

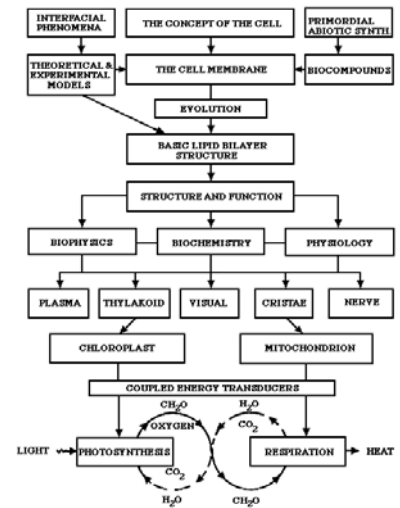


Research objectives as well as the pedagogic work in the course PSL 420 are intended for advanced students and new researchers interested in **membrane biophysics**. The focus is on biophysical aspects of biological membranes. The area of membrane biophysics is perused from the origin of the **lipid bilayer** concept to **membrane transport**, **electrochemistry**, **physiology**, **bioenergetics**, and to **membrane photobiology**. Emphasis in the research is placed on theoretical and experimental model systems, as related to the structure and function of biomembranes.

**The Basic Concept:** The connecting thread among these topics is the **experimental bilayer lipid membranes (planar BLMs, supported BLMs, and spherical liposomes)**. The basic principles of thermodynamics, kinetics, the Nernst-Planck equation, colloid and surface chemistry are applied to the above-listed topics of membrane biophysics. Some potential practical applications of **self-assembled lipid bilayers as biosensors** are an essential part of the research work in the laboratory, but also of the PSL 420 course for advanced undergraduate and also interested graduate students. This is because of the fact that recent advances in the **microelectronics** coupled with **membrane research** of the past decades have come of age and are poised for **biotechnological exploitation**.

**New Areas of Research:** Many exciting new discoveries are happening in the interdisciplinary sciences. Membrane biophysics, membrane physiology and biosensors development are only few disciplines in this exciting area of the fast development and of the potential for the future. Also, another important project is the international collaboration with Slovak Republic and Czech Republic in developing a Center of Interface Sciences (CIS) at the Department of Microelectronics, Faculty of Electrical Engineering and Information Technology of the Slovak Technical University in Bratislava during 1990s. This work was supported over 6 years by US AID grant in the middle of 1990s and continues until present in a number of joint publications in the interdisciplinary field between molecular biology and microelectronics.

**Latest Publications in This Field:** Dr. A. Ottova is author of 3 major book publications in biophysics, the first one with the Editorial office Alfa in the former Czechoslovakia in 1993 and 2 Elsevier book publications together with Dr. H. Ti Tien in 2000 and in 2003. Their respective URLs are:  
<http://www.elsevier.com/inca/publications/store/6/7/2/6/8/6/index.htm>  
[http://www.msu.edu/user/ottova/planar\\_lipid\\_bilayers.html](http://www.msu.edu/user/ottova/planar_lipid_bilayers.html)



**Fig 1 The life cycle, biomembranes, their interrelationship and methods of inquiry .**  
The pivotal concept of biomembranes is the lipid bilayer. The life cycle, driven by the solar energy, is represented by an infinity sign shown at the bottom of the figure. The two-coupled circles depict a steady-state energy transducing system of life.

**Fig.2 An idealized cell together with its organelle membrane systems.**

An idealized plasma membrane of the cell possesses an elaborate array of transmembrane entities embedded in the lipid bilayer. Also shown are its organelle membrane systems

(1) The Lipid Bilayer: An universal element of all cell membranes. (2) Membrane Proteins: Manners by which they are associated with the lipid bilayer: (a) span the bilayer, (b) partially immersed in the bilayer, (c) held by non-covalent interactions with other proteins, and (d) attach to fatty acid chains that help to anchor the protein in one surface of the bilayer. (3) Permeability and Transport: The passive transport occurs either by the simple diffusion or by the facilitated diffusion. The active transport needs an input of the metabolic energy. (4) The Electrochemical Potential  $\mu$ : The driving force for the membrane transport, oxidative- phosphorylation and photo-phosphorylation. (5) The  $\text{Na}^+/\text{K}^+$  Pump: Virtually all animal cells contain a  $\text{Na}^+/\text{K}^+$  pump that operates as an antiport, actively pumping  $\text{K}^+$  into the cell and  $\text{Na}^+$  out against their electrochemical gradients. (6) Ion Channels: There are ligand-gated and voltage-gated channels made of proteins, which open in response to the ligand interaction and voltage change. For example, a  $\text{Ca}^{2+}$  channel may be depicted as a port containing negatively charged sites, density and dimensions appropriate to act as "selectivity filter" to distinguish among different cations, with voltage-sensors conferring voltage dependence on channel opening and closing. (7) The Nucleus: It is where the genetic material (DNA) is located. Its nuclear membrane has numerous pores ( up to  $\sim 80$  nm in diameter) which probably transport large particles selectively. (8) Energy-transducing Organelle Membranes: The mitochondrion converts foods into usable energy (ATP), whereas the chloroplast, in plants and other photosynthesizing organisms, transduces the electromagnetic radiation (solar energy) into other forms of energy. (9) Experimental Bilayer Lipid Membranes: They can be prepared. Since their inception in the early 1960s, such lipid bilayer systems, either in the form of a planar BLM or of a vesicular liposome, have been used extensively as models of biomembranes.

