High Resolution Studies of Biomolecular Interfaces

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MEMPHYS – Center for Biomembrane Physics
DaMBIC – Danish Molecular Biomedical Imaging Center,

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MEMPHYS Barbecue, June, 2008

• Senior staff = 10
• Post docs = 7
• PhD students = 10-12
• Master + Project students = 5
• Technical + Admin staff = 2

MEMPHYS - Center for Biomembrane Physics

Luis Bagatolli
Ole Mouritsen
Uffe Bernchou
Adam Simonsen
John Ipsen

MEMPHYS Barbecue, June, 2008
Group Competences

- Center of Excellence. Danish National Research Foundation (2001-2011)
- Bioimaging Microscopy Facility from 2011 (DaMBIC).

Microscopy
- 3xAFM
- Force Spectroscopy
- Imaging Ellipsometry + BAM
- Confocal (1 + multiphoton) Fluorescence, Spinning disc confocal
- Single particle tracking
- Micromanipulation

Sample Prep
- Surfaces + Interfaces
- Chemical Modifications
- Liposomes
- Cell Lab
- Molecular Biology
- Cleanroom + SEM (@ NanoSYD)

Computer simulations
- Molecular Dynamics
- Coarse Grained Simulations
- Monte Carlo

Analytical Theory
- Statistical Physics
- Thermodynamics
- Mean Field Theory

Spectroscopy
- Calorimetry (DSC, ITC)
- Optical
- ESR
AFM and Fluorescence Microscopy

EMCCD camera

AFM

Fiber-coupled monochromatic Xenon light source
Imaging Ellipsometry
Confocal, Spinning Disc, Single Particle Tracking
Common Focus Area:
Understanding the Physics of Biomembranes


Examples of Project Topics

1. Artificial Model Membranes and Monolayers
   a) Domain formation
   b) Texture and domain substructure
   c) Effect of enzymes, drugs, embedded molecules
   d) Langmuir monolayers
   e) Dynamics and non-equilibrium in membranes


3. Encapsulation Technology. Liposomes & Particles

4. Plasmonics. Structured substrates and interfaces

5. Apply and develop new characterization tools.

6. Development of sample preparation
Supported membranes from spincoated lipid films

- Double supported membranes (M2)
- Membrane islands (M2)

Example:
Ripple Texture of Stripe Domains
Thermodynamic Phases in Membranes

- Gel/Solid
- Ripple
- Liquid Disordered

+ Cholesterol → Liquid Ordered
Molecular conformation of ripple membranes: Evidence from simulations

Distorted solid phase with interdigitated acyl chains

de Vries et al
PNAS 102, 5392–5396 (2005)

Head group width and dipole moment regulate ripple formation

Sun and Gezelter
Questions related to the ripple phase

• What is the Molecular Microstructure of the ripple phase?

• What is the large-scale domain pattern of the ripple phase

• Connection between 'stripe domains' and the ripple phase?

• Which physical parameters control ripple formation?

• Does the ripple phase have biological relevance?
Stripe domains in binary phospholipid membranes: DLPC, DPPC (1:1)

Temperature ramp from 40 to 22°C

50 µm
Supported membrane versus GUVs

Korlach et al PNAS 96, 8461–8466 (1999)
Correlated Fluorescence and AFM of ripple domains

Stripe domains have a ripple sub-structure
DLPC, DPPC (1:1)
Nucleation of ripple domains
Former Students:

Uffe Bernchou

Henrik Midtiby

Current Students:

Jes Dreier

Mette Marie Bruun Nielsen

Morten Christensen

Colleagues:

John Hjort Ipsen

Luis Bagatolli

Ole G. Mouritsen

Jonathan Brewer

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