Membrane Biology and Bioenergetics

THEORY

1. **Introduction to biomembranes (4 lectures)**
   Composition of biomembranes - prokaryotic, eukaryotic, neuronal and subcellular membranes. Study of membrane proteins. Fluid mosaic model with experimental proof. Monolayer, planer bilayer and liposomes as model membrane systems.
   [*Lehninger: Principles of Biochemistry (2013) Nelson and Cox, p385-394; Molecular Cell Biology (2013) Lodish et al., p445-448, p452-455, p462-464]*

2. **Membrane structures (4 lectures)**
   Polymorphic structures of amphiphilic molecules in aqueous solutions - micelles and bilayers. CMC, critical packing parameter. Membrane asymmetry. Macro and micro domains in membranes. Membrane skeleton, lipid rafts, caveolae and tight junctions. RBC membrane architecture.
   [*Biochemistry (2010) Garret and Grisham, p244-245, p260, p265-267; Principles of Biochemistry (2008) Voet, Voet and Pratt, p260-261, p272-278*]

3. **Membrane dynamics (4 lectures)**
   Lateral, transverse and rotational motion of lipids and proteins. Techniques used to study membrane dynamics - FRAP, TNBS labeling etc. Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity.
   [*Lehninger: Principles of Biochemistry (2013) Nelson and Cox, p395-399; Biochemistry (2010) Garret and Grisham, p261-264*]

4. **Membrane transport (10 lectures)**
   Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins**.** Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactose permease, Na^+-glucose symporter. ABC family of transporters - MDR, CFTR. Group translocation. Ion channels - voltage-gated ion channels (Na^+/K^+ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, bacteriorhodopsin. Ionophores - valinomycin, gramicidin.
   [*Lehninger: Principles of Biochemistry (2013) Nelson and Cox, p402-426, p464-469]*

5. **Vesicular transport and membrane fusion (4 lectures)**
   Types of vesicle transport and their function - clathrin, COP I and COP II coated vesicles. Molecular mechanism of vesicular transport. Membrane fusion. Receptor mediated endocytosis of transferrin.
   [*Molecular Cell Biology (2013) Lodish et al., p634-660*]

6. Introduction to bioenergetics (4 lectures)

Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

[*Lehninger: Principles of Biochemistry (2013) Nelson and Cox, p20-29, p505-511, p517-537*]

7. Oxidative phosphorylation (10 lectures)

Mitochondria. Electron transport chain - its organization and function. Inhibitors of ETC and uncouplers. Peter Mitchell's chemiosmotic hypothesis. Proton motive force. F_o F_1ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis. Alternative respiratory pathways in plants.

[*Lehninger: Principles of Biochemistry (2013) Nelson and Cox, p737-763*]

8. Photophosphorylation (8 lectures)

General features of photophosphorylation, historical background, Hills reaction, photosynthetic pigments, light harvesting systems of plants and microbes and resonance energy transfer. Bacterial photophosphorylation in purple bacteria, Green sulfur bacteria and *Halobacterium salinarum*. Photophosphorylation in plants - structure of chloroplast, molecular architecture of Photosystem I and Photosystem II, Z-scheme of photosynthetic electron flow, oxygen evolving complex and action of herbicides. Cyclic photophosphorylation and its significance. Photo inhibition. Evolution of oxygenic photosynthesis.

[*Lehninger: Principles of Biochemistry (2013) Nelson and Cox, p769-788*]

Essential Readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
2. Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2.
3. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
4. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2

PRACTICALS

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Determination of CMC of detergents.
3. RBC ghost cell preparation and to study the effect of detergents on membranes.
4. Separation of photosynthetic pigments by TLC.
5. Isolation of mitochondria from liver and assay of marker enzyme SDH.
6. Study photosynthetic O_2 evolution in hydrilla plant.
7. Isolation of chloroplast from spinach leaves, estimation of chlorophyll and photosynthetic activity.