Human Physiology

By

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Targeted Group

Designer

Nursing Students

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General Objective

This course is designed to provide the nursing students with basic theoretical and laboratory knowledge about different human provides information about the mutual interaction between cells , tissues , and organs of these systems in performing their functions and maintaining of the internal environment in stable condition .

Learning Outcome

- 1- Recognize the Functions of the body
- 2- Know the mechanism of the normal body functions
- 3- Understand the relation between structures and functions of different parts of the body .

Unit 1

- Body Fluids

Unit 2

- Physiology of the digestive system

Unit 3

- Physiology of the respiratory system

Unit 4

- Physiology of the muscular system

Unit 5

- Physiology of the nervous system

Unit 6

- Physiology of the cardiovascular system

Unit 7

- Physiology of the urogenital system

Unit 8

- Physiology of the endocrine system

Unit One

Body Fluids

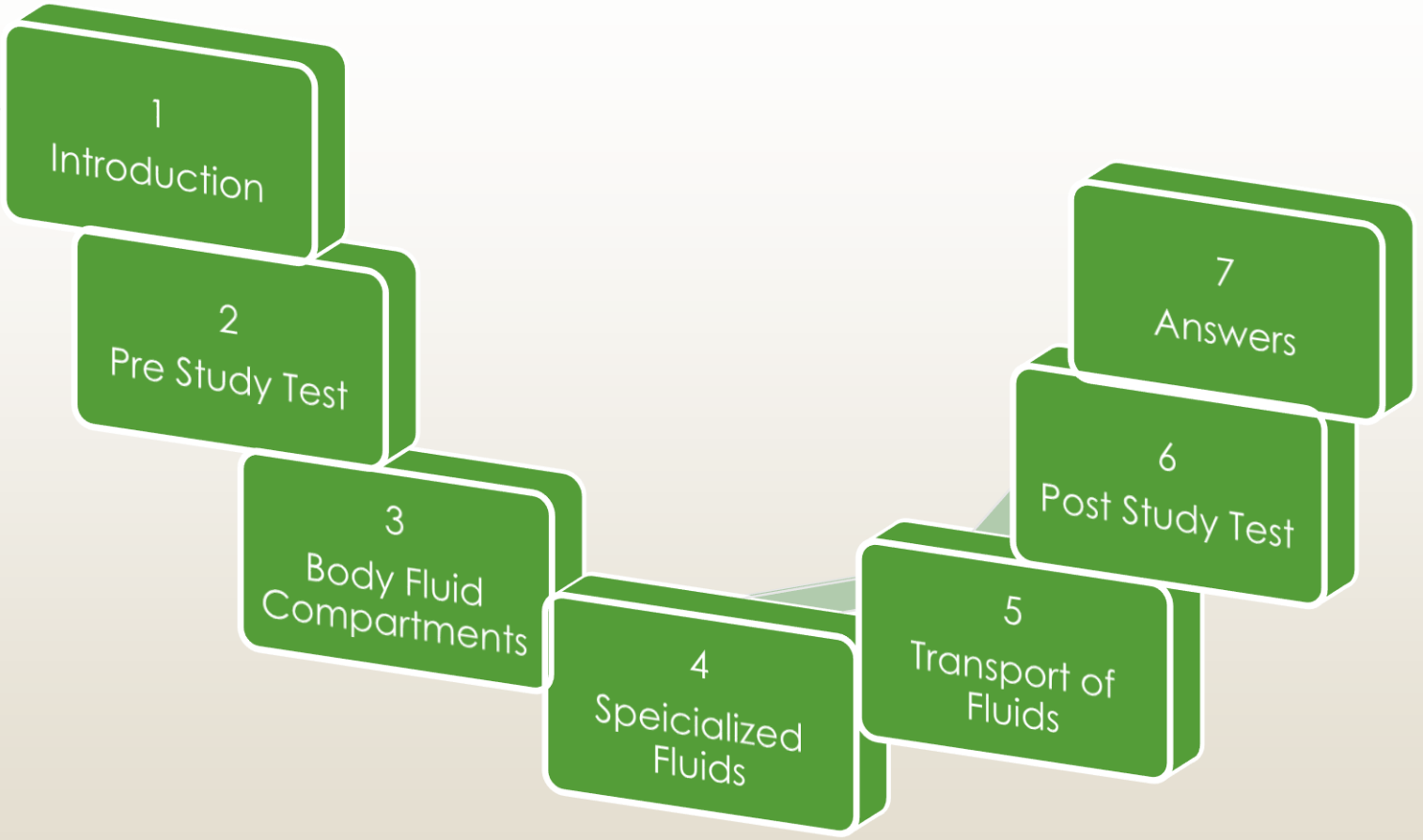
General Objective

- **Describe clinical utility of various analytes in various body fluids**. Interpret results from measurements of analytes in various body fluids. Understand the following fluids: serous, pleural, peritoneal, pericardial, synovial, amniotic, cerebrospinal.

Learning Outcome

After studying the unit , The student should be able to:-

- Understand the fluids in the body
- Describe the fluid movement
- Composition of body fluids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Pre Study Test
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Body Fluid Compartments
4
Speicialized Fluids
5
Transport of Fluids
6
Post Study Test
7
Answers

Body Fluids

- Total amount of fluid in the human body is approximately 70% of body weight
- Body fluid has been divided into two compartments –
  - Intracellular fluid (ICF)
    - Inside the cells
    - 55% of total body water
  - Extracellular fluid
    - Outside the cells
    - 45% of total body water

Pre Study Test

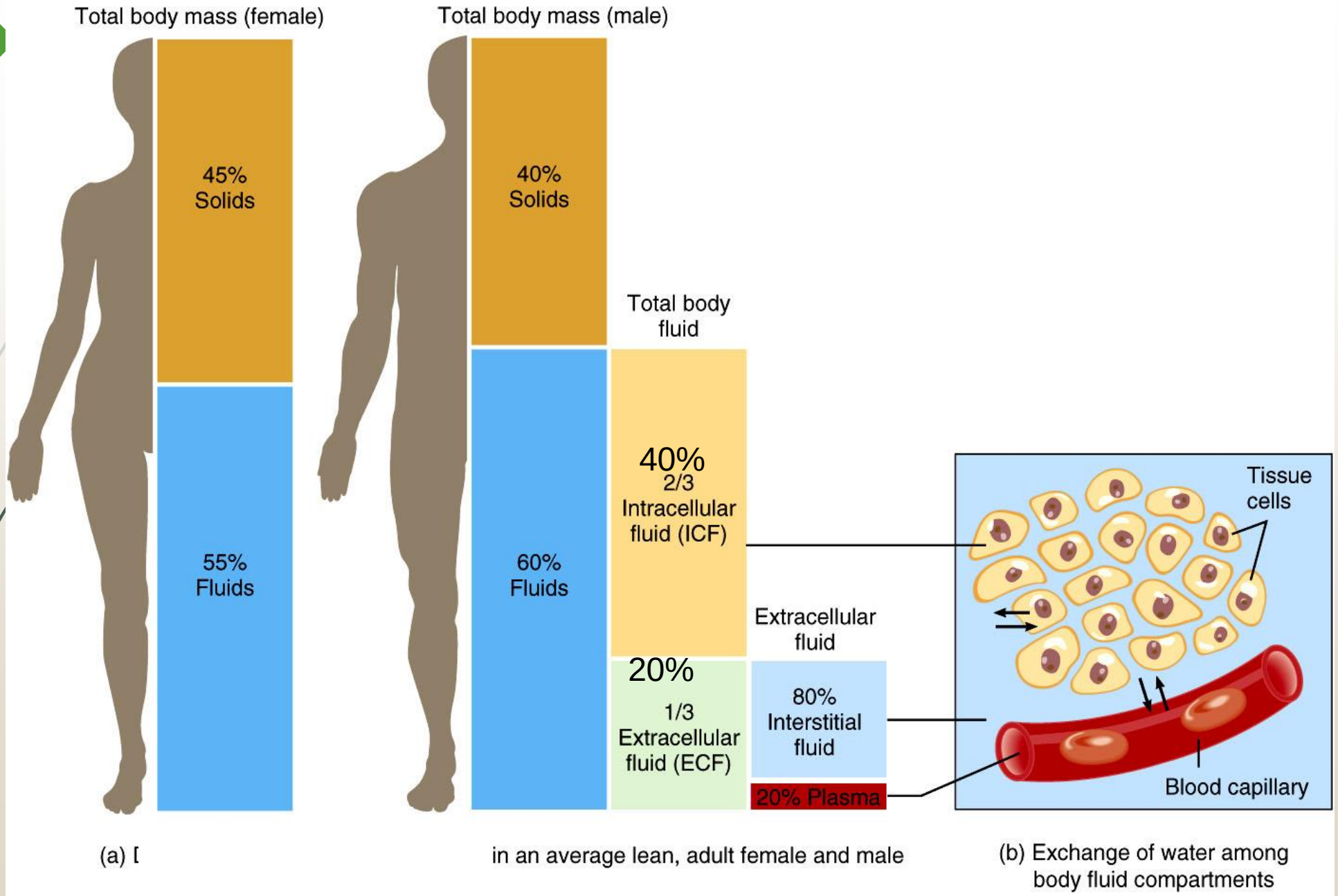
- 1-What is the **Total amount of fluid in the human body**
- 2-What is **Intracellular fluid (ICF)**
- 3-**what is Extracellular fluid**

Body Fluid Compartments

Extracellular fluid includes

- **Interstitial fluid: Present between the cells ,Approximately 80% of ECF**
- **Plasma Present in blood ,Approximately 20% of ECF**
- **Transcellular fluid include: synovial fluid ,aqueous humor ,cerebrospinal fluid. vitreous body, endolymph, perilymph, pleural, pericardial and peritoneal fluids.**

Body Fluid Compartments



(a) [in an average lean, adult female and male

(b) Exchange of water among body fluid compartments

Barriers separate ICF, interstitial fluid and plasma

- Plasma membrane(cell membrane) Separates ICF from surrounding interstitial fluid
- Blood vessel wall Separate interstitial fluid from plasma

Composition of body fluids

Organic substances: Glucose, Amino acids, Fatty acids, Hormones and Enzymes.

Inorganic substances: Sodium, potassium, Calcium, Magnesium, Chloride, Phophate,Sulphate

Sodium Na^+

- Most abundant ion in ECF
- 90% of extracellular cations
- Plays pivotal role in fluid and electrolyte balance as it accounts for half of the osmolarity of ECF

Chloride ions cl^-

- Most prevalent anion in ECF
- Moves easily between ECF and ICF because most plasma membranes contain Cl^- leakage channels and transporters
- Can help balance levels of anions in different fluids

Bicarbonate HCO_3^-

- Second most prevalent extracellular anion
- Concentration increases in blood passing through systemic capillaries picking up carbon dioxide
- Chloride shift helps maintain correct balance of anions in ECF and ICF

Potassium K^+

- Most abundant cation in ICF
- Establish resting membrane potential in neurons and muscle fibers
- Maintains normal ICF fluid volume
- Helps regulate pH of body fluids when exchanged for H^+

Magnesium

- Mg^{2+} in ICF (45%) or ECF (1%)
- Second most common intracellular cation
- Cofactor for certain enzymes and sodium-potassium pump
- Essential for synaptic transmission, normal neuromuscular activity and myocardial function

Specialized Fluids of the Body

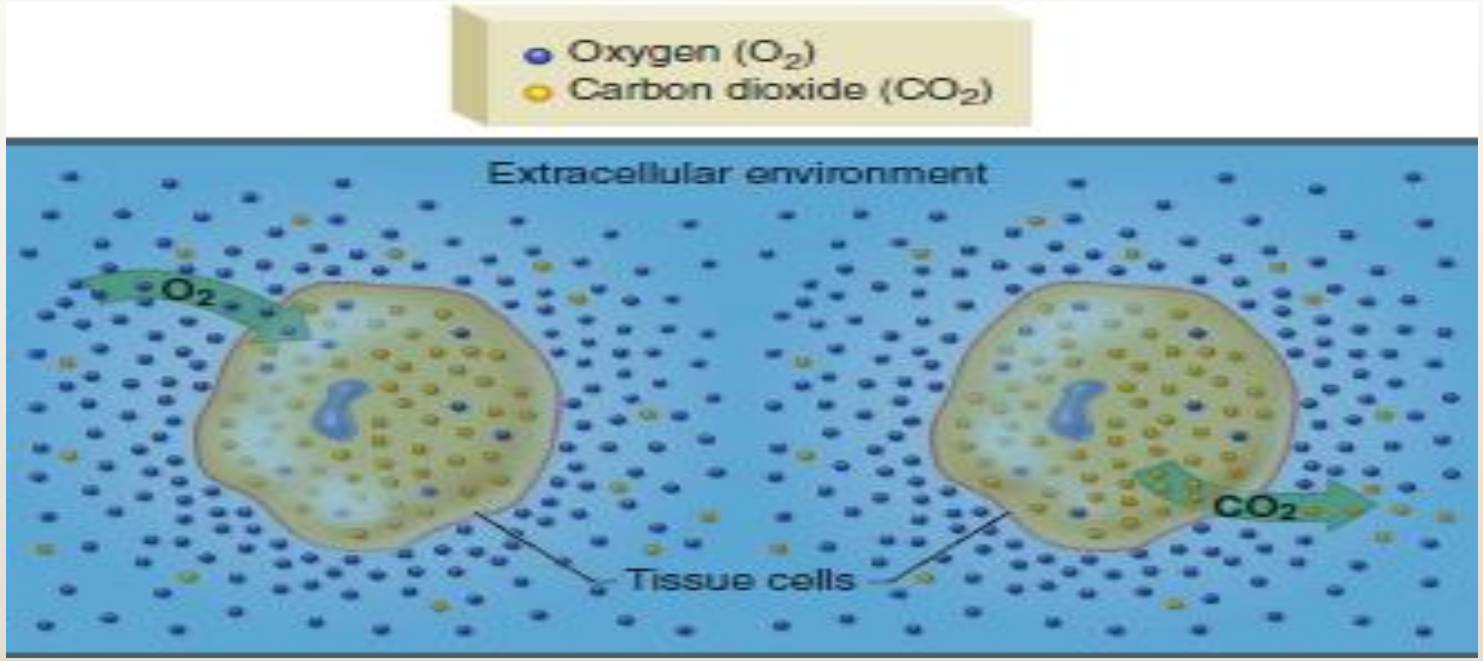
- Lymph
- Milk
- Cerebrospinal fluid
- Amniotic fluid
- Aqueous humor
- Sweat
- Tears

Diffusion

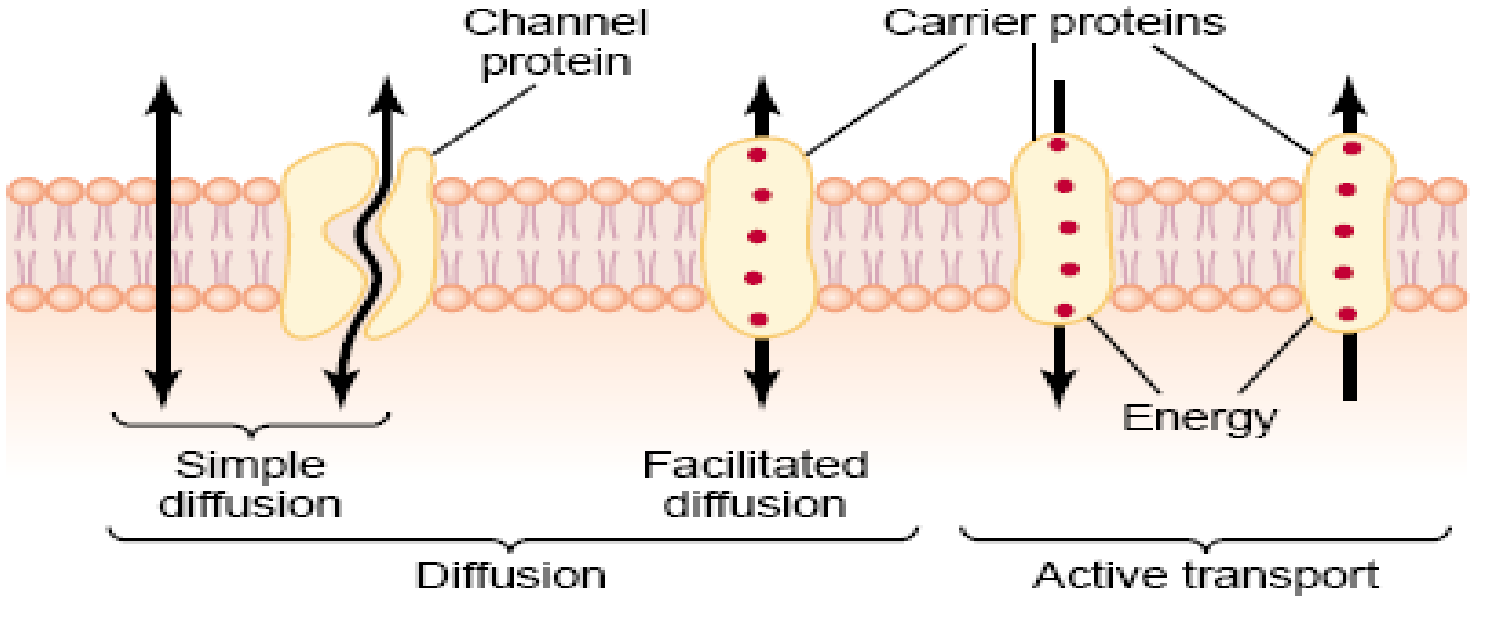
A. Diffusion is the net movement of molecules or ions from regions of higher to regions of lower concentration.

1. This is a type of passive transport—energy is provided by the thermal energy of the molecules, not by cellular metabolism.

2. Net diffusion stops when the concentration is equal on both sides of the membrane.

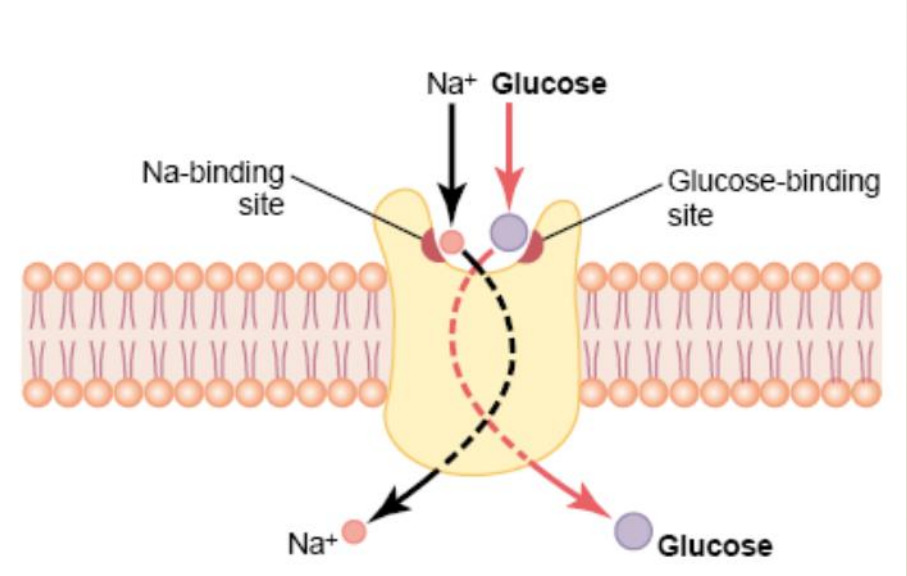


Gas exchange occurs by diffusion. The colored spheres, which represent oxygen and carbon dioxide molecules, indicate relative concentrations inside the cell and in the extracellular environment. Gas exchange between the intracellular and extracellular compartments thus occurs by diffusion


Channel protein
Carrier proteins
Energy
Simple diffusion
Facilitated diffusion
Diffusion
Active transport

Co-Transport of Glucose and Amino Acids Along with Sodium Ions

Sodium co-transport of glucose and amino acids occurs especially through the epithelial cells of the intestinal tract and the renal tubules of the kidneys to promote absorption of these substances into the blood.



Osmosis is the simple diffusion of solvent (water) through a membrane that is more permeable to the solvent than it is to the solute.

1. Water moves from the solution that is more dilute to the solution that has a higher solute concentration.

2. Osmosis depends on a difference in total solute concentration, not on the chemical nature of the solute.

a. The concentration of total solute, in moles per kilogram (liter) of water, is measured in osmolality units.

b. The solution with the higher osmolality has the higher osmotic pressure.

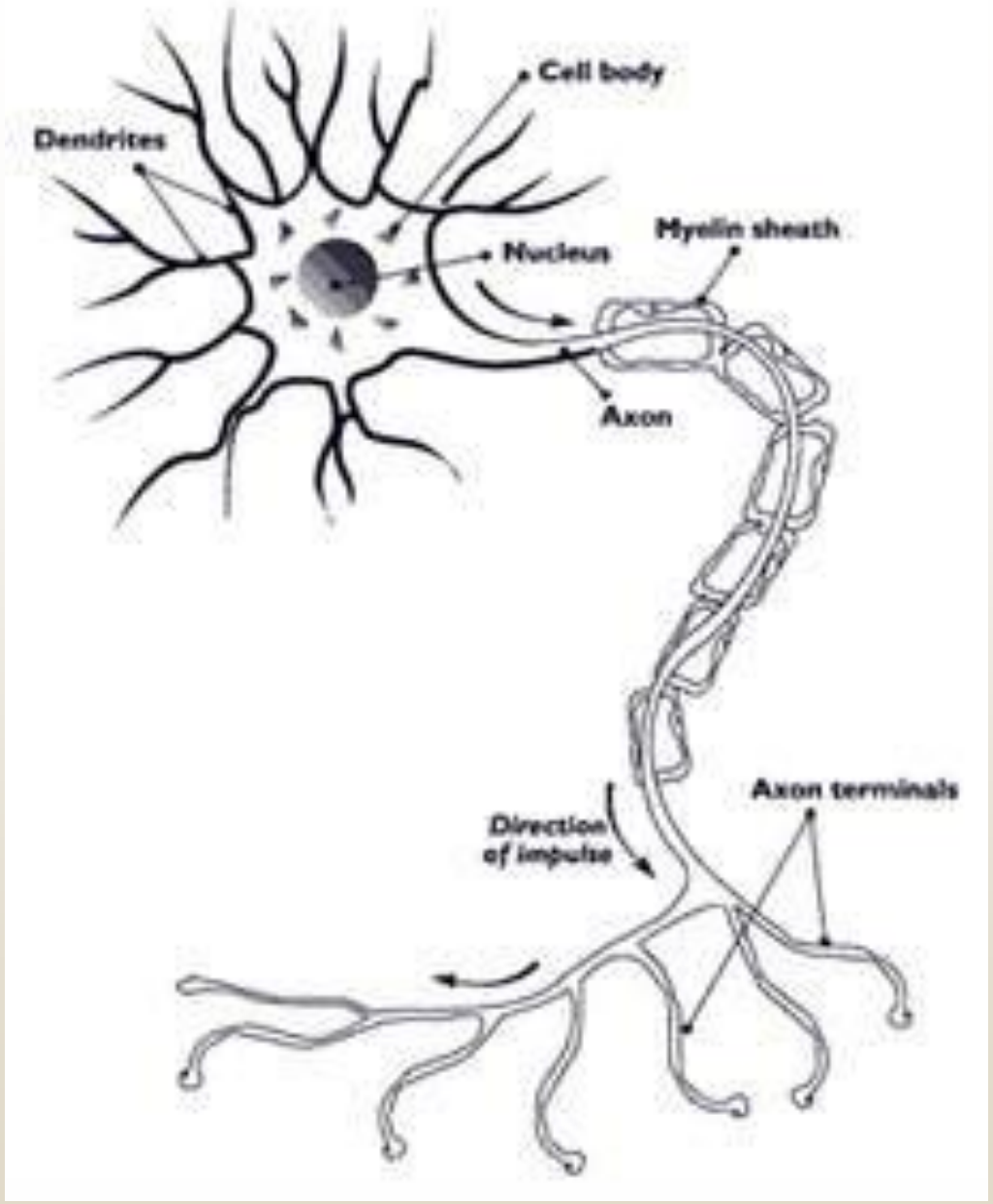
c. Water moves by osmosis from the solution of lower osmolality and osmotic pressure to the solution of higher osmolality and osmotic pressure.

What is irritability?

An ability of all living tissues to respond to stimuli (either external or internal environment)

What is excitability?

An ability of specialized cells to respond to certain stimuli by producing electrical signals known as action potential at its membrane


Cell body
Dendrites
Myelin sheath
Nucleus
Axon
Axon terminals
Direction of impulse

What are 2 basic properties of excitable cell membranes?

1. The membranes have an electrical excitability across it, and may transmit an impulse along the membrane
2. The membranes contain a variety of ion channels (pores) that may be opened or closed, allowing specific ions to flow across.

In summary, the 3 factors that contribute to the negative charges inside the membrane are:

1-The diffusion of k ions to the outside of the membrane is more than the diffusion of Na ions to the inside.

2-The Na-K pump.

3-The presence of negatively charged proteins inside the membrane.

Post Study Test

- 1-what are the Specialized Fluids of the Body
- 2-What are 2 basic properties of excitable cell membranes?
- 3-what is Osmosis

Answers :Pre Study Test

- 1-Total amount of fluid in the human body is approximately 70% of body weight
- 2-Intracellular fluid (ICF)

Inside the cells

55% of total body water

- 3-Extracellular fluid

Outside the cells

45% of total body water

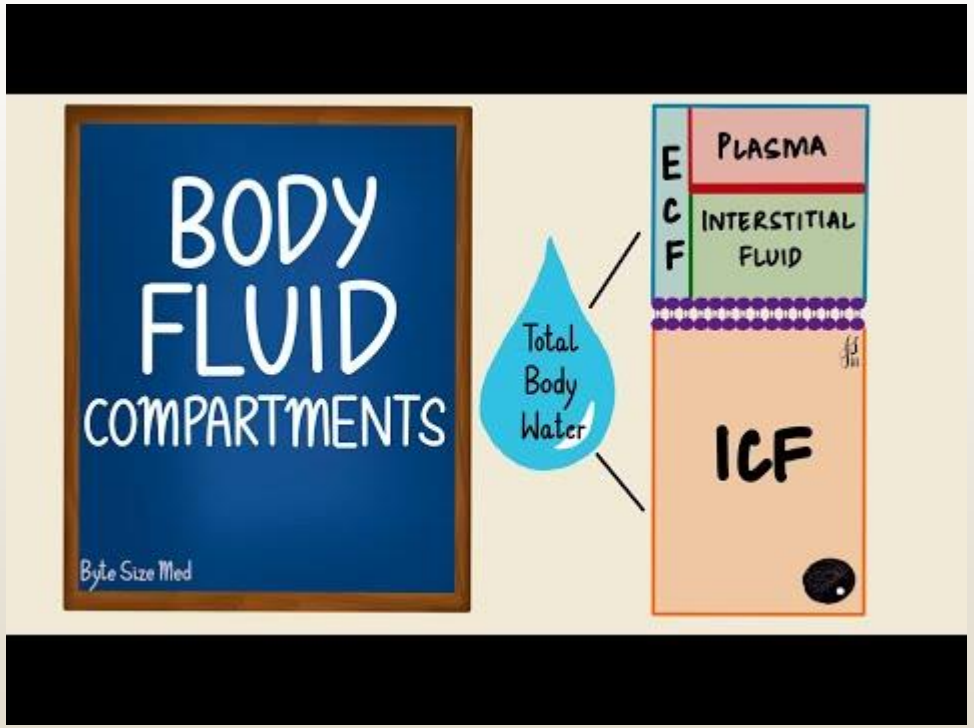
Answers :Post Study Test

- **1-Lymph, Milk ,Cerebrospinal fluid ,Amniotic fluid, Aqueous humor, Sweat and Tears**
- **2-a.** The membranes have an electrical excitability across it, and may transmit an impulse along the membrane
  b. The membranes contain a variety of ion channels (pores) that may be opened or closed, allowing specific ions to flow across.
- **3-Osmosis** is the simple diffusion of solvent (water) through a membrane that is more permeable to the solvent than it is to the solute.

A. Water moves from the solution that is more dilute to the solution that has a higher solute concentration.

B-. Osmosis depends on a difference in total solute concentration, not on the chemical nature of the solute.

Video



https://www.youtube.com/watch?v=v3BTWpNTyLU

Unit Two

Physiology of The Digestive System

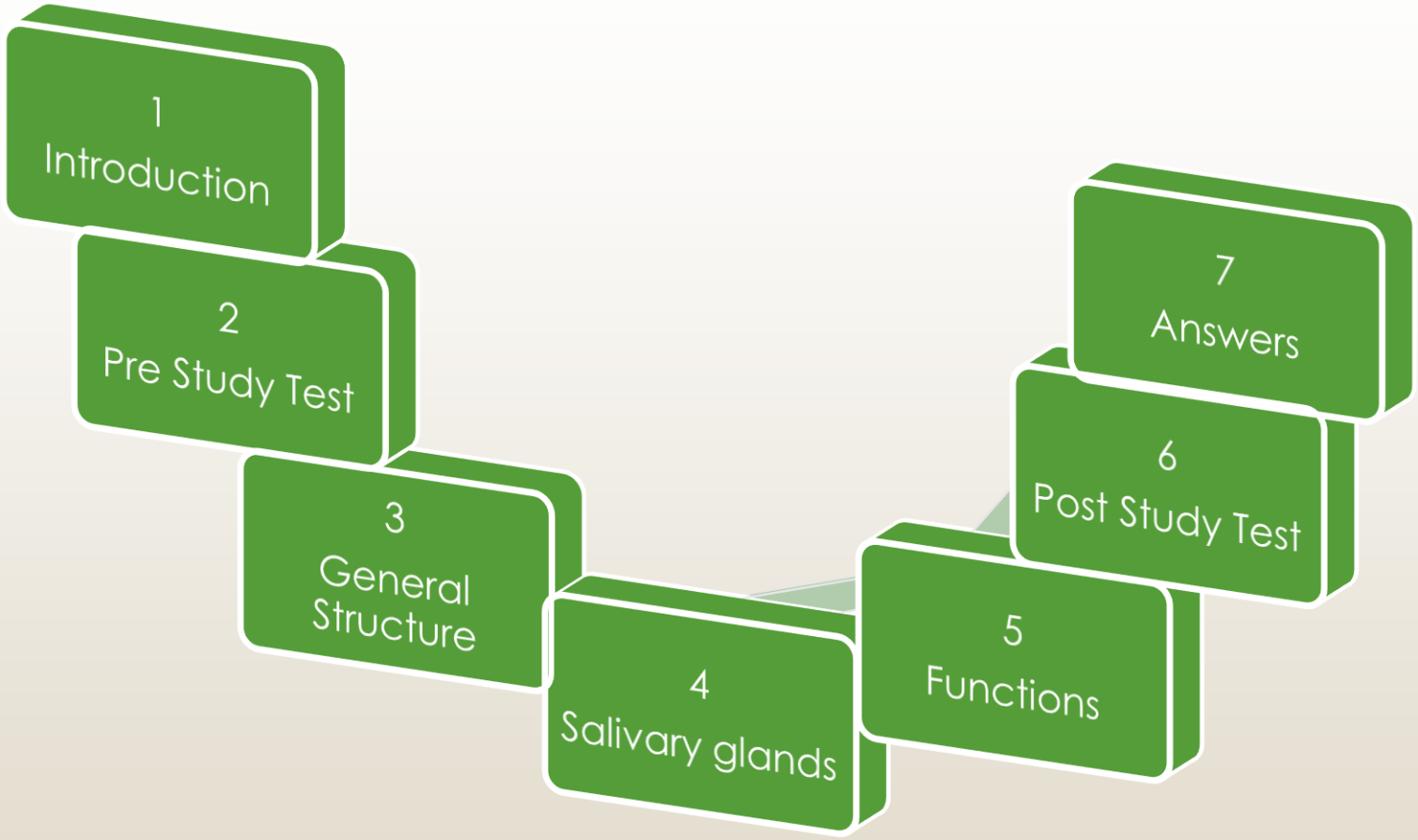
General Objective

- Learners will be able to identify all the primary and accessory organs of the digestive system.
- Learners will know the fuction of each organ in the digestive system.

Learning Outcome

After studying the unit , The student should be able to:-

- General Structure of digestive system
- Functions of Saliva
- Physiology of Digestion in Mouth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General Structure
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Salivary glands
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Functions
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Post Study Test
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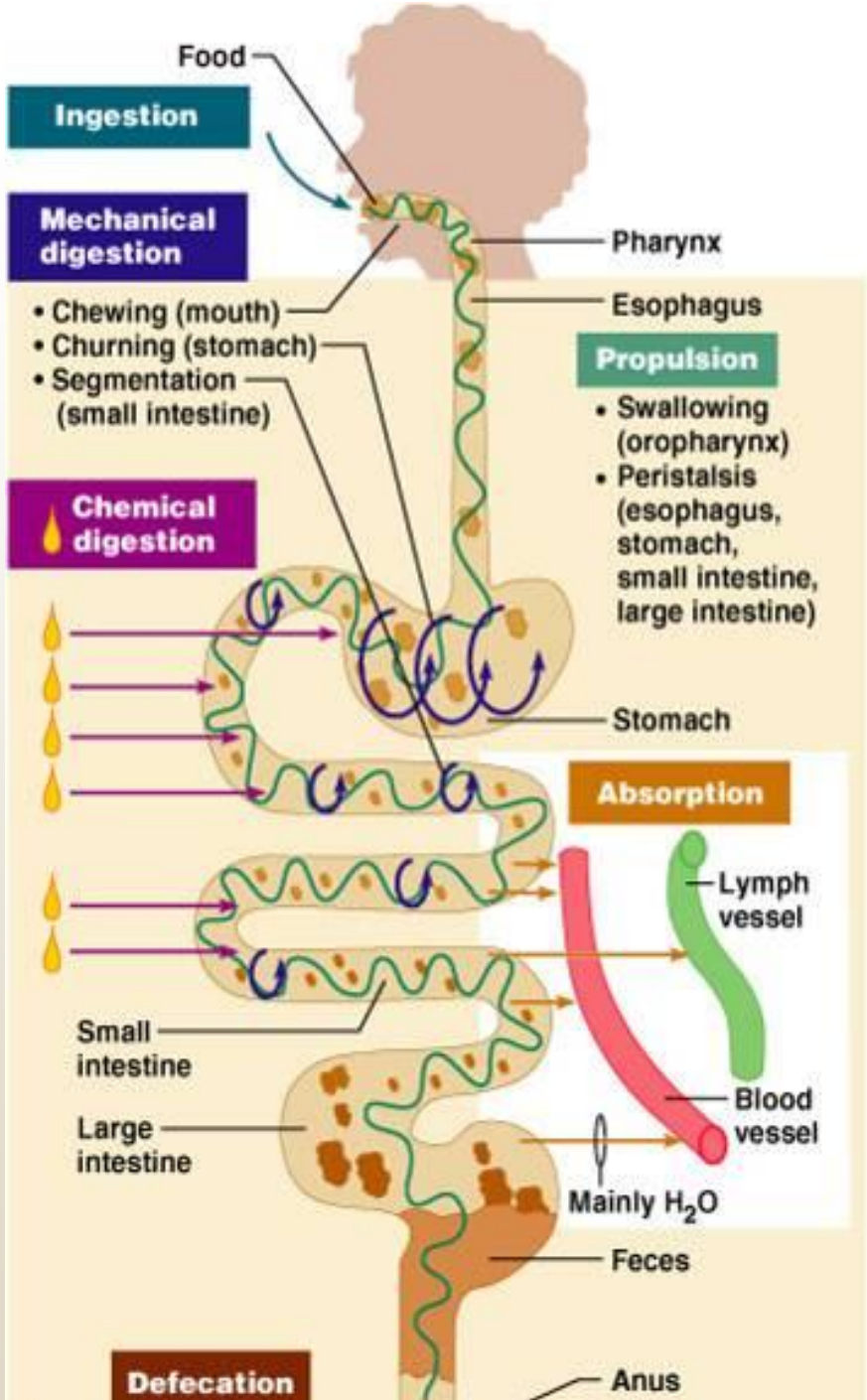
Answers

Digestive Process

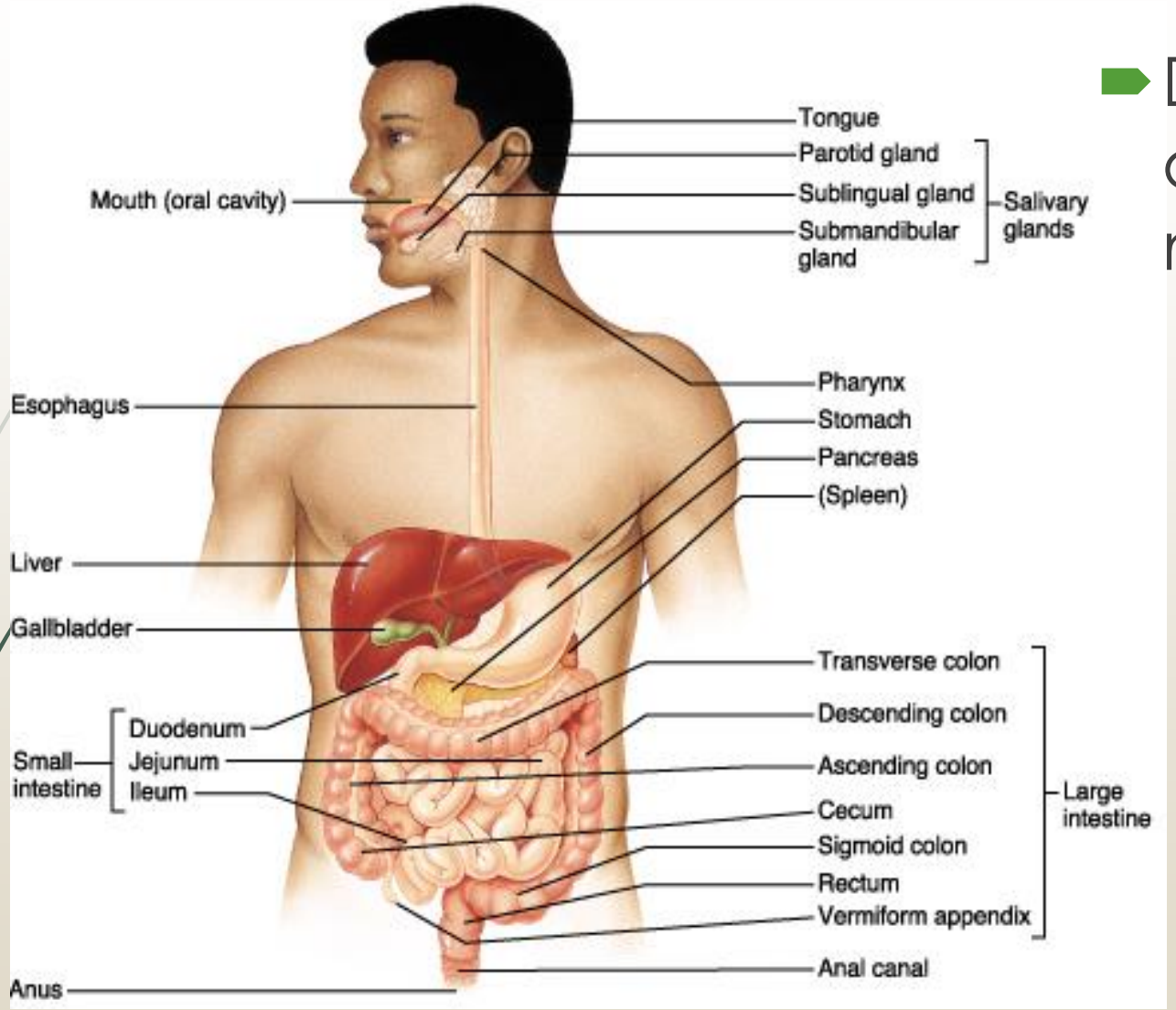
- Ingestion
- Movement of food
- Digestion
  - Mechanical digestion
  - Chemical digestion
- Absorption
- Defecation



Pre Study Test

- 1-What is the digestive process
- 2-What are the 2 types of Digestion
- What are the 2 main digestive organs groups

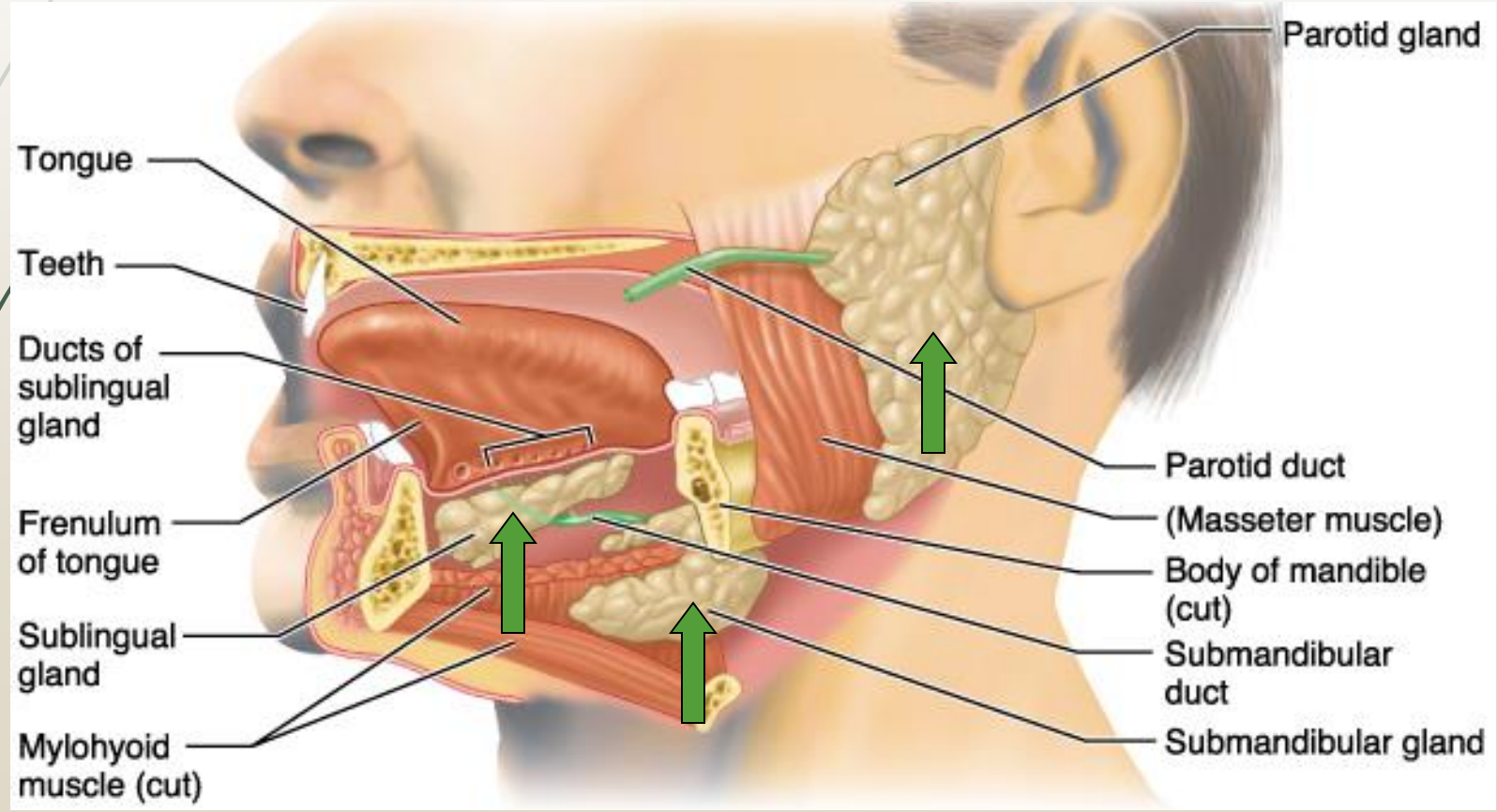
General Structure



- Digestive organs divided into 2 main groups
  - GI (alimentary) tract
  - Accessory structures
    - cheeks, teeth, tongue, salivary glands
    - liver, gallbladder, pancreas

Salivary Glands

- 3 pairs salivary glands
  - Parotid glands
  - Submandibular glands
  - Sublingual glands



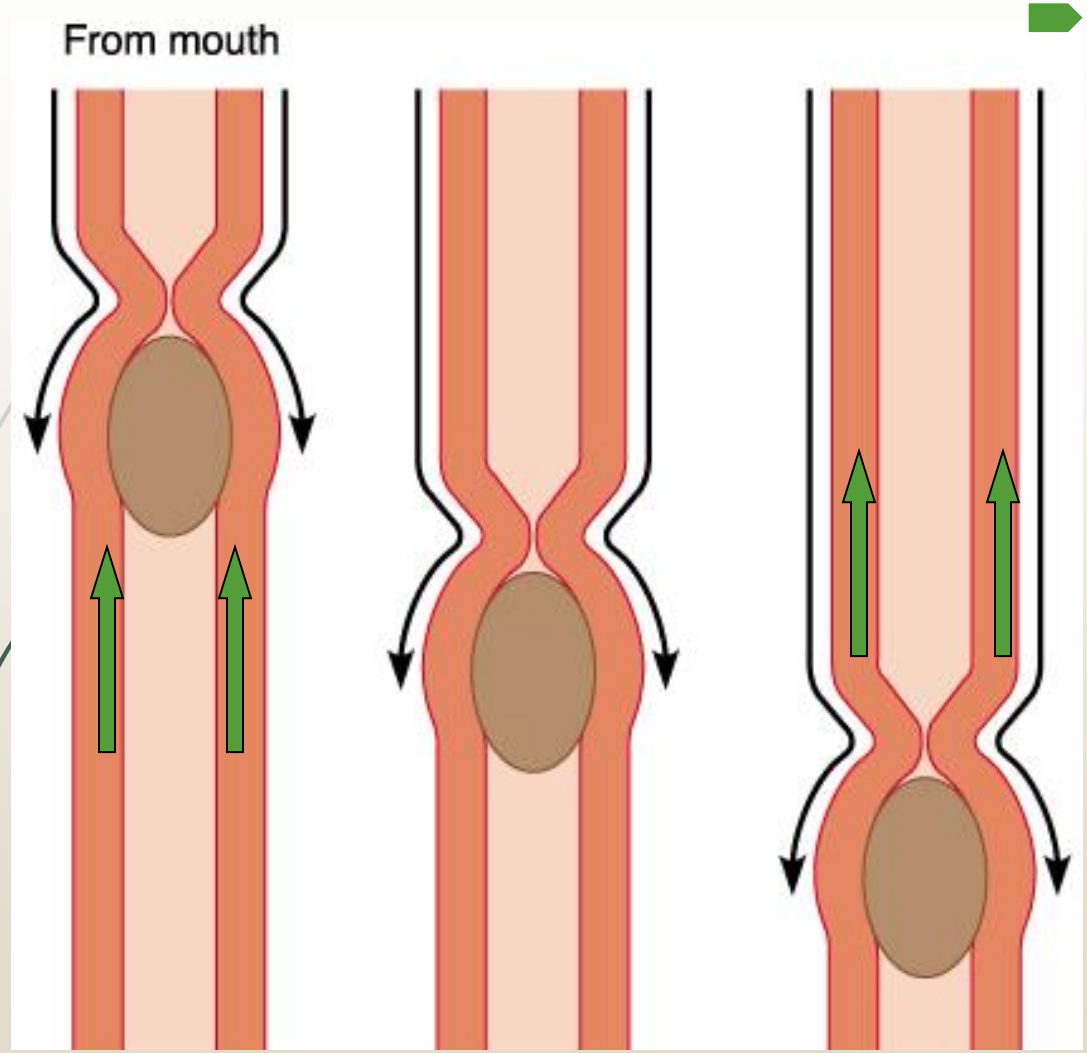
Salivary Glands

- Functions of Saliva
  - Water dissolves food for taste and digestion
  - Mucous moistens and lubricates food
  - Mucous lubricates oral surfaces for smooth actions in swallowing and speech
  - Cl^- ions activate amylase
  - HCO_3^- and PO_4^- ions buffer bacterial acids
  - IgA, lysozymes, cyanide, defensins: protect against microorganisms

Physiology of Digestion in Mouth

- Mechanical digestion
  - Chewing = mastication
  - Food mixed with saliva
  - Shaped into a bolus
- Chemical digestion – salivary amylase breaks down and converts polysaccharides (starches) to disaccharides (maltose) and monosaccharides (glucose) [no enzymatic action with cellulose which is also a polymer of glucose]

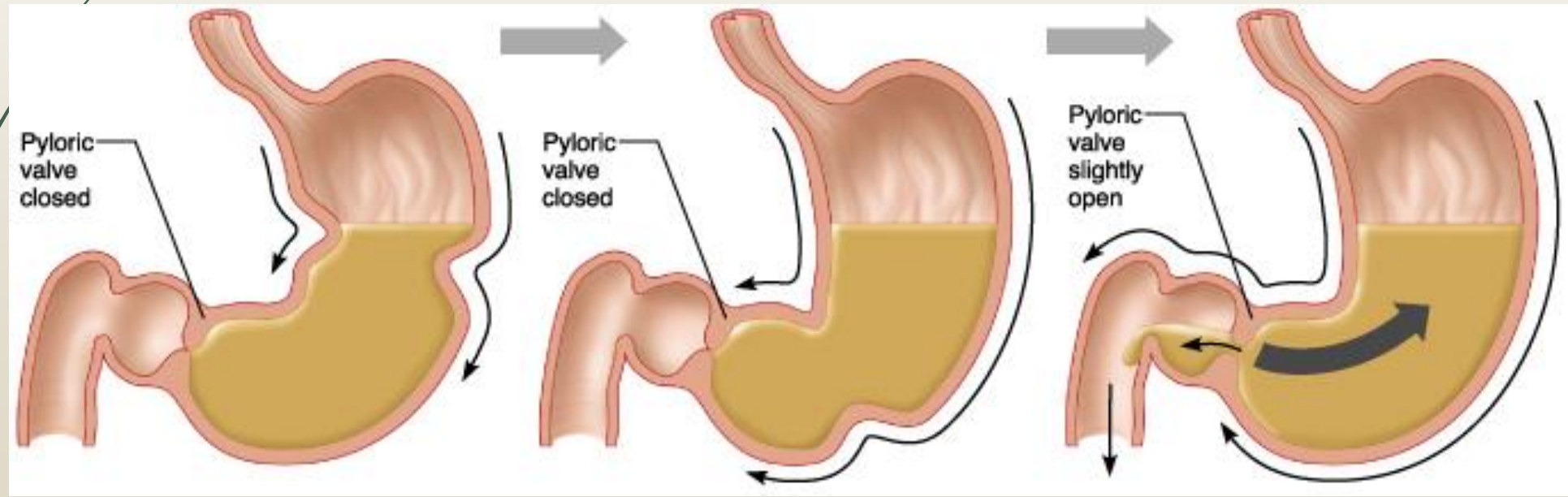
Esophagus



- Peristalsis
  - Involuntary, rhythmic contraction of muscularis
  - Controlled by medullary centers
  - A movement activity: inner circular layer of smooth muscle contracts behind bolus to push it forward; outer longitudinal muscle contracts to pull esophagus wall up

Stomach

- Physiology of digestion - Mechanical digestion
  - peristaltic movement (mixing waves) back and forth between body and pylorus
  - 3 muscle layers: longitudinal, circular, and oblique
  - chyme



Stomach

- Physiology of digestion - Chemical digestion
  - **parietal** cells secrete **intrinsic factor for B_{12}** absorption
  - **parietal** cells secrete **HCl** by active transport
  - Function of HCl:
    - kills microbes, denatures proteins
    - causes some acid hydrolysis of food molecules
    - stimulates secretion of hormones for bile & pancreatic juice flow
  - **chief cells** secrete **pepsinogen** (inactive precursor)
    - Pepsinogen is activated to pepsin by HCl acid and by other pepsins.

Pancreas

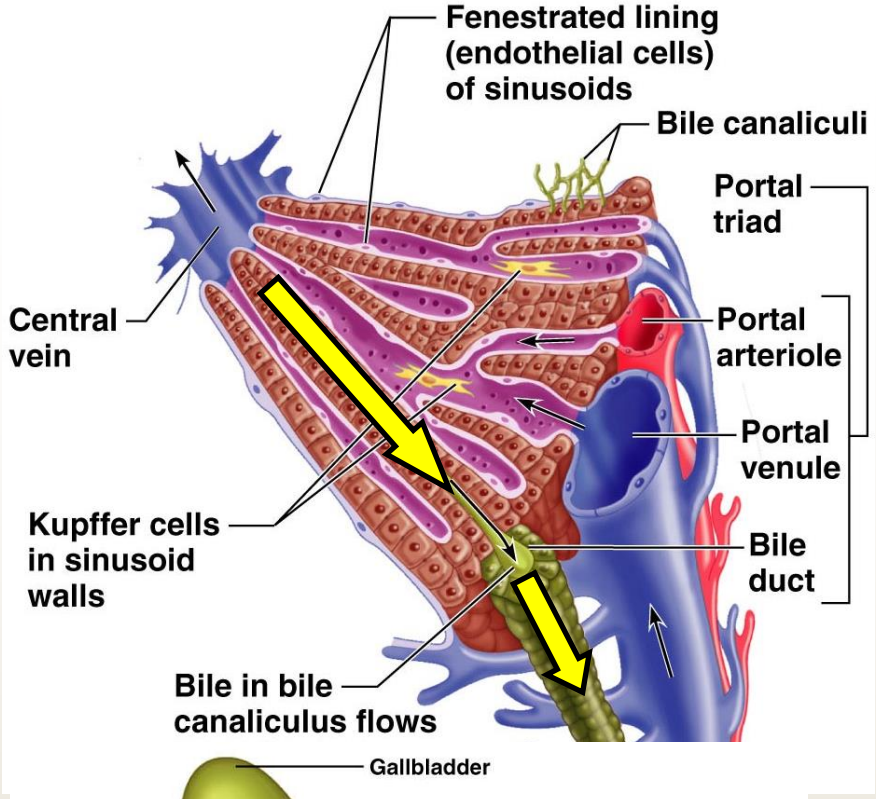
- Pancreatic juice
  - 1.2-1.5 L/day
  - Mostly water some salts, bicarbonate, enzymes
    - alkaline, pH 7.1-8.2
    - buffers acidic gastric juice, stops pepsin activity, creates proper alkaline pH for enzymes acting in the intestine
  - Enzymes include:
    - pancreatic amylase
    - trypsinogen, chymotrypsinogen, procarboxypeptidase (inactive zymogens)
    - pancreatic lipase
    - ribonuclease and deoxyribonuclease

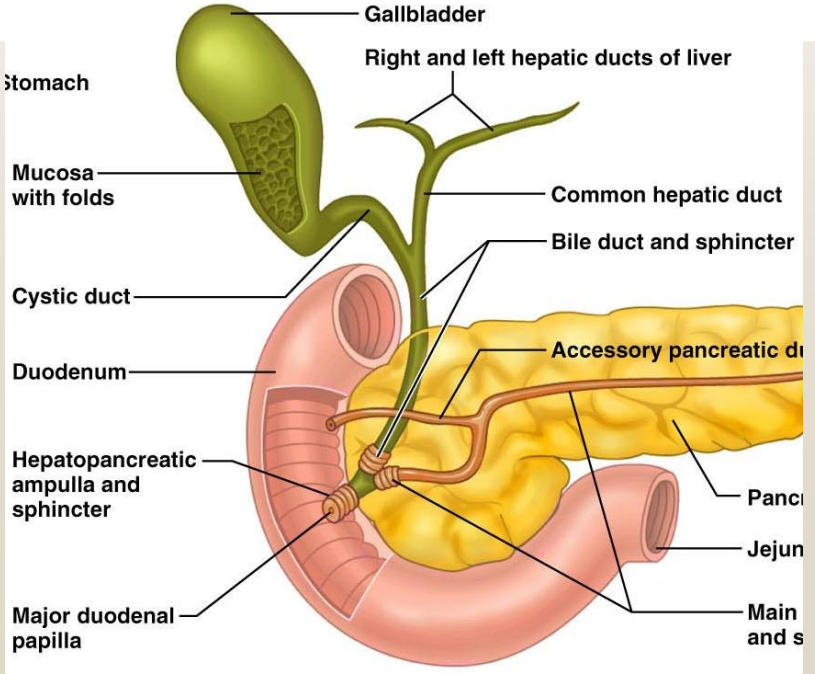
Liver: Bile Secretion

- Bile is 800-1000 ml/day , Yellow, brownish, or olive-green liquid,pH 7.6-8.6. Composition: mostly water, bile salts, bile acids, cholesterol, lecithin (pho spholipid), bile pigments, and ions
- Part of bile is digestive secretion and other part is excretory product:

The bile salts help in emulsification of ingested fats.

bilirubin and other bile pigments are wastes from lipid catabolism





Liver

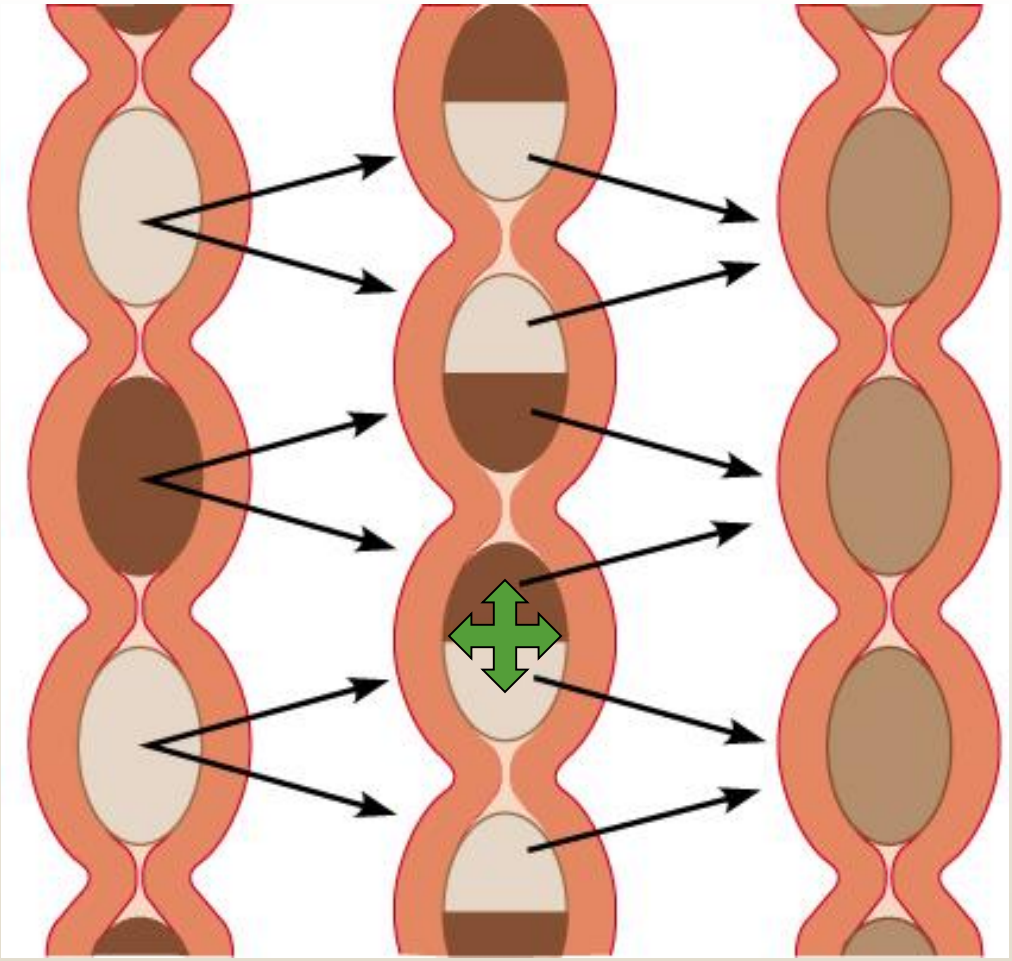
- Functions of the liver – processes vital to life
  - Carbohydrate metabolism – regulates blood glucose levels
    - glycogenesis (insulin)
    - glycogenolysis (glucagon)
    - gluconeogenesis (glucagon)
  - Lipid metabolism -
    - stores, metabolizes some triglycerides
    - synthesizes new cholesterol
    - degrades excess cholesterol for bile salt production
  - Protein metabolism -
    - deaminates AA's by removing amino groups ($-NH_2$) from AA's
      - deaminated AA's used for ATP production or changed to carbohydrates or fats as needed
      - detoxifies ammonia (NH_3) by synthesizing urea ($1\ CO_2 + 2\ NH_3$ = urea)
    - can convert AA's from one to another (transamination)
    - synthesizes and secretes most plasma proteins

Liver

- Functions of the liver (cont)
  - Storage – oil-soluble vitamins, iron, other nutrients and minerals
  - Phagocytosis
  - Removal of dietary toxins, hormones, drugs
    - detoxify or store or secrete compounds into bile
    - metabolize thyroid, steroid hormones
  - Synthesis of bile salts
  - Excretion of bile - bilirubin
  - Activation of Vitamin D

Small Intestine: Segmentation

- primary action of small intestine when food is present
- a form of mechanical digestion
- a mixing activity
- alternate contraction, relaxation of antagonistic smooth (circular and longitudinal) muscle segments in the intestine
- controlled by the autonomic nervous system



Small Intestine: Chemical Digestion

- Chemical digestion in the small intestine:

Carbohydrate digestion :

- pancreatic amylase digests starches
- disaccharidases liberate monosaccharides

Protein digestion

- pancreatic proteases (trypsin, chymotrypsin, carboxypeptidase)
- finished by brush border proteases in the lining epithelium

Lipid digestion

- bile salts for emulsification
- pancreatic lipase

Nucleic acid digestion

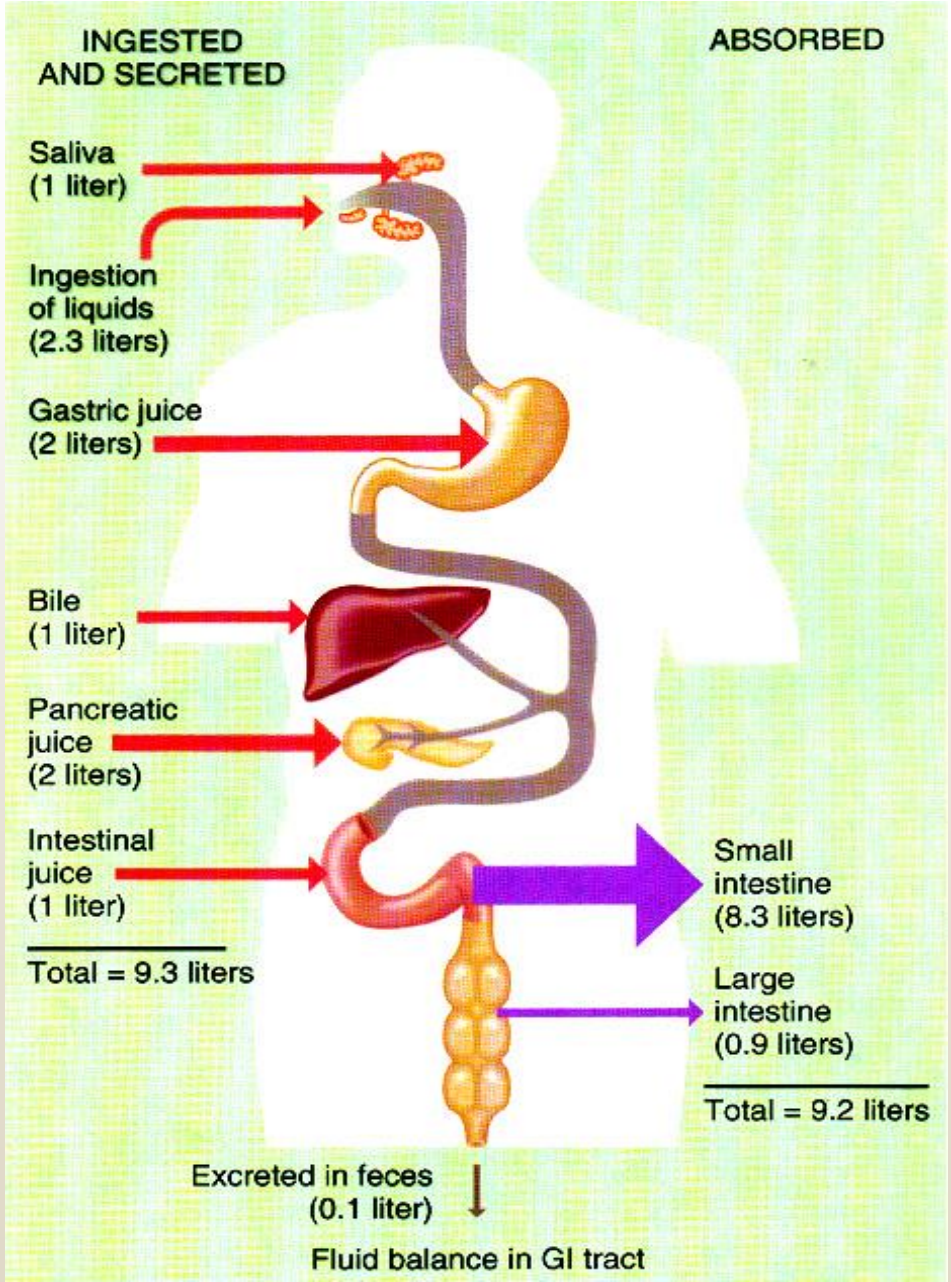
- pancreatic ribonuclease and deoxyribonuclease
- brush border enzymes digest nucleotides

Small Intestine: Nutrient Absorption

- Electrolytes (minerals)
  - Na^+: Primary active transport
  - K^+: facilitated diffusion
  - Fe: Active transport
  - Ca^{2+}: Active transport, vitamin D is a cofactor
- Vitamins
  - Water-soluble vitamins (B complex & C) absorbed by diffusion - B_{12} absorbed with intrinsic factor
  - Fat-soluble vitamins (A, D, E, K) included with other lipids in micelles/chylomicrons

Small Intestine: Water Absorption

- Total volume added to the small intestine/day - 9.3 L
  - ~2.3 L from ingestion
  - ~7.0 L from secretions
- Small intestine absorbs ~8.3 L /day
  - passive absorption following nutrient molecules
  - Osmosis
- The rest of the water (~1.0L/day) passes to



Large Intestine

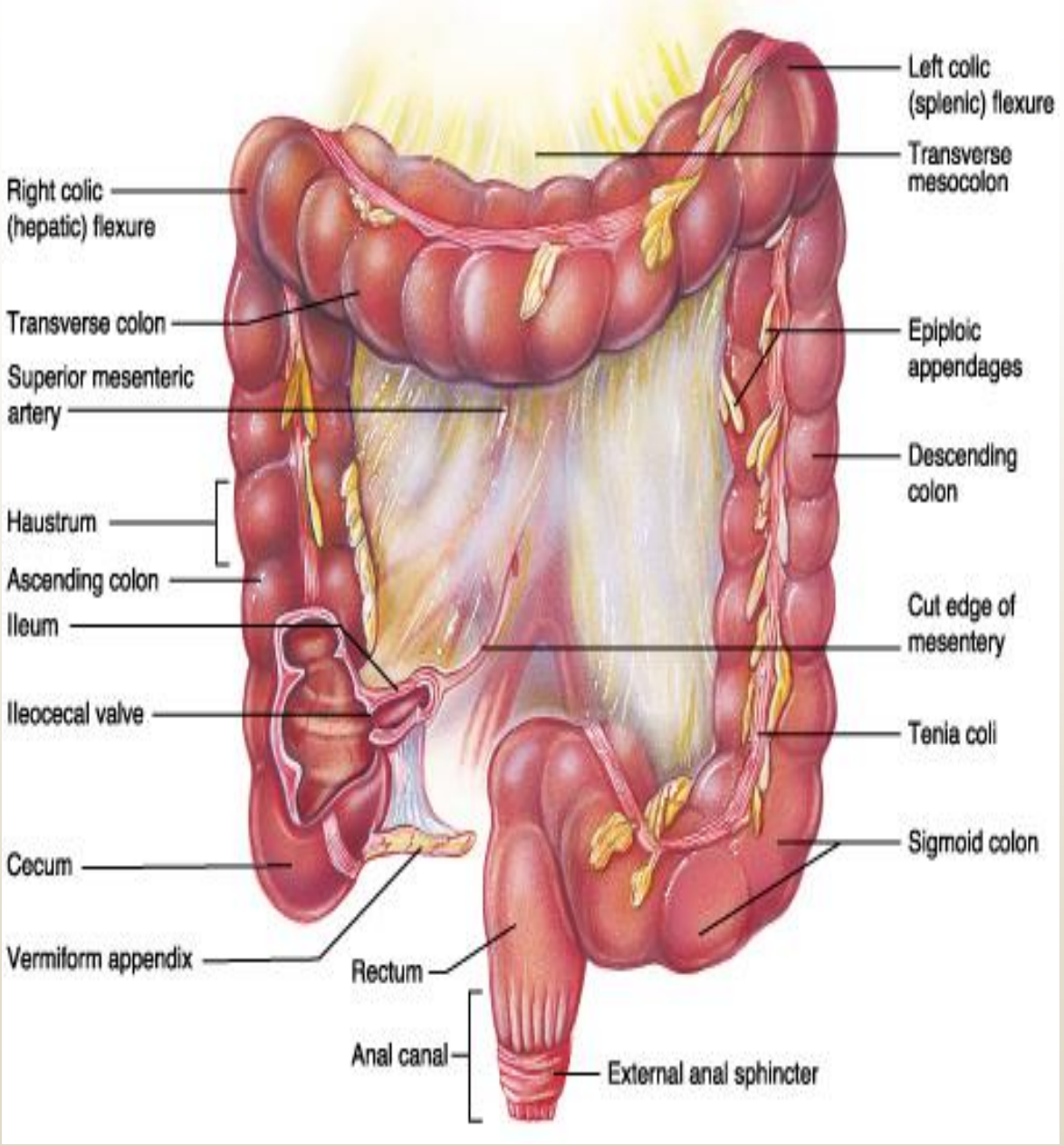
- **Functions**

1. **Complete absorption of H_2O**
2. **Normal flora manufacture certain vitamins (B complex, K)**
3. **Formation and expulsion of feces**

Anatomy :Its 1.5 m L, 6.5 cm W.

Divided into 4 general areas:

- **cecum**
- **colon**
- **rectum**
- **anal canal**



Large Intestine

- Absorption and feces formation
  - Chyme
    - after 3-10 hours in the large intestine, chyme becomes solidified (due to water reabsorption) into feces
    - large intestine absorbs water, electrolytes, some vitamins and any toxins
  - Feces
    - water, inorganic salts, sloughed off intestinal epithelial cells, bacteria, products of bacterial decomposition, undigested parts of food
    - most water is reabsorbed in small intestine, but the large intestine is also important in water reabsorption

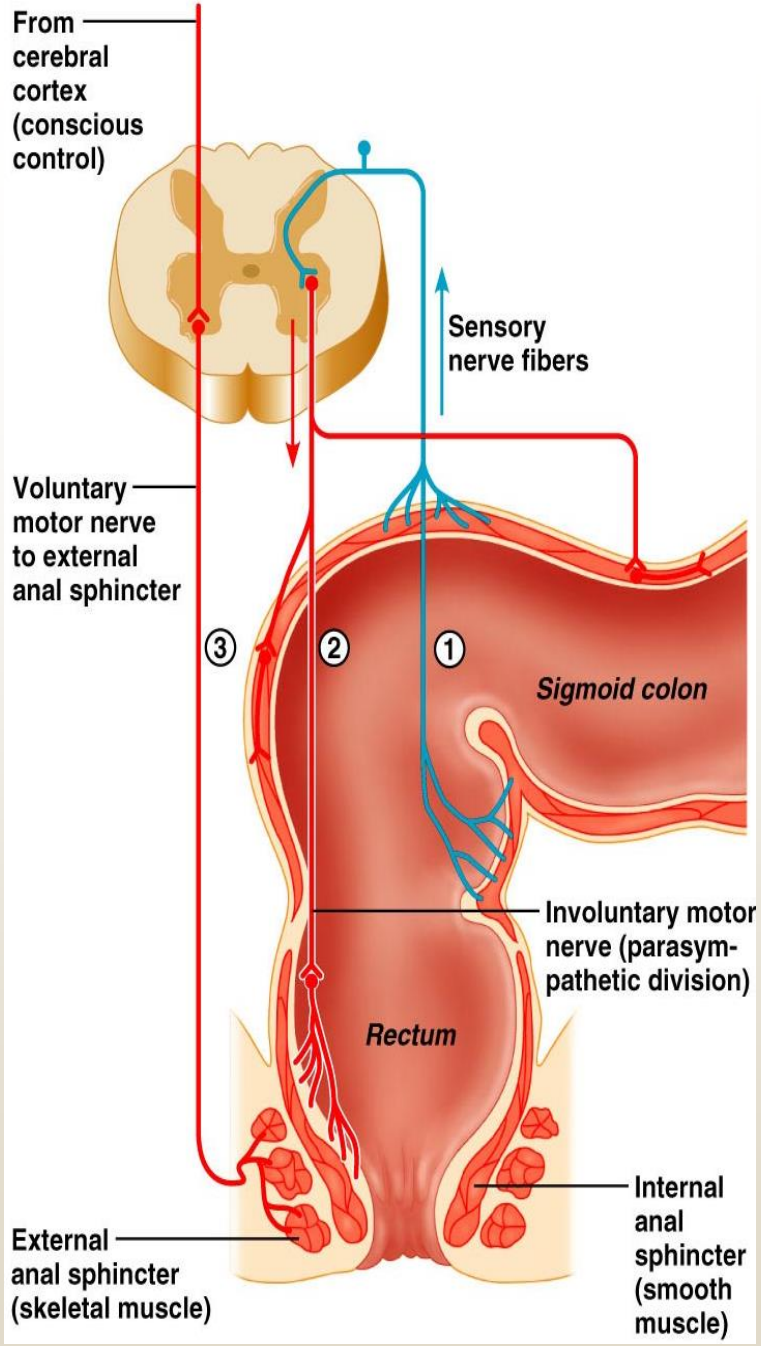
Physiology of defecation:

- Mass **peristalsis** **pushes fecal matter into rectum the distension stimulates stretch receptors initiating reflex for defecation**

- **stimulates contraction of rectum**
- **shortens and increases pressure in**

  rectum

- **Conscious stimulation** relaxes external sphincter then **feces expelled**



Post Study Test

- 1-What is Peristalsis
- 2-What is Bile
- 3-What are the functions of the large intestine

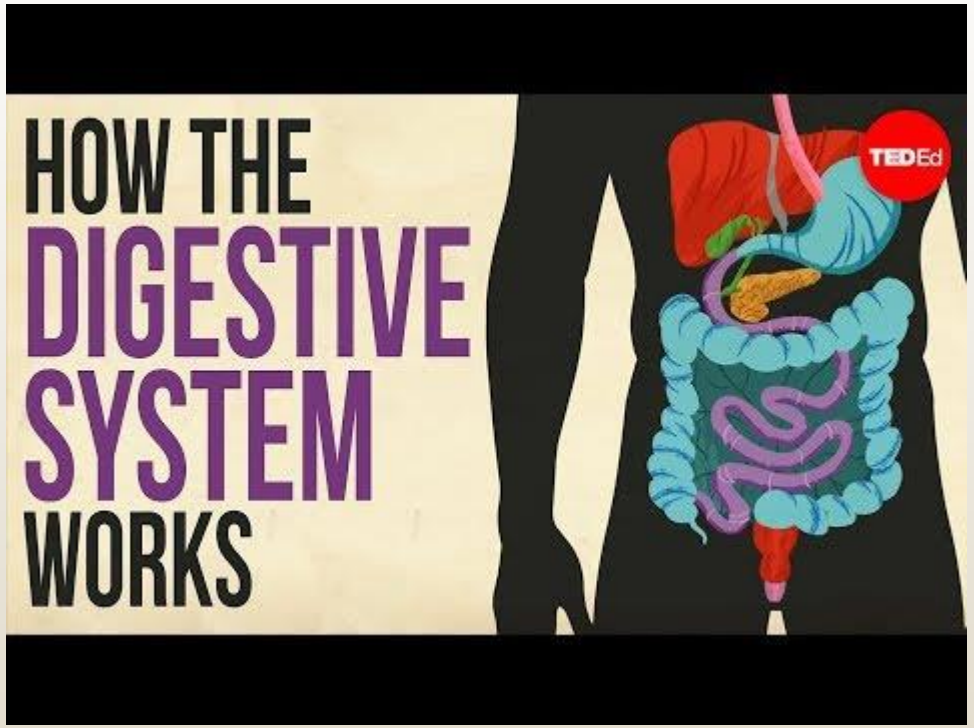
Answers :Pre Study Test

- 1-Ingestion ,Movement of food ,Digestion ,Mechanical digestion, Chemical digestion, Absorption and Defecation
- 2-Mechanical digestion and Chemical digestion
- 3-GI (alimentary) tract and Accessory structures

Answers :Post Study Test

- 1-Peristalsis : Involuntary, rhythmic contraction of muscularis Controlled by medullary centers
- 2-Bile is 800-1000 ml/day , Yellow, brownish, or olive-green liquid,pH 7.6-8.6. Composition: mostly water, bile salts, bile acids, cholesterol, lecithin (pho spholipid), bile pigments, and ions
- 3-Functions of the large intestine:
- A.Complete absorption of H2O
- B.Normal flora manufacture certain vitamins (B complex, K)
- C.Formation and expulsion of feces

Video



https://www.youtube.com/watch?v=Og5xAdC8EUI

Unit Three

Physiology of The Respiratory System

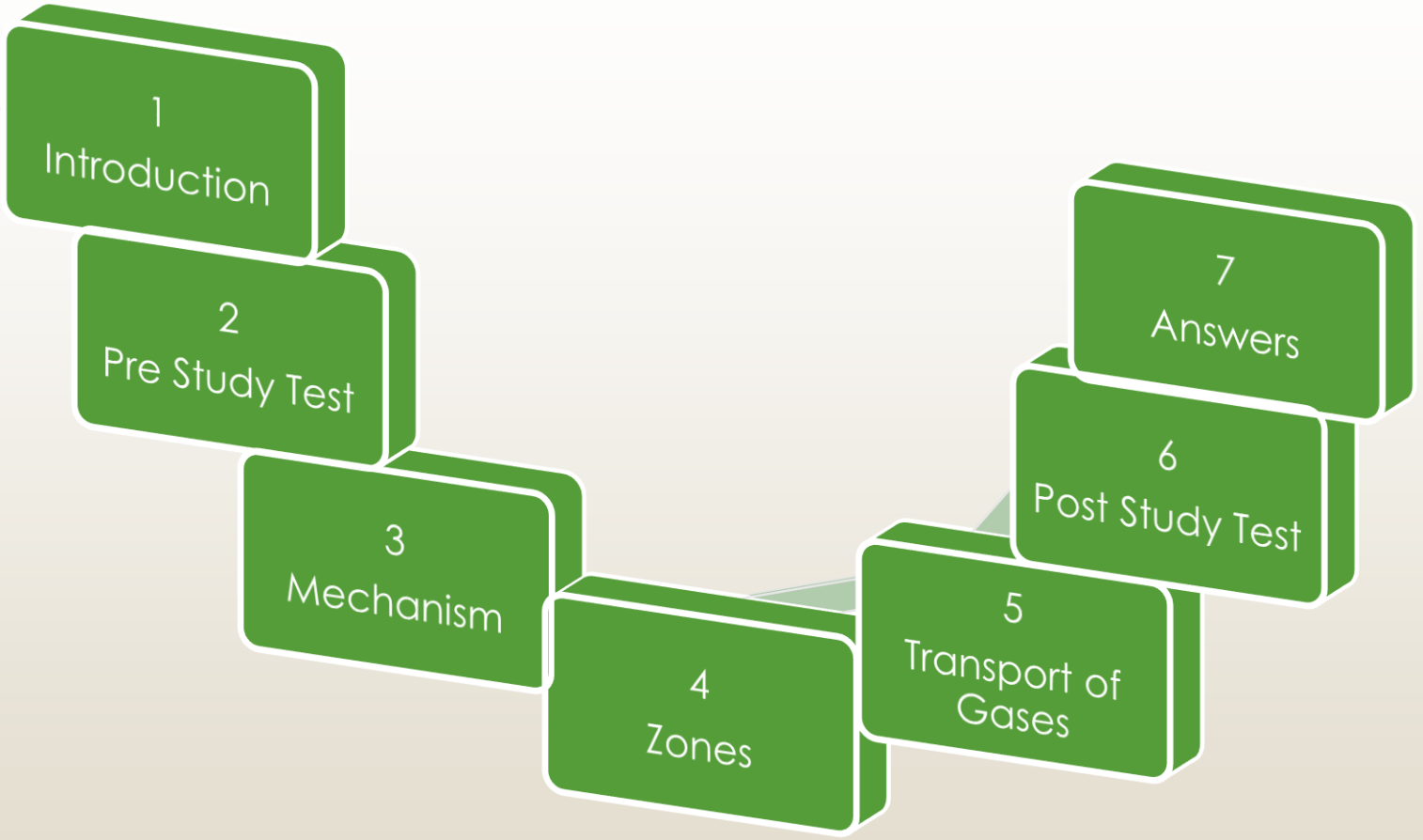
General Objective

- describe and illustrate the main anatomical structures of the respiratory system and the mechanics of inspiration and expiration
- discuss the factors that affect pulmonary ventilation
- outline the mechanisms of O2 and CO2 transport in the blood

Learning Outcome

After studying the unit , The student should be able to:-

- Functions of the Respiratory System
- Respiratory movements
- Pulmonary disorders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Mechanism
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Zones
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Transport of Gases
6
Post Study Test
7
Answers

Respiration

- It is the process by which the body takes in oxygen and utilizes and removes CO_2 from the tissues into the expired air
- It comprises of
  - **Ventilation** by the lungs

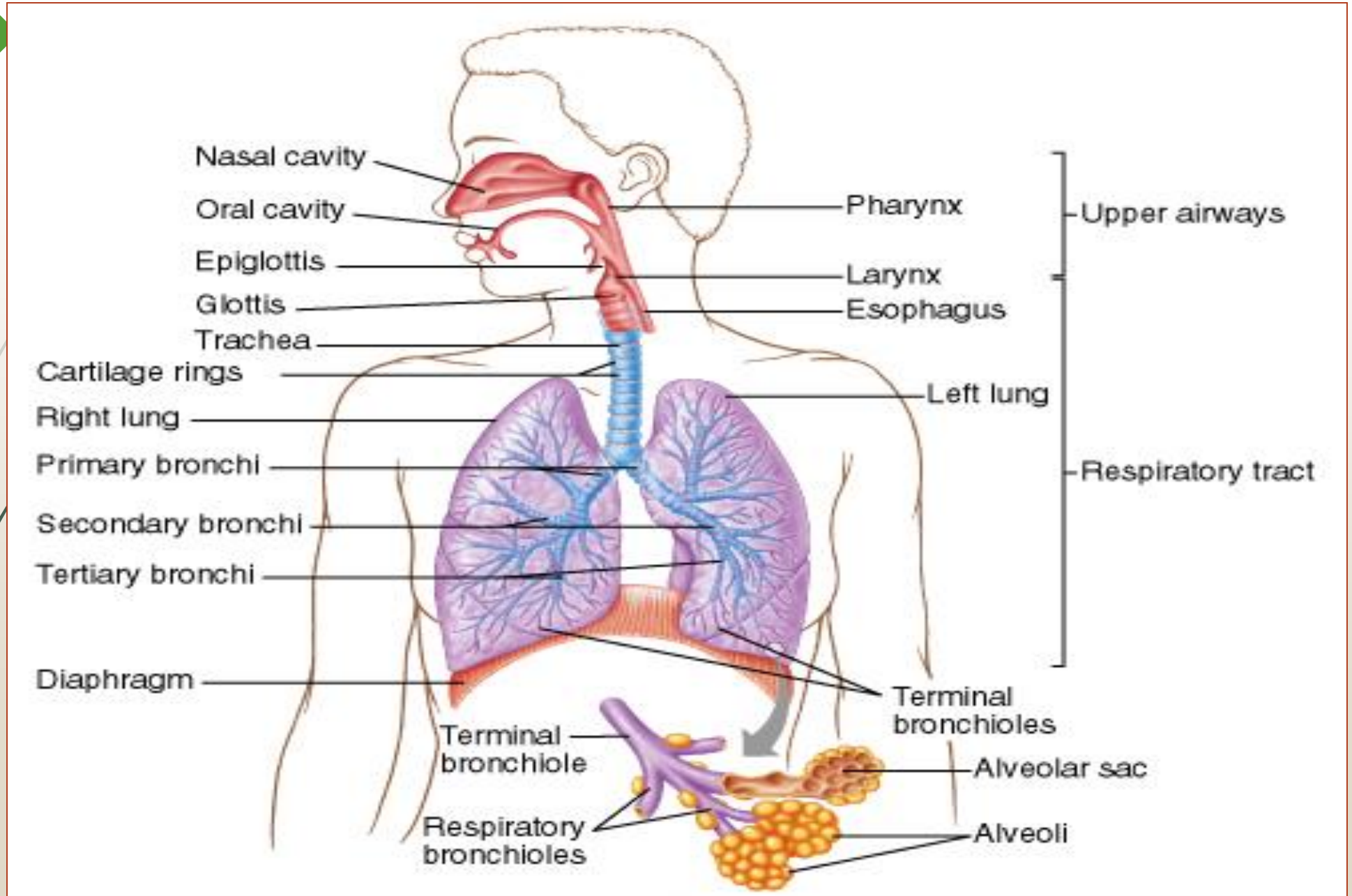
    inspiration and expiration
  - **Gas exchange** across alveolar membrane

    Diffusion in the alveoli, Fick's law
  - **Transport of gases** by blood (haemoglobin)
  - **Uptake of O_2 and release of CO_2 by tissues**
    Diffusion at the cellular level

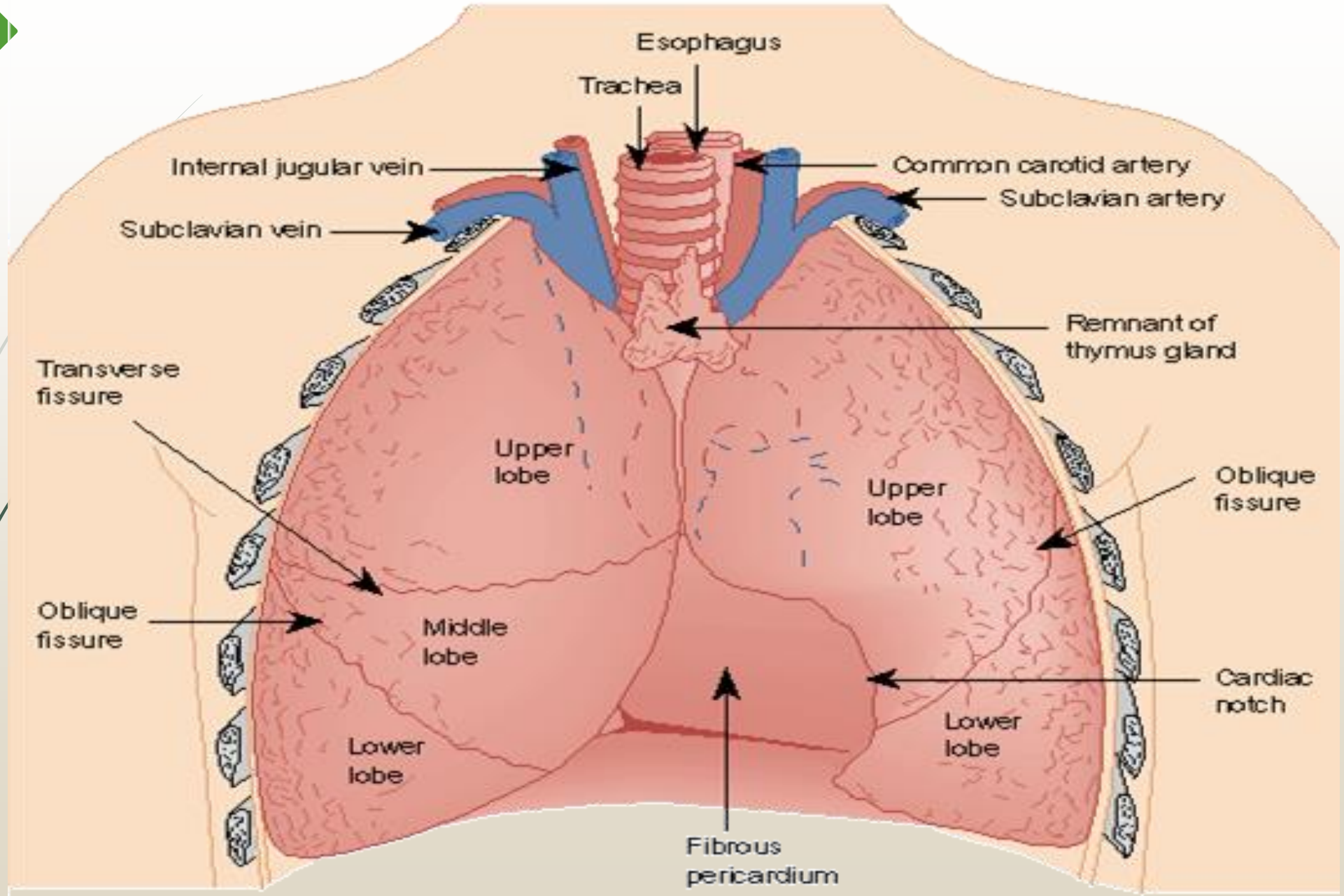
Pre Study Test

- 1-Define Respiration
- 2-What is the element that helps in transport of gases
- 3- how Gas Exchange happens

Anatomy of Respiratory Tree



The Thorax and its contents

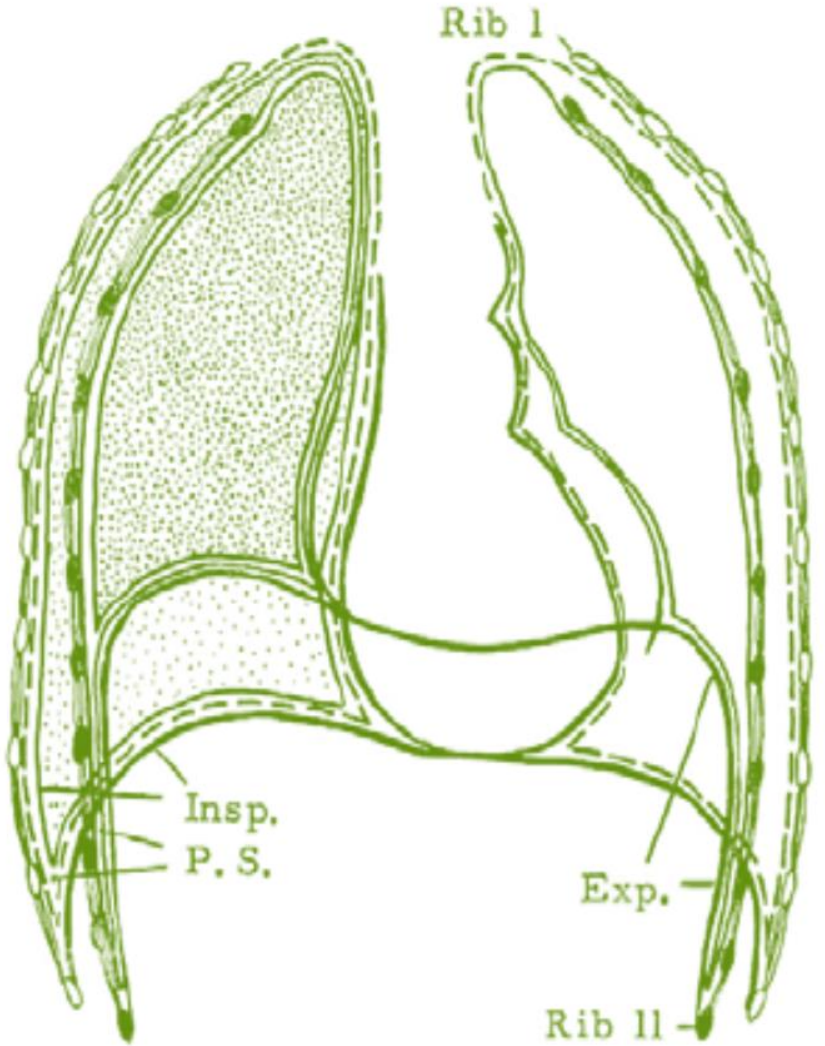


Functions of the Respiratory System

- Gas Exchange
  - O_2, CO_2
- Acid-base balance
  - $CO_2 + H_2O \longleftrightarrow H_2CO_3 \longleftrightarrow H^+ + HCO3^-$
- Phonation
- Pulmonary defense
- Pulmonary metabolism and handling of bioactive materials

Inspiratory Movements

- Inspiration
  - Ribs flex out and up
  - Diaphragm pulls down
  - Lung moves with changes in intrathoracic pressure



Thoracic Cavity

- Diaphragm:
  - Sheets of striated muscle divides anterior body cavity into 2 parts.
- Above diaphragm: thoracic cavity:
  - Contains heart, large blood vessels, trachea, esophagus, thymus, and lungs.
- Below diaphragm: abdominopelvic cavity:
  - Contains liver, pancreas, GI tract, spleen, and genitourinary tract.

Mechanics of breathing

- Gas: the more volume, the less pressure (Boyle's)
- **Inspiration:**
- lung volume increases ->
  - decrease in intrapulmonary pressure, to just below atmospheric pressure ->
  - air goes in!
- **Expiration:** viceversa

Mechanics of breathing

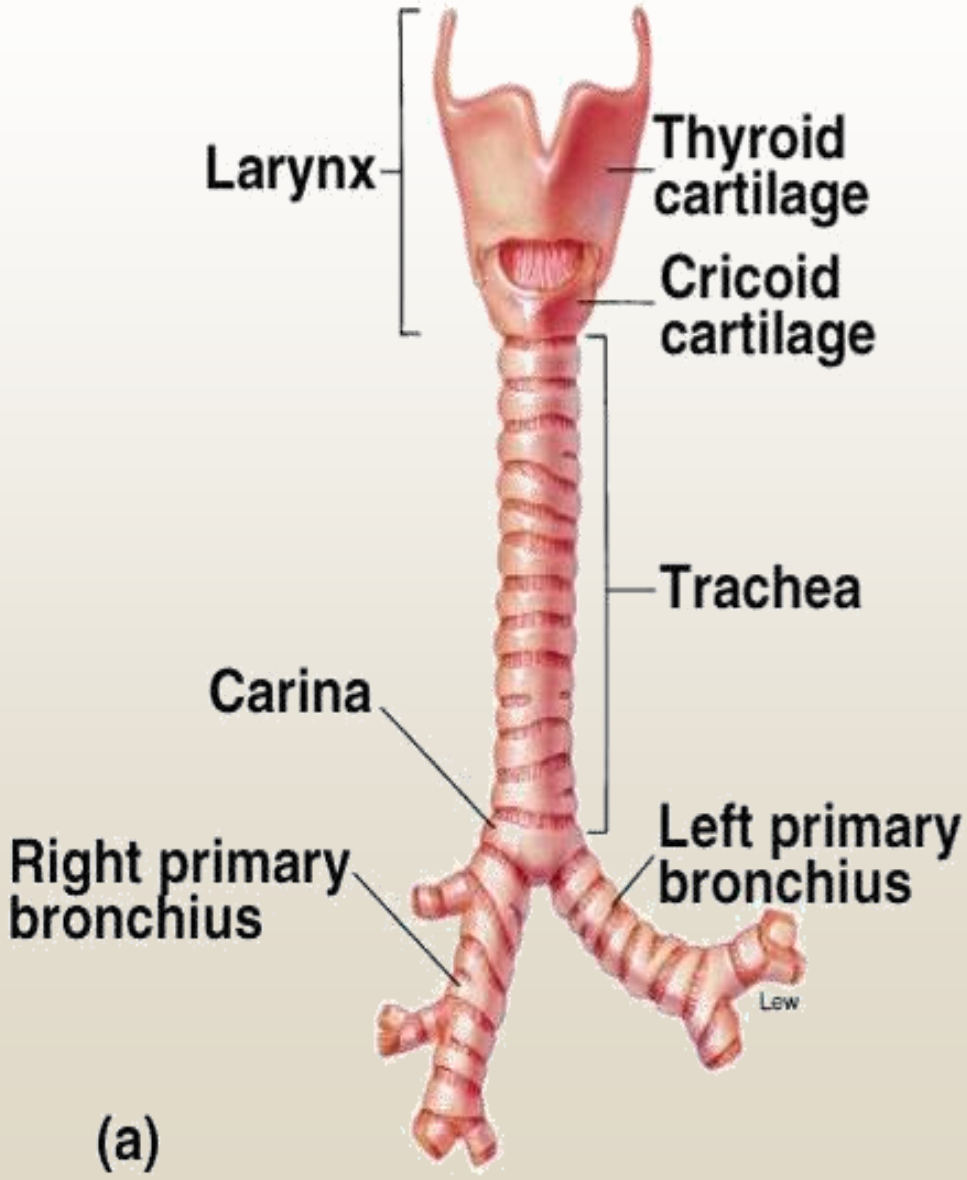
- **Compliance**:
  - This the ability of the lungs to stretch during inspiration
  - lungs can stretch when under tension.
- **Elasticity:**
  - It is the ability of the lungs to recoil to their original collapsed shape during expiration
  - Elastin in the lungs helps recoil

Mechanics of breathing

- **During Quiet breath**:
- The intrapulmonary pressure is
  - +/- 3 mmHg.
- **During Forced breath:**
  - Extra muscles are used, like abdominal msl,sternomastoid.
  - Theintrapulmonary pressure is +/- 20-30 mm Hg

Conducting Zone

- **<u>Conducting zone:</u>**
- Includes all the structures that air passes through before reaching the respiratory zone.
- Mouth, nose, pharynx, glottis, larynx, trachea, bronchi.



Conducting Zone

- **Functions of conducting zone**
- Warms and humidifies until inspired air becomes:37 degrees,Saturated with water vapor
- Filters and cleans:
  - Mucus is secreted to trap particles
  - Mucus with particles will be moved by cilia to be expectorated.

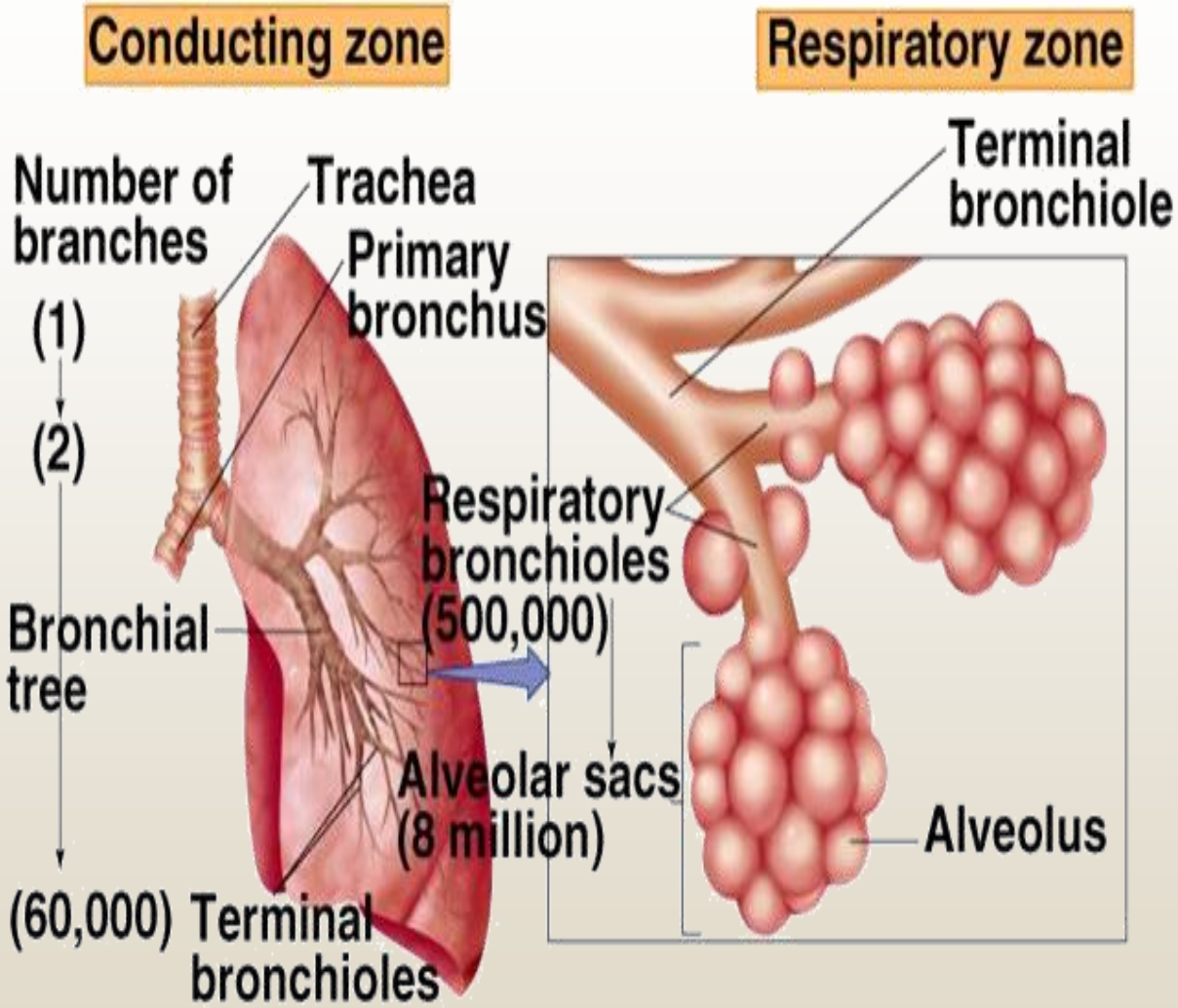
Respiratory Zone

- **Respiratory zone**

- Region of gas exchange between air and blood,

which includes:

- Respiratory bronchioles
- Alveolar ducts, Alveolar Sacs and Alveoli



Respiratory Zone

- **Alveoli :** Are air sacs with Honeycomb-like clusters,its around ~ 300 million.
- Large surface area (60–80 m^2).
  - Each alveolus has only 1 thin cell layer.
  - Total air barrier is 2 cells across (2 μm) (alveolar cell and capillary endothelial cell).

The Alveolar cells are of 2 types:

type I: structural cells.

type II: secrete surfactant

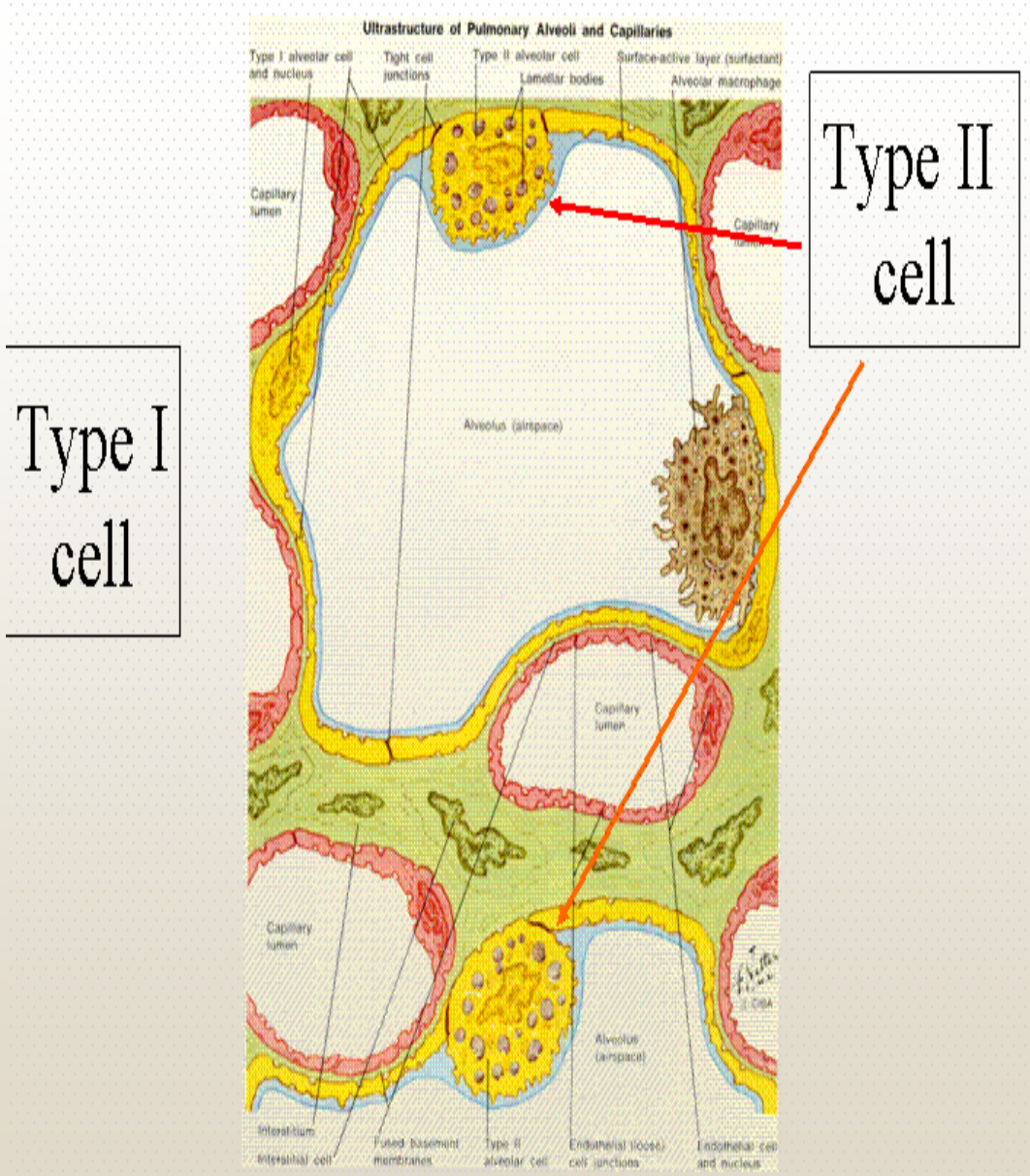
Alveoli

8 million alveolar ducts

300 million alveoli (diameter 70-300 μm)

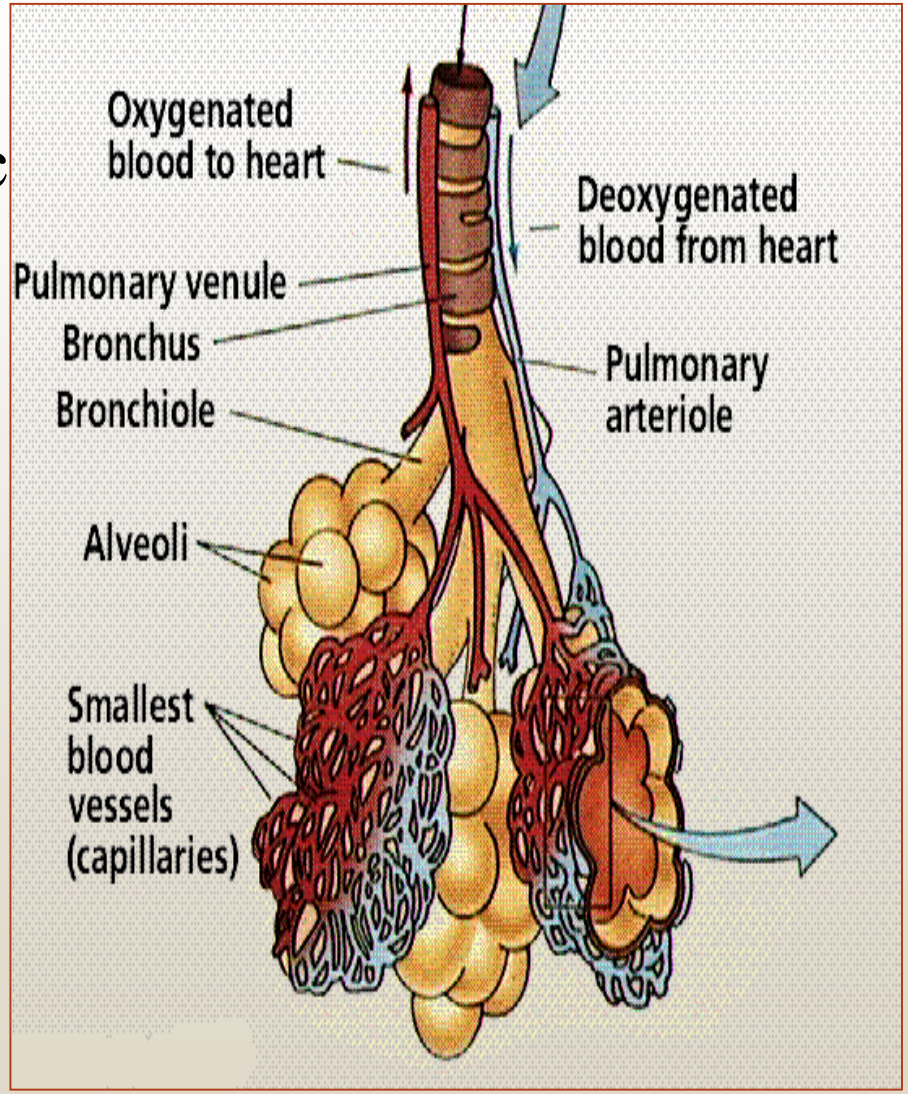
Total alveolar surface area ~ 70 m^2

Alveolar membrane thickness < 1 μm.



Blood Vessels of the Lung

- Pulmonary Artery: carries Deoxygenated (venous) cardiac output.
- Pulmonary capillaries are extremely dense
- Pulmonary Veins: carries Oxygenated (arterial) cardiac output.



Pulmonary disorders

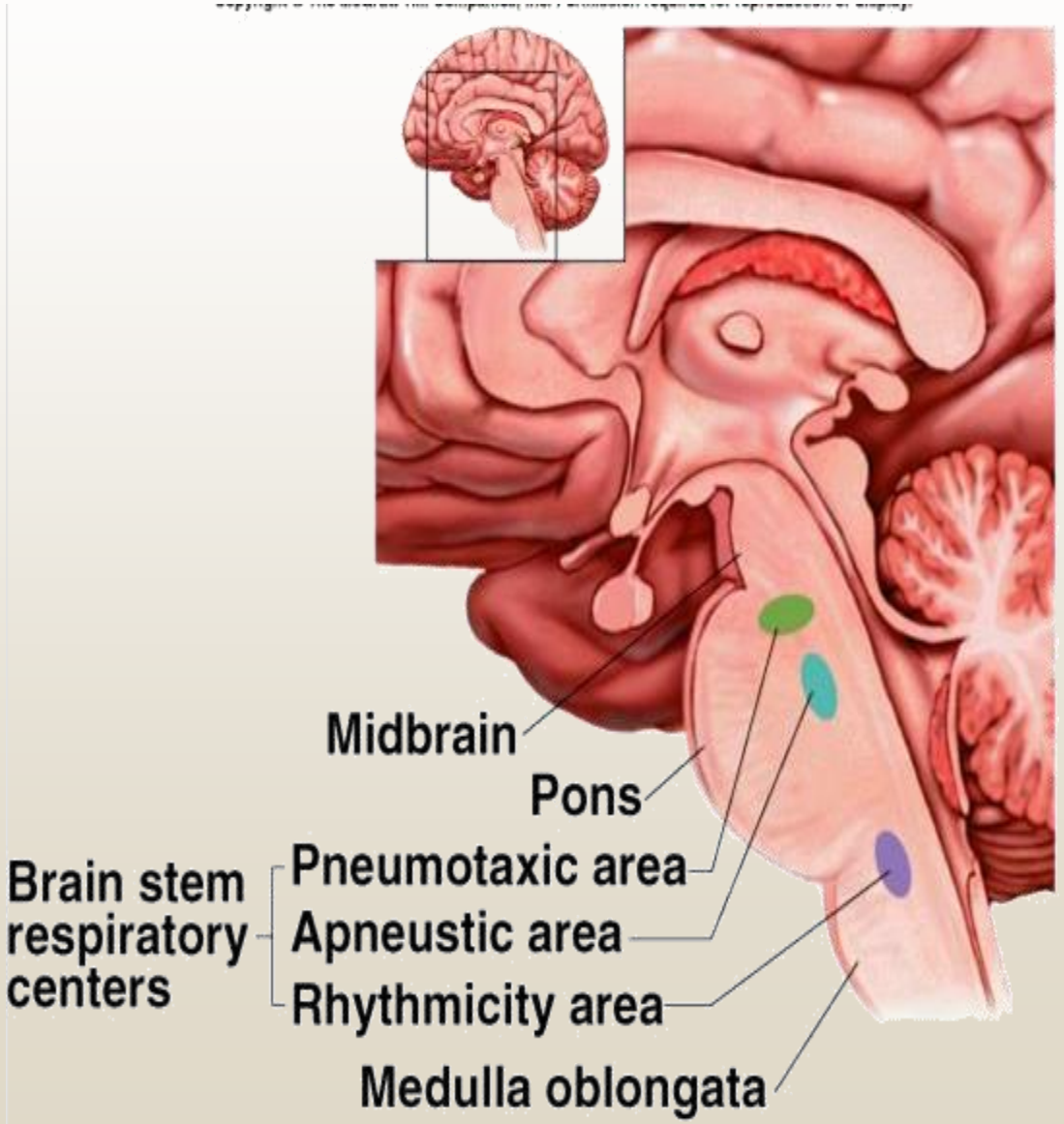
- **Restrictive disorder:**
  - Vital capacity is reduced.
  - Less air in lungs.
- **Obstructive disorder:**
  - Rate of expiration is reduced.
  - Lungs are “fine,” but bronchi are obstructed.
- COPD (chronic obstructive pulmonary disease):
- Smoking is the main cause for COPD
  - Asthma,Emphysema,Chronic bronchitis

Pulmonary Circulation

- Left ventricle pumps to entire body,
- Right ventricle only to lungs.
- Both ventricles pump 5.5 L/min
- Pulmonary circulation: various adaptations.
  - Low pressure, low resistance.
  - Prevents pulmonary edema.
  - Pulmonary arteries dilate if $P0_2$ is low (opposite of systemic)

Neural control

- Respiratory centers
- In hindbrain
  - - medulla oblongata
  - - pons
- Automatic breathing



Hemoglobin

It's the red carrying pigment of blood

The Loading/unloading of O2 by Hb depends on:

1. P02
2. Affinity between hemoglobin and 02
3. pH
4. temperature

- Affinity between hemoglobin and 0_2:
- pH falls -> less affinity -> more unloading (and vice versa if pH increases)
- temp rises -> less affinity -> more unloading
- exercise, fever

$C0_2$ Transport

- $C0_2$ transported in the blood in 3 forms:
  1- most as bicarbonate ion ($HC0_3^-$)
  2- dissolved $C0_2$
  3- $C0_2$ attached to hemoglobin (Carbaminohemoglobin)

Acid-Base Balance

- $H_20 + C0_2 \longleftrightarrow H_2C0_3 \longleftrightarrow H^+ + HC0_3^-$
- **Hypoventilation**:
  - $PC0_2$ rises, pH falls (acidosis).
- **Hyperventilation**:
  - $PC0_2$ falls, pH rises (alkalosis).

Ventilation is normally adjusted to keep pace with metabolic rate, so blood pH is maintained.

Other Functions of the Respiratory System

- BEHAVIORAL- talking, laughing, singing, reading
- DEFENSE- humidification, particle expulsion (coughing, sneezing), particle trapping (clots), immunoglobulins from tonsils and adenoids, a-1 antitrypsin, lysozyme, interferon, complement system
- SECRETIONS- mucus (goblet cells, mucus glands)

Other Functions: cont

- METABOLIC- forms angiotensin II, prostacyclin, bradykinin, serotonin and histamine
- ACID - BASE BALANCE- changes in ventilation e.g., acute acidosis of exercise
- MISCELLANAEOUS- lose heat and water, liquid reservoir for blood,force generation for lifting, vomiting, defaecation and childbirth

Post Study Test

- 1-Define Elasticity
- 2-What is Conducting zone
- 3- Define COPD

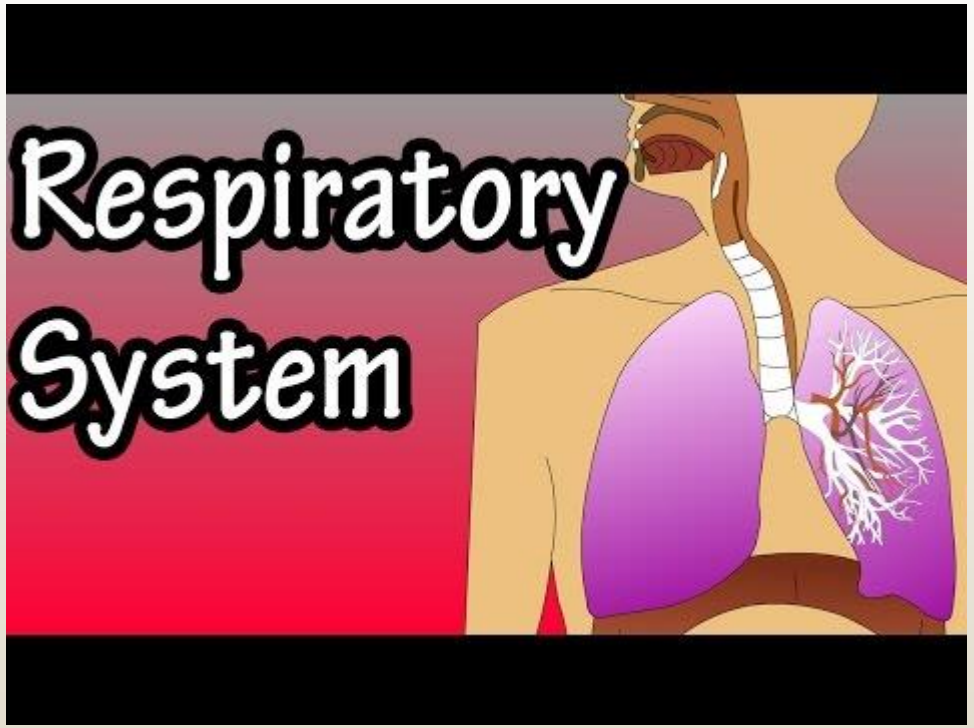
Answers :Pre Study Test

- 1-Respiration:It is the process by which the body takes in oxygen and utilizes and removes CO2 from the tissues into the expired air
- 2-Transport of gases by blood (haemoglobin)
- 3-Gas exchange across alveolar membrane Diffusion in the alveoli, Fick's law

Answers :Post Study Test

- 1-Elasticity: It is the ability of the lungs to recoil to their original collapsed shape during expiration Elastin in the lungs helps recoil
- 2-Conducting zone: Includes all the structures that air passes through before reaching the respiratory zone. Mouth, nose, pharynx, glottis, larynx, trachea, bronchi.
- 3-COPD (chronic obstructive pulmonary disease): Smoking is the main cause for COPD Asthma,Emphysema,Chronic bronchitis

Video



https://www.youtube.com/watch?v=UTR1IsX55dc

Unit Four

Physiology of The Muscular System

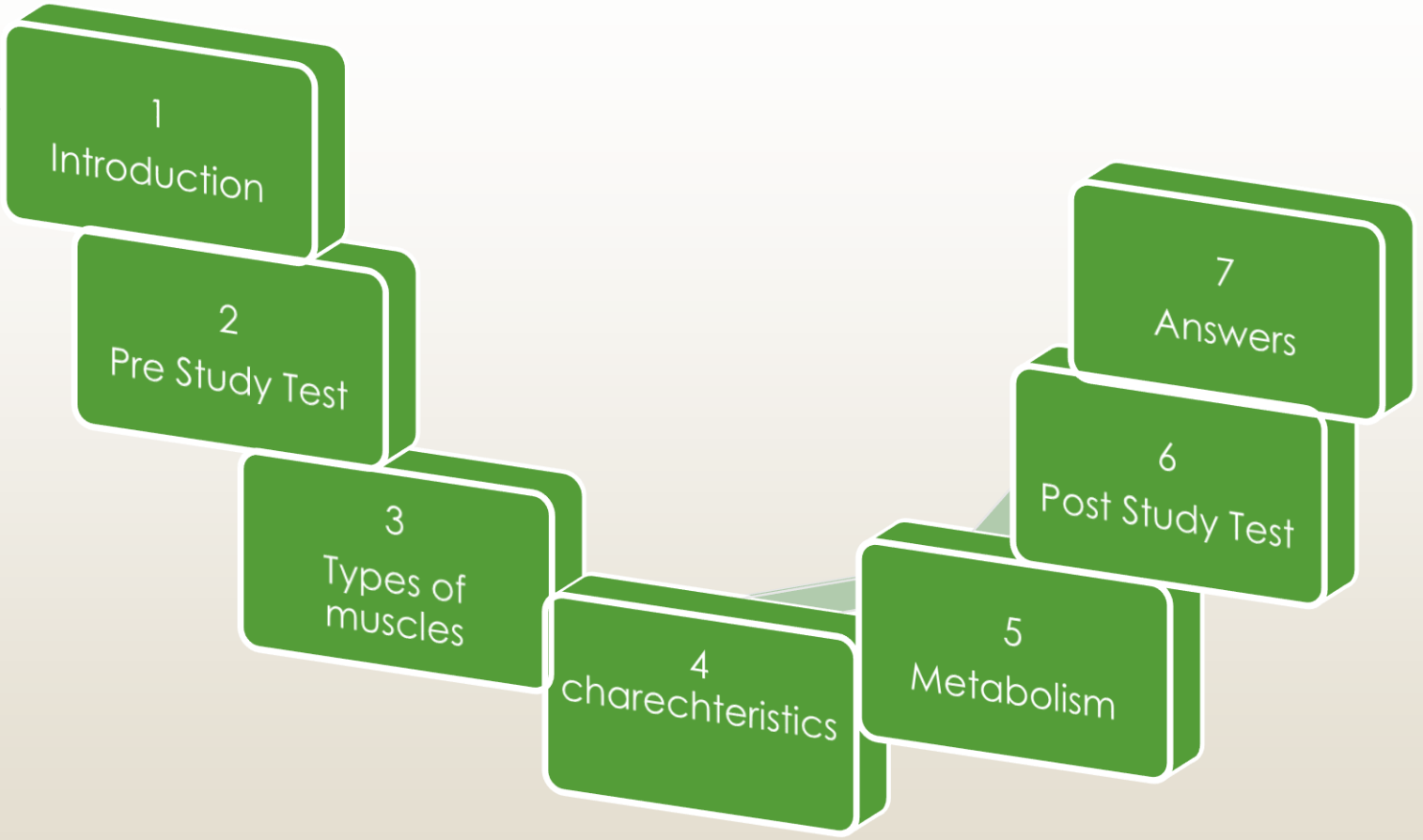
General Objective

- Identify the three types of muscle and describe the muscular system's functions.
- Describe the location and function of skeletal muscles.
- Locate and identify smooth muscle in the body.

Learning Outcome

After studying the unit , The student should be able to:-

- Types of the types of muscles
- Metabolism
- Muscles Disorders


1
Introduction
2
Pre Study Test
3
Types of muscles
4
charechteristics
5
Metabolism
6
Post Study Test
7
Answers

Muscle Tissue

- Skeletal Muscle
- Cardiac Muscle
- Smooth Muscle

There are three types of muscle tissue in the body. Skeletal muscle is the type that attaches to our bones and is used for movement and maintaining posture. Cardiac muscle is only found in the heart. It pumps blood. Smooth muscle is found in organs of the body such as the GI tract. Smooth muscle in the GI tract moves food and its digested products.

Pre Study Test

- 1-How many types of muscles in the body?
- 2-What is the type of muscle that attaches to our bones ?
- 3- which type of muscle moves food and its digested products?

Cardiac Muscle

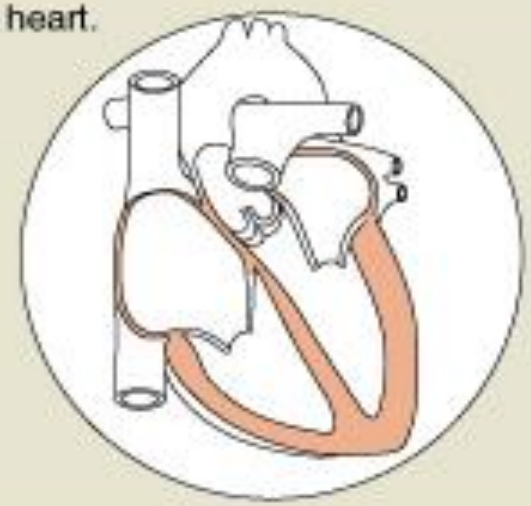
- Branching cells
- One/two nuclei per cell
- Striated
- Involuntary
- Medium speed contractions

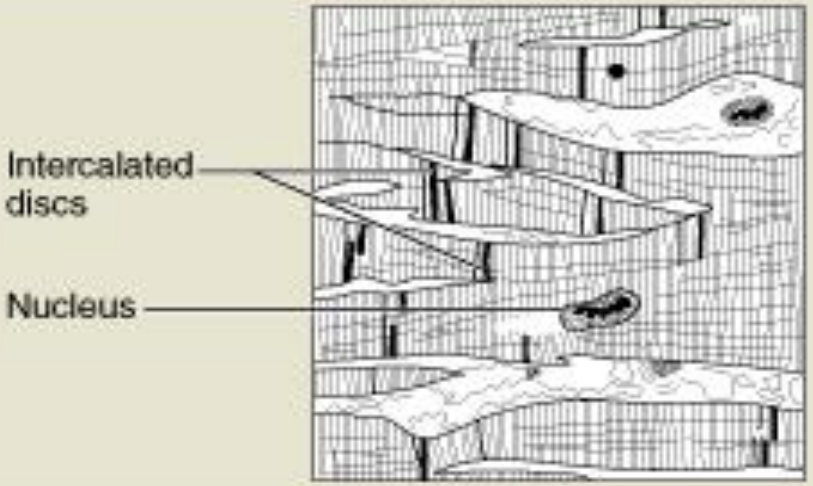
(b) Cardiac muscle

Description: Branching, striated, generally uninucleate cells that interdigitate at specialized junctions (intercalated discs).

Function: As it contracts, it propels blood into the circulation; involuntary control.

Location: The walls of the heart.





Cardiac muscle tissue is only found in the heart.
Cardiac cells are arranged in a branching pattern.
Only one or two nuclei are present each cardiac cell.
Like skeletal muscle, cardiac muscle is striated.
Cardiac muscle is involuntary.
Its speed of contraction is not as fast as skeletal, but faster than that of smooth muscle.

Smooth Muscle

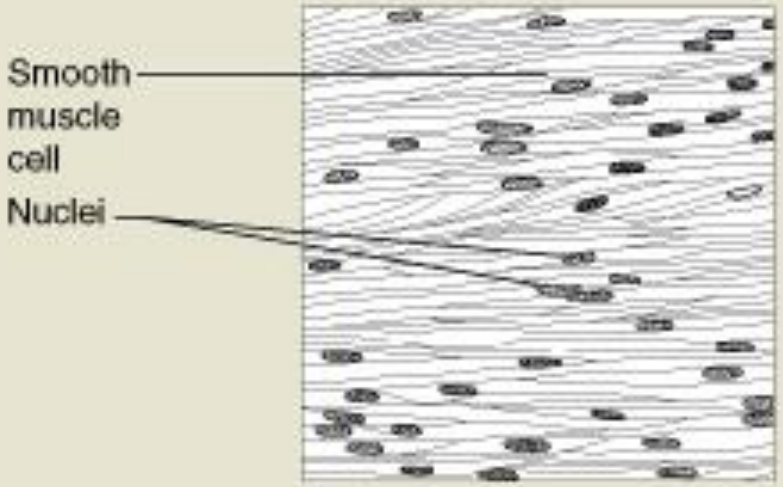
- Fusiform cells
- One nucleus per cell
- Nonstriated
- Involuntary
- Slow, wave-like contractions

(c) **Smooth muscle**

Description: Spindle-shaped cells with central nuclei; cells arranged closely to form sheets; no striations.

Function: Propels substances or objects (foodstuffs, urine, a baby) along internal passageways; involuntary control.

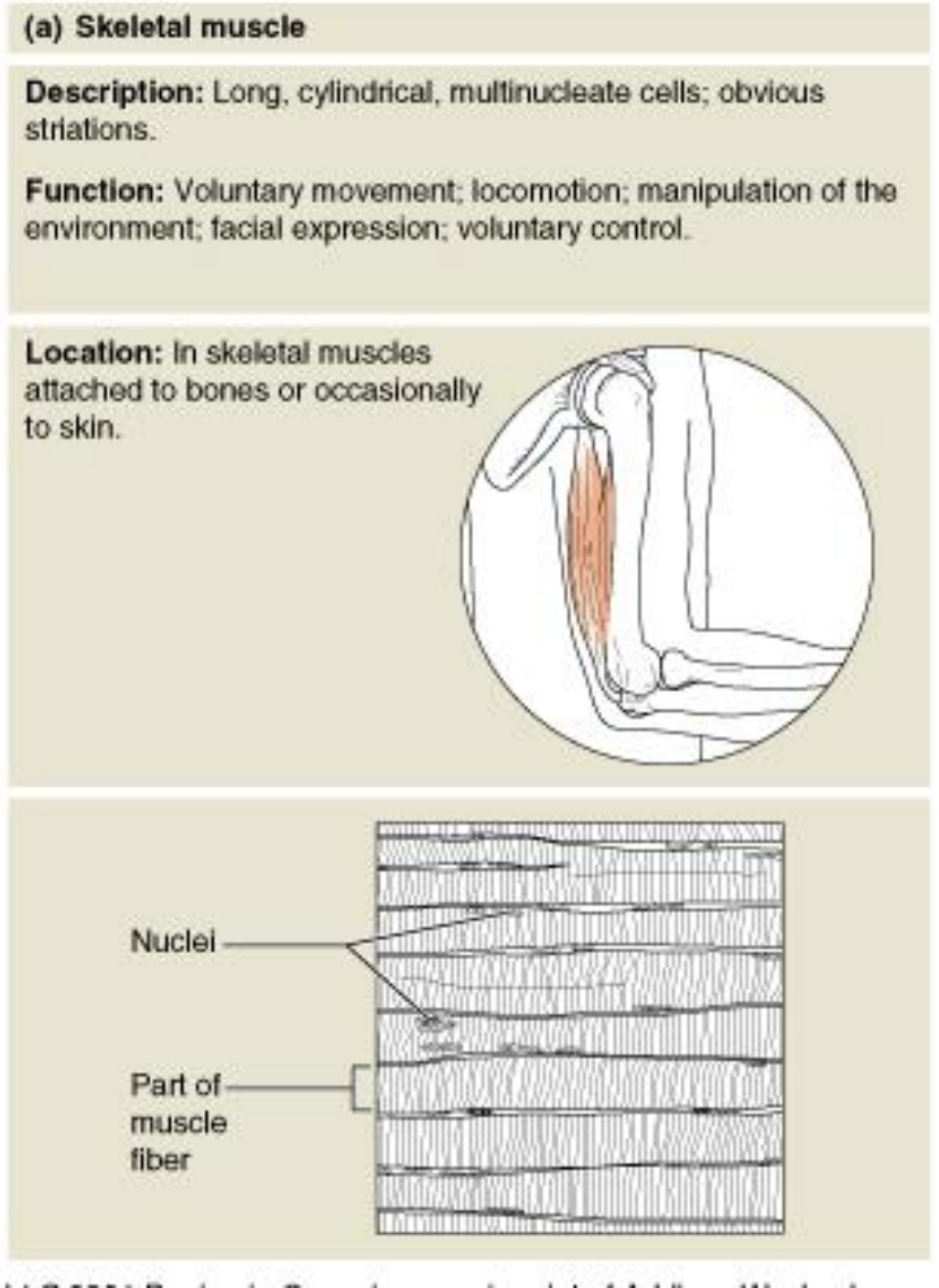
Location: Mostly in the walls of hollow organs.



Smooth muscle is found in the walls of hollow organs.
***Their muscle cells are fusiform in shape.**
***Smooth muscle cells have just one nucleus per cell.**
***Smooth muscle is nonstriated.**
***Smooth muscle is involuntary.**
***The contractions of smooth muscle are slow and wave-like.**

Skeletal Muscle charechteristics

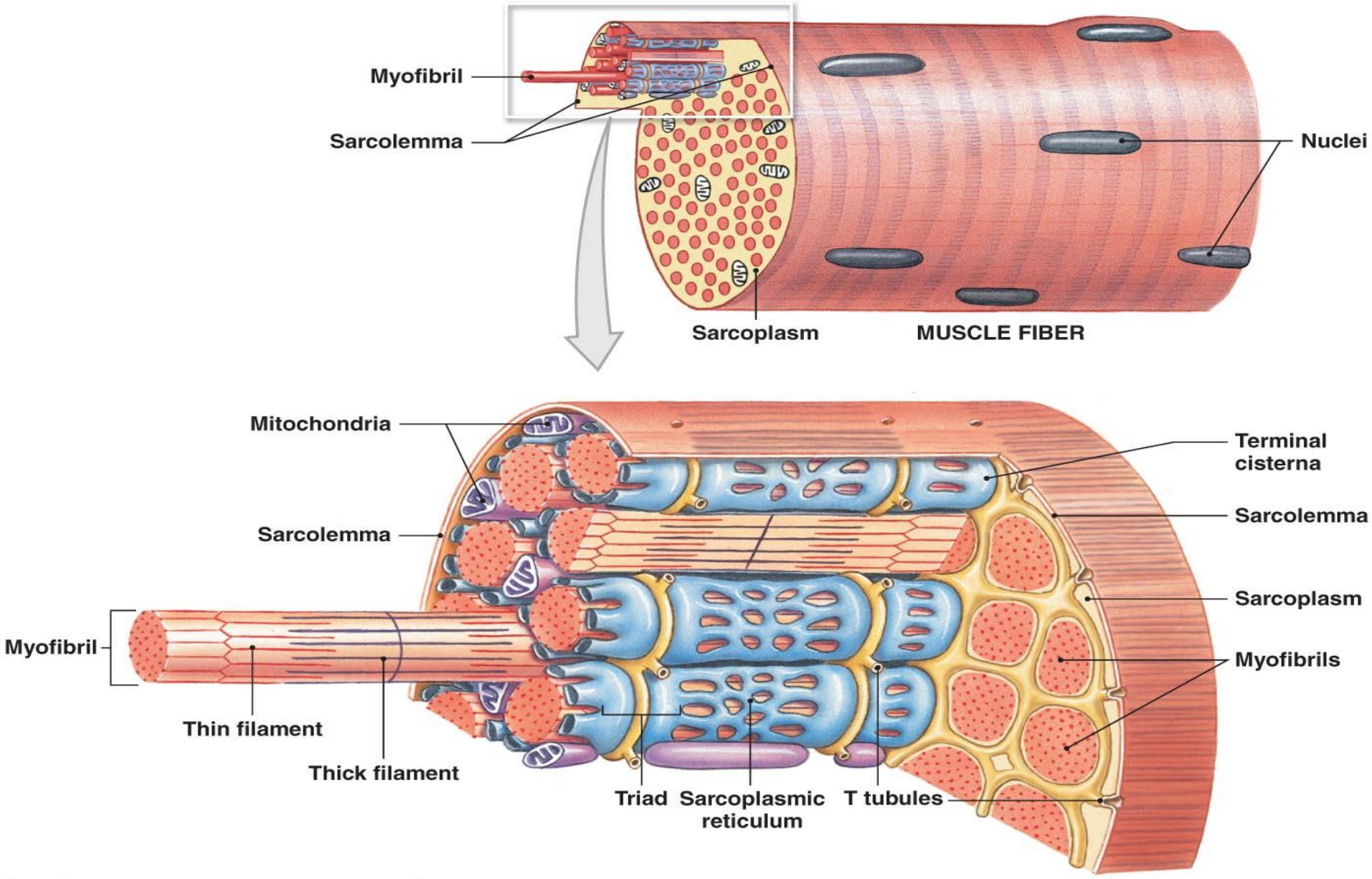
- Long cylindrical cells
- Many nuclei per cell
- Striated
- Voluntary
- Rapid contractions



A Comparison of Skeletal, Cardiac and Smooth Muscle :

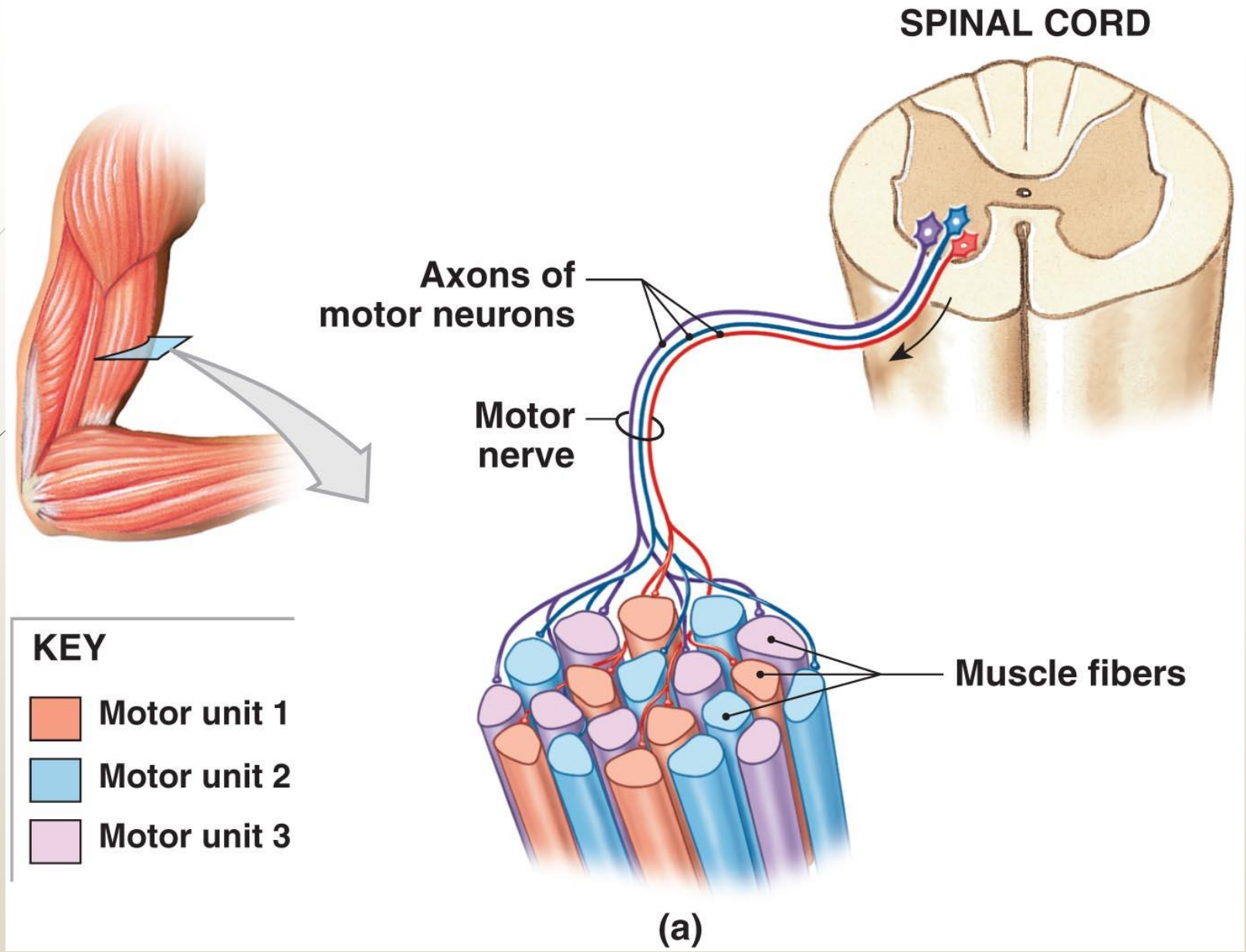
Property	Skeletal Muscle	Cardiac Muscle	Smooth Muscle
Striations?	Yes	Yes	No
Relative Speed of Contraction	Fast	Intermediate	Slow
Voluntary Control?	Yes	No	No
Membrane Refractory Period	Short	Long	
Nuclei per Cell	Many	Single	Single
Control of Contraction	Nerves	Beats spontaneously but modulated by nerves	Nerves Hormones Stretch
Cells Connected by Intercalated Discs or Gap Junctions?	No	Yes	Yes

Skeletal Muscle Fiber



Summary of Muscle Contraction:

1) Ca 2+ ion is released from the SR
2) Ca 2+ bind to troponin
3) Myosin cross-bridges bind to the actin
4) The myosin head pivots towards the center of the sarcomere
5) The myosin head binds an ATP molecule and detaches from the actin
6) The free myosin head splits the ATP


SPINAL CORD
Axons of motor neurons
Motor nerve
Muscle fibers
KEY
Motor unit 1
Motor unit 2
Motor unit 3
(a)

Metabolism

- Aerobic metabolism
  - 95% of cell demand
  - Kreb's cycle
  - 1 pyruvic acid molecule ➔ 17 ATP
- Anaerobic metabolism
  - Glycolysis ➔ 2 pyruvic acids + 2 ATP
  - Provides substrates for aerobic metabolism
  - As pyruvic acid builds converted to lactic acid

Muscle Fatigue

- **Muscle Fatigue**
  - When muscles can no longer perform a required activity, they are **fatigued**
- **Results of Muscle Fatigue**
  - Depletion of metabolic reserves
  - Damage to sarcolemma and sarcoplasmic reticulum
  - Low pH (lactic acid)
  - Muscle exhaustion and pain

Muscle Hypertrophy

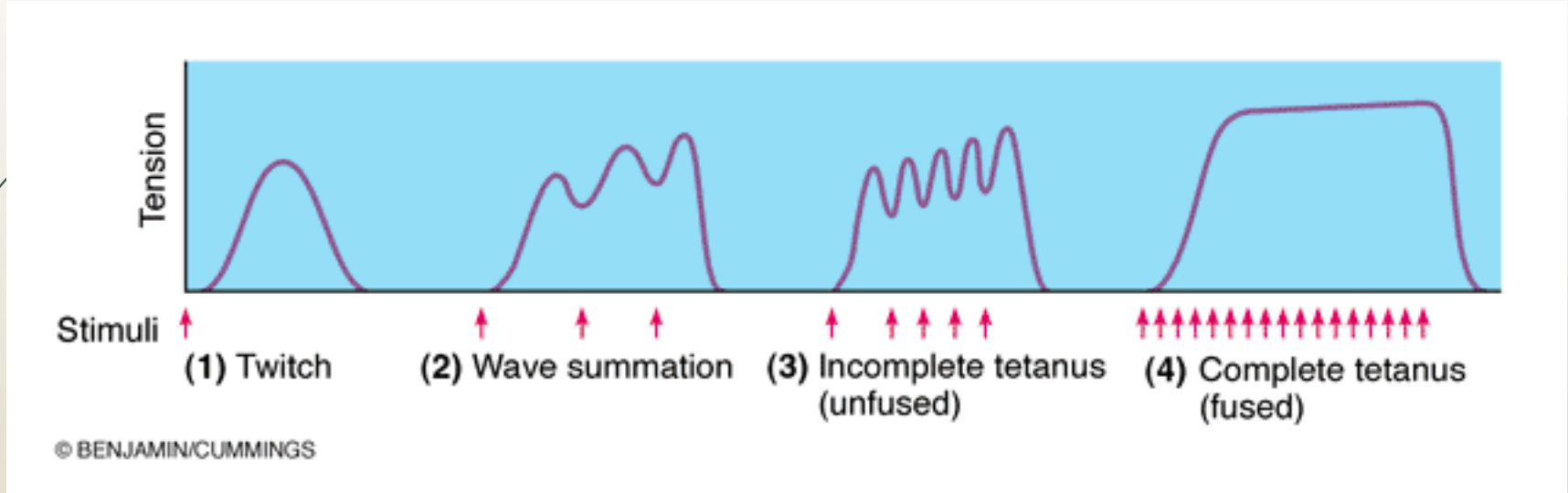
- Muscle growth from heavy training
  - Increases diameter of muscle fibers
  - Increases number of myofibrils
  - Increases mitochondria, glycogen reserves

Muscle Atrophy

- Lack of muscle activity
  - Reduces muscle size, tone, and power

Tetanus:

Sustained contraction of a muscleResult of a rapid succession of **nerve impulses**



Effect of Hormones

- Growth hormone & testosterone – stimulate synthesis of contractile proteins & enlargement of skeletal muscles
- Thyroid hormones – elevate rate of energy consumption in resting & active skeletal muscles
- Epinephrine – stimulate muscle metabolism and increase the duration of stimulation and force of contraction

Post Study Test

- 1-What are the Skeletal Muscle charechteristics ?
- 2-Define Tetanus
- 3- What are the Effect of Hormones?

Answers :Pre Study Test

- **1-** There are three types of muscle tissue in the body
- **2-** Skeletal muscle is the type that attaches to our bones
- **3-** Smooth muscle in the GI tract moves food and its digested products.

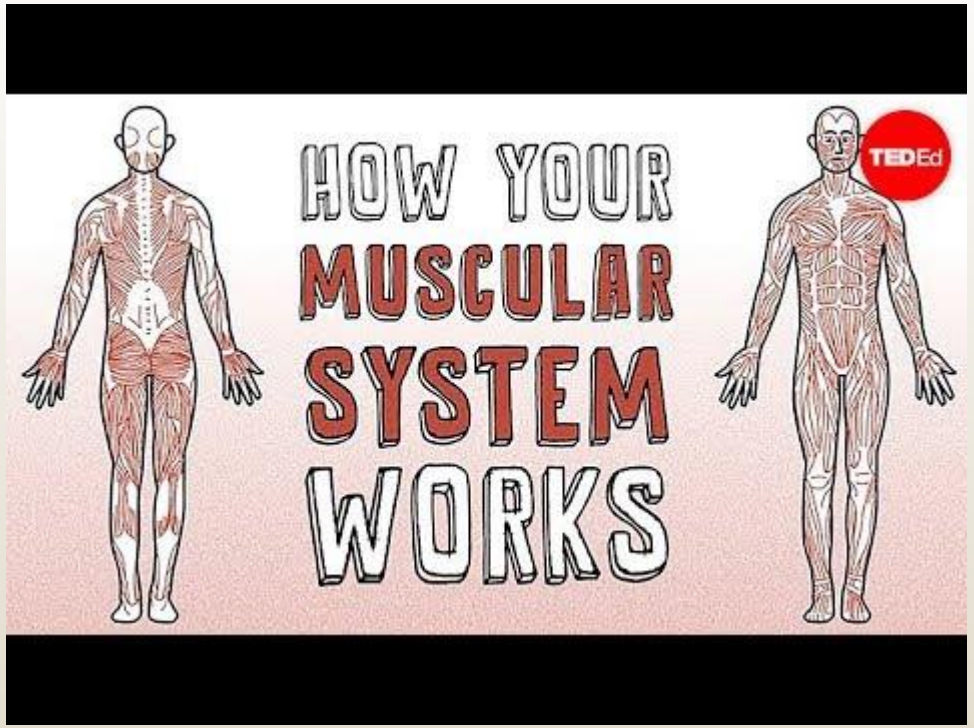
Answers :Post Study Test

- **1-**Long cylindrical cells, Many nuclei per cell, Striated, Voluntary and Rapid contractions
- **2-** Tetanus: Sustained contraction of a muscleResult of a rapid succession of **nerve impulses**
- **3-**Growth hormone & testosterone – stimulate synthesis of contractile proteins & enlargement of skeletal muscles

Thyroid hormones – elevate rate of energy consumption in resting & active skeletal muscles

Epinephrine – stimulate muscle metabolism and increase the duration of stimulation and force of contraction

Video



https://www.youtube.com/watch?v=VVL-8zr2hk4

Unit Five

Physiology of The Nervous System

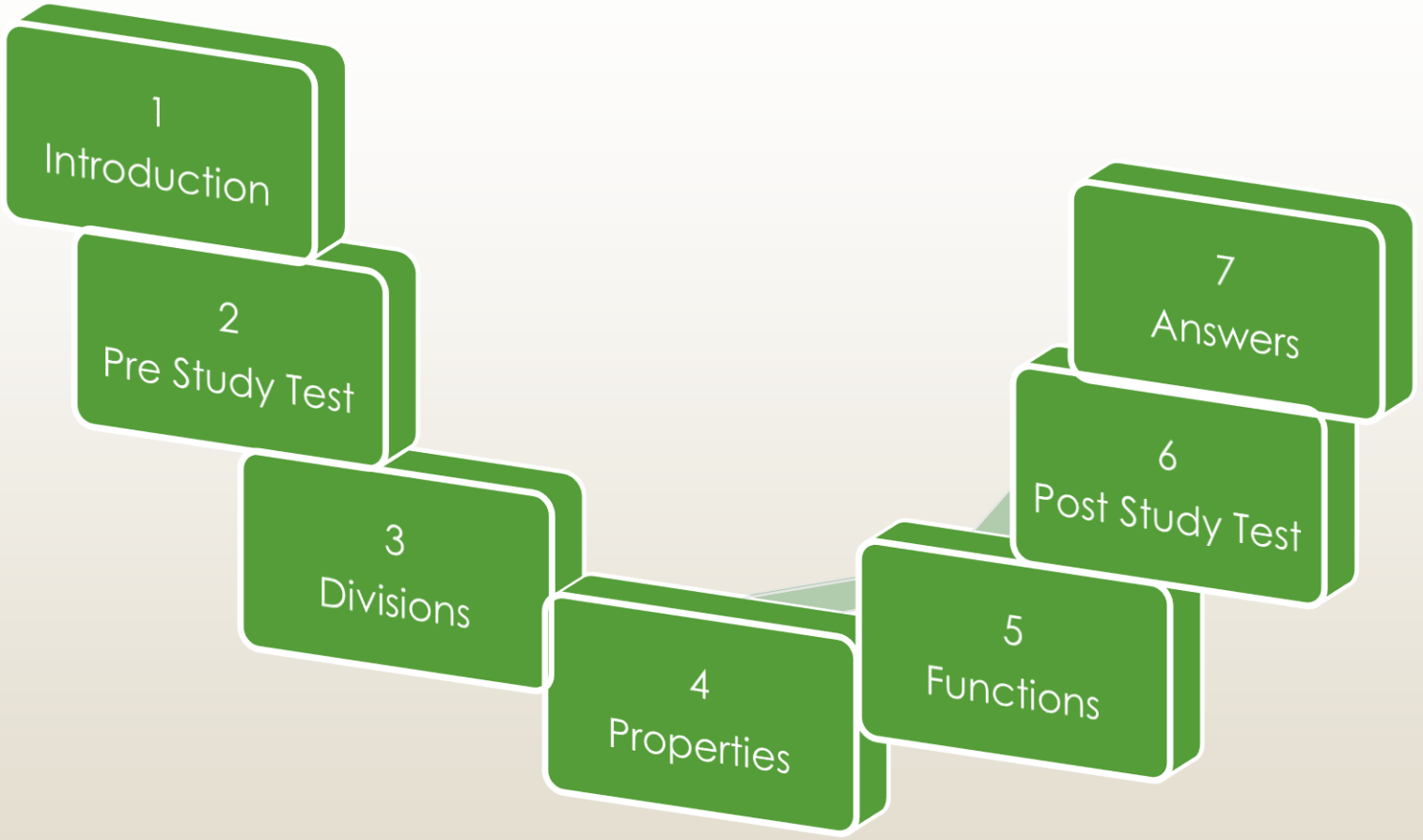
General Objective

- Identify the parts of the central nervous system
- Explain each component's function
- Use content-specific language related to the central nervous system

Learning Outcome

After studying the unit , The student should be able to:-

- Parts of the nervous system
- Functions
- Properties of Synapse


1
Introduction
2
Pre Study Test
3
Divisions
4
Properties
5
Functions
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Post Study Test
7
Answers

Nervous System

Central Nervous System

- To control voluntary and conscious functions e.g. voluntary movements, appreciation of sensations etc.

Autonomic Nervous System

- To control in-voluntory functions e.g. beating of heart, movements of intestine etc.

Pre Study Test

- 1-Define Central Nervous System
- 2-What is Autonomic Nervous System
- 3- how many pairs of cranial nerves in the body

Central Nervous System

- Anatomical Division :

  Brain & twelve pairs of cranial nerves

  Spinal Cord & thirty one pairs of spinal nerves

Brain

- Forebrain - Cerebrum
  - Thalamus
  - Hypothalamus
- Midbrain
- Hindbrain - Pons
  - Medulla
  - Cerebellum

(Grey matter outside & white matter inside)

Brain…

- Blood Supply : 700-800 ml/minute by

  Circle of Willis.

. Brain is covered by three meninges.

. Lymph is replaced by CSF, present in

  ventricles of brain & subarachnoid

Spinal Cord

- Parts : - Cervical
  - Thoracic
  - Lumbar
  - Sacral

Gray matter inside with anterior and posterior roots.

White matter outside with anterior, lateral and posterior columns.

Physiological Division

- Motor Component

  Frontal lobe

  Descending tract

  Anterior horn cell

  Motor nerve

  Muscle

- Sensory component
  - Receptor Sensory nerv
  - Ascending tract Thala
  - Parietal lobe

Neuron

- A functional unit of nervous system
- One way conduction in neuron
- Cell body is sensory
- Axon is motor
- Velocity of impulse depends upon
  - Myelination
  - Diameter

Synapse

- Functional junction between two neurons
- Transmission is via Neurotrans mi**t**er
- Excitatory NTs are Ach, Adr, NA
- Inhibitory NTs are Serotonin, GABA, Dopamine, Glycine
- (Inhibition can be presynaptic or

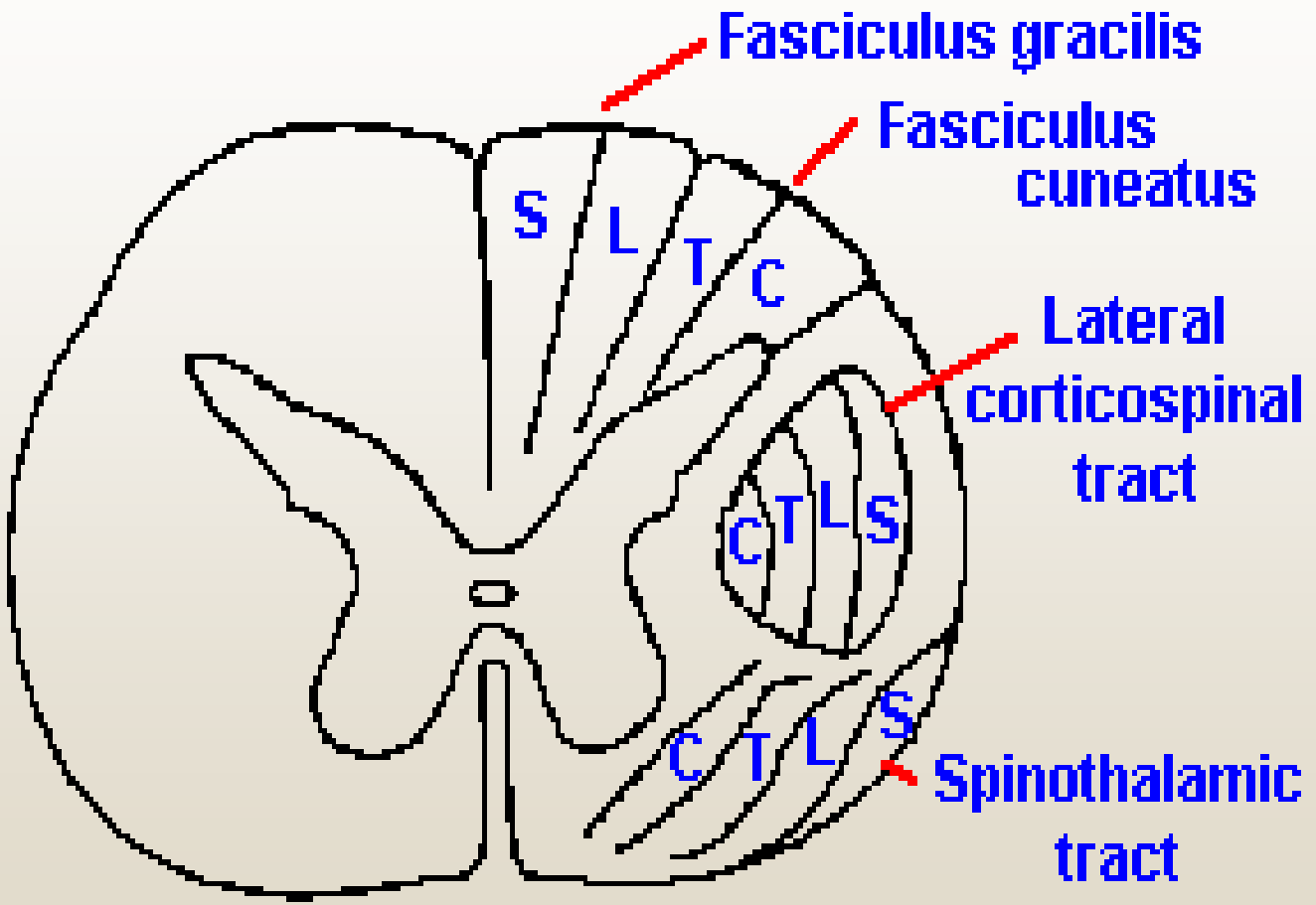
Properties of Synapse

1. One way conduction
2. Fatigue
3. Delay
4. Excitation or Inhibition
5. Reciprocal inhibition or cross extensor reflex
6. Reverberation
7. Irradiation

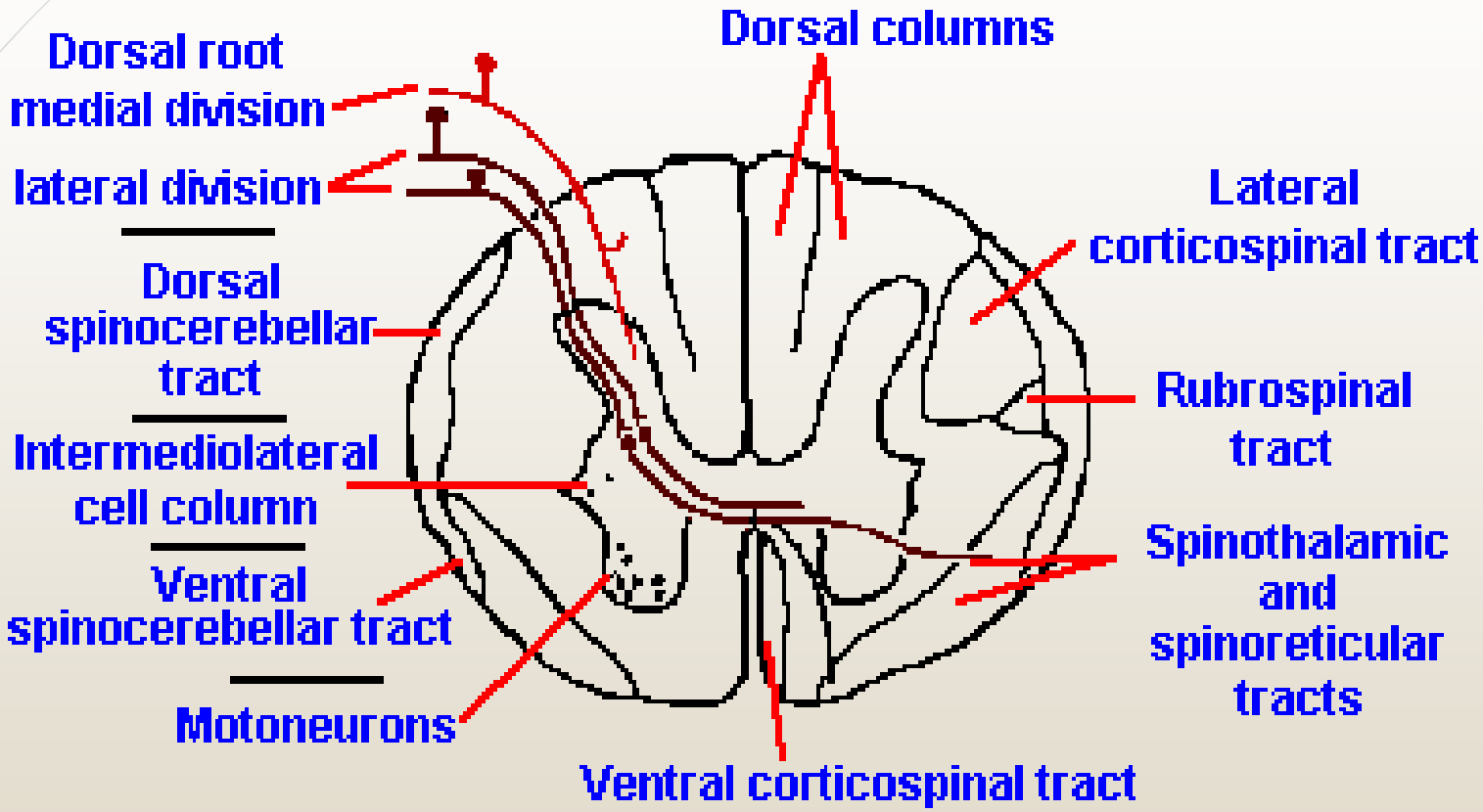
Functions of Spinal cord

1. Reflex action
2. Ascending tracts (Sensory)
3. Descending tracts (Motor)
4. Origin to ANS
5. Inhibitory neurons with different functions

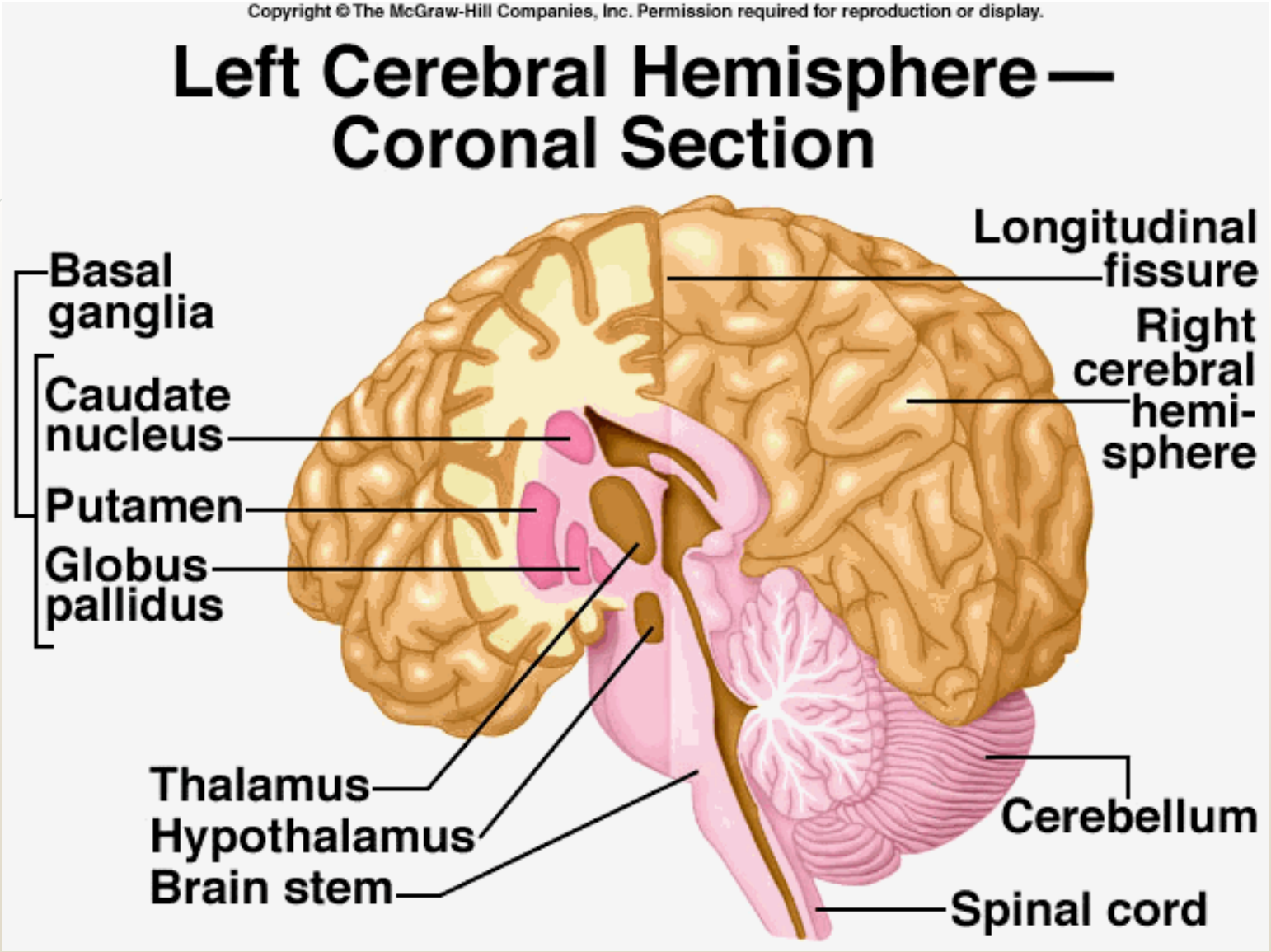
Tracts in Spinal Cord



Tracts in Spinal cord



Left Cerebral Hemisphere — Coronal Section



Functions of Cerebral Cortex

Frontal lobe(Motor Functions)

1. Control of Voluntary movements
2. Control of Speech and writing

Prefrontal lobe (Intellectual Functions)

3. Memory and intelligence
4. Thinking and solving of problems
5. Prediction and future planning

Parietal lobe (Sensory functions)

1. Appreciation of fine sensations
2. Stereognosis, barognosis
3. Appreciation of taste sensation

Temporal lobe (Auditory functions)

1. Appreciation of hearing
2. Behavioral functions like fear and rage

Occipital lobe (Visual functions)

Appreciation of vision including colors

Functions of Hypothalamus

1. **Endocrine control on Pituitary gland**
2. **Regulation of**
   - **Food intake**
   - **Thirst**
   - **Body temperature**
   - **Sex behavior**
   - **Circadian rhythms**
   - **ANS**

Functions of Basal Ganglia

1. **Regulation of muscle tone**
2. **Inhibition of motor cortex**
3. **Timing and scaling of movements**
4. **Involuntary associative movements**
5. **Regulation of gross intentional acts**

Functions of Cerebellum

1. **Co-ordination of Voluntary movements**
2. **Timing, planning and scaling of movements**
3. **Regulation of Muscle tone**
4. **Regulation of Posture and Equilibrium**
5. **Regulation of Conjugate eyeball movements**
6. **Inhibition of Motor cortex**

Post Study Test

- 1-What are the parts of the brain
- 2-What is Neuron
- 3- What is the function of Temporal lobe

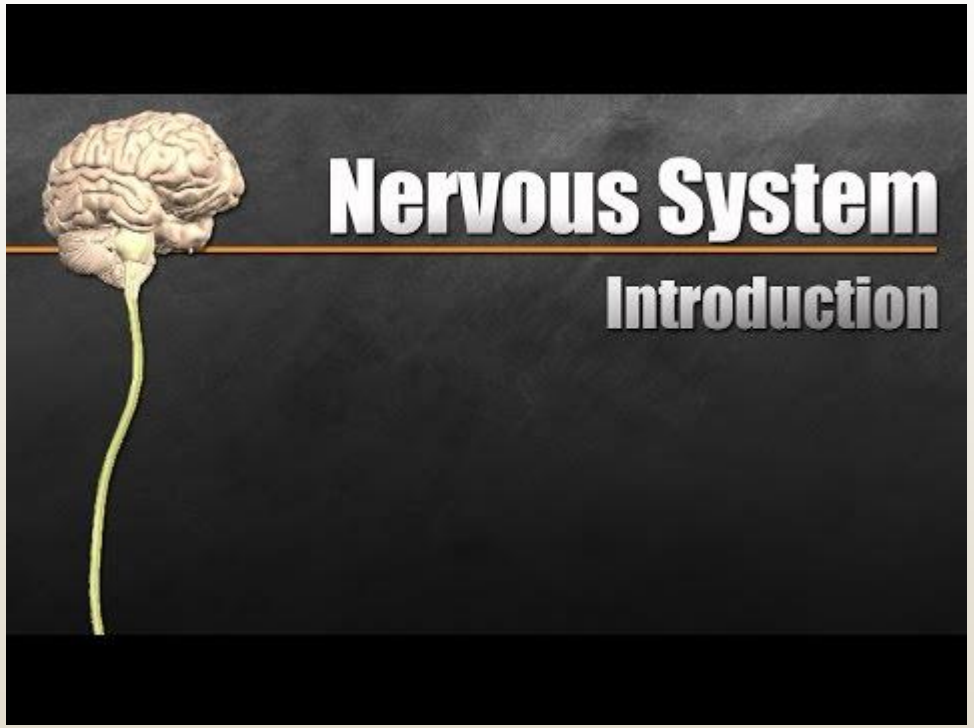
Answers :Pre Study Test

- 1-Central Nervous System To control voluntary and conscious functions e.g. voluntary movements, appreciation of sensations etc.
- 2- Autonomic Nervous System To control in- voluntory functions e.g. beating of heart, movements of intestine etc.
- 3- There are 12 pairs of cranial nerves

Answers :Post Study Test

- 1- Forebrain , Midbrain and Hindbrain
- 2-Neuron: A functional unit of nervous system One way conduction in neuron
- 3-Appreciation of hearing and Behavioral functions like fear and rage

Video



https://www.youtube.com/watch?v=44B0ms3XPKU

Unit Six

Physiology of The Cardiovascular System

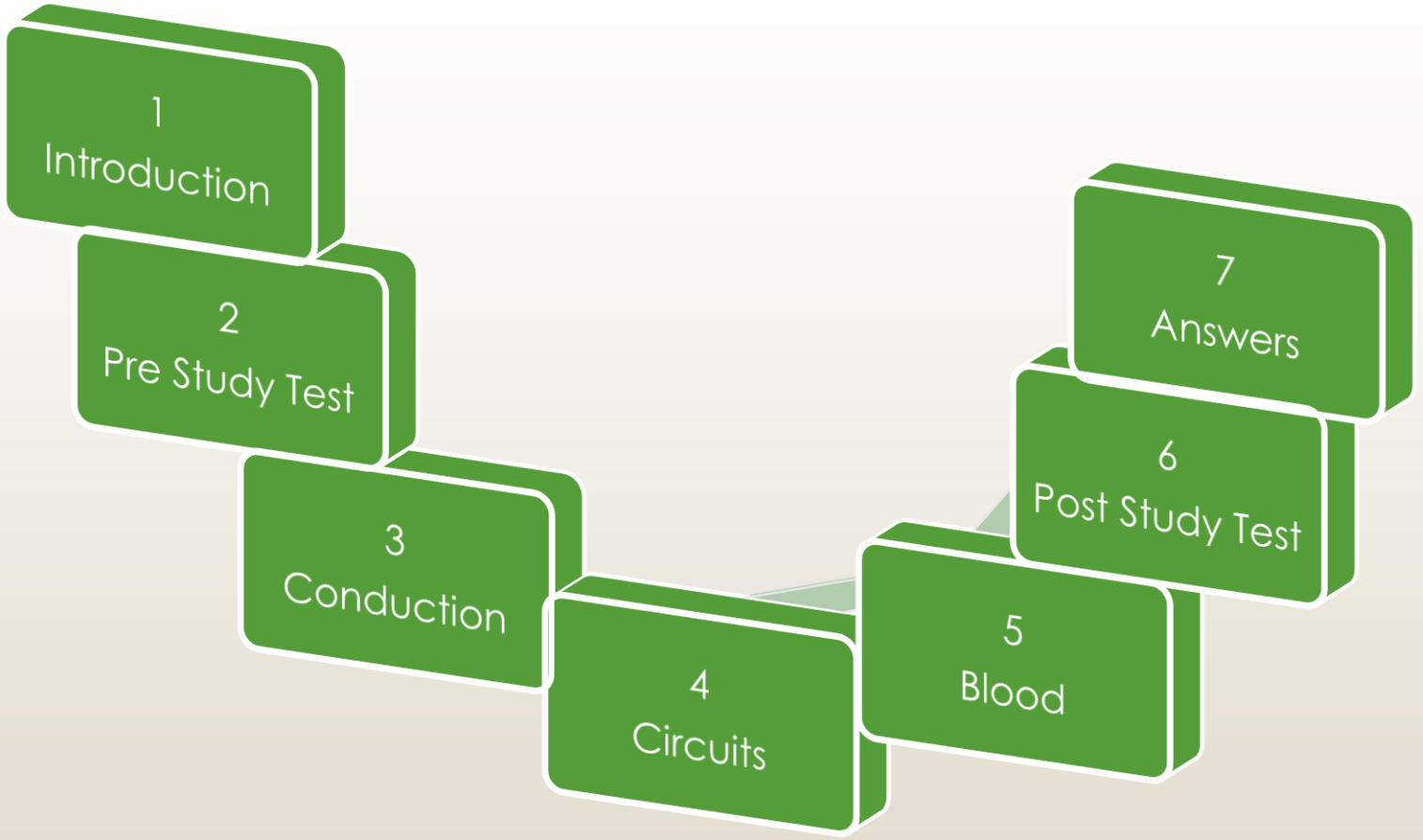
General Objective

- Identify the major components of the circulatory system and describe their
- functions.
- • Describe the exchange of gases between the lungs and bloodstream.
- • Identify the components of blood.
- • Describe the components and functions of plasma.

Learning Outcome

After studying the unit , The student should be able to:-

- Conduction system of the heart
- Blood Components
- Clotting process


1
Introduction
2
Pre Study Test
3
Conduction
4
Circuits
5
Blood
6
Post Study Test
7
Answers

The Heartbeat

- Each heartbeat is called a *cardiac cycle*.
- When the heart beats, the two atria contract together, then the two ventricles contract; then the whole heart relaxes.
- *Systole* is the contraction of heart chambers; *diastole* is their relaxation.
- The *heart sounds*, lub-dup, are due to the closing of the atrioventricular valves, followed by the closing of the semilunar valves.

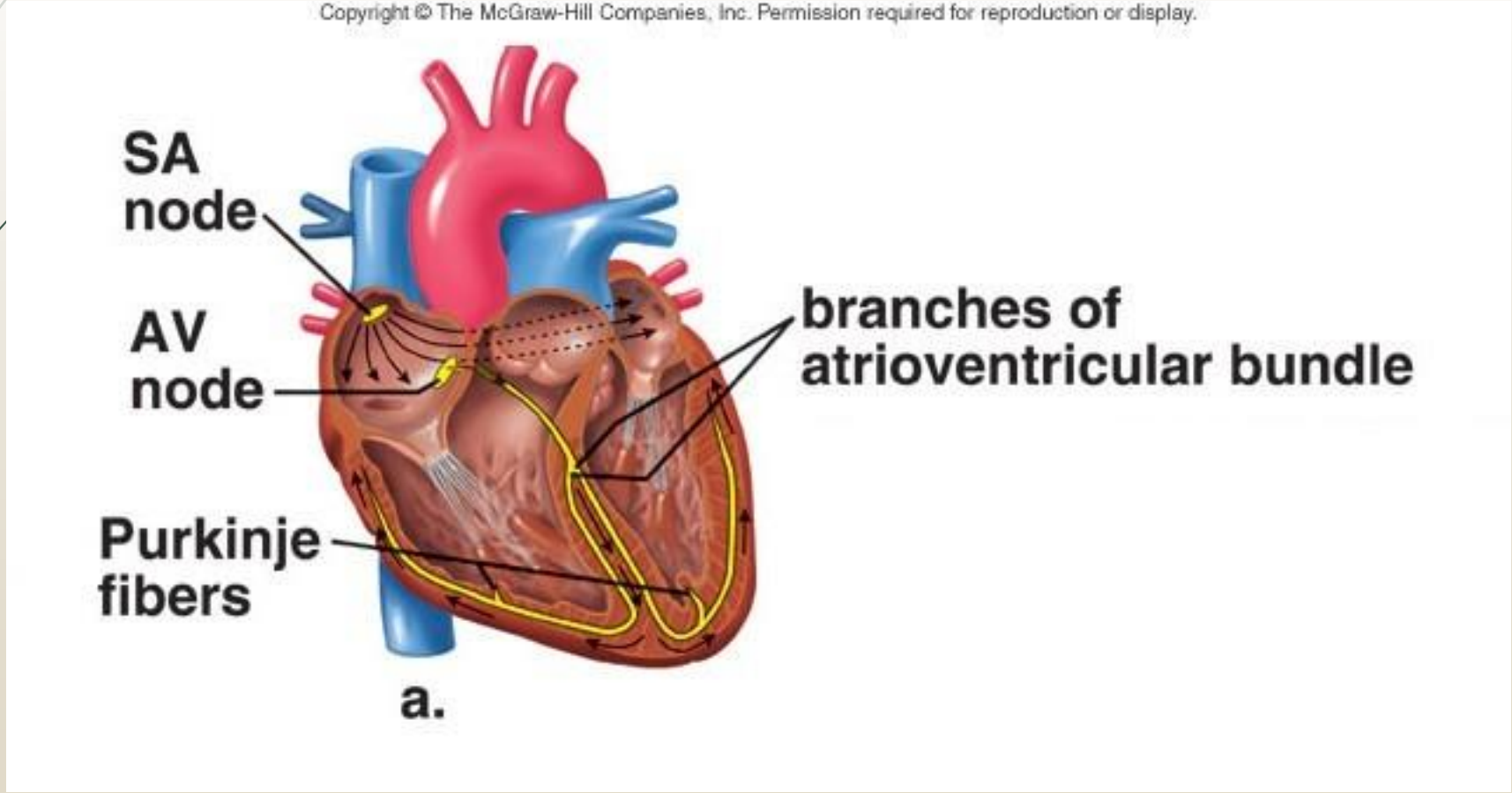
Pre Study Test

- 1-What is *cardiac cycle*
- 2-Define Systole
- 3- Describe the heart sounds

Intrinsic Control of Heartbeat

- The *SA* (*sinoatrial*) *node*, or *pacemaker*, initiates the heartbeat and causes the atria to contract on average every 0.85 seconds.
- The *AV* (*atrioventricular*) *node* conveys the stimulus and initiates contraction of the ventricles.
- The signal for the ventricles to contract travels from the AV node through the *atrioventricular bundle* to the smaller *Purkinje fibers*.

Conduction system of the heart



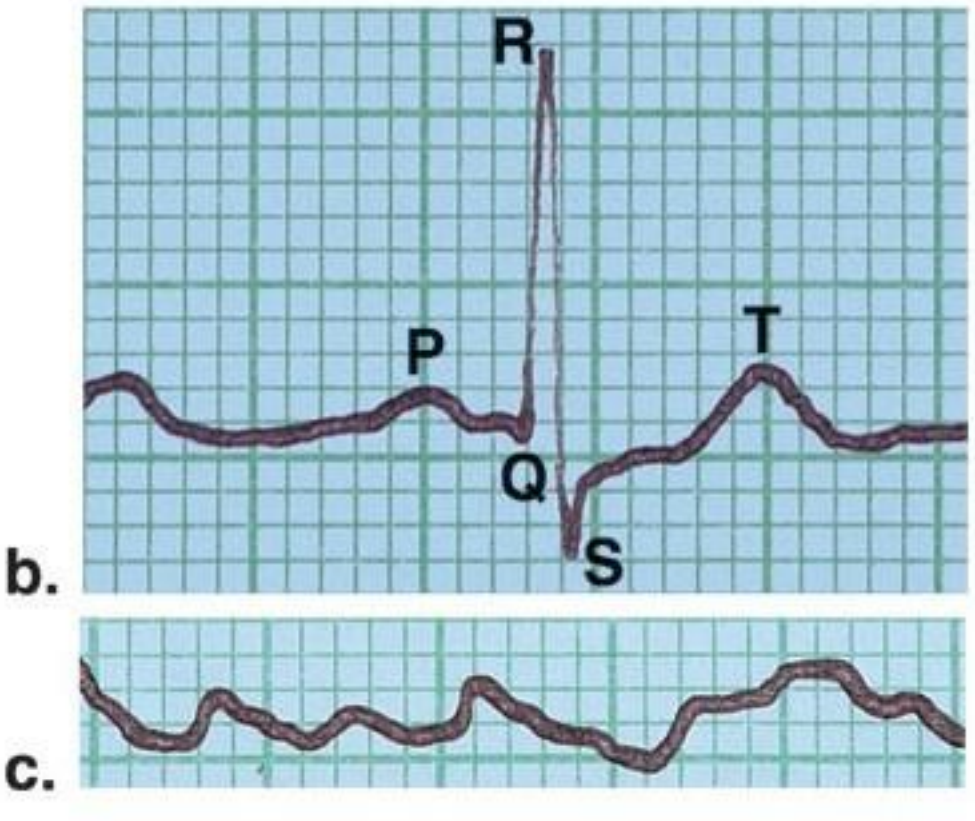
Extrinsic Control of Heartbeat

- A *cardiac control center* in the medulla oblongata speeds up or slows down the heart rate by way of the autonomic nervous system branches: *parasympathetic system* (slows heart rate) and the *sympathetic system* (increases heart rate).
- Hormones *epinephrine* and norepinephrine from the adrenal medulla also stimulate faster heart rate.

The Electrocardiogram

- An *electrocardiogram* (ECG) is a recording of the electrical changes that occur in the myocardium during a cardiac cycle.
- *Atrial depolarization* creates the *P wave*, *ventricle depolarization* creates the *QRS wave*, and *repolarization* of the ventricles produces the *T wave*.

Electrocardiogram

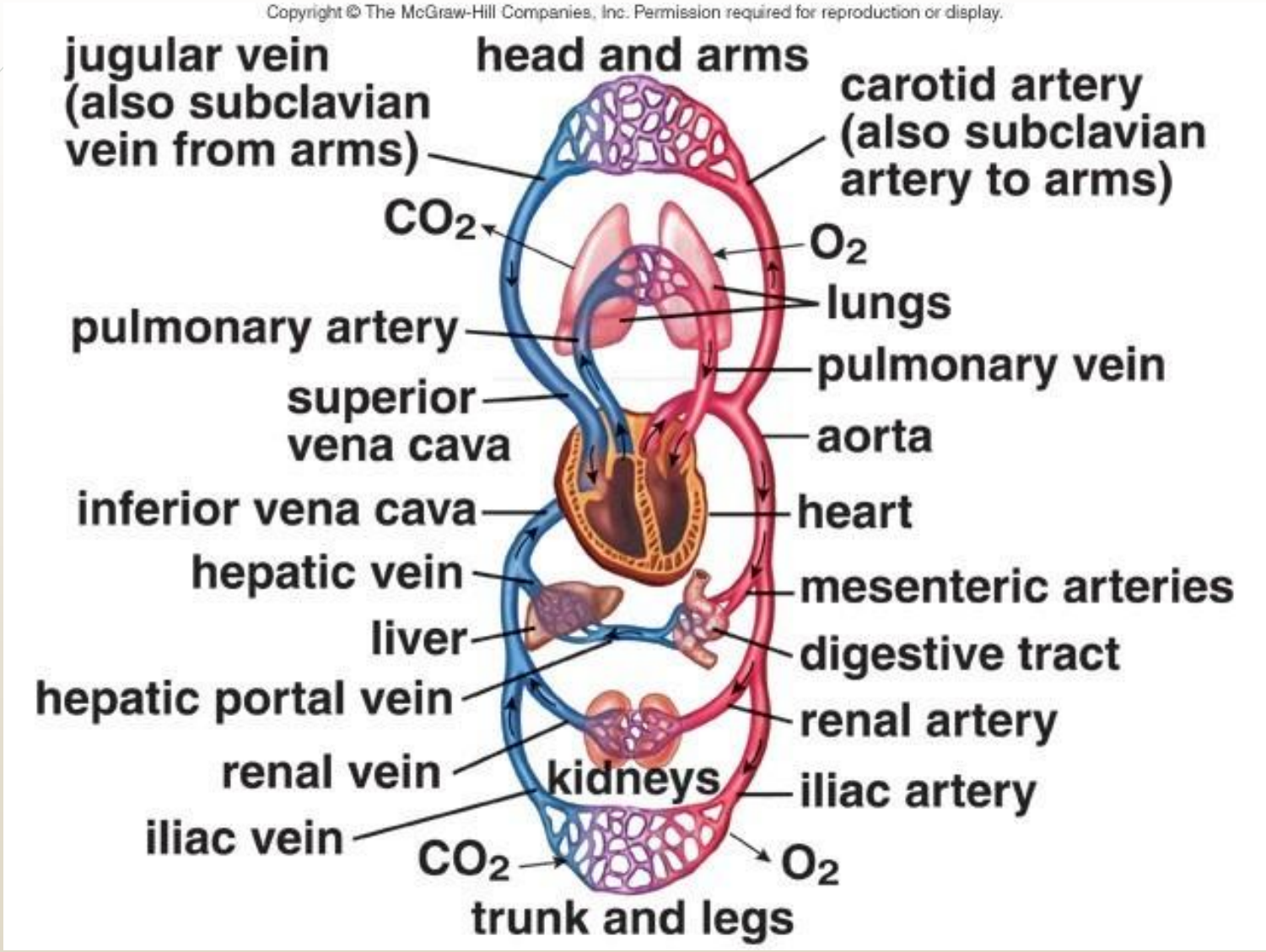


The Vascular Pathways

- The cardiovascular system includes two circuits:

2) *Pulmonary circuit* which circulates blood through the lungs, and
3) *Systemic circuit* which circulates blood to the rest of the body.
4) Both circuits are vital to homeostasis.

Cardiovascular system diagram



The Pulmonary Circuit

- The *pulmonary circuit* begins with the *pulmonary trunk* from the right ventricle which branches into two *pulmonary arteries* that take oxygen-poor blood to the lungs.
- In the lungs, oxygen diffuses into the blood, and carbon dioxide diffuses out of the blood to be expelled by the lungs.
- Four *pulmonary veins* return oxygen-rich blood to the left atrium.

The Systemic Circuit

- The *systemic circuit* starts with the aorta carrying O_2-rich blood from the left ventricle.
- The aorta branches with an artery going to each specific organ.
- Generally, an artery divides into arterioles and capillaries which then lead to venules.

- The vein that takes blood to the vena cava often has the same name as the artery that delivered blood to the organ.
- In the adult systemic circuit, arteries carry blood that is relatively high in oxygen and relatively low in carbon dioxide, and veins carry blood that is relatively low in oxygen and relatively high in carbon dioxide.
- This is the reverse of the pulmonary circuit.

- The *coronary arteries* serve the heart muscle itself; they are the first branch off the aorta.
- Since the coronary arteries are so small, they are easily clogged, leading to heart disease.
- The *hepatic portal system* carries blood rich in nutrients from digestion in the small intestine to the liver, the organ that monitors the composition of the blood.

Blood Flow

- The beating of the heart is necessary to homeostasis because it creates pressure that propels blood in arteries and the arterioles.
- Arterioles lead to the capillaries where nutrient and gas exchange with tissue fluid takes place.

Blood Flow in Arteries

- *Blood pressure* due to the pumping of the heart accounts for the flow of blood in the arteries.
- *Systolic pressure* is high when the heart expels the blood.
- *Diastolic pressure* occurs when the heart ventricles are relaxing.
- Both pressures decrease with distance from the left ventricle because blood enters more and more arterioles and arteries.

Blood Flow in Capillaries

- Blood moves slowly in capillaries because there are more capillaries than arterioles.
- This allows time for substances to be exchanged between the blood and tissues.

Blood Flow in Veins

- Venous blood flow is dependent upon:

2) skeletal muscle contraction,
3) presence of valves in veins, and
4) respiratory movements.

- Compression of veins causes blood to move forward past a valve that then prevents it from returning backward.

- Changes in thoracic and abdominal pressure that occur with breathing also assist in the return of blood.
- *Varicose veins* develop when the valves of veins become weak.
- *Hemorrhoids* (piles) are due to varicose veins in the rectum.
- *Phlebitis* is inflammation of a vein and can lead to a blood clot and possible death if the clot is dislodged and is carried to a pulmonary vessel.

Blood

- Blood separates into two main parts: *plasma* and *formed elements*.
- Plasma accounts for 55% and formed elements 45% of blood volume.
- Plasma contains mostly water (90–92%) and plasma proteins (7–8%), but it also contains nutrients and wastes.
- *Albumin* is a large plasma protein that transports bilirubin; *globulins* are plasma proteins that transport lipoproteins.

Composition of blood

FORMED ELEMENTS

Red Blood Cells (erythrocytes)

4 million–6 million per mm^3 blood

White Blood Cells (leukocytes)
4,000–11,000 per mm^3 blood

Granular leukocytes

- Basophils

20–50 per mm^3 blood

- Eosinophils

100–400 per mm^3 blood

- Neutrophils

3,000–7,000 per mm^3 blood

FORMED ELEMENTS

Agranular leukocytes

- Lymphocytes

1,500–3,000 per mm^3 blood

- Monocytes

100–700 per mm^3 blood

- **Platelets** (thrombocytes)

150,000–300,000 per mm^3 blood

PLASMA

Water (90–92% of plasma)

Plasma proteins (7–8% of plasma)
- Albumin
- Globulins
- Fibrinogen

Salts (less than 1% of plasma)

Gases
- Oxygen
- Carbon dioxide

Nutrients
- Lipids
- Glucose
- Amino acids

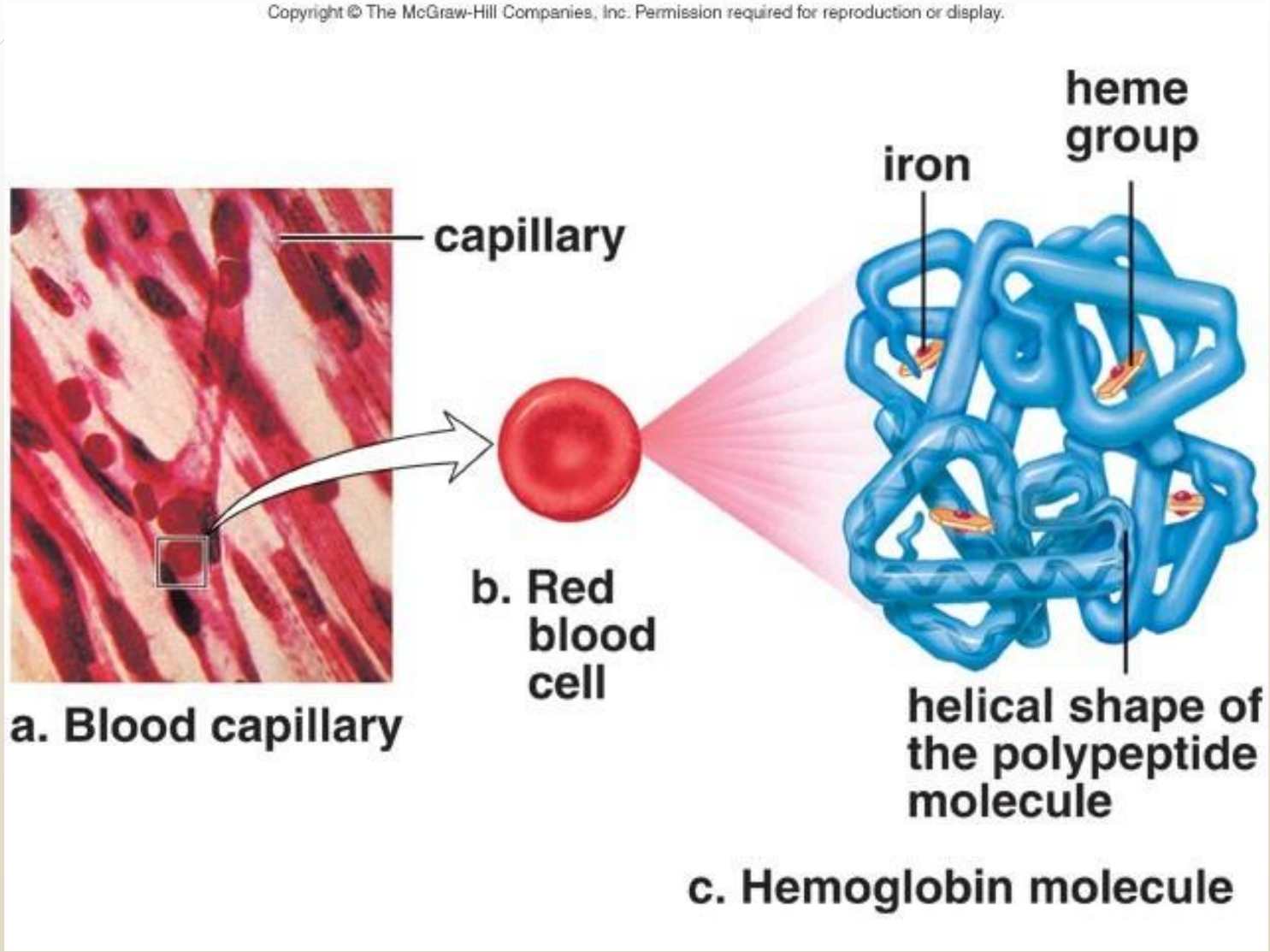
Nitrogenous wastes
- Urea
- Uric acid

Other
- Hormones, vitamins, etc.

The Red Blood Cells

- *Red blood cells* (*erythrocytes* or *RBCs*) are made in the *red bone marrow* of the skull, ribs, vertebrae, and the ends of long bones.
- Normally there are 4 to 6 million RBCs per mm^3 of whole blood.
- Red blood cells contain the pigment *hemoglobin* for oxygen transport; hemogobin contains *heme*, a complex iron-containing group that transports oxygen in the blood.

Physiology of red blood cells



- The air pollutant *carbon monoxide* combines more readily with hemoglobin than does oxygen, resulting in oxygen deprivation and possible death.
- Red blood cells lack a nucleus and have a 120 day life span.
- When worn out, the red blood cells are dismantled in the liver and spleen.

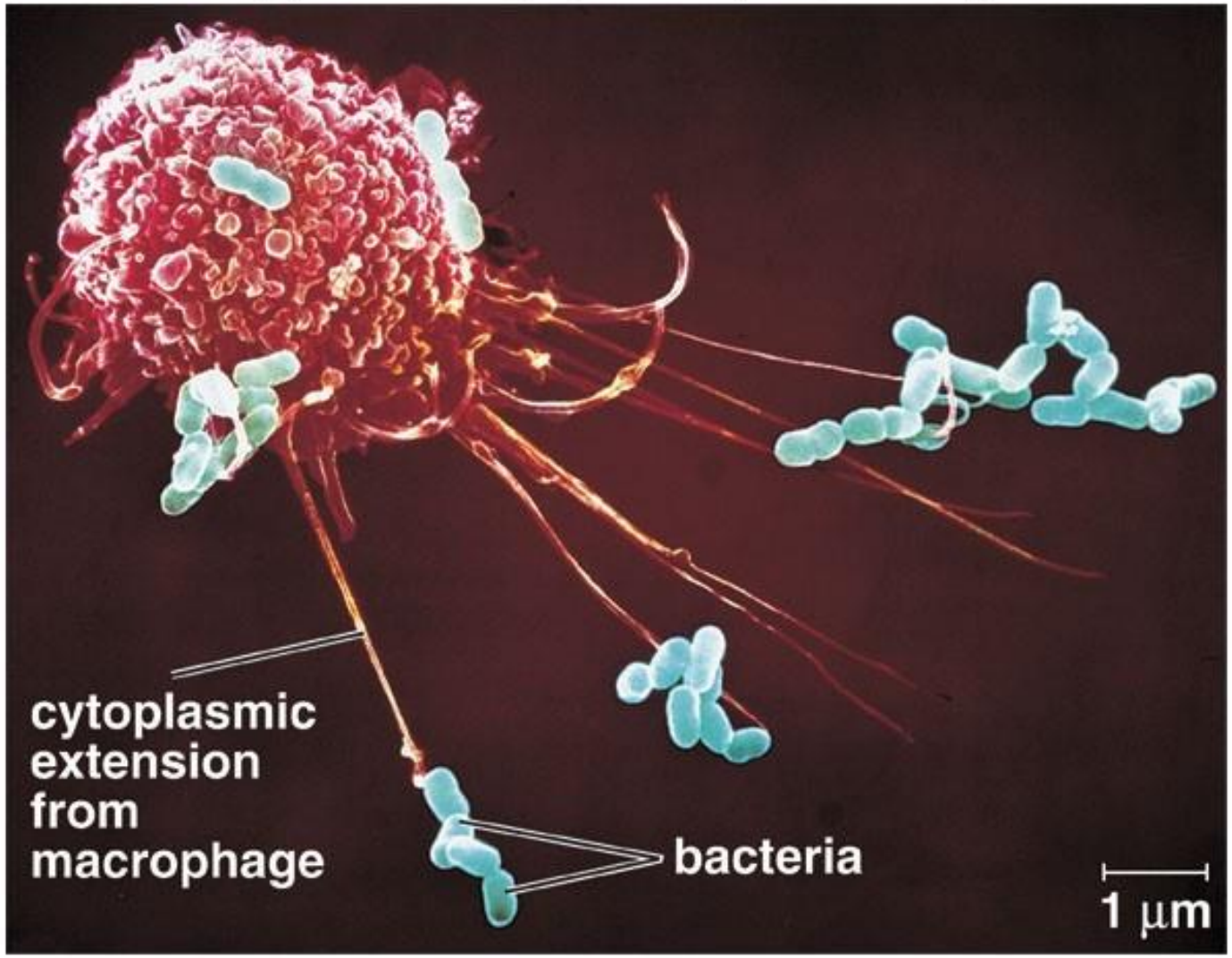
- Iron is reused by the red bone marrow where stem cells continually produce more red blood cells; the remainder of the heme portion undergoes chemical degradation and is excreted as bile pigments into the bile.
- Lack of enough hemoglobin results in *anemia*.
- The kidneys produce the hormone *erythropoietin* to increase blood cell production when oxygen levels are low.

The White Blood Cells

- *White blood cells* (*leukocytes*) have nuclei, are fewer in number than RBCs, with 5,000 – 10,000 cells per mm^3, and defend against disease.
- Leukocytes are divided into *granular* and *agranular* based on appearance.
- Granular leukocytes (*neutrophils*, *eosinophils*, and *basophils*) contain enzymes and proteins that defend the body against microbes.

- The aganular leukocytes (*monocytes* and *lymphocytes*) have a spherical or kidney-shaped nucleus.
- Monocytes can differentiate into *macrophages* that *phagocytize* microbes and stimulate other cells to defend the body.
- Lymphocytes are involved in immunity.
- An excessive number of white blood cells may indicate an infection or *leukemia*; HIV infection drastically reduces the number of lymphocytes.

Macrophage engulfing bacteria



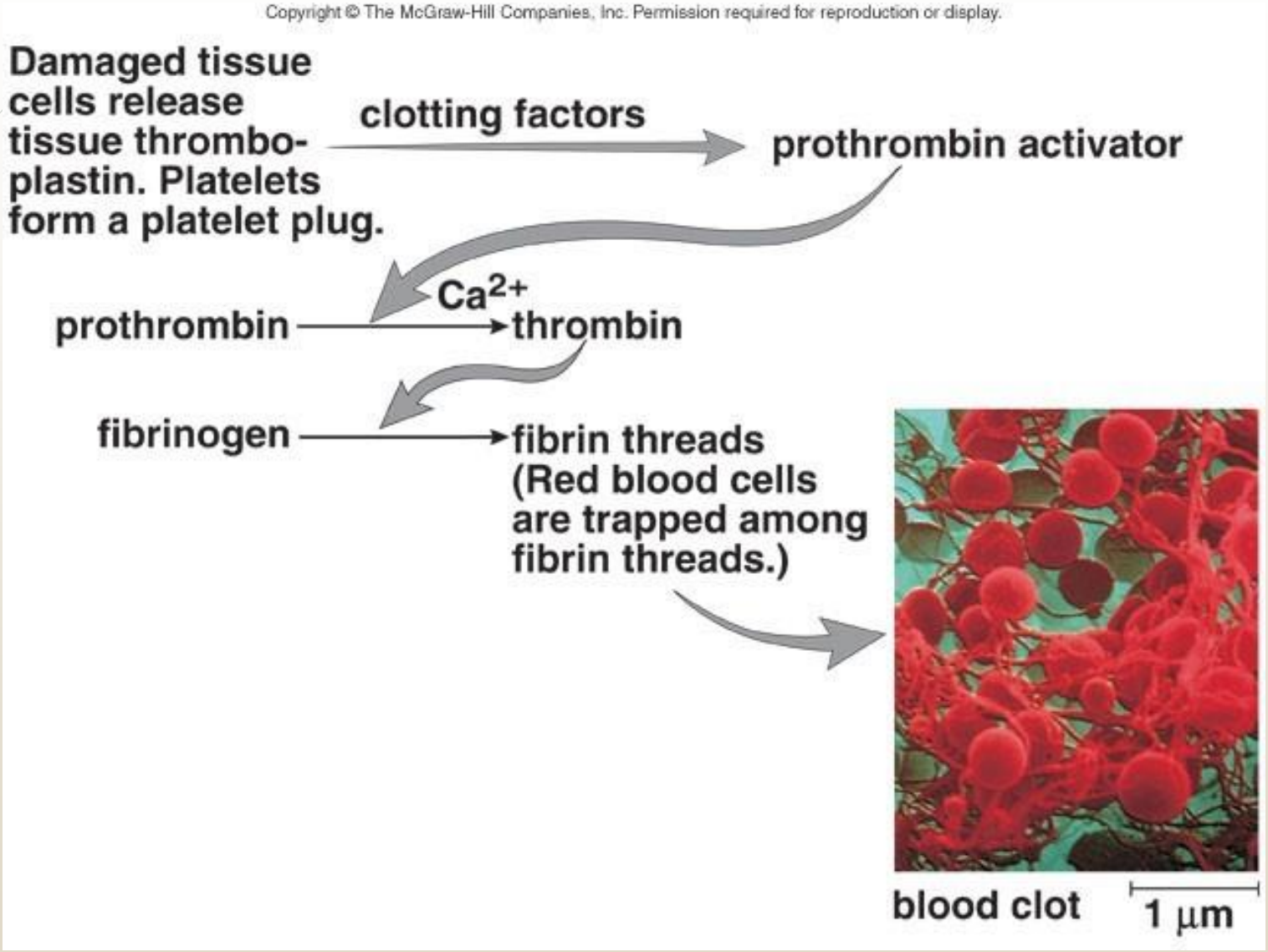
The Platelets and Blood Clotting

- Red bone marrow produces large cells called *megakaryocytes* that fragment into *platelets* at a rate of 200 billion per day; blood contains 150,000–300,000 platelets per mm^3.
- Twelve *clotting factors* in the blood help platelets form blood clots.

Blood Clotting

- Injured tissues release a clotting factor called *prothrombin activator*, which converts prothrombin into thrombin.
- Thrombin, in turn, acts as an enzyme and converts fibrinogen into insoluble threads of *fibrin*.
- These conversions require the presence of calcium ions (Ca^{2+}).
- Trapped red blood cells make a clot appear red.

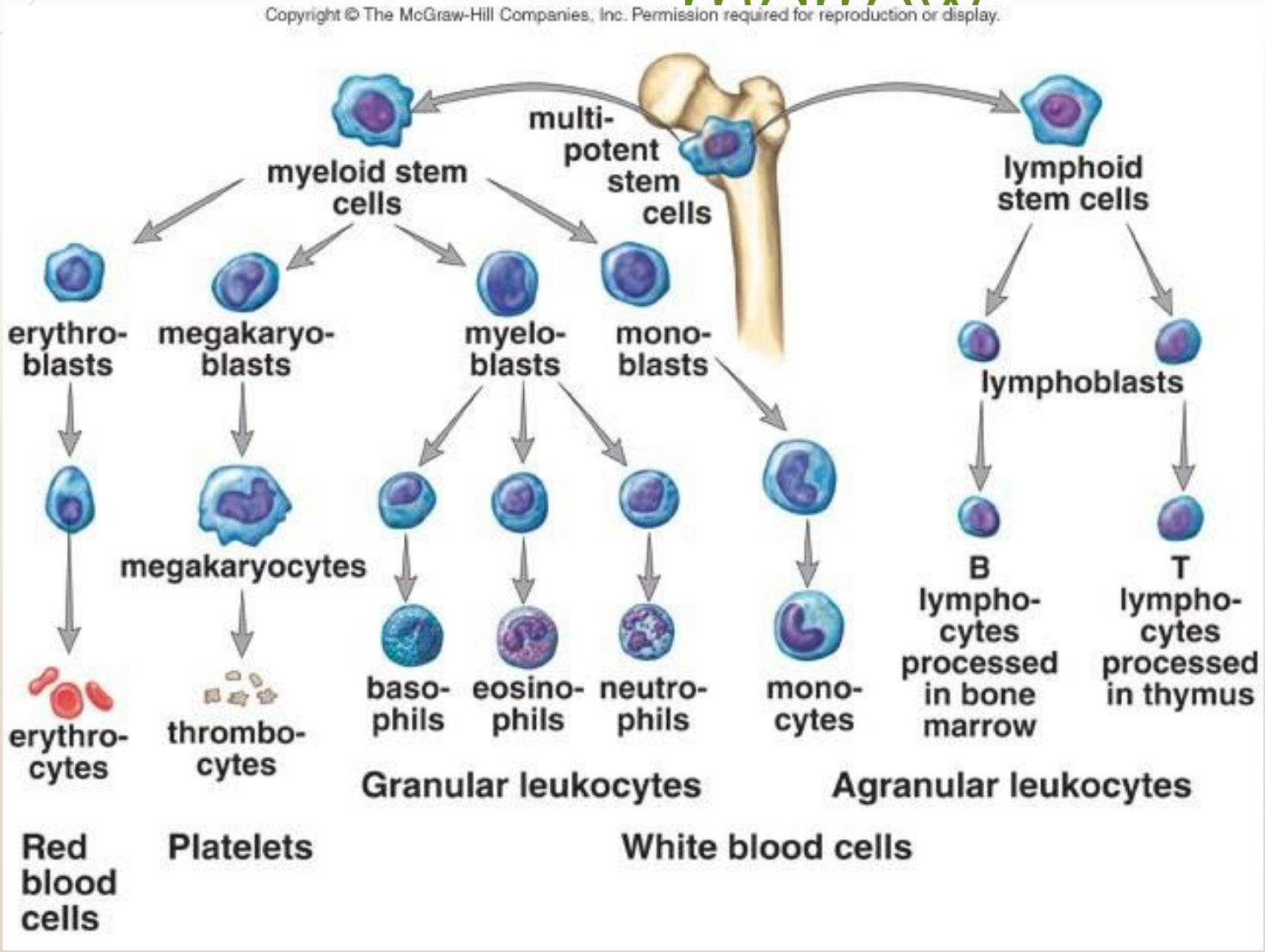
Blood clotting



Bone Marrow Stem Cells

- A *stem cell* is capable of dividing into new cells that differentiate into particular cell types.
- Bone marrow is *multipotent*, able to continually give rise to particular types of blood cells.
- The skin and brain also have stem cells, and *mesenchymal stem cells* give rise to connective tissues including heart muscle.

Blood cell formation in red bone marrow

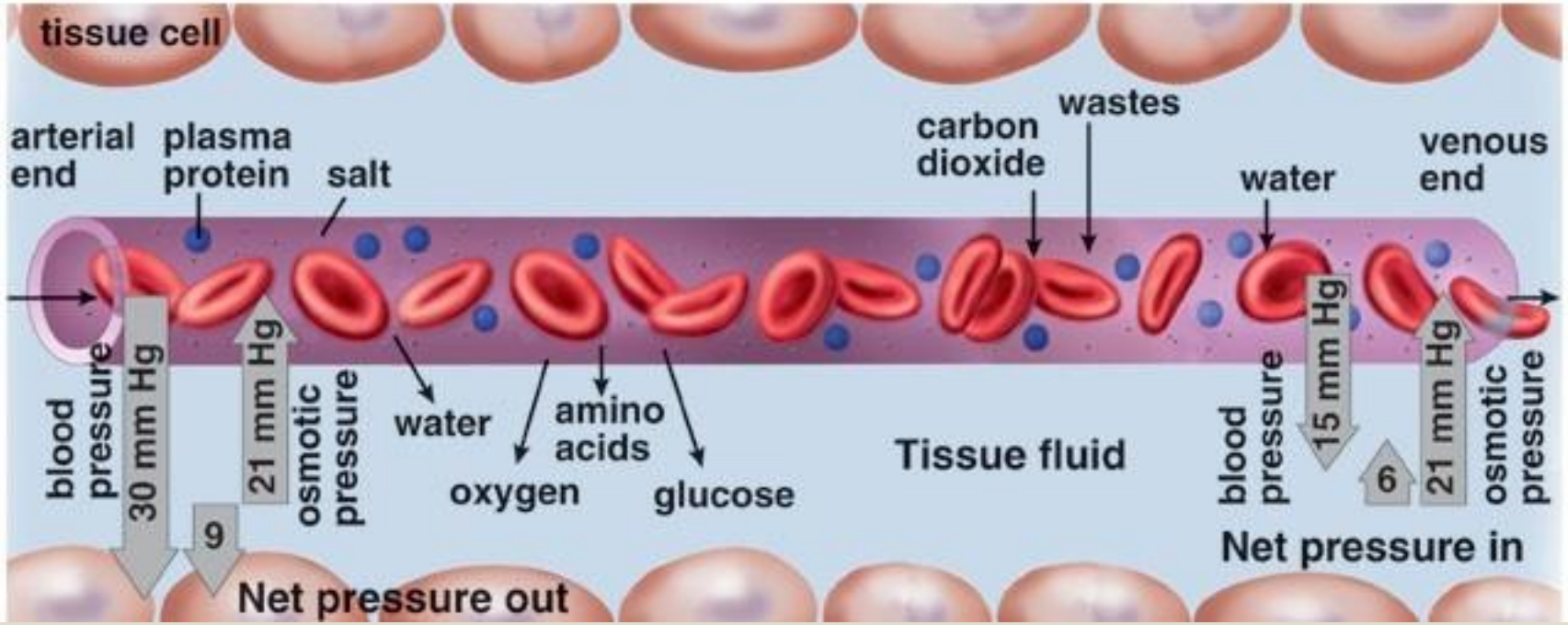


Capillary Exchange

- At the arteriole end of a capillary, water moves out of the blood due to the force of *blood pressure*.
- At the venule end, water moves into the blood due to *osmotic pressure* of the blood.
- Substances that leave the blood contribute to *tissue fluid*, the fluid between the body's cells.

- In the midsection of the capillary, nutrients diffuse out and wastes diffuse into the blood.
- Since plasma proteins are too large to readily pass out of the capillary, tissue fluid tends to contain all components of plasma except it has lesser amounts of protein.
- Excess tissue fluid is returned to the blood stream as *lymph* in *lymphatic vessels*.

Capillary exchange



Post Study Test

- 1-Define ECG
- 2-Describe the blood
- 3- How Blood Clotting Happens

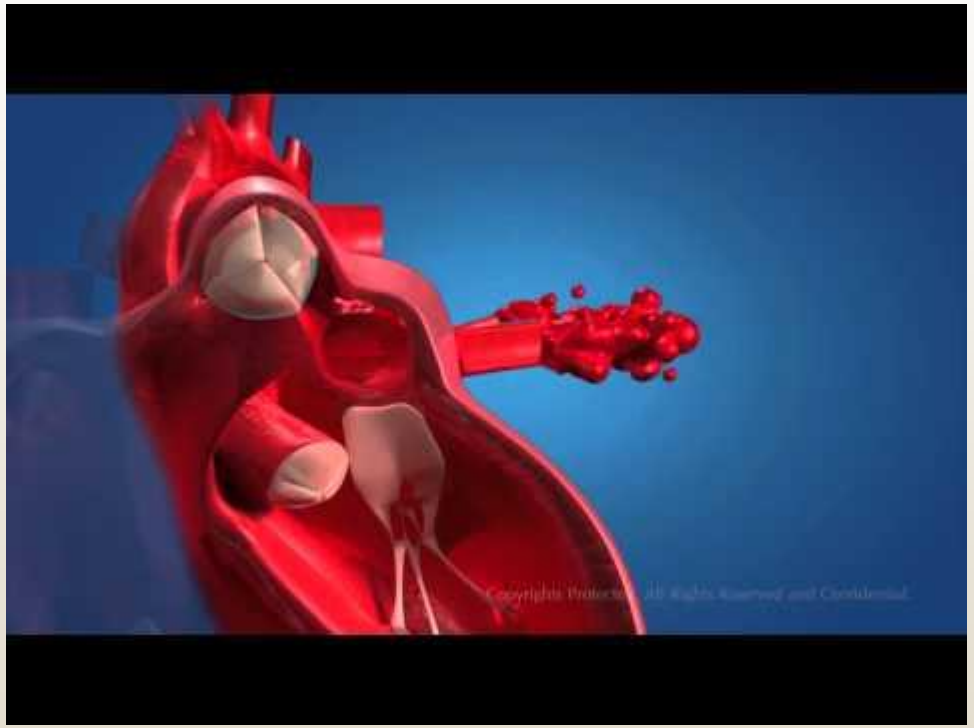
Answers :Pre Study Test

- 1-. Each heartbeat is called a cardiac cycle.
- 2-. Systole is the contraction of heart chambers; diastole is their relaxation.
- 3-The heart sounds, lub-dup, are due to the closing of the atrioventricular valves, followed by the closing of the semilunar valves.

Answers :Post Study Test

- 1-An electrocardiogram (ECG) is a recording of the electrical changes that occur in the myocardium during a cardiac cycle.
- 2-. Blood separates into two main parts: plasma and formed elements. Plasma accounts for 55% and formed elements 45% of blood volume. Plasma contains mostly water (90–92%) and plasma proteins (7–8%), but it also contains nutrients and wastes.
- 3-Injured tissues release a clotting factor called prothrombin activator, which converts prothrombin into thrombin. Thrombin, in turn, acts as an enzyme and converts fibrinogen into insoluble threads of fibrin. These conversions require the presence of calcium ions (Ca2+). Trapped red blood cells make a clot appear red.

Video



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Unit Seven

Physiology of The Urogenital System

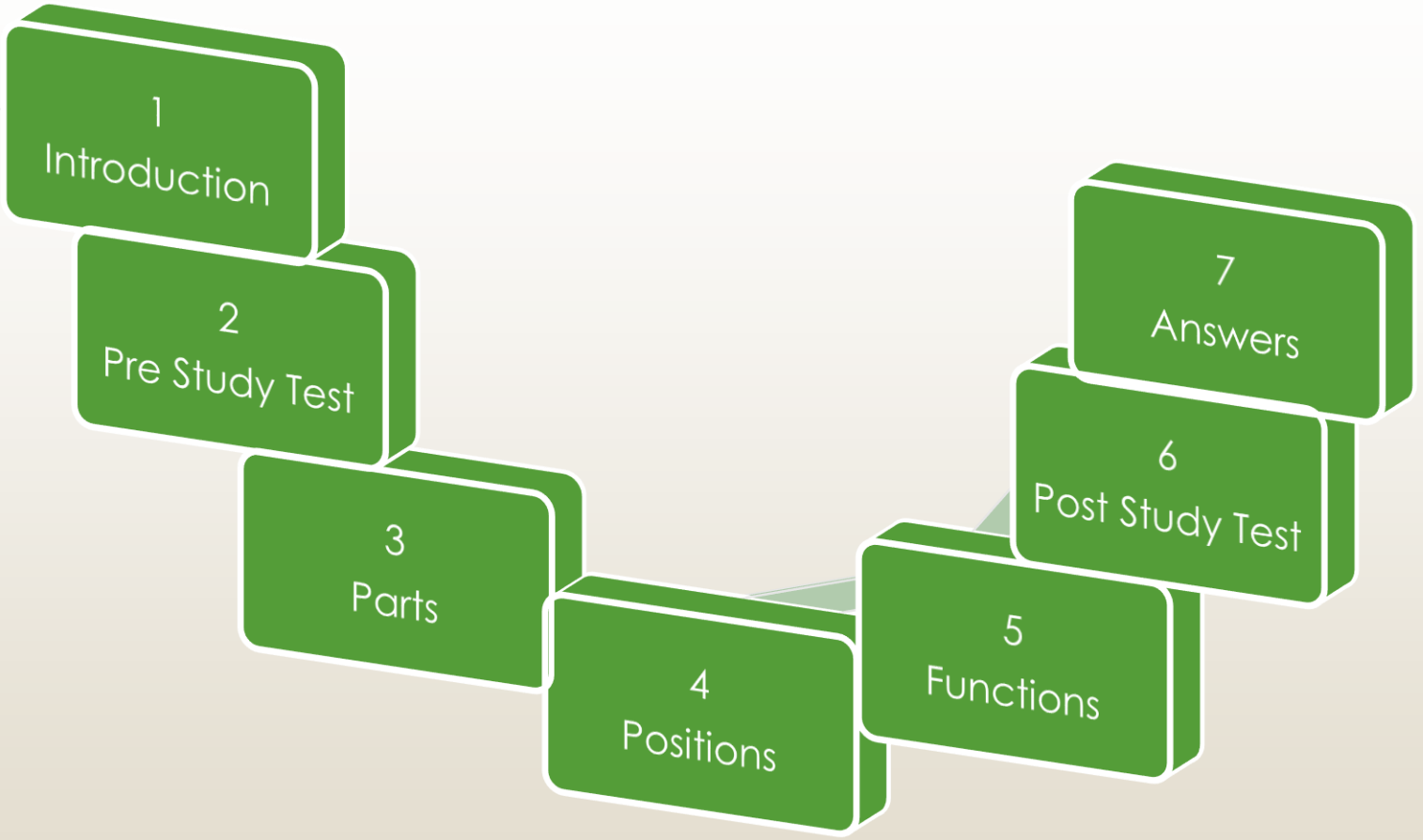
General Objective

- explain the function of the urinary system
- name and describe the major organs of the urinary system
- . Trace the process through which urine is produced.

Learning Outcome

After studying the unit , The student should be able to:-

- Urinary System Parts
- Male Reproductive System
- Female Reproductive System


1
Introduction
2
Pre Study Test
3
Parts
4
Positions
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Functions
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Post Study Test
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Answers

The Urinary System

An Introduction to the Urinary System

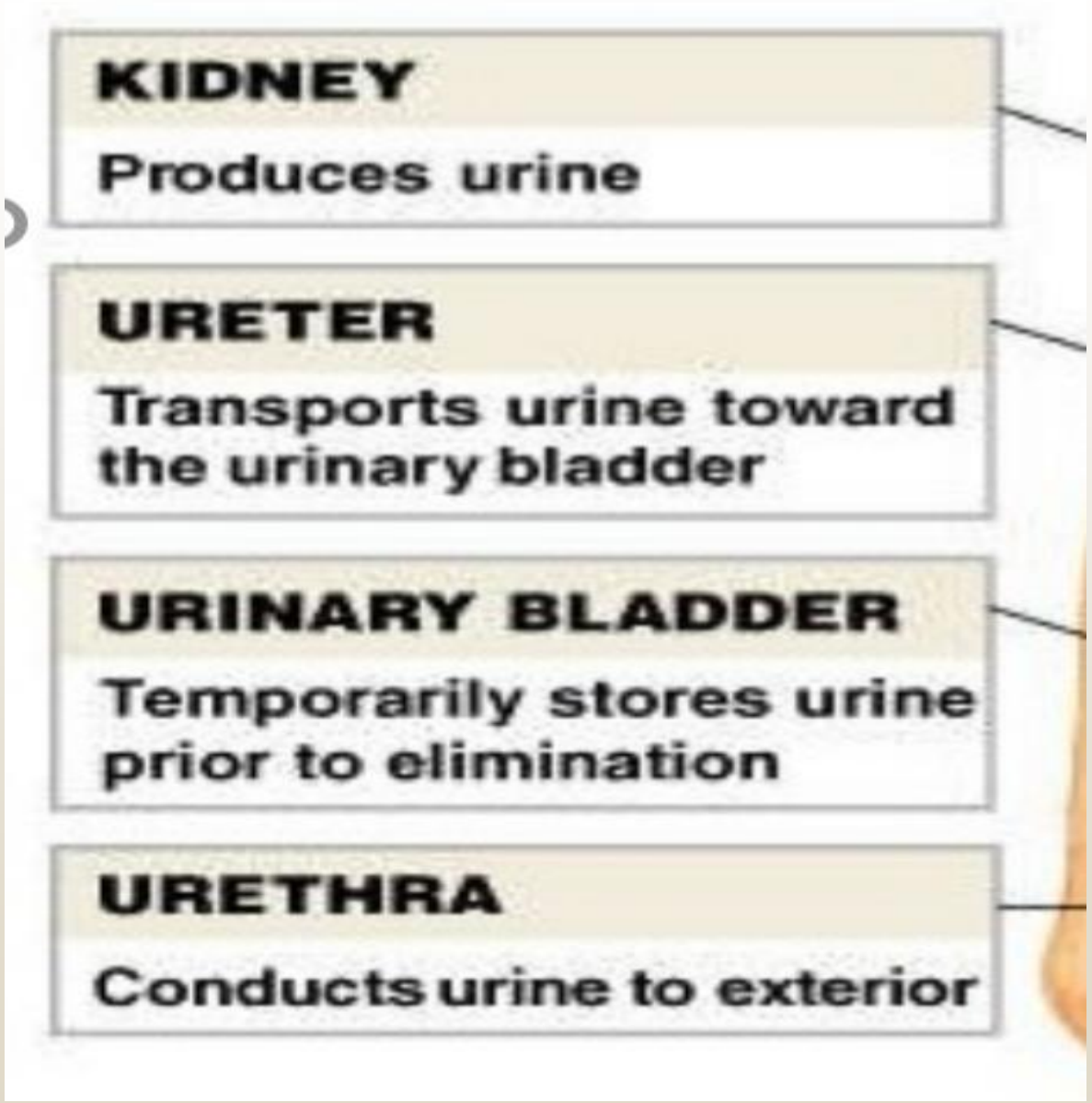


Figure 26-1

Pre Study Test

- 1-what are the functions of Kidneys
- 2-what is the urinary bladder
- 3- what does the urethra do

Functions of the Urinary System

- Excretion:
  - removal of organic wastes from body fluids
- Elimination:
  - discharge of waste products
- Homeostatic regulation:
  - of blood plasma volume and solute concentration

Conserve valuable nutrients:

- by preventing excretion while excreting organic waste products

Assist liver to detoxify poisons

Homeostatic Functions of Urinary System

1. Regulate blood volume and blood pressure:
   - by adjusting volume of water lost in urine
   - releasing erythropoietin and renin
2. Regulate plasma ion concentrations:
   - sodium, potassium, and chloride ions (by controlling quantities lost in urine)
   - calcium ion levels (through synthesis of calcitriol)
1. Help stabilize blood pH:
   - by controlling loss of hydrogen ions and bicarbonate ions in urine

Kidneys

- Organs that excrete urine

Urinary Tract

- Organs that eliminate urine:
  - ureters (paired tubes)
  - urinary bladder (muscular sac)
  - urethra (exit tube)

Urination or Micturition

- Process of eliminating urine
- Contraction of muscular urinary bladder forces urine through urethra, and out of body

Functions of Renal Tubule

1. Reabsorb useful organic nutrients that enter filtrate
2. Reabsorb more than 90% of water in filtrate
3. Secrete waste products that failed to enter renal corpuscle through filtration at glomerulus

Renal Physiology

- The goal of urine production:
  - is to maintain homeostasis
  - by regulating volume and composition of blood
  - including excretion of metabolic waste products
    - Urea
      - Due to breakdown of aa
    - Creatinine
      - Due to breakdown of creatinine kinase (important in muscle contraction)
    - Uric acid
      - Formed due to recycling of ATGCU

- The Concentration of components
  - in a urine sample depends on osmotic movement of water

- Normal Urine
  - Is a clear, sterile solution
  - Yellow color (pigment urobilin) generated in kidneys from urobilinogens

The Ureters

- Are a pair of muscular tubes
- Extend from kidneys to urinary bladder
- Begin at renal pelvis
- attached to posterior abdominal wall
- Penetrate posterior wall of the urinary bladder
- rounded
- Shape helps prevent backflow of urine:
  - when urinary bladder contracts

Peristaltic Contractions

- Begin at renal pelvis
- Sweep along ureter
- Force urine toward urinary bladder
- Every 30 seconds

The Urinary Bladder

- Is a hollow, muscular organ
- Functions as temporary reservoir urine storage
- Full bladder can contain 1 liter of urine

Bladder Position

- Is stabilized by several peritoneal folds
- Posterior, inferior, and anterior surfaces:
  - lie outside peritoneal cavity
- Ligamentous bands:
  - anchor urinary bladder to pelvic and pubic bones

Organs for the Conduction and Storage of Urine

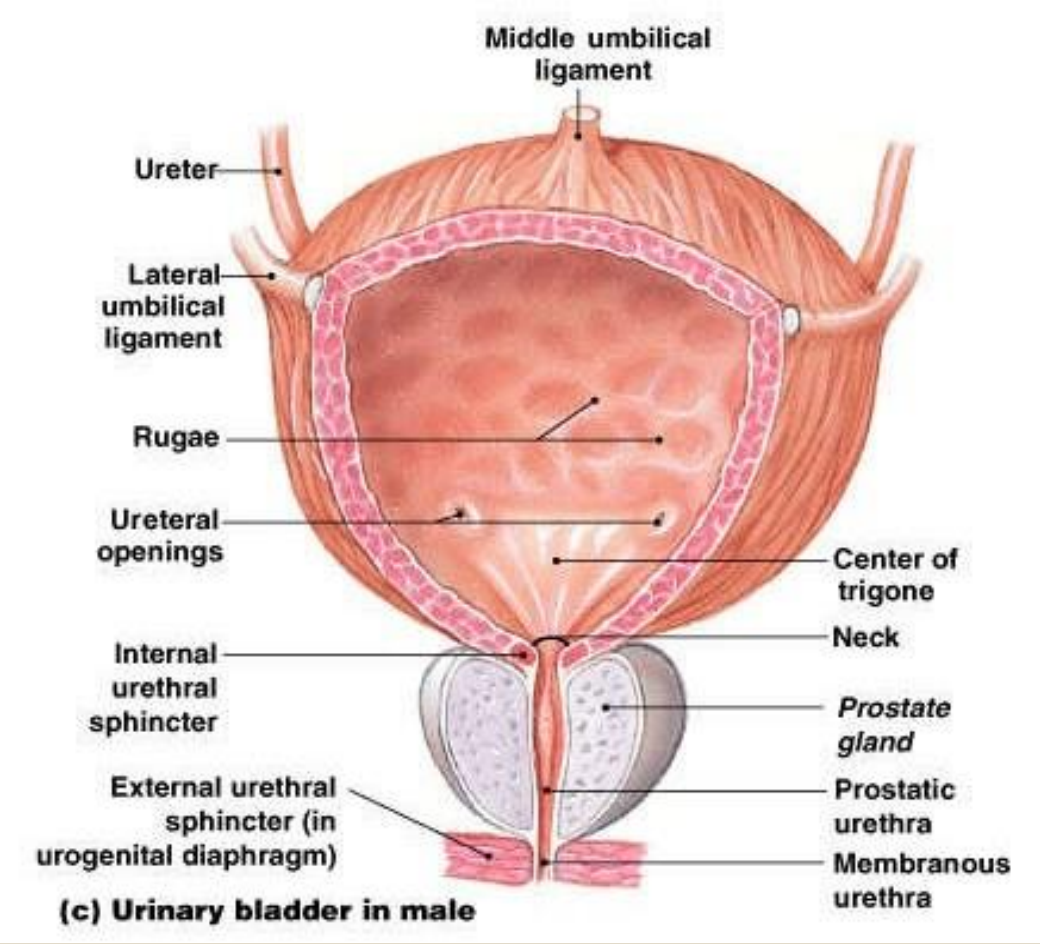


Figure 26-18c

The Urethra

- Extends from neck of urinary bladder
- To the exterior of the body

The Male Urethra

- Extends from neck of urinary bladder
- To tip of penis (18–20 cm)

The Female Urethra

- Is very short (3–5 cm)
- Extends from bladder to vestibule
- External urethral orifice is near anterior wall of vagina

MALE

REPRODUCTIVE SYSTEM

Main functions of male reproducitve system

- For production,maintenance, and transportation of the male sex cell (sperm)
- For discharge of the sperm cell to the female reproductive tract
- For production of male hormone testosterone
- For secretion of semen
- For development of male secondary sex characteristics


MALE

I. External structures of male sex organs

1. PENIS – the pendant organ anterior to the scrotum and attached to the pubis

   - parts:

      a. shaft

      b. root

      c. glans penis

   - functions:

   a. organ for coitus

   b.convey urine and seminal fluid to the outside of the body

URETHRA

- Long,slender tube which is connected to the ejaculatory duct
- Parts:
    a. prostatic urethra
    b. membranous urethra
    c. penile urethra
- Functions : passageway of semen to the female reproductive tract
- Passageway of the urine from the urinary bladder

2. Scrotum

- Thin pouch of skin, posterior to the penis and external to the testes
- Contains several nerves and blood vessels

- Function: enclose and protect the testes

3. TESTES

- The primary sex organs
- Located posterior to the penis within the scrotum
- Parts:
    a. seminiferous tubules
    b. cells of leydig
- Functions: production of sperm cells (spermatogenesis)
  production of hormones

4. EPIDIDYMIS

- the mass of tubules attached to the posterior surface of thetestes
- Functions: site for sperm maturation
  for storage of spermatozoa

5. VAS DEFERENS

- Ducts extending from the epididymis to the ejaculatory duct
- Functions: storage of spermatozoa,transport of sperm during ejaculation

Male Internal Reproductive Organs

1. EJACULATORY DUCTS

- Short ducts between the ductus deferentia and the prostatic urethra
- Functions: receives the spermatozoa and additives to produce seminal fluid

2. ACCESSORY GLANDS

A. SEMINAL VESICLES

- Club-shaped glands posterior to the prostate and are attached to the ejaculatory glands
- Functions: secrete alkaline fluid (60%) of the semen which contain nutrients and prostaglandins

B.PROSTATE GLAND

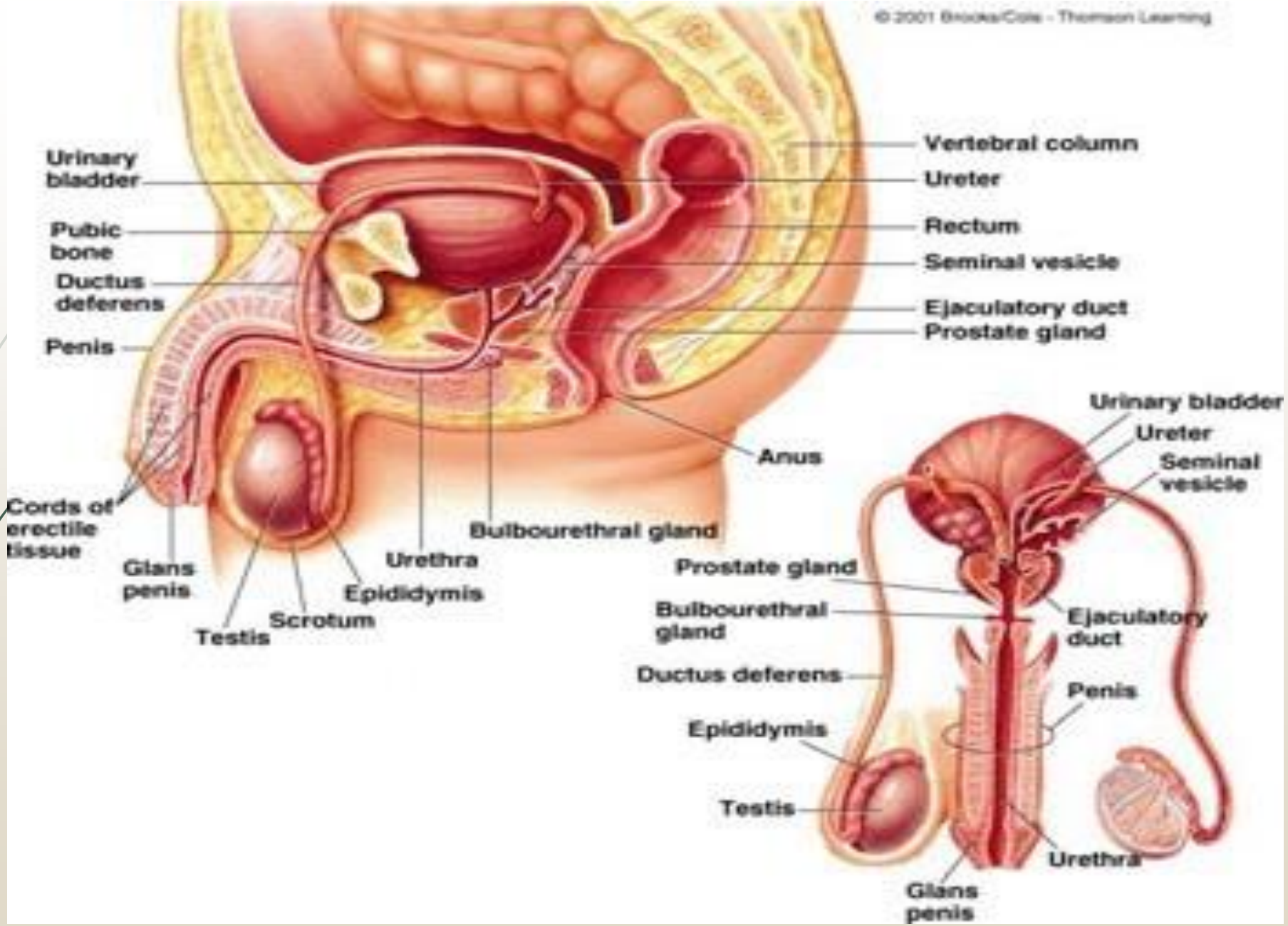
- Walnut-shaped gland at the base of the urinary bladder
- Surrounds the prostatic urethra
- Functions : secretes alkaline fluid (20%) that help neutralize the acidic vaginal environment and enhance the motility of the sperm

C.BULBOURETHRAL GLANDS

- Pea-sized glands inferior to the prostate
- Empty into the membranous urethra
- Function:

  -secretes fluid that lubricates the urethra and the end of penis

  - cleanses the urethra prior to the ejaculation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Urinary bladder
Pubic bone
Ductus deferens
Penis
Cords of erectile tissue
Glans penis
Testis
Scrotum
Epididymis
Urethra
Bulbourethral gland
Anus
Vertebral column
Ureter
Rectum
Seminal vesicle
Ejaculatory duct
Prostate gland
Urinary bladder
Ureter
Seminal vesicle
Prostate gland
Bulbourethral gland
Ductus deferens
Epididymis
Testis
Ejaculatory duct
Penis
Urethra
Glans penis

FEMALE

REPRODUCTIVE SYSTEM

FEMALE REPRODUCTIVE SYSTEM

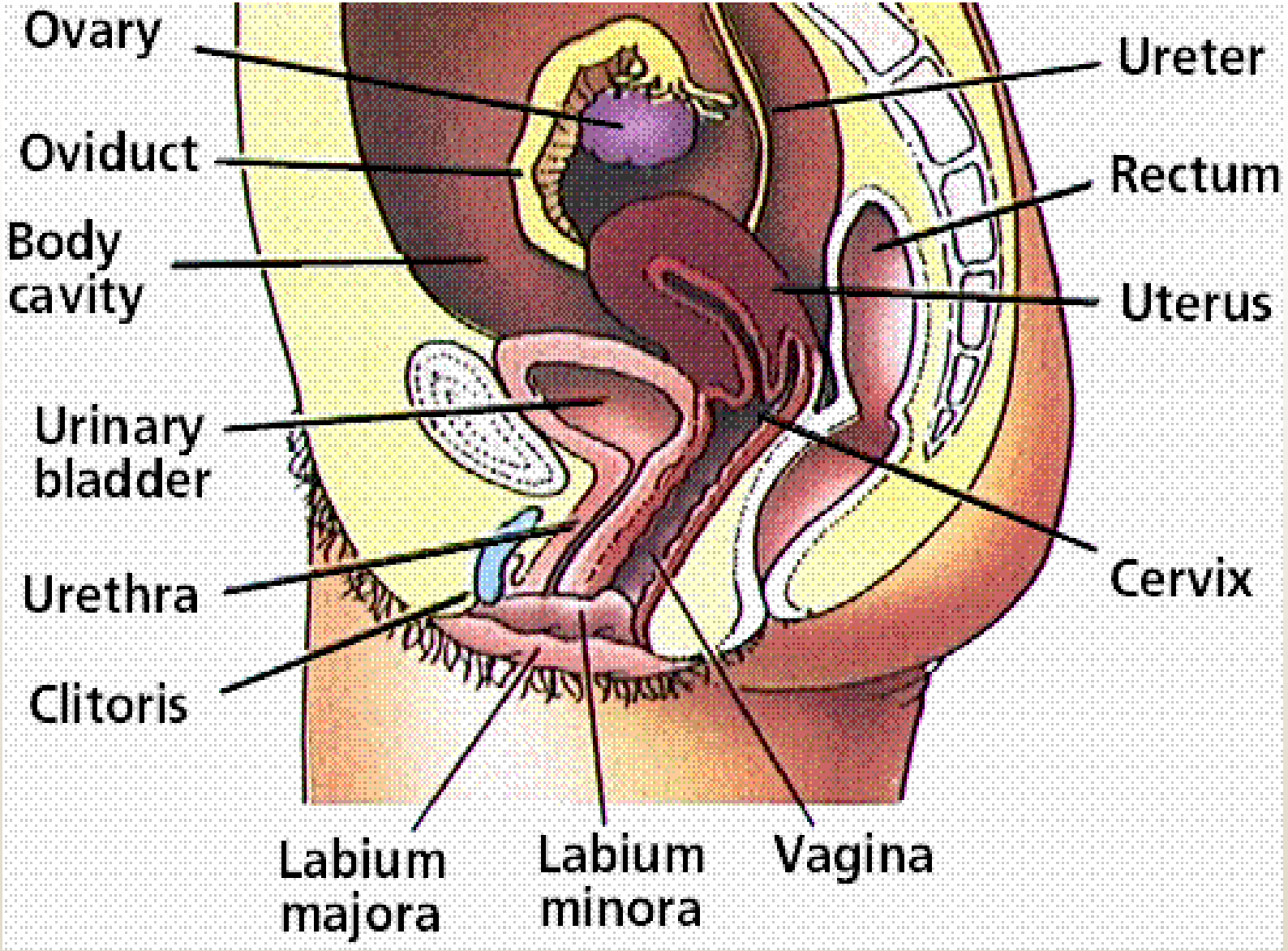
- Both sexes have reproductive organs call GENITALS or GENITALIA, designed for the purpose of intercourse and conception.
- Only the female has organs for pregnancy and childbirth.

EXTERNAL FEMALE ANATOMY

- **Vulva:** the general term to describe all the external female sex organs.
- **Pudendum or Pubes:** the area in the body where the sex organs are located.
- **Mons Pubis:** a mount of fatty tissue which covers the pubic bone. At puberty this area is covered
- with coarse pubic hair. The mons contains many touch sensitive receptors.
- **Labia Majora:** (large lips) two folds of skin running from the mons pubis to below the vaginal
- opening. The labia majora meet and fold together forming protection for the genitals. The labia majora are covered with pubic hair and contain many touch sensitive receptors.

- **Labia Minora:** two smaller folds of tissue which lie just within the labia majora. The labia minora
- join at the top, forming a hood over the clitoris.
- The labia minora are without hair and are rich in touch receptors and blood vessels.

- **Clitoris:** the center of sexual sensation and stimulation in the female. It is composed of erectile tissues and many sensitive nerve endings. It is found where the folds of the labia minora meet in the front.
- **Urethra:** below the clitoris, the opening to the bladder.


Ovary
Oviduct
Body cavity
Urinary bladder
Urethra
Clitoris
Ureter
Rectum
Uterus
Cervix
Labium majora
Labium minora
Vagina

INTERNAL ORGANS

- **Hymen:** a thin ring of tissue covering the opening to the vagina. It is the dividing line between external and internal sex organs. It has been over emphasized as a sign of virginity.
- **Vagina:** female organ of intercourse, it is actually an empty passageway leading from the vaginal
  - opening to the uterus.
  - It is only 3-4 inches long and shaped like a flattened funnel.

3 MAIN FUNCTIONS OF THE VAGINA:

- 1-channel for the menstrual flow
- 2- receptacle for the male penis during intercourse
- 3-birth canal -the vaginal walls are made of many small folds of membrane that stretch greatly to accommodate a baby during birth.

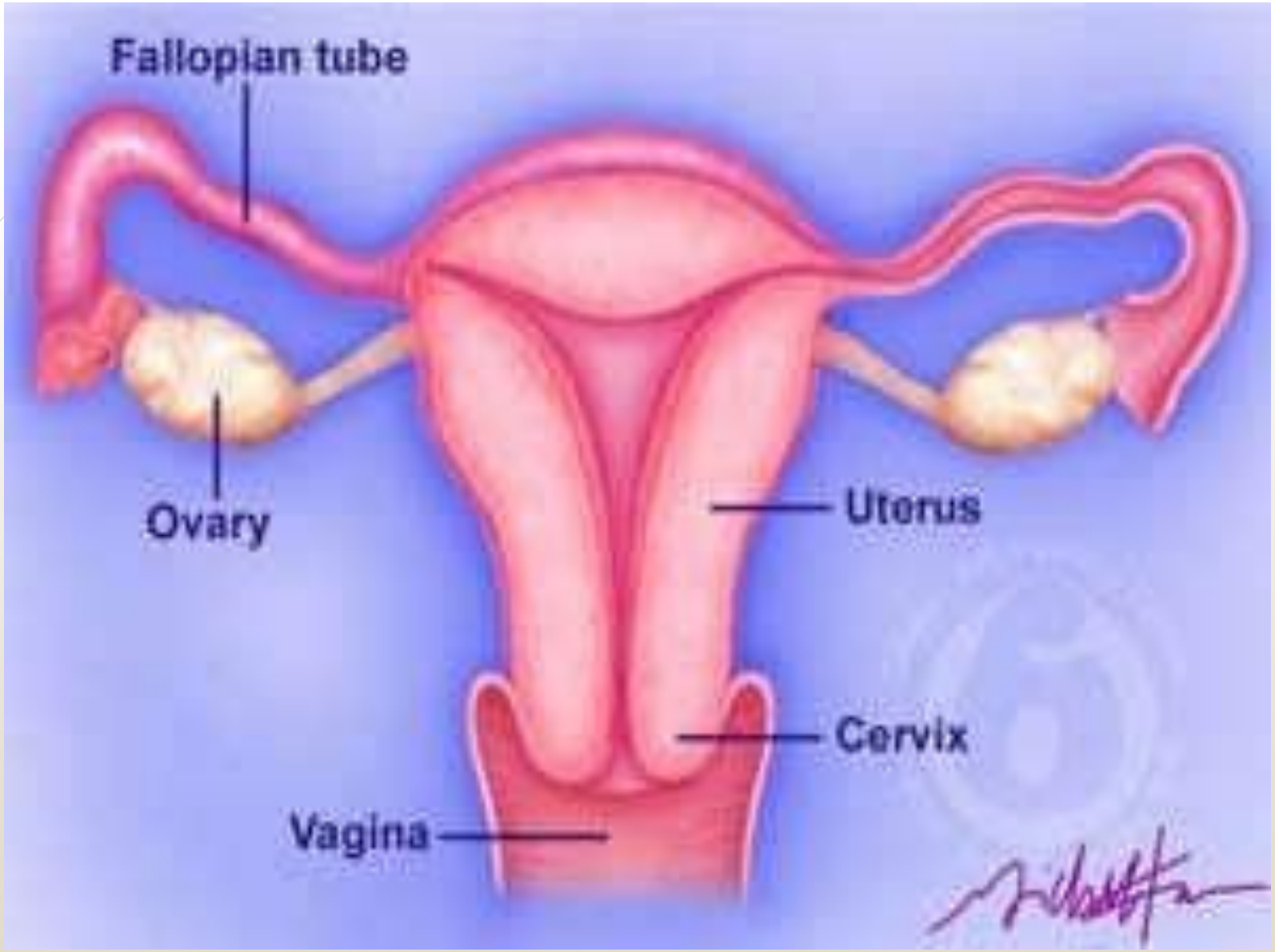
Cervix: the neck or opening of the uterus. A normal healthy cervix is the strongest muscle in the body.

- It dips down about half an inch into the vagina.
- It is normally plugged by mucus.
- It stays tightly closed during pregnancy, but thins and opens for the delivery of the baby

Uterus: the uterus is a hollow, muscular organ shaped somewhat like an upside-down pear, about

three inches long and two inches wide.

- Function: The uterus has one main function – to protect and nourish a fetus until it is ready to live outside the mother's body.
- The walls of the uterus stretch much like a balloon that is blown up.
- After childbirth the uterus shrinks back to the original shape in 6-8 weeks.


Fallopian tube
Ovary
Uterus
Cervix
Vagina

Post Study Test

- 1-Desribe the urine characteristics
- 2-Enumrate the external parts of male reproductive system
- 3- What is the Cervix

Answers :Pre Study Test

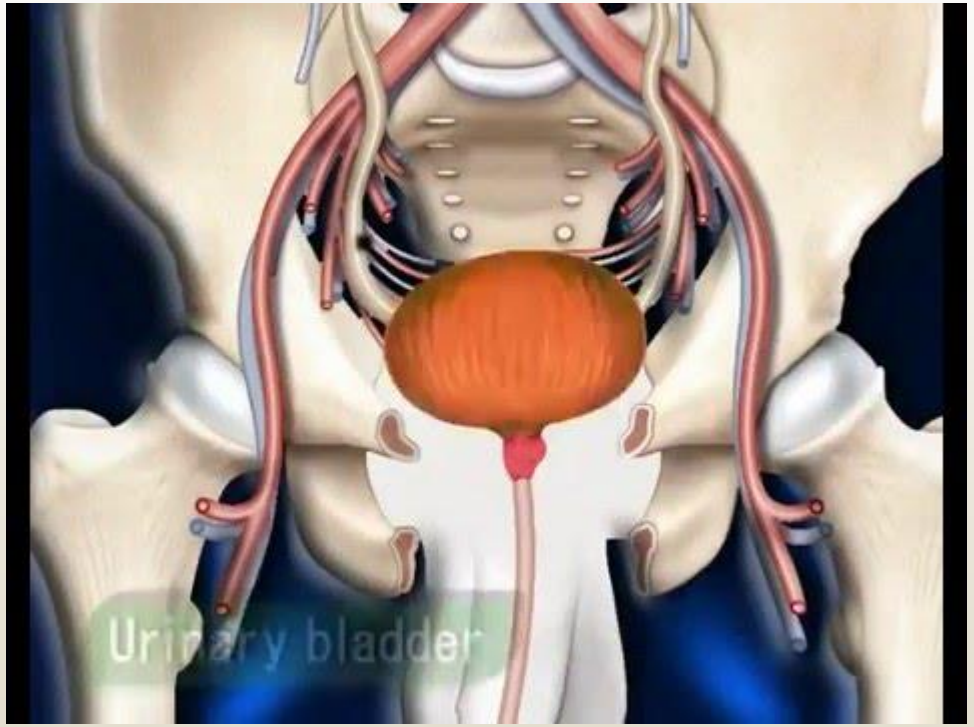
- 1-.Kidney: Produces urine.
- 2-Urinary bladder: temporarily stores urine prior to elimination
- 3-Urethra: Conducts urine to exterior

Answers :Post Study Test

- 1-. Normal Urine Is a clear, sterile solution Yellow color (pigment urobilin) generated in kidneys from urobilinogens
- 2-. A-penis b-scrotum c-testes d-epididymis e-vas deferens

- 3-Cervix: the neck or opening of the uterus. A normal healthy cervix is the strongest muscle in the body.It dips down about half an inch into the vagina. It is normally plugged by mucus. It stays tightly closed during pregnancy, but thins and opens for the delivery of the baby

Video



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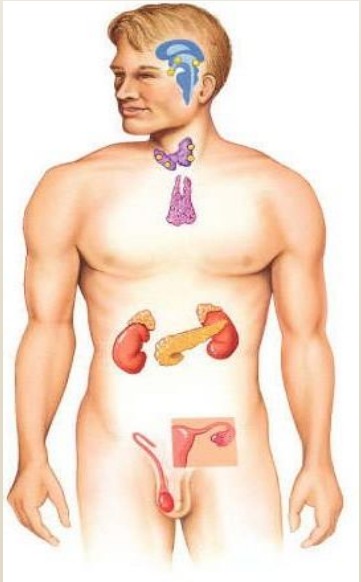
Unit Eight

Physiology of The Endocrine System



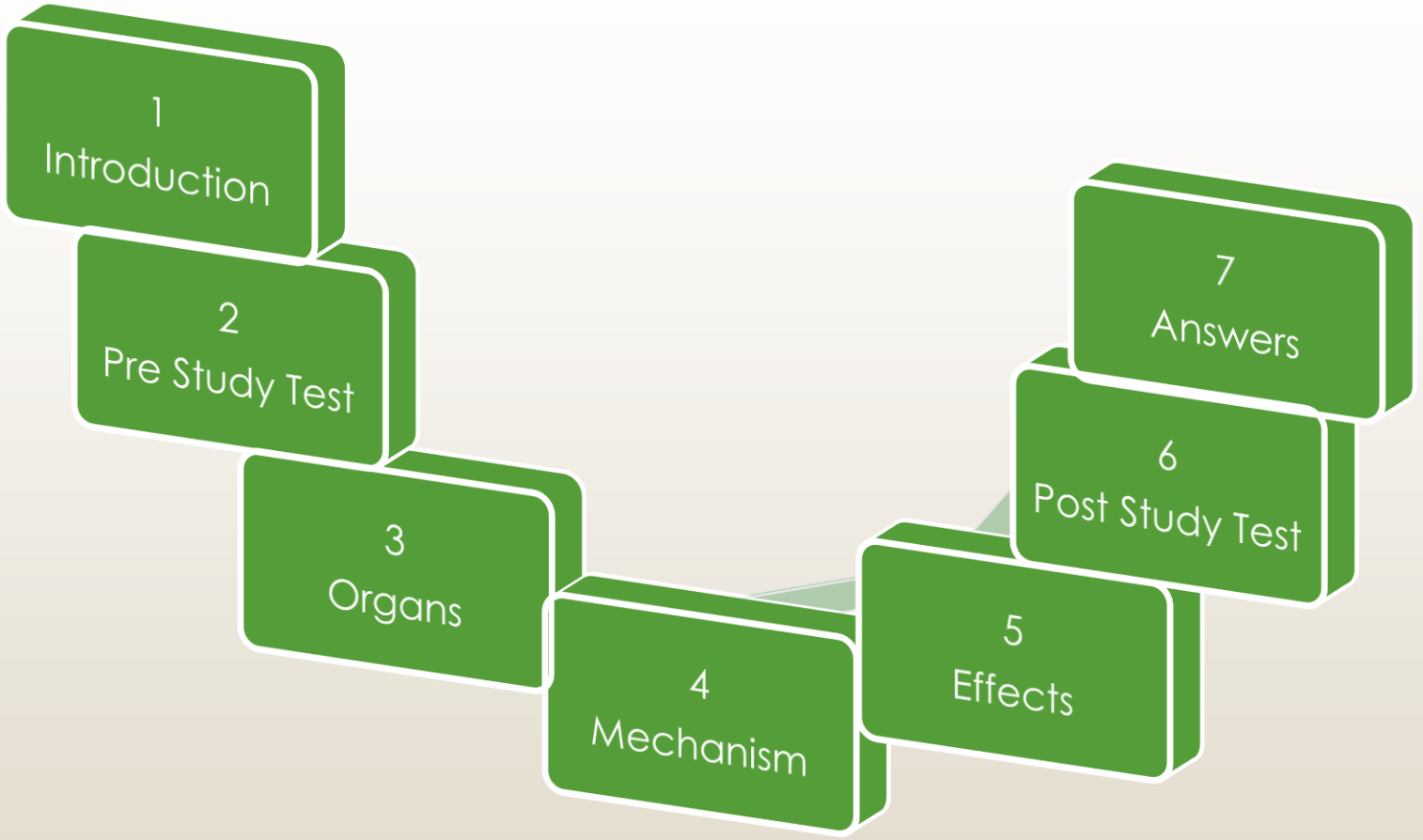
General Objective

- Demonstrate how the homeostatic model applies to every endocrine system in normal physiology and disease.
- Demonstrate that the same biochemical and cellular processes of chemical communication are involved in endocrinology as they are in any other biological systems; i.e., all chemical communicators (hormones) work in essentially the same manner.
- Demonstrate the concept of cross talk between physiological systems and within target cells between signaling pathways;
- Demonstrate how endocrine systems can be disrupted with respect to synthesis, transport, receptors, mechanisms of action, and metabolism/excretion.

Learning Outcome

After studying the unit , The student should be able to:-

- **Endocrine Organs**
- **Mechanisms of hormone release**
- ***What the letters stand for***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Mechanism
5
Effects
6
Post Study Test
7
Answers

Overview of the Endocrine System

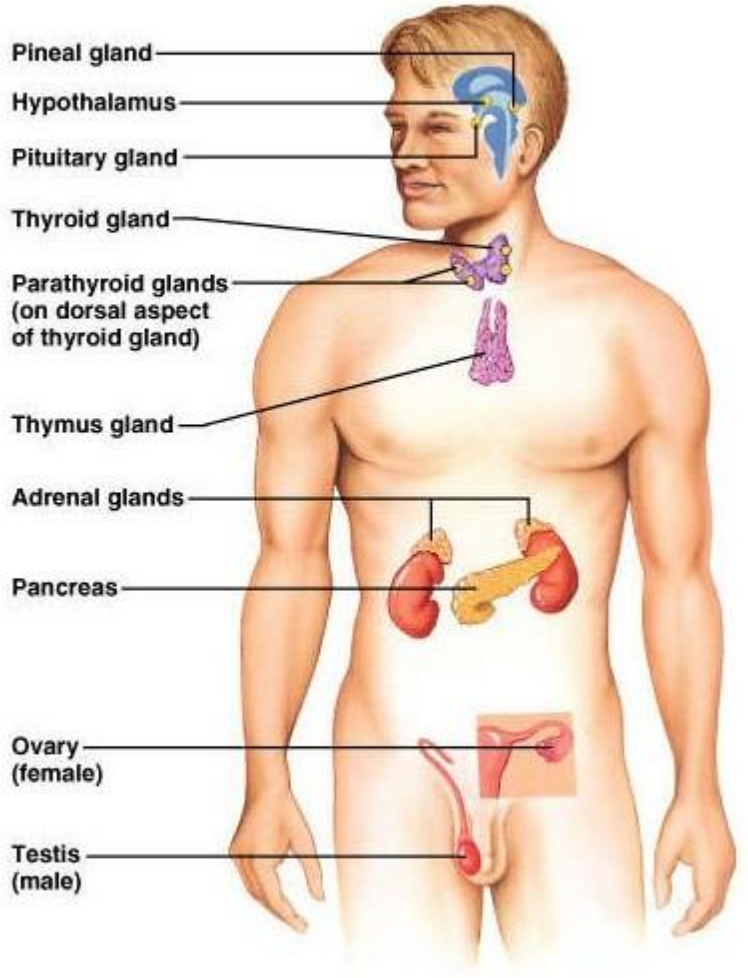
- System of ductless glands that secrete hormones
  - Hormones are “messenger molecules”
  - Circulate in the blood
  - Act on distant target cells
  - Target cells respond to the hormones for which they have receptors
  - The effects are dependent on the programmed response of the target cells
  - Hormones are just molecular triggers
- Basic categories of hormones
  - Amino acid based: modified amino acids (or *amines*), peptides (short chains of amino acids), and proteins (long chains of amino acids)
  - Steroids: lipid molecules derived from cholesterol

Pre Study Test

- 1-Define Hormones
- 2-what are the Basic categories of hormones
- 3- Give 3 examples of endocrine glands in the body

Endocrine Organs

- Purely endocrine organs
  - Pituitary gland
  - Pineal gland
  - Thyroid gland
  - Parathyroid glands
  - Adrenal: 2 glands
    - Cortex
    - Medulla
- Endocrine cells in other organs
  - Pancreas
  - Thymus
  - Gonads
  - Hypothalamus

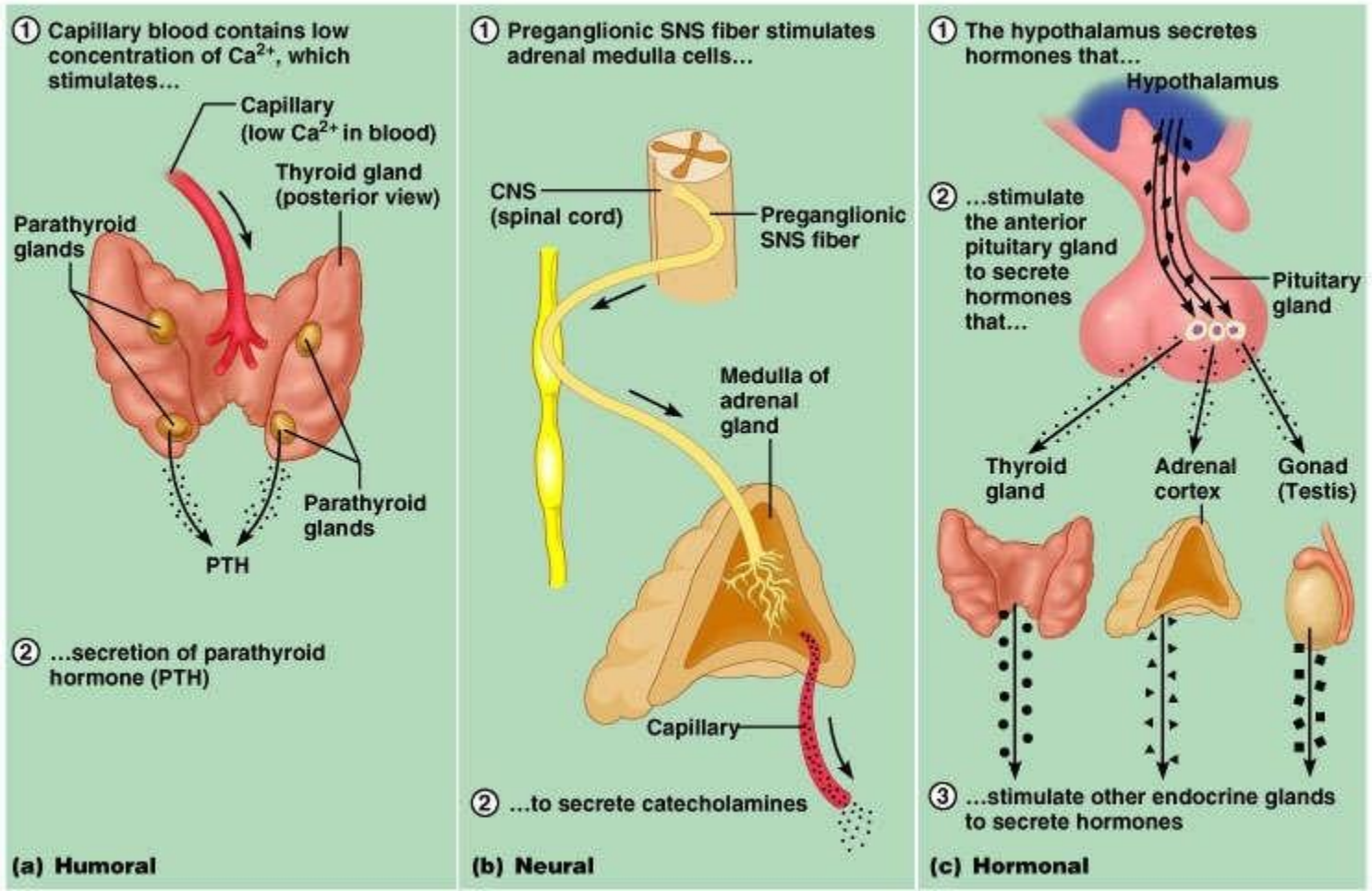


Mechanisms of hormone release

(a) Humoral: in response to changing levels of ions or nutrients in the blood

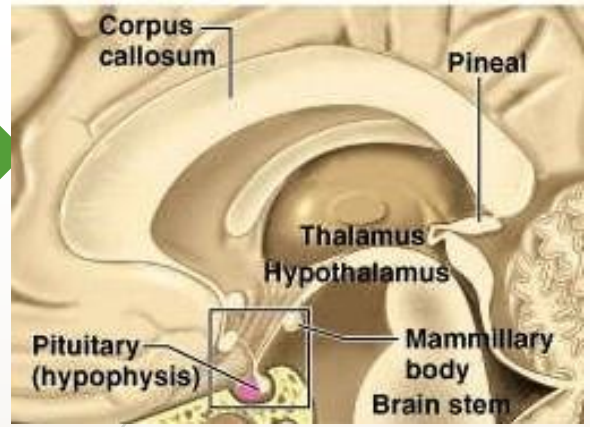
(b) Neural: stimulation by nerves

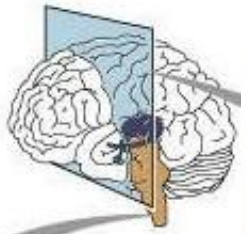
(c) Hormonal: stimulation received from other hormones

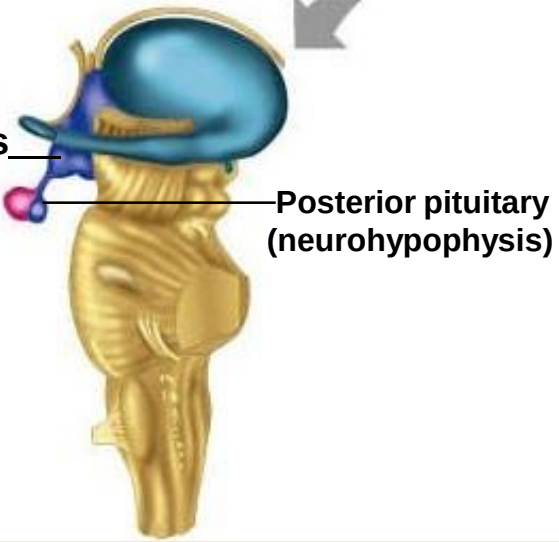


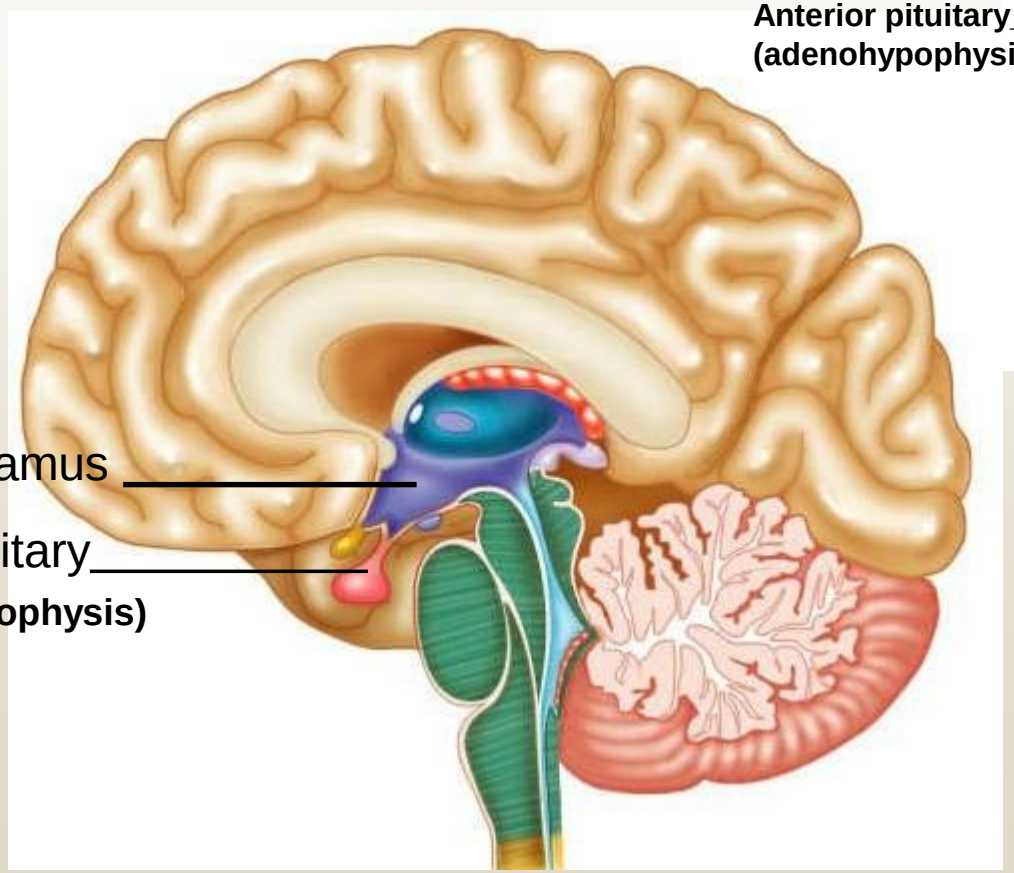
Learn the 3 endocrine organs on this slide:

- Hypothalamus
- Pituitary (hyophysis)
- Pineal









The Pituitary

Sits in hypophyseal fossa: depression in sella turcica of sphenoid bone

Pituitary secretes 9 hormones

Two divisions:

- Anterior pituitary (adenohypophysis)

1. TSH
2. ACTH
3. FSH
4. LH
5. GH
6. PRL
7. MSH

The first four are "tropic" hormones, they regulate the function of other hormones

- Posterior pituitary (neurohypophysis)

8. ADH (antidiuretic hormone), or vasopressin
9. Oxytocin

What the letters stand for…

- TSH: thyroid-stimulating hormone
- ACTH: adrenocorticotropic hormone
- FSH: follicle-stimulating hormone
- LH: luteinizing hormone
- GH: growth hormone
- PRL: prolactin
- MSH: melanocyte-stimulating hormone

- ADH: antidiuretic hormone
- Oxytocin

Hypothalamus controls anterior pituitary hormone release

- Releasing hormones (releasing factors)
  Secreted like neurotransmitters from neuronal axons into capillaries and veins to anterior pituitary (adenohypophysis)
  TRH-----turns on TSH
  CRH-----turns on ACTH
  GnRH (=LHRH)---turns on FSH and LH
  PRF-----turns on PRL
  GHRH----turns on GH
- Inhibiting hormones
  PIF-----turns off PRL
  GH inhibiting hormone ---turns off GH

So what do the pituitary hormones do?

The four tropic ones regulate the function of other hormones:

- TSH stimulates the thyroid to produce thyroid hormone
- ACTH stimulates the adrenal cortex to produce corticosteroids: aldosterone and cortisol
- FSH stimulates follicle growth and ovarian estrogen production; stimulates sperm production and androgen-binding protein
- LH has a role in ovulation and the growth of the corpus luteum; stimulates androgen secretion by interstitial cells in testes

The others from the anterior pituitary…

- GH (aka somatrotropic hormone) stimulates growth of skeletal epiphyseal plates and body to synthesize protein
- PRL stimulates mammary glands in breast to make milk
- MSH stimulates melanocytes; may increase mental alertness

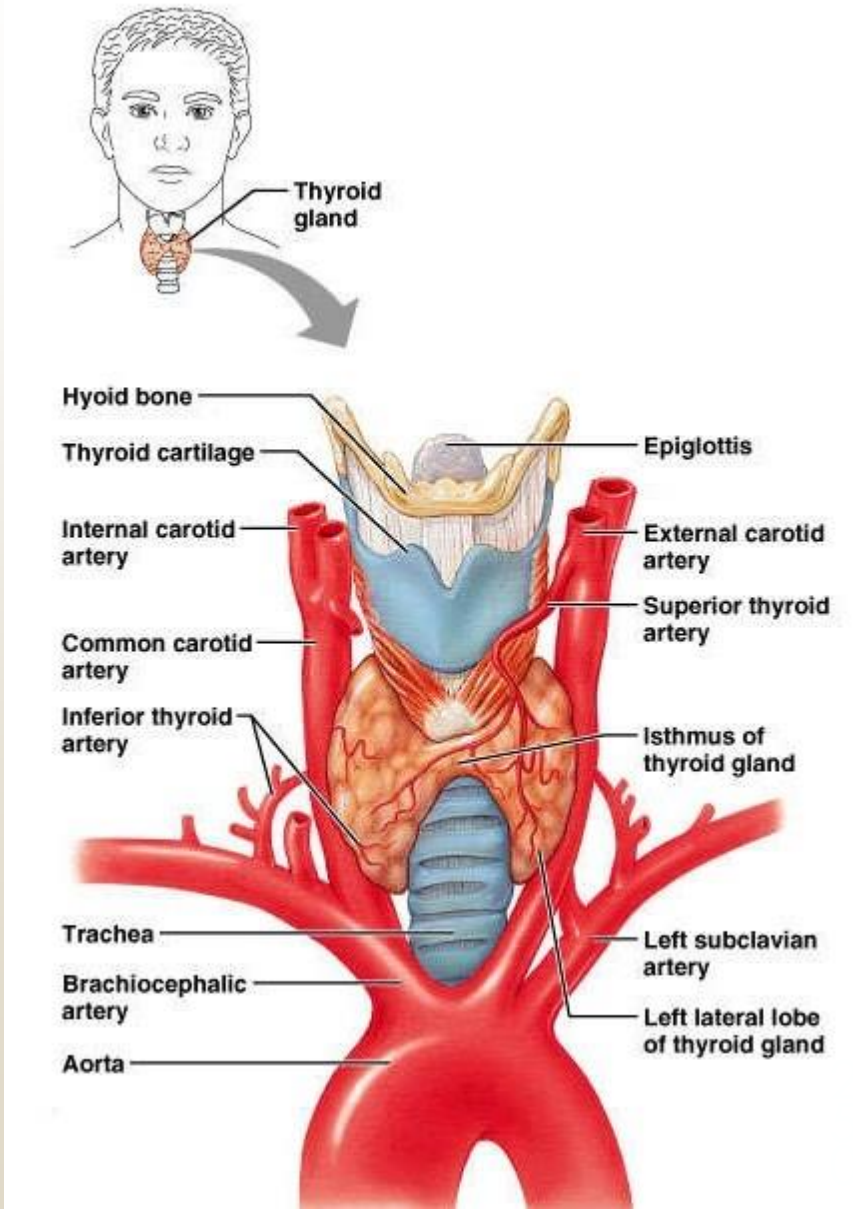
From the posterior pituitary (neurohypophysis)

structurally part of the brain

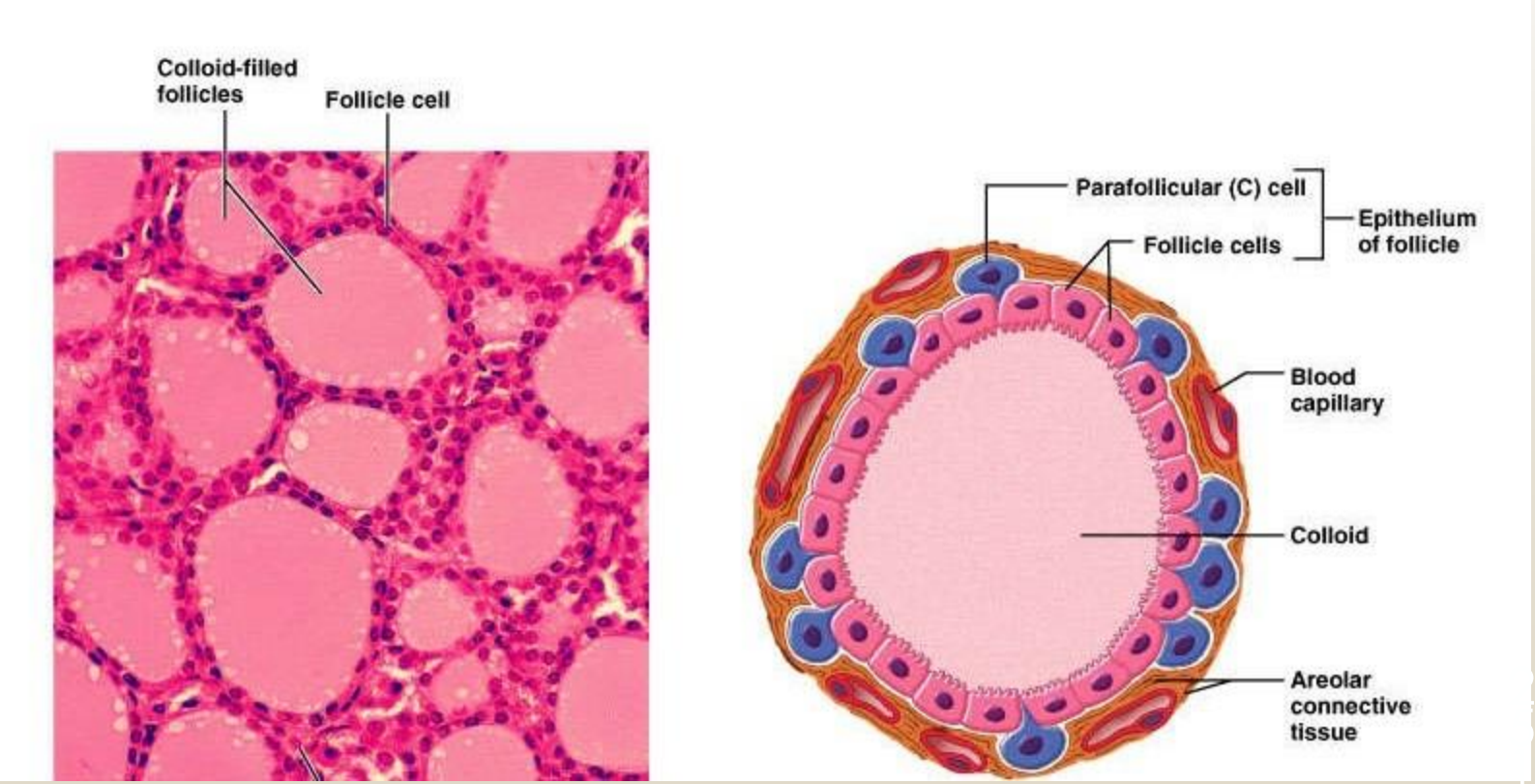
- ADH (antidiuretic hormone AKA vasopressin) stimulates the kidneys to reclaim more water from the urine, raises blood pressure
- Oxytocin prompts contraction of smooth muscle in reproductive tracts, in females initiating labor and ejection of milk from breasts

The Thyroid Gland

- Anterior neck on trachea just inferior to larynx
- Two lateral lobes and an isthmus
- Produces two hormones
  - Thyroid hormone: tyrosine based with 3 or 4 iodine molecules
    - T4 (thyroxine) and T3
  - Calcitonin involved with calcium and phosphorus metabolism



- Thyroid is composed of spherical follicles
  - Follicle cells: produce thyroglobulin, the precursor of thryoid hormone (thyroxin)
  - Colloid lumen is of thyroglobulin
  - Parafollicular “C” cells: produce calcitonin



Some Effects of Thyroid Hormone (Thyroxine)

- Increases the basal metabolic rate
  - The rate at which the body uses oxygen to transform nutrients (carbohydrates, fats and proteins) into energy
- Affects many target cells throughout the body; some effects are
  - Protein synthesis
  - Bone growth
  - Neuronal maturation
  - Cell differentiation

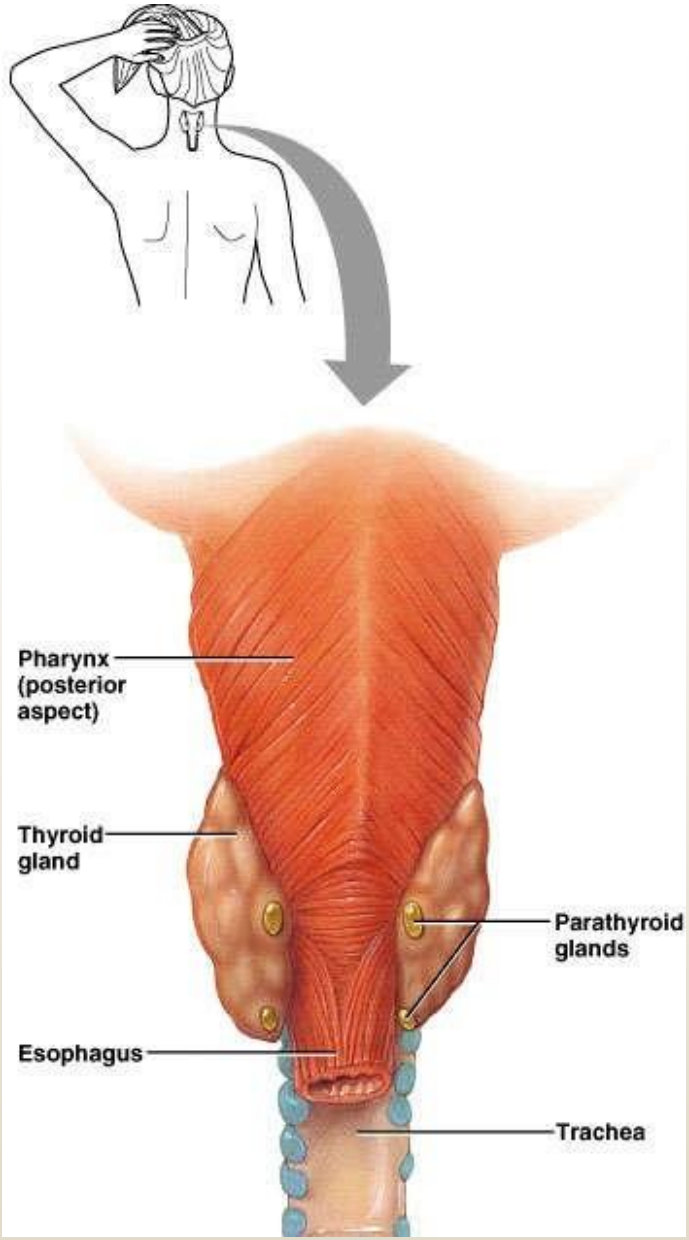
The Effects of Calcitonin

- Secreted from thyroid parafollicular (C) cells when blood calcium levels are high
- Calcitonin lowers Ca++ by slowing the calcium-releasing activity of osteoclasts in bone and increasing calcium secretion by the kidney
- Acts mostly during childhood

The Parathyroid Glands

- Most people have four
- On posterior surface of thyroid gland

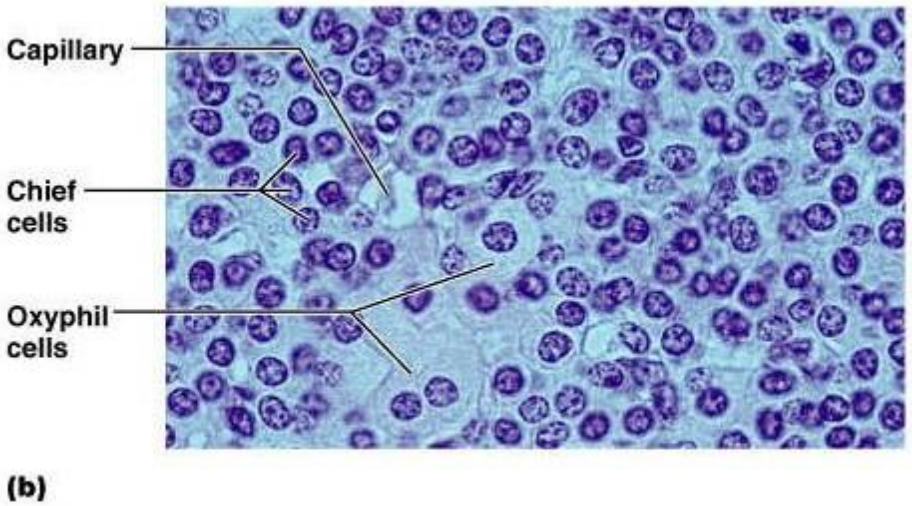
(sometimes embedded)

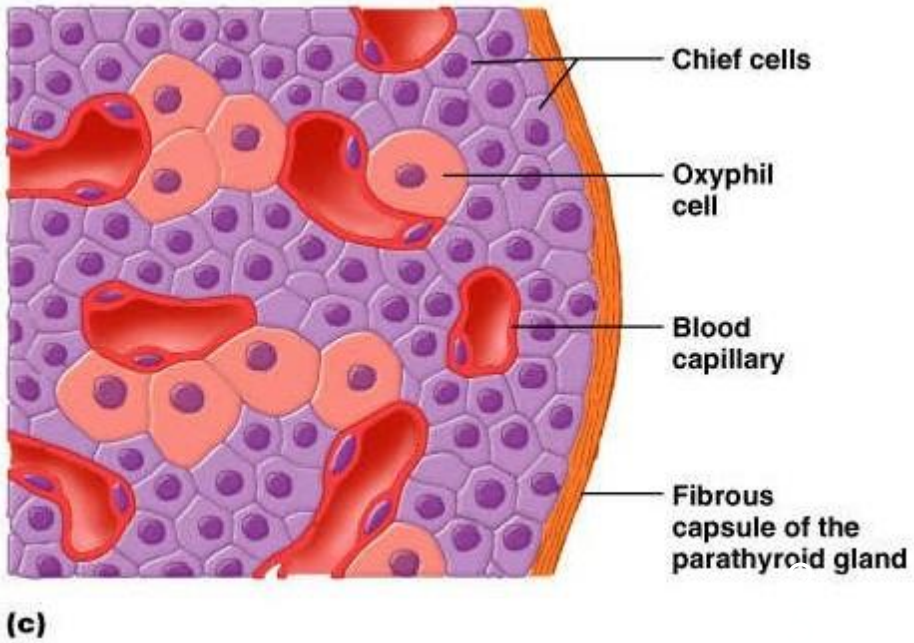


Parathyroids (two types of cells)

- Rare chief cells
- Abundant oxyphil cells (unknown function)

- Chief cells produce PTH
  - Parathyroid hormone, or parathormone
  - A small protein hormone





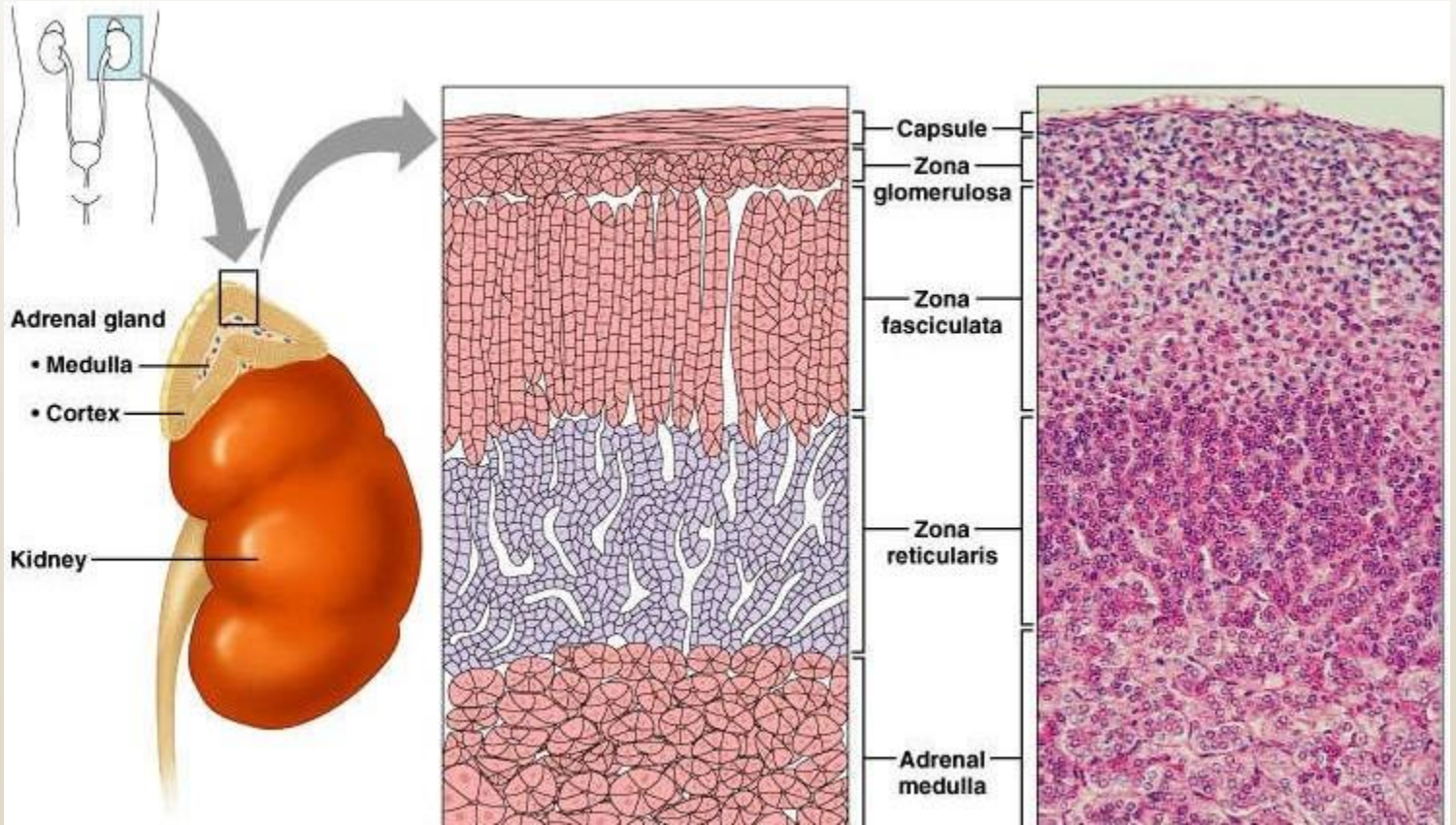
Function of PTH (parathyroid hormone or "parathormone")

- ***Increases blood Ca++ (calcium) concentration when it gets too low***
- ***Has opposite effect on calcium as calcitonin (which lowers Ca++ levels)***

Adrenal (suprarenal) glands

("suprarenal" means on top of the kidney)

- Each is really two endocrine glands
  - Adrenal cortex (outer)
  - Adrenal medulla (inner)
- Unrelated chemicals but all help with extreme situations



Adrenal Gland

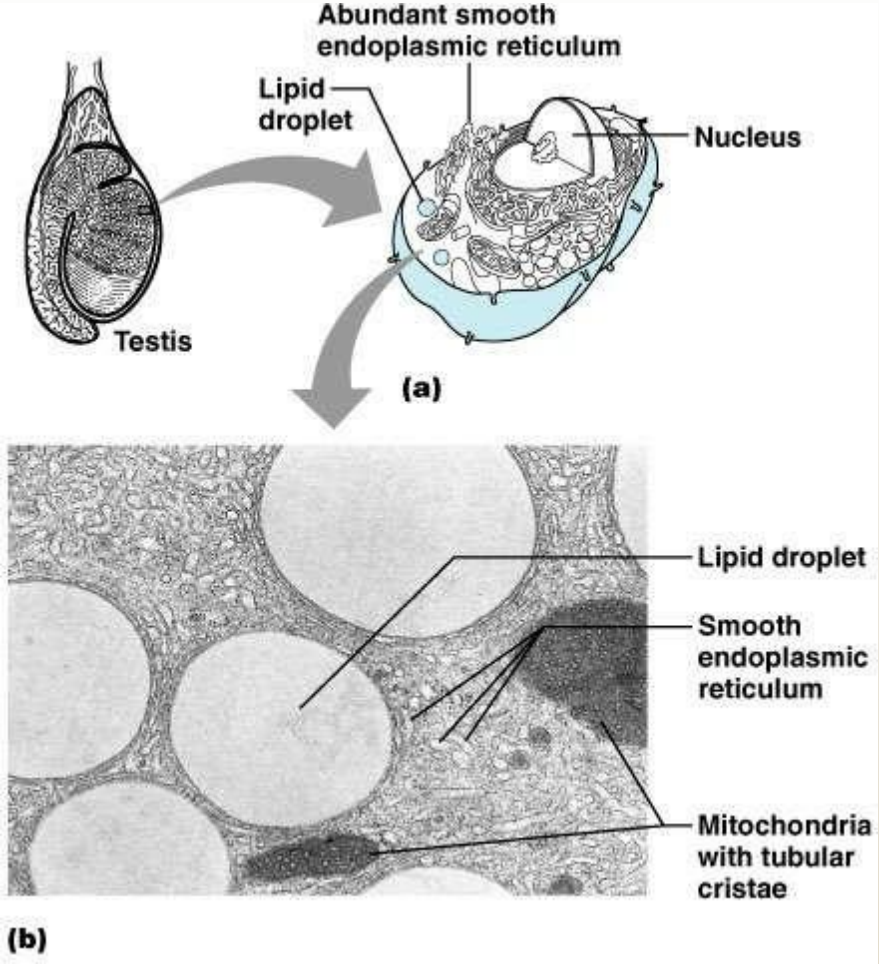
- Adrenal cortex
  - Secretes lipid-based steroid hormones, called “corticosteroids” – “cortico” as in “cortex”
    - MINERALOCORTICOIDS
      - **Aldosterone is the main one**
    - GLUCOCORTICOIDS
      - **Cortisol (hydrocortisone) is the main one**

- Adrenal medulla
  - Secretes epinephrine and norepinephrine

Aldosterone, the main *mineralocorticoid*

- Secreted by adrenal cortex in response to a decline in either blood volume or blood pressure (e.g. severe hemorrhage)
  - Is terminal hormone in renin-angiotensin mechanism
- Prompts distal and collecting tubules in kidney to reabsorb more sodium
  - Water passively follows
  - Blood volume thus increases

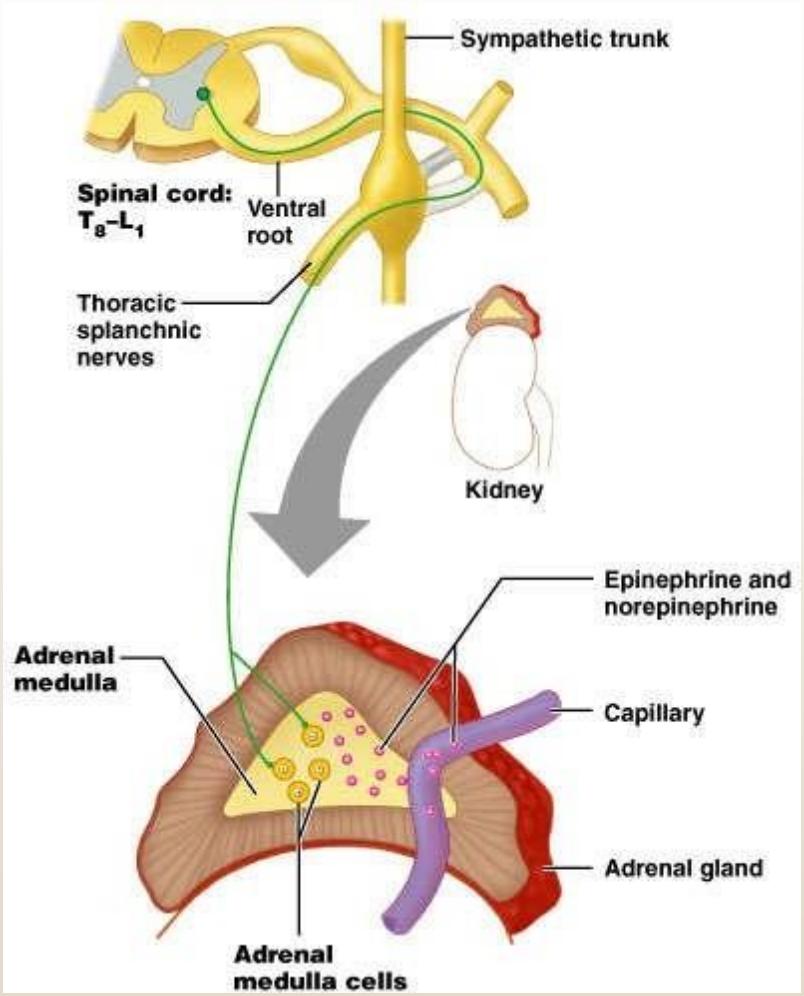
In general:



- Steroid-secreting cells have abundant smooth ER
  - As opposed to rough ER in protein-secreting cells
- Steroids directly diffuse across plasma membrane
  - Not exocytosis
- Abundant lipid droplets
  - Raw material from which steroids made

Adrenal medulla

- Part of autonomic nervous system
- Spherical chromaffin cells are modified postganglionic sympathetic neurons
  - Secrete epinephrine and norepinephrine
  - Amine hormones
  - Fight, flight, fright
- Vesicles store the hormones



The Pineal Gland

- At the end of a short stalk on the roof of the diencephalon
- Pinealocytes with dense calcium particles
- Can be seen on x-ray (because of Ca++)
- Melatonin helps regulate the circadium rhythm
  - The biological clock of the diurnal (night/day) rhythm
  - Complicated feedback via retina's visual input

The Pancreas

Exocrine and endocrine cells

- Acinar cells (forming most of the pancreas)
  - *Exocrine* function
  - Secrete digestive enzymes
- Islet cells (of Langerhans)
  - *Endocrine* function

The Gonads (testes and ovaries)

main source of the steroid sex hormones

- Testes
  - Interstitial cells secrete androgens
  - Primary androgen is testosterone
    - Maintains secondary sex characteristics
    - Helps promote sperm formation
- Ovaries
  - Androgens secreted by thecal folliculi
    - Directly converted to estrogens by follicular granulosa cells
  - Granulosa cells also produce progesterone
  - Corpus luteum also secretes estrogen and progesterone

Endocrine cells in various organs

- The heart: atrial natriuretic peptide (ANP)
  - Stimulates kidney to secrete more salt
  - Thereby decreases excess blood volume, high BP and high blood sodium concentration
- GI tract & derivatives: Diffuse neuroendocrine system (DNES)

Endocrine cells in various organs continued

- The placenta secretes steroid and protein hormones
  - Estrogens, progesterone
  - CRH
  - HCG
- The kidneys
  - Juxtaglomerular cells secrete renin
    - Renin indirectly signals adrenal cortex to secrete aldosterone
  - Erythropoietin: signals bone marrow to increase RBC production
- The skin
  - Modified cholesterol with uv exposure becomes Vitamin D precursor
  - Vitamin D necessary for calcium metabolism: signals intestine to absorb

CA++

Post Study Test

- 1-what are the divisions of the pituitary gland
- 2-Describe the thyroid gland
- 3- Define the pineal gland

Answers :Pre Study Test

- 1-.Hormones are “messenger molecules ”Circulate in the blood Act on distant target cells Target cells respond to the hormones for which they have receptors
- 2-Basic categories of hormones

Amino acid based: modified amino acids (or amines),peptides (short chains of amino acids), and proteins (long chains of amino acids)

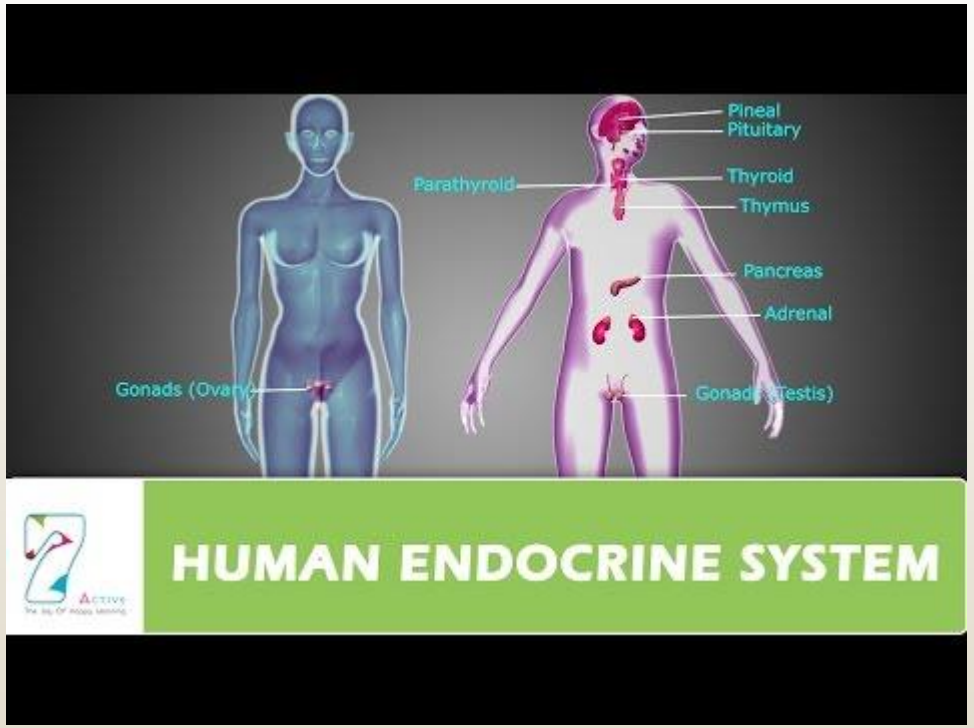
Steroids: lipid molecules derived from cholesterol

- 3-a-adrenal b-pancreas c-thymus

Answers :Post Study Test

- 1-.
  - Anterior pituitary (adenohypophysis)
  - Posterior pituitary (neurohypophysis)
- **2-Thyroid gland Anterior neck on trachea just inferior to larynx ,Two lateral lobes and an isthmus Produces two hormones Thyroid hormone: tyrosine based with 3 or 4 iodine molecules T4 (thyroxine) and T3**
- **3-Pineal gland At the end of a short stalk on the roof of the diencephalon Pinealocytes with dense calcium particles Can be seen on x-ray (because of Ca++), Melatonin helps regulate the circadium rhythm The biological clock of the diurnal (night/day)**

Video



https://www.youtube.com/watch?v=BenVSmBG7wU

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