

TOPIC 2: THE CELL**I. General Structure**

- A. 75 trillion cells in body
- B. Major parts (Fig 2.14)
 - 1. cell membrane (sometimes called plasma membrane)
 - 2. nucleus
 - 3. cytoplasm
- C. Cell (or plasma) membrane (Fig 2.15)
 - 1. Thin structure
 - 2. Encloses each cell
 - 3. Mechanical barrier that is *selectively permeable*
 - 4. Intracellular fluid (ICF) fluid inside cell
 - 5. Extracellular fluid (ECF) fluid outside cells
- D. Cytoplasm (2.14)
 - 1. That part of cell that is not nucleus.
 - 2. Contains organelles dispersed in a gel like mass called cytosol
 - 3. Organelles are separate compartments specialized for particular functions
 - 4. Cytosol is semiliquid mass laced with elaborate protein network called Cytoskeleton.
- E. Nucleus (Fig 2.17)
 - 1. distinct sphere in center with its own membrane
 - 2. contains DNA which is packaged into chromosomes

II. Organelles (see Table 2.2 for summary)

- A. Endoplasmic reticulum
 - 1. Structure (Fig 2.18)
 - a) One continuous organelle; membrane continuous with cell membrane
 - b) fluid filled membrane structure
 - c) two types: rough (RER) & smooth (SER)
 - 2. Function of RER
 - a) is rough because of attached ribosomes
 - b) ribosomes synthesize proteins
 - c) RER involved in synthesis and release of proteins
 - d) Lots of RER found in cells specialized for protein synthesis
 - 3. Function of SER
 - a) Discharge site for molecule transport from ER to Golgi complex.
 - b) Piece of SER pinches off with molecule inside; called a transport vesicle
 - c) Some cells: SER specializes in lipid synthesis & transport
 - d) Liver cells, SER detoxifies harmful chemicals & excretes them
- B. Golgi complex (Figs 2.19)
 - 1. Structure
 - a) Flat, slightly curved membrane enclosed sacs
 - b) Closely associated with ER
 - c) one to hundreds of stacks/cell
 - 2. Function
 - a) Destination point for ER transport vesicle
 - b) Processes proteins from ER into final form
 - c) Sort & direct finished products to final destination in cell

- C. Lysosomes (Fig 2.21)
 - 1. Structure
 - a) Membrane enclosed sacs derived from Golgi complex
 - b) Contain powerful hydrolytic enzymes
 - 2. Function
 - a) Digest cellular debris & foreign material
 - b) Can also digest aged and damaged organelles
 - c) Injured or dead cell: lysosome ruptures & digests *whole* cell
- D. Mitochondria (Fig 2.20)
 - 1. Structure
 - a) Bacteria sized rod or oval shaped
 - b) Outer membrane surrounds mitochondria
 - c) Inner membrane that forms infoldings called cristae
 - d) Inner membrane projects into cavity called matrix
 - 2. Function
 - a) Powerhouse of cell
 - b) Produce high energy molecules (ATP) in presence of oxygen

III. Cytosol (Fig 2.14)

- A. Structure
 - 1. Semiliquid highly organized gelatinous mass
 - 2. 55% of cell volume
- B. Function
 - 1. Intermediary metabolism
 - a) metabolism of small organic molecules
 - b) glycolysis (see below)
 - 2. Protein synthesis
 - a) proteins needed in cytosol itself (e.g. glycolytic enzymes)
 - 3. Storage of fat and glycogen

IV. Cytoskeleton (Fig 2.23)

- A. Overview
 - 1. “Bone and muscle” of cell
 - 2. Permeates cytosol
- B. Microtubules (Fig 2.25)
 - 1. Structure
 - a) Largest of cytoskeletal elements
 - b) Slender, long hollow straight tubes
 - c) Composed of small globular protein called tubulin
 - 2. Function
 - a) Maintain asymmetrical cell shape (e.g. axons)
 - b) Secretory vesicles transported down Microtubules by motor proteins
 - c) Dominant components of cilia & flagella which are used to move materials across cell surface or to propel cell
 - d) Forms mitotic spindle which organizes chromosomes during mitosis
- C. Microfilaments (Fig 2.24)
 - 1. Structure
 - a) Smallest of cytoskeletal elements

- b) Usually composed of small globular protein called actin
 - c) Usually two strands of actin twisted together
 - d) Sometimes composed of myosin instead of actin (muscles)
2. Function
- a) Part of contractile systems within cell
 - (1) cell locomotion
 - (2) split cell during mitosis
 - b) mechanical stiffeners
 - (1) microvilli-projections from gut epithelium

V. Cellular Energetics

- A. Cellular Energy
 - 1. $\text{ATP} \rightarrow \text{ADP} + \text{P}_i + \text{energy}$
 - 2. Energy stored in ATP can be used to run cellular processes
 - a) Synthesis of new compounds
 - b) Membrane transport
 - c) Mechanical work (e.g., muscle contraction)
- B. Glycolysis (Fig 3.14) in Cytosol
 - 1. Aerobic: 1 x 6-carbon glucose \rightarrow 2 x 3-carbon pyruvate + 2 ATP
 - 2. Pyruvate converted to Acetyl CoA
- C. Krebs Cycle (Fig 3.17) in Mitochondria
 - 1. Aerobic (requires O_2)
 - 2. Pyruvate from glycolysis converted to Acetyl CoA
 - 3. Acetyl CoA consumed and produces high energy electrons and 2 ATP.
- D. Oxidative phosphorylation (Fig 3.20) in Mitochondria
 - 1. High energy electrons produced by TCA cycle pass through inner membrane of mitochondria (electron transport chain) and their energy is converted to energy stored in chemical bonds of ATP (chemiosmotic coupling).
 - 2. Produces 34 ATP.
- E. Summary of glucose oxidation (Fig 3.21)
 - 1. Aerobic: 38 ATP/glucose (2 from glycolysis, 2 from Krebs, and 34 from oxidative phosphorylation)
- F. Anaerobic respiration (Fig 3.22)
 - 1. Glycolysis runs but pyruvate converted to lactate
 - 2. Krebs cycle and oxidative phosphorylation can not occur without oxygen
 - 3. 2 ATP/glucose produced
- G. Overall Reactions
 - 1. food + O_2 converted to $\text{CO}_2 + \text{H}_2\text{O} + \text{ATP}$
 - 2. this is like a wood fire, except about 40% of the energy of food is converted to chemical energy instead of being lost as heat and light as happens in a wood fire.