

CELLS AND TISSUES

CELLS

- A. Size and shape
 - a. Human cells vary considerably in size
 - b. All are microscopic
 - c. Cells differ notably in shape
- B. Composition
 - a. **Cytoplasm** containing specialized **organelles** surrounded by a plasma membrane
 - b. Organization of cytoplasmic substances important for life
- C. Structural parts
 - a. **Plasma membrane**
 - i. Forms outer boundary of cell
 - ii. Thin two-layered membrane of phospholipids containing proteins
 - iii. Is selectively permeable
 - b. **Cytoplasm**
 - i. **Organelles**
 - 1. **Ribosomes**
 - a. May attach to rough ER or lie free in cytoplasm
 - b. Manufacture proteins
 - c. Often called protein factories
 - 2. **Endoplasmic reticulum**
 - a. Network of connecting sacs and canals
 - b. Carry substances through cytoplasm
 - c. Types are rough and smooth
 - d. Rough ER collects and transports proteins made by ribosomes
 - e. Smooth ER synthesizes chemicals; makes new membrane
 - 3. **Golgi Apparatus**
 - a. Group of flattened sacs near nucleus
 - b. Collect chemicals that move from the smooth ER in vesicles
 - c. Called the chemical processing and packaging center
 - 4. **Mitochondria**

- a. Composed of inner and outer membranes
- b. Involved with energy-releasing chemical reactions
- c. Often called power plants of the cell

5. Lysosomes

- a. Membranous-walled organelles
- b. Contain digestive enzymes
- c. Have protective function (eat microbes)
- d. Often called *suicide bags*

6. Centrioles

- a. Paired organelles
- b. Lie at right angles to each other near nucleus
- c. Function in cell reproduction

7. Cilia

- a. Fine, hair like extensions found on free or exposed surfaces of some cells
- b. Capable of moving in unison in a wavelike fashion

8. Flagella

- a. Single projections extending from cell surfaces
- b. Much larger than cilia
- c. "tails" of sperm cells only example of flagella in humans

c. Nucleus

- i. Controls cell because it contains the genetic code—instructions for making proteins, which in turn determine cells structure and function
 - ii. Component structures include nuclear **envelope, nucleoplasm, nucleolus, and chromatin granules**
 - iii. **Chromosomes** contain DNA
- d. Relationship of cell structure and function
- i. Regulation of life processes
 - ii. Survival of species through reproduction of the individual
 - iii. Relationship of structure to function apparent in number and type of organelles seen in different cells
 - 1. Heart muscle cells contain many mitochondria required to produce adequate energy needed for continued contractions
 - 2. Flagellum of sperm cell gives motility, allowing movement of sperm through female reproductive tract, thus increasing chances for fertilization

MOVEMENT OF SUBSTANCES THROUGH CELL MEMBRANES

- A. **Passive transport processes** do not require added energy and result in movement “*down a concentration gradient*”
- a. Diffusion
 - i. Substances scatter themselves evenly throughout an available space
 - ii. It is unnecessary to add energy to the system
 - iii. Movement if from high to low concentration
 - iv. Osmosis and dialysis are specialized example of diffusion across a selectively permeable membrane
 - v. Osmosis is diffusion of water
 - vi. Dialysis is diffusion of solutes
 - b. Filtration
 - i. Movement of water and solutes caused by hydrostatic pressure on one side of membrane
 - ii. Responsible for urine formation
- B. **Active transport processes** occur only in living cells; movement of substances is ‘*up the concentration gradient*’; **requires energy from ATP**
- a. Ion Pumps
 - i. An **ion pump** is protein complex in cells membrane
 - ii. Ion pumps use energy from ATP to move substances across cell membranes against their concentration gradients
 - iii. Examples: sodium-potassium pump, Calcium pump
 - iv. Some ion pumps work with other carriers so that glucose or amino acids are transported along with ions
 - b. **Phagocytosis** and **pinocytosis**
 - i. Both are active transport mechanisms because they require cell energy
 - ii. Phagocytosis is a protective mechanism often used to destroy bacteria
 - iii. Pinocytosis is used to incorporate fluids or dissolve substances into cells
 - c. Several severe diseases result from damage to cell transport processes
 - i. **Cystic fibrosis**, characterized by abnormally thick secretions in the airways and digestive ducts, results from improper CF transport
 - ii. **Cholera** is a bacterial infection that causes Cl^- and water to leak from cells lining the intestines, resulting in severe diarrhea and water loss

CELL REPRODUCTION

A. DNA structure –

- a. large molecules shaped like a spiral staircase;
- b. *sugar (deoxyribose)* and *phosphate units* compose sides of the molecule;

- c. **base pairs** (*adenine-thymine* or *guanine-cytosine*) compose the “steps” base pairs always the same but sequence of base pairs differs in different DNA molecules; a gene is a specific sequence of base pairs within a DNA molecule;
- d. **genes dictate formation of enzymes and other proteins by ribosomes**, thereby indirectly determining a cells’ structure and functions;
- e. in short, **genes are heredity determinants**

B. Genetic code

- a. **Genetic information** – stored in base pair sequences on genes, expressed through protein synthesis
 - b. **RNA molecules and protein synthesis**
 - i. DNA—contained in cell nucleus
 - ii. *Protein synthesis*—occurs in cytoplasm thus genetic information must pass from the nucleus to the cytoplasm
 - iii. Processes of transferring genetic information from nucleus to cytoplasm where proteins are produced requires completion of **transcription** and **translation**
 - c. **Transcription**
 - i. *Double-stranded DNA separates to form messenger RNA (mRNA)*
 - ii. Each strand of mRNA duplicates a particular gene (base-pair) sequence) from a segment of DNA
 - iii. *mRNA molecules pass from the nucleus to the cytoplasm*, where they direct protein synthesis in ribosomes and ER
 - d. **Translation**
 - i. Involves **synthesis of proteins in cytoplasm by ribosomes**
 - ii. Requires use of information contained in mRNA
- C. *Abnormal DNA* that is inherited, or that results from damage from viruses or other factors, is often the basis of disease
- D. **Cell division** – reproduction of cell involving division of the nucleus (mitosis) **and the cytoplasm**;
- a. period when the cell is not actively dividing is called **interphase**
- E. **DNA replication**—process by which each half of a DNA molecule becomes a whole molecule identical to the original DNA molecule; precedes mitosis
- F. **Mitosis**—process in cell division that distributes identical chromosomes (DNA molecules) to each new cell formed when the original cell divides; enables cells to reproduce their own kind; makes heredity possible
- G. **Stages of mitosis**
- a. **Prophase** – first stage
 - i. Chromatin granules become organized

- ii. Chromosomes (pairs of linked chromatids) appear
 - iii. Centrioles move away from the nucleus
 - iv. Nuclear envelope disappears, freeing genetic material
 - v. Spindle fibers appear
 - b. **Metaphase** – second stage
 - i. Chromosomes align across center of the cell
 - ii. Spindle fibers attach themselves to each chromatid
 - c. **Anaphase** –third stage
 - i. Centromeres break apart
 - ii. Separated chromatids now called chromosomes
 - iii. Chromosomes are pulled to opposite ends of the cell
 - iv. Cleavage furrow develops at the end of anaphase
 - d. **Telophase** – fourth stage
 - i. Cell division is completed
 - ii. Nuclei appear in daughter cells
 - iii. Nuclear envelope and nucleoli appear
 - iv. Cytoplasm is divided (Cytokinesis)
 - v. Daughter cells become fully functional
- H. Changes in cell growth and reproduction
- a. **Changes in growth or individual cells**
 - i. **Hypertrophy** – increase in size of individual cells, increasing size of tissues
 - ii. **Atrophy** – decrease in size of individual cells, decreasing size of tissue
 - b. **Changes in cell reproduction**
 - i. **Hyperplasia** – increase in cell reproduction, increasing size of tissue
 - ii. **Anaplasia** – production of abnormal, undifferentiated cells
 - iii. Uncontrolled cell reproduction results in formation of a benign or malignant neoplasm

TISSUES

A. Epithelial tissue

- a. Covers body and lines body cavities
- b. Cells packed closely together with little matrix
- c. **Classified by *shape of cells***
 - i. Squamous
 - ii. Cuboidal
 - iii. Columnar
 - iv. Transitional

- d. **Classified by arrangement of cells**
 - i. Simple
 - ii. Stratified
- e. **Simple Squamous epithelium**
 - i. Single layer of scale like cells
 - ii. Function is *transportation (absorption)*
- f. **Stratified Squamous epithelium**
 - i. Several layers of closely packed cells
 - ii. Function is absorption
- g. **Simple columnar epithelium**
 - i. Columnar cells arranged in a single layer
 - ii. Line stomach and intestines
 - iii. Contain mucus-producing goblet cells
 - iv. *Specialized for absorption*
- h. **Stratified transitional epithelium**
 - i. Found in body areas, such as urinary bladder, that stretch
 - ii. *Up to 10 layers of roughly cuboidal-shaped cells that distort to Squamous shape when stretched*
- i. **Pseudostratified epithelium**
 - i. Each cell touches basement membrane
 - ii. Lines the trachea
- j. **Simple cuboidal epithelium**
 - i. *Often specialized for secretory activity*
 - ii. Cuboidal cells may be grouped into glands
 - iii. May secrete into ducts, directly into blood, and on the body surface
 - iv. Examples of secretions include saliva, digestive juice, and hormones
 - v. Cuboidal epithelium also forms the urine-producing tubules of the kidney

B. **Connective tissue**

- a. Most abundant tissue in the body
- b. Most widely distributed tissue in the body
- c. Multiple types, appearances, and functions
- d. Relatively few cells in intercellular matrix
- e. Types
 - i. **Areolar** – glue that holds organs together
 - ii. **Adipose** (fat) – lipid storage is primary function
 - iii. **Fibrous** – strong fibers; example is tendon
 - iv. **Bone** – matrix is calcified; function is support and protection

- v. **Cartilage** – chondrocytes is cell type
- vi. **Blood** – matrix is fluid; function is transportation

C. Muscle tissue

- a. Types
 - i. **Skeletal** – attaches to bones; also called striated or voluntary; control is voluntary; striation apparent when viewed under a microscope
 - ii. **Cardiac** – also called striated involuntary; composes heart wall; ordinarily cannot control contraction
 - iii. **Smooth** – aka non-striated involuntary; or visceral; no cross striations; found in blood vessels and other tube-shaped organs

D. Nervous tissue

- a. Cell types
 - i. **Neurons** – conducting cells
 - ii. **Glia** – (neuroglia) supportive and connecting cells
- b. **Neurons**
 - i. Cell components
 - 1. **Cell body**
 - 2. **Axon** (one) carries nerve impulse (action potential) away from cell body (efferent)
 - 3. **Dendrites** (one or more) carry nerve impulse toward the cell body (afferent)
 - c. *Functions – rapid communication between body structures and control of body functions*

E. Tissue repair – usually accomplished by means of regeneration of tissue

- a. Epithelial and connective tissues regenerate easily
- b. Muscle and nervous tissues have very limited abilities to repair themselves

