

# Review (chapters 11, 12, 15-17)

## April 9, 2010

### Chapter 11. Carbohydrates

**Monosaccharides and the complex:** definition; Fisher projections; D and L configuration; chemical structures of common monosaccharides; trioses, tetroses, pentoses; hexoses (glucose and fructose), and heptoses; Hemiacetal and hemiketal; Haworth projections;  $\alpha$  and  $\beta$  configurations; Conformation of pyranose and furanose ring; O- and N-glycosidic bonds; chemical structures of sucrose, lactose, and maltose; glycogen, starch, and cellulose; General form of a glycosyltransferase; O, A, and B antigens.

**Glycoproteins:** N-linkage and O-linkage; locations of Protein glycosylation, i.e. ER and Golgi complex; dolichol; I-cell disease: Mannose 6-phosphate targets lysosomal enzymes to their destinations; lectins.

### Chapters 12 & 13 Lipids and cell membrane and more

**Common features of membrane:** Sheetlike structure, only two molecules thick, 60 to 100 Å; Contain lipids and proteins (1:4 to 4:1); Have hydrophilic and hydrophobic moieties; Nocovalent assemblies; asymmetric and fluid structures; Electrically polarized.

Fatty acids: definition; systematic name; double bonds.

**Three common types of membrane lipids:** Phospholipids: glycerol based or sphingosine based, chemical structures; Glycolipids; Cholesterol; common properties; Formation of membrane of phospholipids and glycolipids in aqueous solutions.

**Trans-membrane proteins and membrane associated proteins:** Proteins can span the membrane with alpha helices: the most common motifs in membrane proteins; A channel protein can be formed from beta sheet; Embedding part of a protein in a membrane can link it to Membrane surface; Some proteins associate with membranes through covalently attached hydrophobic groups; Diffusion in membranes; Fluid mosaic model; Membrane fluidity is controlled by fatty acid composition and cholesterol content; Cell plasma membrane, mitochondria membrane, ER, nuclear membrane, and etc; •Proteins are targeted to specific compartments by signal sequences such as nucleus localization signal: -KKKK or -(K/R)-X<sub>10-12</sub>-(K/R)-.

## Membrane channels and pumps

**Chapter 14 & 15. Metabolism: Basic concepts and design. Signal-transduction pathways: an introduction**

**Basic concepts of Metabolism:** different forms of energy can be transformed in vivo. Catabolism vs. anabolism; reactions coupling. ATP, chemical structure and high energy bonds, and ATP hydrolysis and the coupled reactions; other high phosphoryl transfer potential compounds. **Activated carriers:** ATP is the activated carrier of phosphoryl groups; activated carriers of electrons: NAD<sup>+</sup>, NADP<sup>+</sup>, and FAD; coenzyme A: an activated carrier for acyl groups. Key reactions are reiterated throughout metabolism. **Metabolic regulation:** transcription level; the enzyme catalytic activities: reversible allosteric control and covalent modification; the accessibility of substrates: controlling the flux of substrate; compartmentation. Many reactions in metabolism are controlled by the energy status of the cell: energy charge and phosphorylation potential.

**Signal transduction pathways:** basic concepts. Common second messengers: cAMP, Inositol 1,4,5-triphosphates (IP<sub>3</sub>) & diacylglycerol, and Ca<sup>2+</sup>. Seven-transmembrane-helix receptors: conformation change, G protein, and cAMP: how does the signal transduction pathways pass and amplify the information (the first message to the second message to the final signals)?

## Chapter 16. Glycolysis

**History:** Hans Buchner and Eduard Buchner; Gustav Embden, Otto Meyerhof, and etc. Anaerobes vs. aerobes.

**Glycolysis:** chemical reactions (chemical structures of the intermediates). glucose transporter; Enzymes, such as hexokinase, Phosphoglucose isomerase, aldolase, Phosphofruktokinase, Triose phosphate isomerase, glyceraldehyde 3-phosphate dehydrogenase (mechanism), phosphoglycerate kinase, and pyruvate kinase. General chemical reaction equation. NAD<sup>+</sup> regeneration. Entry points in glycolysis for galactose and fructose. Intolerant of milk.

**The regulation of glycolytic pathway:** Hexokinase, phosphofruktokinase, and pyruvate kinase (allosteric inhibition and transcription control).

## **Chapter 17. The Citric Acid Cycle**

**Overview:** the tricarboxylic acid cycle and the Krebs cycle. In eukaryotes, the reactions of the citric acid cycle take place inside mitochondria. The function of the citric acid cycle is the harvesting of high energy electrons from carbon fuels (H<sup>+</sup> gradient to ATP). Chemical structure of acetyl coenzyme A.

**From pyruvate to acetyl CoA:** Under aerobic conditions, the pyruvate is transported into mitochondria matrix in exchange for OH<sup>-</sup>, by the pyruvate carrier, an antiporter. This irreversible reaction is catalyzed by pyruvate dehydrogenase complex and is the link between glycolysis and the citric acid cycle. Composition of

pyruvate dehydrogenase complex and coenzymes or prosthetic groups. Mechanism (important!).

**Citric acid cycle:** all chemical reactions. Enzymes (especially citrate synthase).

**Regulation of citric acid cycle:** The pyruvate dehydrogenase, Isocitrate dehydrogenase, and  $\alpha$ -ketoglutarate dehydrogenase.