The Synapse Neurobiology Training Program, training the next generation of neuroscientists

Research into the functions of synapses is crucial to understanding the mechanisms of highly prevalent brain disorders such as epilepsy, autism and Alzheimer’s disease. Professor Michele Jacob is the director of the Synapse Neurobiology Training Program (SNTP), located at Tufts Sackler School of Graduate Biomedical Sciences in Boston. SNTP provides predoctoral students with individualised, in-depth, multidisciplinary research training to investigate critical areas of synaptic function associated with disease and behaviour. Alumni of SNTP have gone on to receive recognition for both their research discoveries and their impressive contribution to various public engagement initiatives.

Research into synaptic functions is key to understanding many neurological diseases including Alzheimer’s, Parkinson’s, ALS, autism-spectrum disorders, depression, anxiety, epilepsy and insomnia. Synapses are specialised contact sites between single nerve cells and their target cells that function in rapid information processing. They form the basis of our central nervous system’s functions.

Mechanisms that alter synaptic activity affect our behaviours, learning and memory formation. Many disorders of the nervous system involve fundamental alterations in synaptic function, and hundreds of mutations in synaptic proteins have been implicated in human diseases such as epilepsy, autism and cognitive impairments. Additionally, synaptic receptors and channels represent over half of the pharmaceutical industry’s drug development targets, making research both medically and industrially impactful.

THE FUTURE OF SYNAPTIC NEUROBIOLOGY RESEARCH

Future approaches to treating these brain disorders will involve further in-depth investigation of the mechanisms that govern synaptic function, and will also require a community of well-trained synaptic physiologists equipped to carry out research in a complex field. To improve the research skills of their predoctoral students, the Neuroscience faculty at Tufts Sackler School of Graduate Biomedical Sciences in Boston developed the Synapse Neurobiology Training Program (SNTP), with the objective that students graduate with the multi-faceted research skills necessary to address some of the critical neurological problems that have direct consequence to human health.

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The SNTP is run in the Department of Neuroscience, which is Chaired by Professor Philip Haydon, a world class expert in synapse neurobiology. Her research has focused on defining molecular mechanisms that direct the proper maturation and function of neuronal and sensory cell synapses, and the role that their dysfunction plays in intellectual disabilities, autism, childhood epilepsy, and hearing loss.

The SNTP is funded annually by the National Institute of Neurological Diseases and Stroke (NINDS), part of the National Institute of Health (NIH). Each student is co-mentored by two SNTP faculty members that provide training in distinct yet complementary areas, equipping the student with multidisciplinary research skills.

Students are also given one-on-one training in areas such as imaging, bioinformatics, electrophysiology and animal behaviour methods, provided via state-of-the-art core facilities and PhD-level managers in the NINDS-funded Center for Neuroscience Research at Tufts. SNTP training emphasises critical thinking and multidisciplinary approaches for effective and influential research.

STUDENT RESEARCH AREAS

Since 2009, the SNTP has helped augment the neuroscience community by generating a cohort of highly skilled researchers able to produce key breakthroughs in the diagnosis, prevention and treatment of neurological diseases. SNTP students contribute to a wide range of research areas, from synaptic studies investigating appetite and wakefulness to examining the synapse activity associated with disorders such as autism, epilepsy and anxiety.

Working with SNTP mentor Dr Leon Reijmers, Patrick Davis, PhD conducted a study looking at the neuronal mechanisms that control the balance between the opposing systems that regulate the brain’s expression and suppression of fear. Dysfunction of these synaptic mechanisms can lead to “inappropriate” fear responses and have been linked to anxiety disorders, Post-Traumatic Stress Disorder (PTSD) and specific phobias. This work has led to a publication in the high impact Nature Neuroscience journal.

Jonathan Alexander, PhD completed his project under the mentorship of SNTP
Behind the Bench
Professor Michele Jacob

Q&A

What qualities do you look for in students when considering applications to SNTP? The SNTP benefits from a large and diverse pool of students interested in neuroscience, and in particular the synapse. A committee of SNTP faculty mentors selects the trainees. Qualities that distinguish top candidates for the SNTP are outstanding performance in all coursework and research, strong recommendations from their thesis research mentor and thesis advisory committee, high quality of the thesis project, and demonstration of a willingness to assume an active role in one’s education (e.g., inquisitiveness, taking leadership positions).

How does participation in SNTP help prepare your students for a career in the field? The SNTP is designed to provide students with the rigorous, multidisciplinary research training and critical thinking skills they need to compete for research jobs in academia or industry and maintain successful, independent research programs. Dual mentorship is required to provide each SNTP trainee with in-depth exposure to mentors in the fields of their choosing. In addition, the training plan also provides opportunities to acquire effective written and oral communication skills, engage in activities that develop mentoring skills, interact with clinical faculty to gain the clinical perspective on the trainee’s research, and interact as hosts or seminar and symposium speakers to develop a personal contact network with experts in the field.

One of your aims is to get SNTP trainees heavily involved in outreach initiatives and mentoring of younger students. Why do you consider this to be important? SNTP trainees are capable, proactive, and motivated young scientists. They have independently engaged in an impressive array of outreach activities that include teaching workshops at high schools and colleges with large populations of students from underrepresented groups. These activities attest to SNTP trainees’ intellectual curiosity, interactive attitude, sense of community responsibility, and love of science.

What plans do you have for the future of SNTP going forward? Are you looking to make any changes to the structure or aims of the program? The goal of the SNTP is to keep developing talented well-trained young investigators necessary for a vibrant neuroscience research community capable of developing new approaches for disorders caused by synaptic dysfunction.