NEWSLETTER 11th edition | November 2014

IST AUSTRIA
Institute of Science and Technology

Foreword

It is four years ago that the Bertalanffy Foundation Building was inaugurated. In November 2010 the first experimental scientists moved to IST Austria. Today, out of the 35 groups at IST Austria, 17 perform experimental lab work and their "model organisms" are as diverse as they can be: bacteria, flies, ants, fish, rodents and several plant species. Many more are to come, especially when experimental physicists will move to Lab Building West. To research their fields over 200 experimentalists employ high precision instrumentation, from advanced light and electron microscopy to cell sorting and DNA sequencing devices – for all this, highly sophisticated equipment and know-how have been set up on site within the past four years. Although it was not before November 2010 that the first lab instruments and reagents were delivered to IST Austria, there is already a substantial number of top publications in the experimental sciences that were entirely crafted at IST Austria.

For its scientific infrastructure, IST Austria decided to follow a model that is increasingly common at modern research institutions: most elaborate (and expensive) instrumentation is not 'owned' by a research group. Instead, IST Austria runs its SSUs ("Scientific Service Units"), which purchase, maintain and service the equipment. They also offer training for users and counselling regarding experimental design. They build customized equipment, adapt software, breed animals and plants, prepare buffers etc. Such shared scientific services, which are only possible due to the absolute dedication of our SSU managers and staff scientists, allow excellent infrastructure to be developed and to be used by any experimental research group independent of its previous experience and group size, facilitating methodological novelty at high quality and interdisciplinary research at IST Austria.

Michael Sixt | Vice President, IST Austria

Coordination in the spinal cord

The development of embryos requires the production of new cells with specific identities and functions. How does a growing tissue establish and then maintain the right proportions of different cell types? In a study published in Science, IST Austria Professor Tobias Bollenbach and his colloborators address this longstanding question.

The study reveals that different mechanisms are employed during two distinct phases of spinal cord development. Initially, morphogen gradients – long range signals that partition the tissue into domains of distinct cell types – establish the pattern and proportion of different cell types. During the second phase the growth of these domains is controlled by the rate at which progenitor cells differentiate to become neurons. It is this regulation of differentiation rate that appears to account for the domain proportions and and leads to very similar domain proportions in different embryos despite variations in size.

Bollenbach: "In the long term, quantitative experimental studies of this type in combination with theoretical modeling and statistical analysis will help elucidate the cellular mechanisms of tissue patterning in development."

Three new professors join IST Austria

Martin Loose, Jan Maas and Beatriz Vicoso are joining IST Austria as Assistant Professors, bringing the number of the faculty to 34.

Systems biologist Martin Loose aims to understand the mechanisms and evolution of biochemical self-organization and how proteins, which are much smaller than the cell, are able to organize intracellular space.

Mathematician Jan Maas studies problems in probability theory and analysis. His research focuses on stochastic processes, which describe a wide variety of real-world systems subject to randomness or uncertainty. He is mostly interested in optimal transport, stochastic partial differential equations, and stochastic analysis.

Evolutionary biologist Beatriz Vicoso works on the evolution of sex chromosomes, the chromosomes that determine gender in many species. Her postdoctoral work focused on using next-generation sequencing to study the sex chromosomes of various non-model species, including trematodes, birds, snakes and insects.

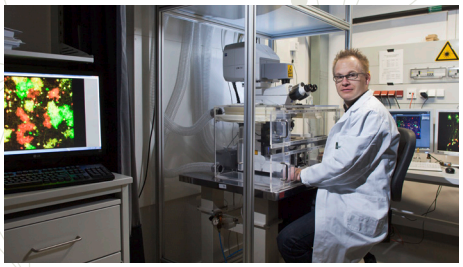
Maas has started on October 1, 2014, Loose and Vicoso will start in early 2015.

New PhD students at IST Austria

25 new students joined our Graduate School in September, bringing the total number of PhD students at IST Austria to 106. The 2014 students were selected from a total of around 1038 applicants. They are a truly international group, coming from 16 nations: Portugal, Germany, Rumania, Spain, China, Iran, Croatia, Russia, India, Slovenia, Slovakia, Mexico, Czech Republic, and Bulgaria. Four PhD students from Austria complete the 2014 yeargroup. Welcome to IST Austria!

Online application for joining the IST Austria Graduate School in fall 2015 is open already. The deadline for applications is January 15, 2015. Positions are available in the fields of evolutionary biology, call and developmental biology, neuroscience, as well as computer science, mathematics, and physics. Students can enter with either a Bachelor or Master degree. They receive a salary for the duration of the program (4-5 years).

Visit ist.ac.at/graduate-school for details on the program.



New grant for genomic imprinting research

Simon Hippenmeyer, Assistant Professor at IST Austria, receives a grant of the Lower Austrian Research and Education Company (NFB). In this project, the neuroscientist investigates the role of genomic imprinting in the development and function of the brain.

For each gene, we possess one copy that we inherited from our mother and one inherited from our father. For a subset of genes, either the maternal or the paternal copy is active. This phenomenon, called genomic imprinting, is critical for our development, metabolism and brain function. When genomic imprinting is disrupted, a range of diseases including several neurological and psychiatric disorders as well as cancer may develop.

Genomic imprinting seems active to varying degrees in different organs and tissues of the body. In the NFB-funded project, Simon Hippenmeyer investigates to which extent genomic imprinting may be restricted to specific neuron-types in the brain, and what role(s) such cell-type specificity of genomic imprinting could play in the development and function of neuronal connections and networks. By using the recently advanced analytical genetic method called MADM, the Hippenmeyer group anticipates to obtain unprecedented results at the individual neuron level.

As part of the Life Science Calls 2013, the NFB supports Hippenmeyer's project with €245'000 for the duration of three years. The project shall provide insights into the role of genomic imprinting in brain development, and advance our understanding of the molecular-genetic basis of diseases.

Science week at IST Austria

"Summer camp - kids discover research" was the title and theme of the first science week for children, organized by IST Austria and the Lower Austrian Teacher Education College. 22 bright heads from Vienna, Klosterneuburg and surrounding areas were participating in the research week on campus from August 18-22. 5 girls and 17 boys attended one of three research groups and were introduced to basic principles of biology, physics and computer science.

Tinkering evolution

In a paper in PLOS Computational Biology, Krishnendu Chatterjee, Professor at IST Austria, and his PhD student Andreas Pavlogiannis together with collaborators Ben Adlam and Martin A. Nowak from Harvard University investigate the timescale required for evolutionary innovation to arise.

A common question asked in evolutionary biology is how long it takes for an advantageous mutation to be established in a population. The authors approached evolutionary innovation from a different angle, asking how long it takes until a new function arises. For a sequence of amino acids with a certain length that undergoes adaptation, what is the expected time it takes until a new function is found? The authors here distinguish between two time requirements: polynomial time, where a new function is realistically achievable in the time course of evolution, and exponential time, where it is possible to get a new function in feasible time, but it is not likely and not expected in general.

The results show that in a broad range of fitness landscapes, it takes in expectation unrealistically long to discover any meaningful innovation if a sequence explores the fitness landscape. But we do see new functions arising during evolution. How are these new functions then achieved? The authors propose a mechanism called "regeneration process". It is based on the idea that evolution solves a problem more easily if it has already solved a similar one. Gene duplication and genome rearrangements provide a constant stream of sequences that are a certain number of mutations away from the target function. These sequences can be regenerated again and again. The researchers show that even without selection, a new function modified from these starting sequences can be reached within realistic, polynomial time with high probability.

Mutation found responsible for low IQ

Gaia Novarino, Assistant Professor at IST Austria, together with collaborators Tim Strom and Hartmut Engels and their teams, published a study in the European Journal of Human Genetics, showing that mutations in the gene SETD5 are a relatively frequent cause of intellectual disability.

Intellectual disability, defined as an IQ of less than 70, occurs in 2-3% of the population. However, as it is an extremely heterogeneous disease, the genetic basis of intellectual disability has been hard to spot in most cases. To find genes responsible for this condition, the team of researchers studied the genes of 300 children with unexplained intellectual disability. They looked for genetic regions that are changed between the children and their parents, who do not have an intellectual disability. If such changes occur in the same gene in different affected children, this makes it likely that the gene is involved in the disease. In two children, the researchers found new mutations in a gene called SETD5. In four other intellectually disabled children, they found deletions of the entire gene.

Novarino and colleagues show that patients with mutations in SETD5 have less protein in their brain and thus develop intellectual disability. An analysis of the structure of SETD5 suggests that it plays a role in chromatin modification and the epigenetic regulation of gene transcription.

SETD5 is found on the short arm of human chromosome 3. A syndrome in which the end of this chromosome is missing, called 3p- syndrome, is characterized by intellectual disability and other symptoms. Only three genes are likely to play a crucial role in this syndrome, one of which is SETD5. As spontaneous changes in genes are a very rare event, the finding that two such mutations and four deletions were found in the same gene in children with intellectual disability makes a compelling case for SETD5 to be associated with the disease. Changes in SETD5 are therefore a relatively frequent cause of intellectual disability, and probably contribute significantly to the intellectual disability symptoms of 3p- syndrome.

Student Visit Day

On November 15, IST Austria opens its doors to students interested in applying for a PhD position for the 2015-16 academic year. The event is designed to discover the rewards of starting a career as a researcher. It is an opportunity for applicants interested in joining the IST Austria Graduate School to meet IST Austria faculty and current PhD students. Please register on our website.

First IST Commemoration Lecture

On November 25, the historian Herwig Czech will give the first IST Commemoration Lecture titled "Nazi Medical Crimes at the Psychiatric Hospital Gugging: Historical Context, Facts, and Legacy." It is the intention of this new series of lectures to introduce the members of the Institute and the public to the past of the IST Austria campus and, in a broader sense, to aspects of the history of science requiring remembrance and reflection. This first IST Commemoration Lecture will be presented by the Chair of the Executive Committee of the Board of Trustees, Haim Harari. Further information on our website.

IST Lecture Terrence J. Collins

Our civilization operates on myriad unsustainable technologies with health and environmental costs externalized to future generations. This untenable sacrificing of the future good is humanity's greatest leadership challenge.

In his lecture on December 4, Terry Collins will share leadership concepts for sustainability. Collins is the Teresa Heinz Professor of Green Chemistry and Director of the Institute for Green Science at Carnegie Mellon University. He invented the first fully functional small molecule replicas of any of the great families of oxidizing enzymes that nature deploys to run aerobic life. Further information can be found on our website.

COLLOQUIUM SPEAKERS

PAST SPEAKERS (September - October): George Zweig, MIT (Sept 15) | Michael Savageau, University of California Davis (Sept 29) | Przemyslaw Prusinkiewicz, University of Calgary (Oct 6) | Jean Dalibard, Laboratoire Kastler Brossel (Oct 13) | Moni Naor, Weizmann Institute (Oct 20) | Gershon Kurizki, Weizmann Institute (Oct 27) | Ralf Schneggenburger, EPFL Lausanne (Nov 3)

FUTURE SPEAKERS (November - January): Anne-Claude Gavin, EMBL Heidleberg (Nov 10) | Pascale Ehrenfreund, Austrian Science Fund (Nov 17) | Matthieu Piel, Institut Curie Paris (Nov 24) | Nathan Linial, The Hebrew University of Jerusalem (Dec 1) | Chris De Zeeuw, Netherlands Institute of Neuroscience (Jan 19) | Felix Randow, University of Cambridge (Jan 26)

SELECTED RECENT PUBLICATIONS

Coordination of progenitor specification and growth in mouse and chick spinal cord | Kicheva A, Bollenbach T, Ribeiro A, Perez Valle H, Lovell-Badge R, Episkopou V & Briscoe J, 2014 | Science 345, DOI: 10.1126/science.1254927.

The Time Scale of Evolutionary Innovation | Chatterjee K, Pavlogiannis A, Adlam B & Nowak MA, 2014 | PLOS Computational Biology DOI: 10.1371/journal.pcbi.1003818.

So Near and Yet So Far: Harmonic Radar Reveals Reduced Homing Ability of Nosema Infected Honeybees | Wolf S, MacMahon DP, Lim KS, Pull CD, Clark SJ, Paxton RJ & Osborne JL, 2014 | PLOS One DOI: 10.1371/journal.pone.0103989.

On secondary instabilities generating footbridges between spiral vortex flow | Altmeyer SA, 2014 | Fluid Dynamics Research 46 025503.

Collective excitations of Bose gases in the mean-field regime | Nam PT & Seiringer R, 2014 | Archive for Rational Mechanics and Analysis DOI: 10.1007/s00205-014-0781-6.

Loss-of-function variants of SETD5 cause intellectual disability and the core phenotype of microdeletion 3p25.3 syndrome | Kuechler A, Zink AM, Wieland T, Lüdecke HJ, Cremer K, Salviati L, Magini P, Najafi K, Zweier C, Czeschik JC, Aretz S, Endele S, Tamburrino F, Pinato C, Clementi M, Gundlach J, Maylahn C, Mazzanti L, Wohlleber E, Schwarzmayr T, Kariminejad R, Schlessinger A, Wieczorek D, Strom TM, Novarino G & Engels H, 2014 | European Journal of Human Genetics doi:10.1038/ejhg.2014.165.

The Altshuler-Shklovskii formulas for random band matrices I: the unimodular case | Erdős L & Knowles A, 2014 | Communications in Mathematical Physics DOI 10.1007/s00220-014-2119-5.

A full list of publications from IST Austria can be found at publist.ist.ac.at.

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