Mathematical Modeling of Membrane Processes in Animal Cells with Emphasis on Exocytosis and Related Processes (e.g., Transfection), **Workshop,** *to be held June 29 - July 2, 2006 in a beautifully situated resort of Roskilde University at Holbæk Bay (60 km West of Copenhagen, Denmark)*

"*The delivery of free-energy into a self-assembling system* (scilicet *membranes*) *is hard to realize bio-chemically. Even mathematically, modeling such processes does not seem easy*." (A. Carbone and M. Gromov, 2001[1])

Visionary hints for advances in *modeling fragments of cell dynamics* and *identifying signatures of such fragments* by Alessandra Carbone and Misha Gromov seem to fit – and to challenge - recent advances in the modeling of membrane processes in animal cells (in particular exocytosis, endocytosis and transfection). As examples can be mentioned the work done by Reinhard Lipowsky and Julian Shillcock of the Potsdam Max-Planck Institute for Colloids and Interfaces in *numerical simulation of vesicle-bilayer fusion in real time*[2]; by Bernhard Wolf ("Medizinische Elektronik") of München Technical University in *making visible calcium oscillations* which are running ahead of exocytosis[3]; by Martin Koch and Angela Otto from Wolf's Chair in *analyzing field equations, frequencies and currents in cell exocytosis*[4]; by James Sneyd of the University of Auckland and collaborators in *control of calcium oscillations by membrane transport*[5]; and by Heinrich Hofmann of the Lausanne EPFL Laboratoire de Technologie des Poudres on *nano-composites powders*[6].

The organizers want to gather these pioneers and other 20-30 biologists, mathematicians, physicists, and engineers for the workshop. The plan is not so much to address biological structures; not to point to DNA pieces and to explain what they code for; not to describe and label what one sees in a cell under the electron microscope; not to investigate material properties of the membranes – as challenging such investigations certainly can be. Instead of that, the workshop shall focus on exchanging ideas and recent research results along the route sketched in Carbone and Gromov's legendary text, but in an extremely concrete and specified context:

Tracking macromolecules. Case exocytosis: how are macromolecules (gathered in tiny vesicles) ejected *by* the cell *out of* the cell? Calcium oscillations always appear in advance of this process. What does this signaling event show us? (Signaling of second messenger ions can be made visible by fluorescence.) What is the *missing (process) link* between hemifusion and fusion pore?

Manipulating and controlling the living cell. Ideas and results on auto-manipulation will be presented, i.e., modeling and simulation of the internal processes leading to hemifusion and exocytosis; and ideas and results on artificial (external) manipulation, e.g., by excitation at suitable frequencies related to the 2001 discovered SET (Single Electron Transistor = kind of electron pump, which is pumping *single* electrons).[7] Among future applications one may speculate the possibility to impair fusion processes in cancer cells by a defined transmission of field-energy.

The workshop will not be restricted to exocytosis, but will also try to have experts on endocytosis, transfection and related vesicle transport processes with their analogous, but different modeling of fragments of cell dynamics. Work done and challenging ideas for identifying signatures of such fragments will be emphasized.

During the workshop, promising aspects of possible future collaboration and possible joint participation in suitable programs from the European Community may be discussed, as well. The workshop is supported by Roskilde University and the Danish network *Mathematical Modelling, Estimation and Control of Biotechnological Systems*. Publishing of the proceedings is intended.

Bernhelm Booß-Bavnbek (Roskilde University, booss at ruc dot dk) Johnny T. Ottesen (Roskilde University)
Angela Otto (Technical University München) Michael Pedersen (Danish Technical University)

[1] *Gazette des mathématiciens* Suppl. no. 88 (2001), 11-80, here p. 62
[2] *Nature Materials* 4 (2005), 225-228, see also http://www.nature.com/nmat/journal/v4/n3/fig_tab/nmat1333_f2.html
[3] http://www.lme.ei.tum.de/englisch/research/microscopy.htm
[4] See M. Koch, Nichtinvasiver Transport von Ladungsträgern in komplexen Materialien, Diss. TU München, 2005
[5] Sneyd, J., Tsaneva-Atanasova, K., Shuttleworth, T., Thompson, J., Yule, D.I., Control of calcium oscillations by membrane transport, *Proc. Natl. Acad. Sci. (USA),* 101 (2004), 1392-1396
[6] Hofmann H.; Bowen P.; Jongen N.; Lemaître J., *Scripta Materialia* 44 (2001), 2197-2201
[7] S.V.Lotkhov, S.A.Bogoslovsky, A.B.Zorin, J.Niemeyer, *Applied Physics Letters* 78/7 (Feb. 12, 2001), 946-948