

Anatomy & Physiology for the EMT - Intermediate

Objectives

- Review A&P of the various body systems.
- Name the levels of organization of the body.
- Describe metabolism, anabolism, catabolism.
- Explain classification of bones.
- Identify the structure of neurons.
- Describe how a muscle contracts and how a nerve cell creates an impulse.
- Identify the division and functions of the autonomic nervous system.
- Name the parts of the electrical conduction system of the heart.

Objectives

- Describe the chemical process of breathing control.
- Define pathophysiology and the immune system response to disease or injury.
- Explain how the body cells utilize glucose and oxygen for energy production.
- Understand the various waste products of metabolism and the mechanisms by which the body rids itself of these components.

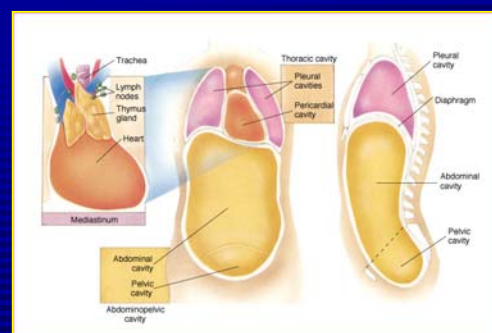
Introduction

- Anatomy.
- Physiology.
- Pathophysiology:
 - Study of disease and injury along with how it affects the body.
- Review the topographical body terms and body positions.
- Study the body planes, directional terms, and body cavities.

Topographical Anatomy

- Positions:
 - Anatomical.
 - Supine.
 - Prone.
 - LLR/RLR.
 - Fowler's.
 - Trendelenburg.
 - Recovery.
 - Reverse Trendelenburg.
 - Knee-Chest.
- Planes:
 - Sagittal.
 - Coronal (Frontal).
 - Transverse.
 - Mid-clavicular.
 - Mid-axillary.
- Terms:
 - Anterior/ventral.
 - Posterior/dorsal.
 - Medial.
 - Lateral.
 - Proximal.
 - Distal.
 - Etc.

Body cavities



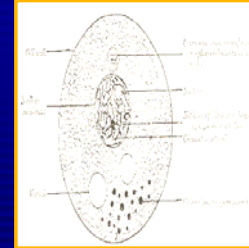
Organization of the body

- Building blocks:
- Chemicals – Atoms & Molecules
- Cells (100 trillion).
 - Organelles.
- Tissues.
- Organs.
- Organ Systems.
- Organism.
- All components work together to maintain homeostasis.

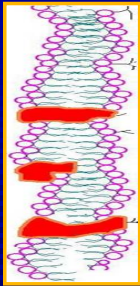


The Cell

- Nucleus:
 - Nucleolus.
- Mitochondria.
- Plasma membrane:
- Other organelles:
 - Exert various functions such as protein manufacture, water storage, waste elimination, and reproduction.

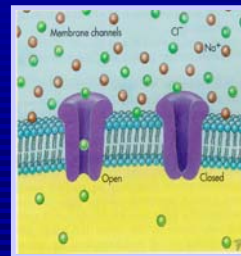


Cellular Process



- Transport:
 - Plasma membrane controls entry/exit of biological material.
 - Semi-permeable.
 - Permeability.
 - Size and composition affect rate of flow.
 - Electrically charged and large particles move slowly.
 - Water moves freely.

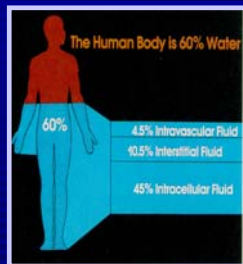
Fluids & Electrolytes



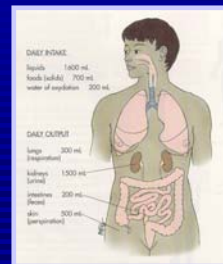
- Cellular Membranes:
 - Permeable:
 - Allow substances to pass through.
 - Semi-permeable:
 - Selectively allows only certain substances to pass through.

Fluids & Electrolytes

- Solvent vs.. Solute.
- Water distribution:
 - Intracellular:
 - 40-50 % of TBW.
 - Extracellular:
 - 15-25 % of TBW.
 - Intravascular:
 - 4.5 % of TBW.
 - Interstitial or intercellular:
 - 10.5 % of TBW.



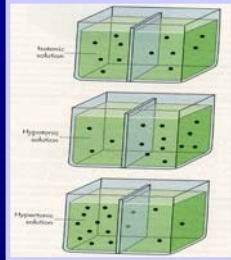
Fluids & Electrolytes



- Homeostasis:
 - Maintained by:
 - Fluid shifts.
 - Urinary system.
 - Thirst.
 - Lungs.
 - Skin.
 - Digestive system.

Fluids & Electrolytes

- **Electrolytes:**
 - Substance that breaks down into particles capable of conducting an electrical current (which are called ions).
 - **Cations:**
 - Positive charge.
 - **Anions:**
 - Negative charge.



Fluids & Electrolytes

- **Essential Cations:**
 - **Sodium (Na⁺):**
 - Extracellular; fluid balance & muscle/nerve function.
 - **Potassium (K⁺):**
 - Intracellular; growth & muscle/nerve function.
 - **Calcium (Ca⁺⁺):**
 - Blood clotting/bone growth/muscle contraction
 - **Magnesium (Mg⁺⁺):**
 - Body temp./metabolism.
- **Essential Anions:**
 - **Chloride (CL⁻):**
 - Extracellular; maintain fluid balance.
 - **Bicarbonate (HCO₃⁻):**
 - Major buffer to maintain acid-base balance.
 - **Phosphate (HPO₄⁻):**
 - Helps with acid-base balance.

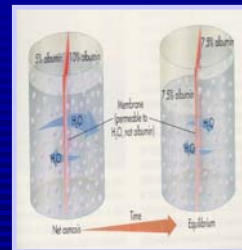
Fluids & Electrolytes

- **Transport mechanisms:**
 - **Diffusion:**
 - Movement of particles from an area of higher particle concentration to an area of lower particle concentration.
 - **Facilitated Diffusion:**
 - Involves a helper protein.



Fluids & Electrolytes

- **Transport Mechanisms:**
 - **Osmosis:**
 - The movement of water from an area of lower particle concentration to an area of higher particle concentration.
 - **Active Transport:**
 - Diffusion in opposite direction. Requires energy.



Energy Production

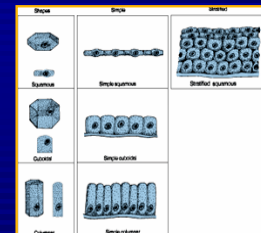
- **Metabolism:**
 - Combination of all chemical processes that take place resulting in growth, energy production, and waste elimination.
 - **Anabolism:**
 - Constructive phase.
 - **Catabolism:**
 - Destructive phase.
- **Cellular respiration:**
 - Complex Krebs cycle in the mitochondria breaks down nutrients for energy production.
 - (ATP) is produced from the conversion of glucose (C₆H₁₂O₆).
 - ATP is the molecule that is the energy food for cells.

Aerobic Metabolism: With Oxygen (More energy - Less wastes).

Anaerobic Metabolism: Without oxygen (Less energy - More wastes).

Tissues

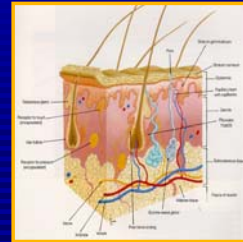
- **Group of cells working together for a common function.**
 - **Epithelial:**
 - **Connective:**
 - **Muscle:**
 - Striated.
 - Smooth.
 - Cardiac.
 - **Nervous:**



Organs & Organ Systems

- Organs are a group of tissues assembled for a common purpose.
- Organ Systems are a group of organs coordinating their functions to achieve a common goal.
- Organism is the sum of all parts and biochemical processes required to sustain life.

Integumentary System



- The body's external surfaces.
- Functions to regulate temperature, defend against disease/injury, and maintain fluid balance.

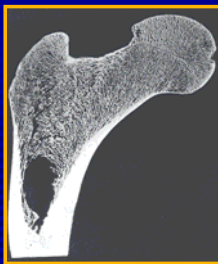
Skeletal System

- Composed of 206 bones and the related ligamentous attachment points.
- Function to protect internal structures, assist with movement and posture, storage for calcium, and blood cell production.

Classification of Bones

- Classified according to size and shape:
 - Long bones:
 - Relatively cylindrical in shape (femur, humerus, etc.).
 - Short bones:
 - Smaller bones (carpals and tarsals).
 - Flat bones:
 - Relatively flat in appearance (ribs, sternum, etc.).
 - Irregular bones:
 - No well defined geometric shape (vertebra).

Bone Structure



- Periosteum:
 - Hard, outer covering.
- Compact bone:
 - Dense middle layer.
- Cancellous bone:
 - Spongy matrix inside.
- Marrow:
 - Fatty/bloody tissue where blood cells are produced.

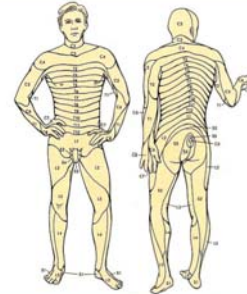
Divisions of the Skeletal System

- Review the difference between the axial and appendicular skeleton.
- Review the different types of joints in the body.
- Study the different types of movement of the joints.
- Study the different bones of the cranium and face.
 - Total of 28 bones:
 - 14 in the cranium.
 - 8 in the face.
 - 6 in the middle ear.

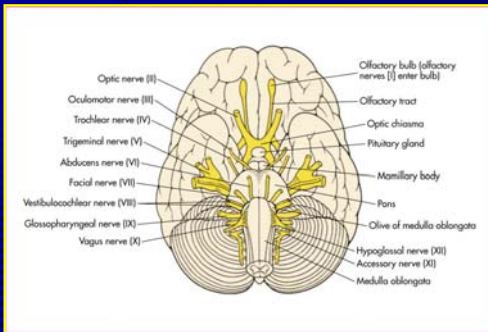
Nerve Impulses

- The impulse is essentially the movement of sodium, potassium, and calcium in and out of the cell (one at a time).
 - This creates a difference in the electrical charge of the cell.
- Depolarization: neuron becomes more positively charged and generates electrical signal.
- Repolarization: neuron returns to resting negative state in preparation for next impulse.
- Sensory (Afferent) pathways.
- Motor (Efferent) pathways.

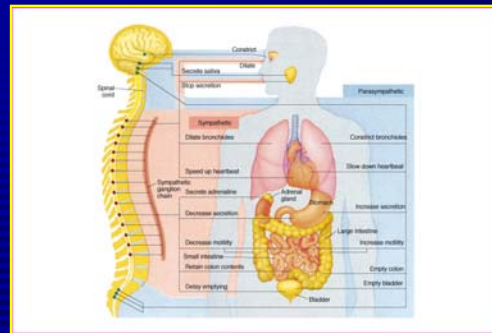
Dermatome map.



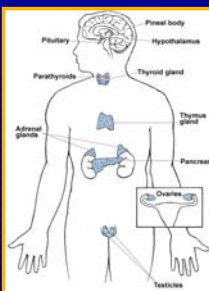
Origin of cranial nerves.



Autonomic Nervous System



The Endocrine System



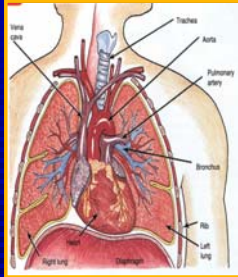
- Glands located throughout the body to secrete hormones.
- Blood circulates hormones to regulate growth, reproduction, temperature, metabolism, and blood pressure.

Cardiovascular System

- AKA Circulatory System.
- Heart, blood, and blood vessels.
 - Functions to transport biochemical substances to the body's cells and to eliminate wastes.
 - Regulates temperature and connects all body tissues together.



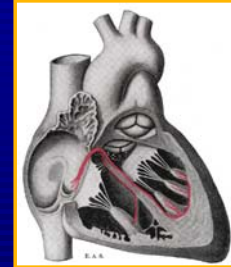
The Heart



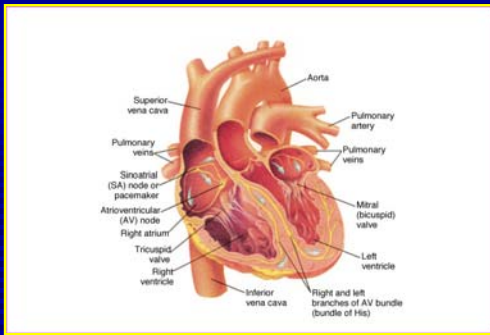
- Located behind the sternum and slightly to the left and is about the size of a closed fist.
 - Review flow of blood.
 - Review valves.
 - Review cardiac cycle.
 - Review terminology.

Cardiac Conduction System

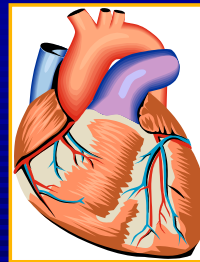
- Sino-atrial node:
 - SA node; Pacemaker; fires @ 60-100/min.
- Atrioventricular node:
 - AV node; fires @ 40-60/min.
- Bundle of His:
 - Delays impulse 0.20 sec.
- Right & Left bundle branches:
 - Spreads impulse to each ventricle.
- Purkinje fibers:
 - Carries impulse to cells.
 - 20-40/ min.



Conduction system of the heart.



Coronary Circulation



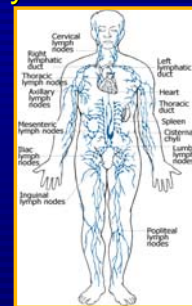
- Right (RCA) and Left (LCA) main coronary arteries branch off the aorta just beyond the aortic semilunar valves.
 - RCA: Supplies SA node; anterior R ventricle; posterior.
 - LCA: Supplies anterior L ventricle; lateral L ventricle.

Important Review

- Vascular system:
 - Arteries/veins/capillaries.
- Valve location & function:
- Blood pressure/cardiac output/stroke volume/peripheral vascular resistance/systole/diastole.
- Flow of blood through the body.
- Starling's Law of the heart:
 - Within limits, if a muscle is stretched before it is stimulated to contract, it contracts harder.

Lymphatic System

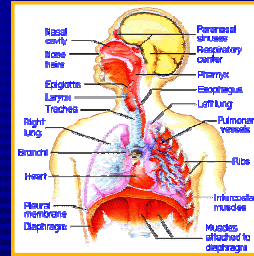
- Passive circulatory system:
 - Drains and filters the interstitial spaces of the body.
 - Drains into lymph vessels into nodes and eventually back to the venous side of the circulatory system.
 - Functions to trap infection causing organisms.



Immune System

- Defends against foreign matter.
- Mechanisms of the immune response:
 - Mechanical Barriers:
 - Skin, tears, saliva, and mucus.
 - Chemicals:
 - Histamine, immunoglobulins.
 - Leukocytes:
 - Seek and destroy foreign material.
 - Antibodies:
 - Develops specific reaction based on the type of antigen.

Respiratory System



- Functions to bring oxygen into the body and eliminate carbon dioxide.
- Additionally functions to eliminate heat and maintain acid/base balance.

Important Review

- Difference between upper and lower airway.
- Tidal volume vs. minute volume.
- Terminology: Hypoxia; hypoxemia; anoxia; apnea; agonal; etc.
- Visceral pleura vs. parietal pleura & the pleural space.
- Lobes of the lungs.
- Mediastinum.
- Ventilation vs. Respiration.

Review how CO₂ is transported and how it relates to acidosis.

Mechanics of Breathing

- Inhalation:
 - Diaphragm & intercostal muscles contract creating negative pressure in the chest.
 - This negative pressure sucks air into the chest.
 - Accessory muscle are sometimes used to aid this process.
- Exhalation:
 - Stretch receptors signal the brain (pons) that the lungs are full.
 - Muscles relax and recoil to their original size, increasing the pressure in the lungs.
 - Air escapes during this relaxation phase.
 - Passive process.

Pressure in the Chest

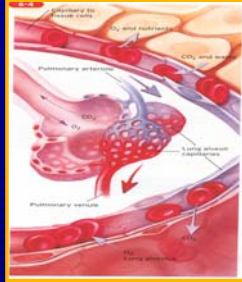
- Stage 0:
 - After last exhalation. Atmospheric pressure is equal to intrathoracic pressure. No air moves.
- Stage 1:
 - Inhalation. Atmospheric pressure is greater than intrathoracic pressure. Air moves into lungs.
- Stage 2:
 - Atmospheric pressure is equal to intrathoracic pressure. No more air moves.
- Stage 3:
 - Exhalation. Intrathoracic pressure is greater than atmospheric pressure. Air moves out of the chest.

Control of Respiration

- Chemoreceptors:
 - Central – CSF.
 - Monitors pH.
 - Peripheral – aorta & carotid arteries.
 - Monitors CO₂.
- Increase in acid (decrease in pH) or CO₂ causes an increase in rate & depth of breathing.
- Decrease in acid (increase in pH) or CO₂ causes a decrease in rate & depth of breathing.
- Pons controls initiation and termination of each respiratory cycle.
- Medulla controls rate and rhythm of breathing.

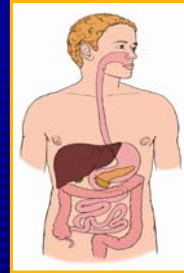
Gas Exchange

- Respiration is the actual exchange of gases.
 - Pulmonary.
 - Cellular.
- Ventilation is the movement of air into and out of the body.



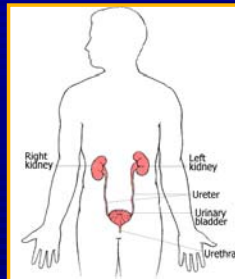
Gastrointestinal System

- AKA Digestive System.
 - Organs involved in consumption, digestion, and elimination of food.
 - Quadrants.
 - Hollow vs. solid organs.



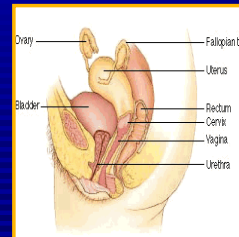
Genitourinary System

- Removes waste products from the blood by complex filtration and elimination.
 - Kidneys; ureters; bladder; urethra.



Reproductive System

- Male and female structures responsible for reproduction.
 - Often injured.
 - Specific diseases and disorders of these systems often produce EMS responses.



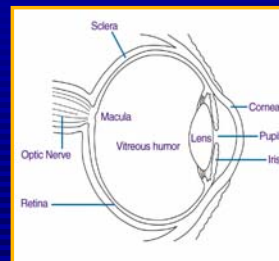
Special Sensory System

- Vision.
- Taste.
- Hearing.
- Smell.
- Touch.



Vision

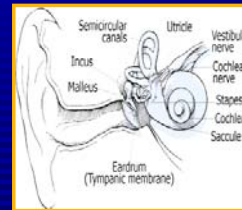
- The Eyes:
 - Vision is received via the retina.
 - Retina sends electrical representation of it's stimulation to the occipital lobe of the brain for interpretation.
 - Image is reversed on retina.
 - Dysfunction of vision can be anatomical or neurological.



Taste

- Taste receptors or buds located on the tongue.
 - Nerves transmit impulse to the frontal lobe of the brain where they are perceived as a specific taste.
 - Dysfunction can be anatomical or neurological.

Hearing

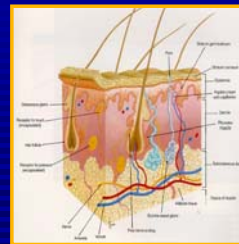


- Vibration of the eardrum by sound waves cause the movement of tiny bones.
- The movement of these bones are converted to electrical impulses and transmitted to the temporal lobes of the brain by the vestibular nerve.
 - Dysfunction can be anatomical or neurological.

Smell

- Olfactory nerves line the nasal cavity.
 - These receptors detect various smells and transmit electrical signals to the hypothalamus via the olfactory nerve.
 - Dysfunction can be anatomical or neurological.

Touch



- Peripheral nervous system receives stimulus of pressure and pain (heat/cold) through the skin.
- Spinal cord completes the path and the frontal lobe interprets the signal.
 - Spinal cord is also reflex center for instant response.

Questions?

