CELL STRUCTURE AND FUNCTION

CELL PATHOLOGY

Kristen Collins, PTA
Mercer Community College
PTA 112 – Pathology
Cell Structure and Function
Normal Structure

- **Cells**
  - Fundamental unit of living matter
  - Largest components
    - Nucleus
    - Cytoplasm
    - Cell membrane

http://www.uvm.edu/~inquiryb/webquest/fa06/mvogenbe/Animal-Cell.jpg
“Control center” “Brain”
- If it dies... so does the cell
- *Exception*: erythrocytes, platelets

Consists of nucleic acids
- Aggregates = chromatin
- Nucleolus = primarily RNA
- *Mitosis* = dividing of cells
  - Each cell must replicate itself for life to continue
    - *Exception*: Nerve and muscle cells
      - Lost/damaged cells cannot be replaced by cellular division
  - Chromatin restructures, strands of DNA condense into chromosomes
Nucleus

- Nucleic acids
  - DNA = Cellular reproduction/division, genetic material
  - RNA = Controls protein synthesis
    - Protein Synthesis
      - Synthesis in nucleus
      - Essential for maintenance of life
        - Cellular growth, replication, metabolism, respiration
        - Structural elements
Cytoplasm

- Consists of a fluid, that contains structures performing vital functions of the cell

- **Mitochondria**
  - Produce most of body’s energy = adenosine triphosphate (ATP)
  - Sites of cellular respiration
  - # proportional to complexity of cell function

- **Ribosomes**
  - Small granules composed of RNA
  - Involved in protein synthesis
Cytoplasm

- **Endoplasmic reticulum**
  - Vesicles and intercommunicating canals
  - Catabolism of drugs, hormones, and nutrients
  - Synthesis of steroid hormones

- **Golgi apparatus**
  - Synthesizes carbohydrate molecules

- **Lysosomes**
  - Digest
    - Nutrients
    - Foreign/damaged cell material

- **Microfilaments & microtubules**
Cell (Plasma) Membrane

- “External wall”
  - Protects cell from external environment
- Double layer of phospholipids with protein molecules
  - Protein molecules act as receptors, ion channels, carrier for specific substances, transducer of signals
  - ***This way, the plasma membrane regulates the internal environment of the cell
- Structural integrity vital in maintenance of all essential functions
Why should I care about cells?

- cells → tissues → organs → organ systems (functional units)
- Organs systems function together to achieve basic, vital functions
Homeostasis

- Dynamic, steady state of internal balance in face of external environment
HOMEOSTASIS

- **Maintenance**
  - **Structures**
    - Medulla oblongata
      - Vital functions
    - Pituitary gland
      - Regulates function of other glands
    - Reticular formation
      - Controls vital reflexes
  - **Minerals**
    - ...and the water it is dissolved in
    - Essential: Na, Cl, K, Ca, Fe
    - Oligominerals: Mg, Zinc, Copper, Selenium
  - **Oxygen and nutrients**
HOMEOSTASIS

- Alterations in cell’s functional environment produces stress to the cell’s ability to maintain homeostasis
  - If cell can alter mechanics and regain homeostasis… adaptation
  - If cell is unable to adapt… injury occurs
Cell Injury

- Types of cell injury
  - Reversible
    - After stimuli removed, cell returns to origin steady state
    - Short lived, mild
  - Irreversible
    - Causes structural changes to the cell that remain after stimuli removed

- Causes
  - Hypoxia/anoxia
  - Toxins
  - Infection
  - Physical injury
  - Genetic disorders
  - Immune reactions
Cell Aging

- Changes to structure and function that can affect the ability to maintain homeostasis
- Proceeds at different rates dependant upon
  - Extent and number of injuries
  - Wear and tear on the cell
Cell Adaptation

- **Atrophy**
  - \( \downarrow \) cell size

- **Hypertrophy**
  - \( \uparrow \) cell size

- **Hyperplasia**
  - \( \uparrow \) # of cells

- **Metaplasia**
  - \( \rightarrow \) Dysplasia

  \( \rightarrow \) Neoplasia

http://www.anesthesia.org.cn/books/pathophysio/ch0001.files/0008.gif
Disease

- “a pattern of response of a living organism to some form of injury”
- “biologic or psychologic alteration that results in malfunction of a body organ or system”
- “alteration in normal function”
- Homeostasis is not maintained
  - Adaptation may have occurred -> person is not always ill
- Pathogenesis = the way the disease develops
Cell Death

- All cells have a finite lifespan
  - Some are replaceable, some are not
  - Brain death = artificial means are required for a person to sustain life

- Types of cell death
  - Necrosis
  - Apoptosis
Necrosis

- Causes
  - Anoxia
  - Toxins

- Necrotic tissues
  - When dry, become black
  - Attract calcium salts
    - Results in calcification
      - Ex. Atherosclerotic arteries, damaged heart valves
Apoptosis

- Genetically programmed cell death
  - “active cell death”

- Physiological
  - Important in formation of all body parts
  - Lack of
    - = pathology

- Pathological
IMPORTANT CONCEPTS AND TERMINOLOGY
Observation of the occurrence of the disease in populations
- demographics = #s, ages
- prevalence = # cases in a given population
- incidence = # cases per unit of time
- endemic = high prevalence in an area where organism is common

Epidemic = high prevalence where the organism is common

Mortality = death rate

Morbidity = rate of sick to well persons in a community