Bio& 241 Unit 1 / Lecture 2



Development of the Cell Theory

- Hooke (1665) named the cell
- Schwann (1800's) states: all animals are made of cells
- Pasteur (1859) disproved idea of spontaneous generation
 - living things arise from nonliving matter
- Modern cell theory emerged

Modern Cell Theory

- All organisms composed of cells and cell products.
- Cell is the simplest structural and functional unit of life.
- Organism's structure and functions are due to the activities of its cells.
- Cells come only from preexisting cells.
- Cells of all species have many fundamental similarities.

Cell Size

- Human cell size
 - most from 10 15 μ m in diameter
 - egg cells (very large)100 μm diameter
 - nerve cell (very long) at 1 meter long
- Limitations on cell size
 - cell growth increases volume faster than surface area
 - nutrient absorption and waste removal utilize surface

Cell Surface Area and Volume



Cell Shape and Function





Fluid Mosaic Model for the Plasma Membrane



Functional Roles of Membrane Protein Molecules



Extracellular fluid Plasma membrane Cytosol

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Channel Allows specific substance (•) to move through water-filled pore. Most plasma membranes include specific channels for several common ions.



Transporter Transports specific substances (○) across membrane by changing shape. For example, amino acids, needed to synthesize new proteins, enter body cells via transporters.



Receptor Recognizes specific ligand (♥) and alters cell's function in some way. For example, antiduretic hormone binds to receptors in the kidneys and changes the water permeability of certain plasma membranes.



Enzyme Catalyzes reaction inside or outside cell (depending on which direction the active site faces). For example, lactase protructing from epithelial cells lining your small intestine splits the disaccharide lactose in the milk you drink.



Cell Identity Marker Distinguishes your cells from anyone else's (unless you are an identical twin). An important class of such markers are the major histocompatability (MHC) proteins.



Linker Anchors filaments inside and outside to the plasma membrane, providing structural stability and shape for the cell. May also participate in movement of the cell or link two cells together.

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Concentration Gradient of lons across a Membrane and the Resulting Electrochemical Potential



Extracellular fluid Plasma membrane Cytosol

Diffusion Rates

- Factors affecting diffusion rate through a membrane
 - temperature \uparrow temp., \uparrow motion of particles
 - molecular weight larger molecules move slower
 - steepness of concentrated gradient \uparrow difference, \uparrow rate
 - membrane surface area \uparrow area, \uparrow rate
 - membrane permeability \uparrow permeability, \uparrow rate

Mechanisms of Membrane Transport of Materials into and outside of Cells



(b) Types of transporters in mediated transport D John Wiley & Sons, Inc.

Primary Active Transport The Sodium/Potassium Pump

Found on many cell of the body including muscle cells and nerve cells.



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Tonicity

- Tonicity ability of a solution to affect fluid volume and pressure within a cell
 - depends on concentration and permeability of solute
- Hypotonic solution
 - low concentration of nonpermeating solutes (high water concentration)
 - cells absorb water, swell and may burst (lyse)
- Hypertonic solution
 - has high concentration of nonpermeating solutes (low water concentration)
 - cells lose water + shrivel (crenate)
- Isotonic solution = normal saline

Movement of Water Across Plasma Membranes

Isotonic solution



(a) Normal RBC shape © John Wiley & Sons, Inc.

Hypotonic solution



(b) RBC undergoes hemolysis

Hypertonic solution



(c) RBC undergoes crenation

Osmolarity

- One osmole = 1 mole of dissolved particles
 - 1M NaCl (1 mole Na⁺ ions + 1 mole Cl⁻ ions) thus 1M NaCl = 2 osm/L
- Osmolarity = # osmoles/liter of solution
- Physiological solutions are expressed in milliosmoles per liter (mOsm/L)
 - blood plasma = 300 mOsm/L
 - osmolality similar to osmolarity at concentration of body fluids



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Vesicular Transport

- Endocytosis
- 1. Phagocytosis
- 2. Pinocytosis
- Exocytosis



Stages of a Typical Cell Cycle

• Interphase

- 1. G1: Cell duplicates organelle and cytosolic components
- 2. S: Replication of DNA
- 3. G2: Cell growth continues and synthesis of enzymes & proteins require for cell divisions



Clinical Terms Associated with Cells

- 1. Neoplasm: An abnormal formation of tissue; for example, a tumor.
- 2. Anaplasia: loss of differentiation of cells, an irreversible alteration in adult cells toward more primitive (embryonic) cell types
- 3. Dysplasia: Cells that look abnormal under a microscope but are not cancer
- 4. Hyperplasia: An abnormal increase in cells in a tissue or organ, excluding tumor formation, whereby the bulk of the tissue or organ is increased.
- 5. Metaplasia: Transformation of cells or tissues from a normal to abnormal states.
- 6. Apoptosis: Cell death in which a programmed sequence of events leads to the elimination of cells