Life Sciences
Newsletter 3
Soft Matters
December´09

Two new members in the LIFENET Advisory Board

Since October, two additional internationally acclaimed scientists joined the LIFENET Advisory Board. The School of Life Sciences succeeded in recruiting **Dr. Pamela A. Padilla** (Associate Professor of Biological Sciences, University of North Texas, Denton, USA) and **Prof. Dr. Sabine Werner** (Institute of Cell Biology, ETH Zürich, Switzerland) to its group of already nine first class researchers.

Pamela A. Padilla, who just recently was awarded the NSF CAREER award program, the most prestigious offered by the National Science Foundation for young investigators, received her PhD in 1998 in Biology at the University of New Mexico, studying Eukaryotic Genetics.

Her research focuses on identifying the molecular mechanisms involved in responses to oxygen deprivation using various animal models, as well as studying interactions between stress responses and aging. Professor Padilla is the first faculty member at her University who holds simultaneous NIH R01 and NSF awards, and is a strong advocate for developing discovery-based student teaching programs. She also serves as a Mentor for SACNAS (Society for Advancement of Chicanos and Native Americans in Science), a US organization to improve and expand opportunities for minorities in the scientific workforce and academia.

Sabine Werner has been a full professor of Cell Biology at the ETH Zurich since 1999. In 1989 she got her Ph.D. at the University of Munich with a research project done at the Max-Planck-Institute of Bio-chemistry in Martinsried. She then joined the University of California at San Francisco, where she worked on the molecular mechanisms of growth factor action and tissue repair. From 1993-1999 she was a group leader at the Max-Planck-Institute of Biochemistry in Martinsried, Germany. In 1996 she obtained a Hermann-and-Lilly Schilling professorship of Medical Research at the same institute and from 1995-1999 she was also Associate Professor of Biochemistry at the Ludwig-Maximilians-University of Munich.
A major emphasis of her research is on the role of growth factors in tissue repair and cancer. In addition, she studies the molecular mechanisms of growth factor action in epithelial cells. During the last years, Professor Werner earned several awards, including the Otto-Hahn medal of the Max-Planck-Society, the Pfizer Academic Award, a Research Award from the AETAS foundation and recently the Cloëtta Award 2008". Since 2005 she has been a member of the scientific board of the Swiss National Science Foundation.

TO COME

LIFENET LECTURES

10.12.2008 12:15h - **Prof. Peter Jonas:**
"GABAergic interneurons: a surprising class of cells in the brain"

10.12.2008 18:15h - **Prof. Dr. Gyorgy Buzsaki:**
"Internally generated cell assembly sequences in the brain: a neuronal substrate for recall and planning?"

(more Information: http://www.frias.uni-freiburg.de/lifenet/veranstaltungen)

REVIEW

Multiscale modeling of biopolymer translocation: a Lattice Boltzmann-Molecular Dynamics approach

Sauro Succi, IAC – CNR (Rome, Italy) and
Initiative in Innovative Computing,
Harvard (Cambridge, USA)

Translocation of DNA molecules is the process by which a single DNA molecule enters through a nanopore in a membrane and migrates to the other side of the membrane. Translocation is a natural process in living cell membranes and viral infections, and it is also used in gene therapy. Recent technology has allowed to create nanopores in silicon thin sheets, and to detect the passage of single DNA molecules through the nanopore by measuring the decay of applied voltages due to the blockage of the DNA molecule when it is translocated. There is currently a great interest in using this phenomenon to read entire sequences of DNA molecules. The time it would take to sequence human DNA with this technique would be around one hour, thus opening the avenue for routine clinical analysis.
The physics involved in this problem is multiscale: from the detailed molecular interaction of the base pairs, to large scale physics due to the long length of the DNA molecule, together with the hydrodynamic interactions due to the solvent. These hydrodynamic interactions turn out to affect notably the dynamics of the translocation process. Sauro Succi has presented Lattice Boltzmann simulations of polymer molecules translocating through a hole in an otherwise solid wall in order to address the effects of hydrodynamic interactions. The solvent is modeled with the Fluctuating Lattice Boltzmann Equation while the polymer is simulated with ordinary Molecular Dynamics. The solvent and the polymer are coupled through a simple Stokes law of force on the monomers of the polymer. An electric potential through the pore drags the polymer chain and induces translocation. >>

Several interesting effects have been elucidated through the simulations. For example, the time is strongly affected by hydrodynamics. In the simulations it is also observed that, depending on the size of the pore, it is possible that several parts of the same polymer go through the nanopore at the same time. This should reflect in a "quantization" of the detected voltage and this is what happens in actual experiments. Of course, such events are to be avoided in a technique that seeks to read DNA sequences of single DNA molecules. The computer resources needed in these simulations are considerable and, in order to go further into the challenging realm of biomolecular specificity, Professor. Succi also stressed the need of new ideas and algorithms.

Pep Español

NEW FELLOW

Sabine Ludwigs
Macromolecular Chemistry
Freiburg, Germany

FRIAS Project: "Correlation between structure and electronic function of conjugated semiconducting polymers"

The project within FRIAS is focusing on the synthesis of semiconducting conjugated polymers and the characterization of their electronic properties. Particularly interesting are highly regioregular poly(3-hexyl thiophenes) which can be regarded as one-dimensional semiconductors. Electrochemical measurements combined with in-situ spectroscopy and conductivity measurements are used to understand conductivity and absorption behavior upon electrochemical doping. Transistor measurements of highly crystalline domains shall further be performed to get a better understanding of the correlation between charge transport and structure.

(more Information: http://www.frias.uni-freiburg.de/matter_research/fellows)

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REVIEW

Sweeping in the Nanoworld:
from Nano-Brushes to Fullerenes in Molecular Machines

On October 21st, 2008, the FRIAS School of Soft Matter Research held an International Symposium on the "Current Status of Soft Matter Research". Six exciting presentations covered a broad range of up-to-date topics of the forefront of soft matter research. PD Dr. Svetlana Santer (IMTEK, Freiburg) introduced the innovative concept of dynamically reconfigurable thin polymer films. Using polymer brushes as well as by exciting surface plasmon interference patterns, directed motion of nanoscale objects can be generated on a sticky surface. Dr. Sebastian Proch (University Bayreuth) presented novel concepts in the chemical design of catalysts as a contribution to sustainable green chemistry. In particular, using a chemical bridging with a spillover source, hydrogen storage at room temperature becomes successful. Dr. David Diaz-Diaz (Dow Chemical, Freienbach, CH) presented examples of the synthesis of functional materials which are inspired by biological soft matter nanomaterials. Along the example of tree resin, he explained the way from identifying the building blocks towards a large-scale functional material. Dr. Sheshanath Bhosale (Monash University, Australia) also transferred concepts from nature to functional devices. In particular, specially designed "yoctowell" nanostructures allow to create artificial photosynthetic reaction centers. Dr. Corinne Vebert (University Basel) discussed novel concepts of polymer-modified oligonucleotides. She presented their synthesis and their bioacitivity, allowing applications in surface preparation, drug delivery, gene therapy, immunology, and tissue engineering. The round dance in the nanoworld ended by the presentation of Dr. Aurelio Mateo-Alonso (Trieste University). He vividly introduced multitask molecular machines based on Fullerenes which are easy to synthesize and which allow, for instance, electrochemically induced switching or electron transfer by moving the counterparts mechanically. Lively discussions on these most recent concepts made the round perfect.

Michael Thorwart

NEW FELLOW

Svetlana Santer
Chemistry & Physics of Interfaces
IMTEK Freiburg,
Germany

FRIAS Project: "SPINAL: Surface plasmon interference nano-lithography"
At FRIAS it is planned to develop novel photoactive functional thin polymer films with integrated metal gratings sensitive to the excitation of surface plasmons. Upon UV-illumination, the photosensitive groups not only respond to the primary external radiation, but also to the secondary emission of UV-light by surface plasmon giving rise to interference patterns and light density distributions below the diffraction limit. In this way, the topography of the thin polymer films can be manipulated in an unprecedented way on a nano metre scale. This opens up several new possibilities in the field of nano manipulation. By imposing a time-dependent protocol on corresponding topography changes in response to variations in irradiation, it should be possible to supply dynamically reconfigurable surface force fields.

(more Information: http://www.frias.uni-freiburg.de/matter_research/fellows)

TO COME

SOFT MATTER RESEARCH LECTURES

03.12.2008 15:15h - **Nobel Laureate Jean-Marie Lehn:** "Perspectives in Chemistry: "From Molecular to Supramolecular Chemistry towards Adaptive Chemistry""

(more Information: http://www.frias.uni-freiburg.de/matter_research/veranstaltungen)

REVIEW

The Genetic Code Revisited – Four Decades after Francis Crick

On November 24th the Freiburg Institute of Advanced Studies (FRIAS) welcomed the renowned scientist, Professor Dieter Söll, Department of Molecular Biophysics and Biochemistry, Yale University at FRIAS. Research in the Söll laboratory centers around functional genomic investigations that explore the translation of the genetic code with canonical and modified amino acids. Prof. Söll's presentation provided evidence that the genetic material of organisms is far from being strictly conserved in various aspects. In E. coli for instance 40 % of the genome is regarded to be foreign/phylogenetically derived from other organisms. Since Crick proposed his adaptor hypothesis it was commonly accepted that all organisms or organelles possess 20 aminoacyl-tRNAs as well as 20 tRNA synthetases, each enzyme specific for attaching one amino acid to tRNA. It is now clear that tRNA formation is far more varied, as the biosynthetic routes to various tRNAs vary greatly in nature. For instance, the amide aminoacyl-tRNAs (Asn-tRNA and Gln-tRNA) can be formed by two redundant mechanisms, direct acylation or pre-translational amino acid modification by amidation. Further highlights of the talk comprised the presentation of the 21st (pyrrolysine) and 22nd (selenocysteine (Sec)) cotranslationally inserted amino acids. The discovery of a non-canonical lysyl-tRNA synthetase gave the first clues on the aminoacylation of pyrrolysine, the 22nd cotranslationally inserted amino acid. In summery findings emphasize the variability in translating the genetic code where a strict and universal codon usage can not be phrased and the specificity of the genetic code is not in every case solely determined by the aminoacyl-tRNA synthetase. The talk was closed with a living discussion underlining the far reaching impact of the presented research.

Stefan Schiller

REVIEW

Nobel Laureate Erwin Neher on "Rate-limiting Steps during sustained activity at a glutamatergic synapse"

On October 29th Peter Jonas, FRIAS fellow and coordinator of the SFB 780, could welcome the first external speaker in the SFB Lecture Series: the Nobel Laureate Erwin Neher (MPI for Biophysical Chemistry, Göttingen). Although the lecture was scheduled late at 6 p.m., the lecture hall in the Center for Neurosciences (ZfN) was not big enough to seat all the interested Neuroscientists. Professor Jonas introduced the famous scientist, who received the Nobel Prize for Medicine/Physiology in 1991 together with Bert Sakmann for the development of the patch-clamp technique, a laboratory technique in electrophysiology that allows the analysis of single or multiple ion channels in cells.
In his talk, Erwin Neher described the paradox of why transmitter release following action potentials at synapses can be fast and neurotransmitter release happens at a very fast rate (about 600 vesicles can be exocytosed per ms!), yet each synapse has its own personality and release can be either sustained, depressed, or facilitated during repetitive stimulation. He further on elaborated on the new concept that not the docking and priming of vesicles at the presynapse are the rate-limiting steps for neurotransmitter release, but that the release rate is determined by ultrastructural parameters at the presynapse, namely the cellular domain [Ca2+] concentration regulated by the presence and vicinity of Ca2+ channels at the active zone. In his unharried and composed presentation, Erwin Neher made it clear that 17 years after being awarded with the Nobel Prize, he still is fascinated by and still is contributing to knowledge about the molecular mechanisms at a synapse. In contrast to some other Nobel Laureates, Professor Neher's scientific output (he has an unbelievable record of highest impact journals in the last 5 years) confirms that a scientific career can still even increase after receiving the most prestigious scientific award.

Britta Küst

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