception, including multi-sensory perception and plasticity in normal and blind humans, as well as attention and memory. Researchers will
conduct experiments that relate to perception and learning disabilities, such as investigating visual and auditory processing in normal as compared to dyslexic individuals. Additional studies will examine rationality and decision-making (in both humans and animals) and the brain mechanisms of language and speech processing. This group will use a broad range of technologies for monitoring human brain activity (such as fMRI, MEG, TMS, and high resolution EEG) as well as single neuron recordings in human patients and will develop sophisticated methods for the characterization of cognitive and behavioral phenomena.

5. Computational Neuroscience

Computational neuroscience, currently a key strength of neuroscience at the Hebrew University, will be a central component of the new Center. Computational neuroscience involves integrating experimental data at many levels—from the molecular up to the behavioral—and using this data to build theoretical models of brain function. Theoretical models are crucial to the construction of a unifying theory of the brain because they result in a set of predictions that can be tested both computationally and experimentally. Thus, the Center will place an important emphasis on the interaction between theoreticians and experimentalists. Researchers in computational neuroscience will work on a broad range of neurodynamic and information theoretic models of the neuronal circuits underlying learning, memory, adaptive sensory integration and motor control. Other research topics include the study of rational behavior, decision-making, and the construction models of artificial and natural image processing.

ELEMENTS OF THE CENTER

a) Building

A state-of-the-art building will be designed and built especially for the Center. The building, which will be designed by a prominent architect, will be located on the Hebrew University's Edmond J. Safra campus. The building modern facilities will consist of approximately laboratories offices for researchers and administration, seminar rooms, auditorium and core research facilities. It is estimated that the planning and design of the building will be completed within two years. Construction of the building will take an additional three years.

b) Core Research Facility

The Core Research Facility will serve the entire scientific community at the Center and scientists of the Hebrew university. It will contain imaging facilities, animal facilities, facilities for molecular biology methods, a computing facility, and several workshops.

c) Recruitment of New Faculty

An International steering committee will advise the center in its academic decisions. An Academic Committee will be appointed to search for talented candidates for new faculty positions at the Center. New faculty will be recruited at a rate of two to three annually for a total of 15 new faculty members over ten years. New members will be offered and encouraged to have joint affiliations with other neuroscience departments, when applicable, to optimize collaborative scientific work in the Hebrew University and the Israeli brain sciences.

d) PhD and Post-doctoral Training

The Center will be engaged in the highest quality interdisciplinary teaching in neuroscience. In particular, the Center will oversee graduate programs in neuroscience, strengthen existing programs such as the
ICNC’s Computational Neuroscience program and the Neurobiology and Behavior program, and develop new curricula, particularly in the area of molecular and cellular neuroscience. A number of PhD student fellowships will be awarded each year to outstanding students. In order to increase the reservoir of top faculty recruits and to develop promising candidates into a cadre of unsurpassed quality from which future core scientists may be recruited, ELSC will fund and send the brightest Ph.D. graduates in Israel to prestigious international labs for postdoctoral research fellowships. Up to five fellowships will be awarded each year. To broaden the pool of future faculty members and the scope of expertise at the new Center, post-doctoral fellowships at the Hebrew University will be offered to promising candidates from institutions both in Israel and abroad.

e) *General Activities*

International collaboration and fruitful intellectual exchanges will be an integral part of the new Center. The new Center will actively participate in international neuroscience conferences and seminars. In order to stay abreast of the developments in the global world, the Center will host visiting scientists and invite top lecturers from abroad. Funding, space and equipment will be set aside for exchange programs.

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