Therapeutic areas & Diseases

Anatomy and Physiology of Human Body

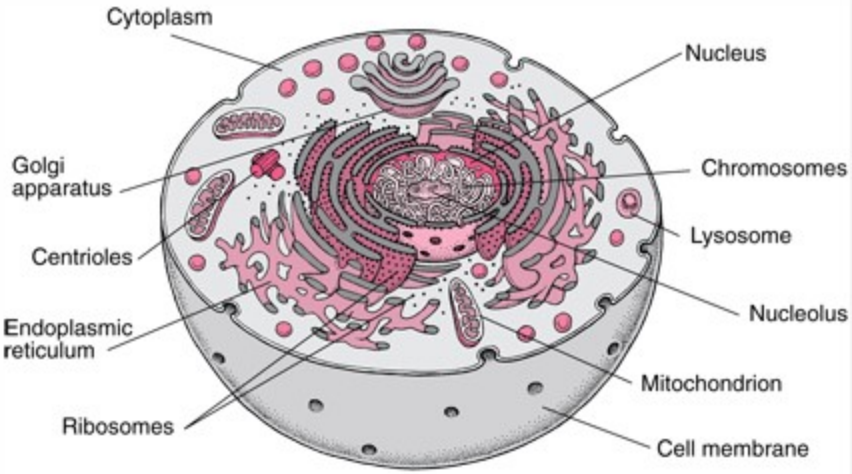
Module 4 Topic 1

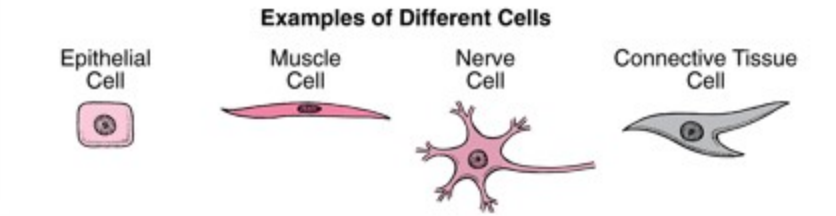
Human Body

- Cell - the smallest functional unit of the human body
- Tissues - Epithelial, Connective, Muscle, Nervous
- Organs - Heart, Lungs, Brain, Liver etc.
- Systems - Digestive, Respiratory, Circulatory, Nervous etc.
- Body - function is survival and propagation of human race

Human Body

- Human cell
  - Protoplasm
  - Cytoplasm
    - Cytoplasmic organelles
  - Nucleus
    - Chromosomes





Cytoplasmic organelles

Organelles and their functions

- Mitochondria – Energy production
- Ribosomes – Protein synthesis
- Golgi bodies – Storage of starch
- Endoplasmic reticulum – Transport system

Human Body

Tissues

- Epithelial tissue
- Connective tissue
- Muscle tissue
- Nervous tissue

Human Body

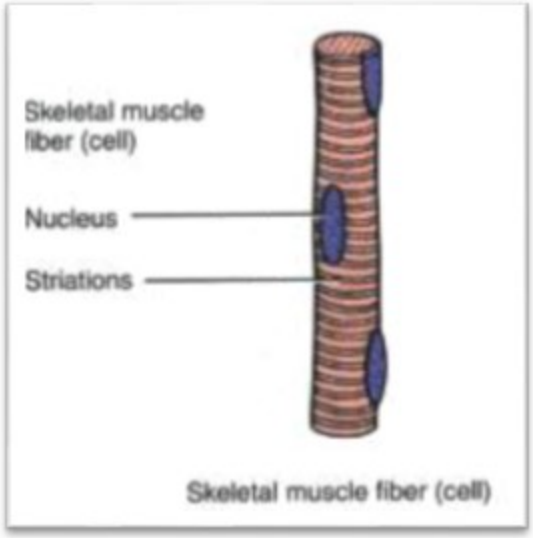
- **Epithelial tissue**
  - Outer covering & inner lining of body surfaces and cavities
  - Simple epithelial tissue
    - *Squamous epithelium* - lining for heart, blood vessels
    - *Cuboidal epithelium* - secretion activity of various glands
    - *Columnar epithelium* - absorption in digestive system
    - *Ciliated columnar epithelium* - lining of bronchi
  - Compound epithelial tissue
    - *Stratified epithelium* - skin
    - *Transitional epithelium* - lining of ureter and urinary bladder

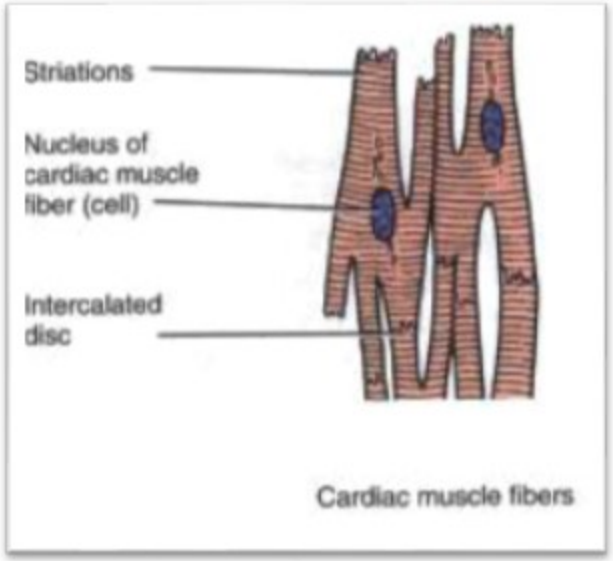
Human Body

- **Connective tissue**
  - Areolar tissue –
    - Fibers (collagen, elastic, and reticular) and cells (Fibroblasts, Macrophages, Mast cells, Fat cells etc.)
    - Provides strength, elasticity, and support
  - Adipose tissue –
    - Adipocytes store triglycerides
  - White fibrous tissue
    - Ligaments, tendons, covering of organs (capsules)
  - Bones and cartilages
    - Skeletal framework, joints

Human Body

- **Muscle tissue**
  - Skeletal or striated or voluntary muscle
  - Visceral or smooth or involuntary muscle
  - Cardiac muscle

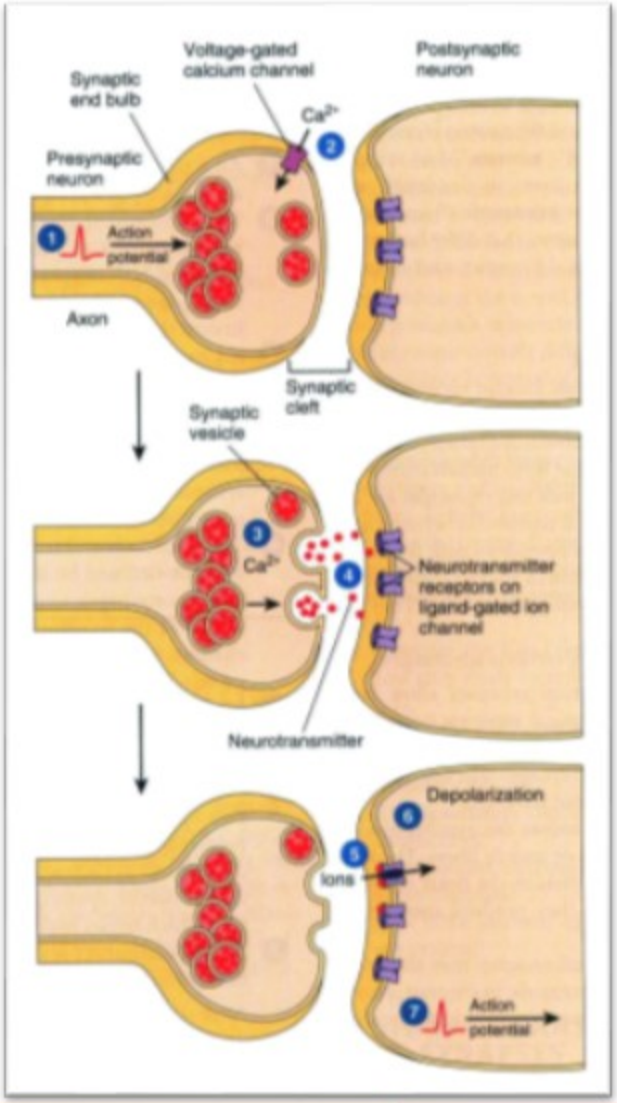




Human Body

- **Nervous tissue**
  - Consists of nerve cells or **neurons** supported by connective tissue called **neuroglia**
  - Analyze information received and send appropriate response
  - Co-coordinating and controlling body functions
  - Synapse - meeting point of two neurons
  - Neurotransmitters - acetylcholine, noradrenaline, dopamine etc.

Synapse


Voltage-gated calcium channel
Postsynaptic neuron
Synaptic end bulb
Ca^{2+}
Presynaptic neuron
Action potential
Axon
Synaptic cleft
Synaptic vesicle
Ca^{2+}
Neurotransmitter receptors on ligand-gated ion channel
Neurotransmitter
Depolarization
Ions
Action potential

Human Body

- **Organs** are made up of a number of tissues

  Examples

  - **Heart**
  - **Lungs**
  - **Brain**
  - **Liver** etc

- A number of organs (& tissues) form a **System**

  Examples

  - **Digestive system**
  - **Respiratory system**
  - **Circulatory system**
  - **Nervous system** etc

Human Body

System	Main function
Cardiovascular system	Pumping & circulation of blood in the body
Digestive system	Intake of food, digestion & absorption of nutrients, and elimination of waste matter
Respiratory system	Intake of Oxygen and elimination of Carbon dioxide
Urinary system	Removal of waste material through urine
Nervous system	Co-ordination & control of body functions and responses
Musculoskeletal system	Movements of body

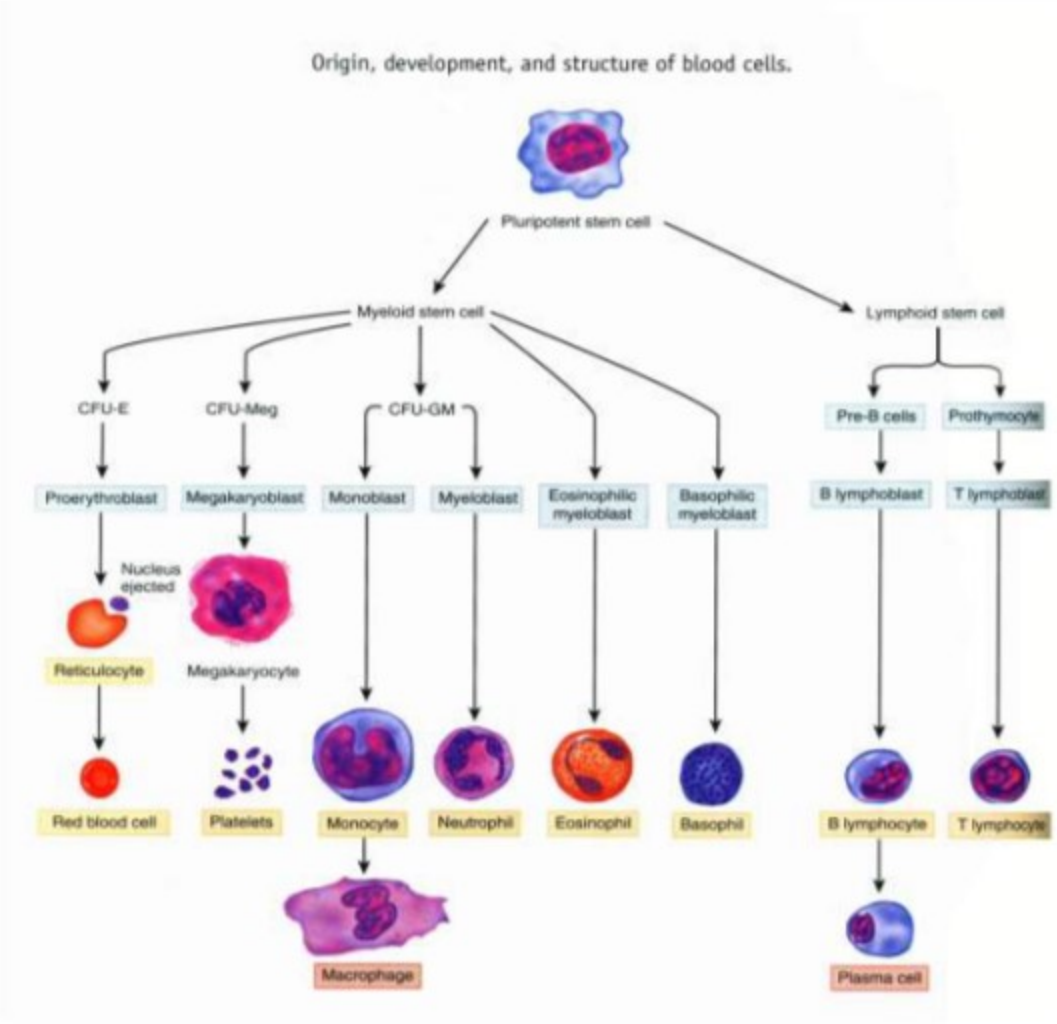
Cardiovascular System

- Pumping of the blood by heart into the blood vessels for circulation through out the body
- Components
  - Blood
  - Blood vessels
  - Heart

Cardiovascular System

- Blood
  - Plasma - light yellow – coloured transparent fluid
    - Plasma proteins, nutrients, gases, electrolytes, waste products, hormones
  - Blood cells
    - Erythrocytes or red blood cells (RBCs)
    - Leukocytes or white blood cells (WBCs)
      - **Granulocytes - neutrophils, eosinophils, basophils**
      - **Agranulocytes - monocytes and lymphocytes**
    - Thrombocytes or platelets

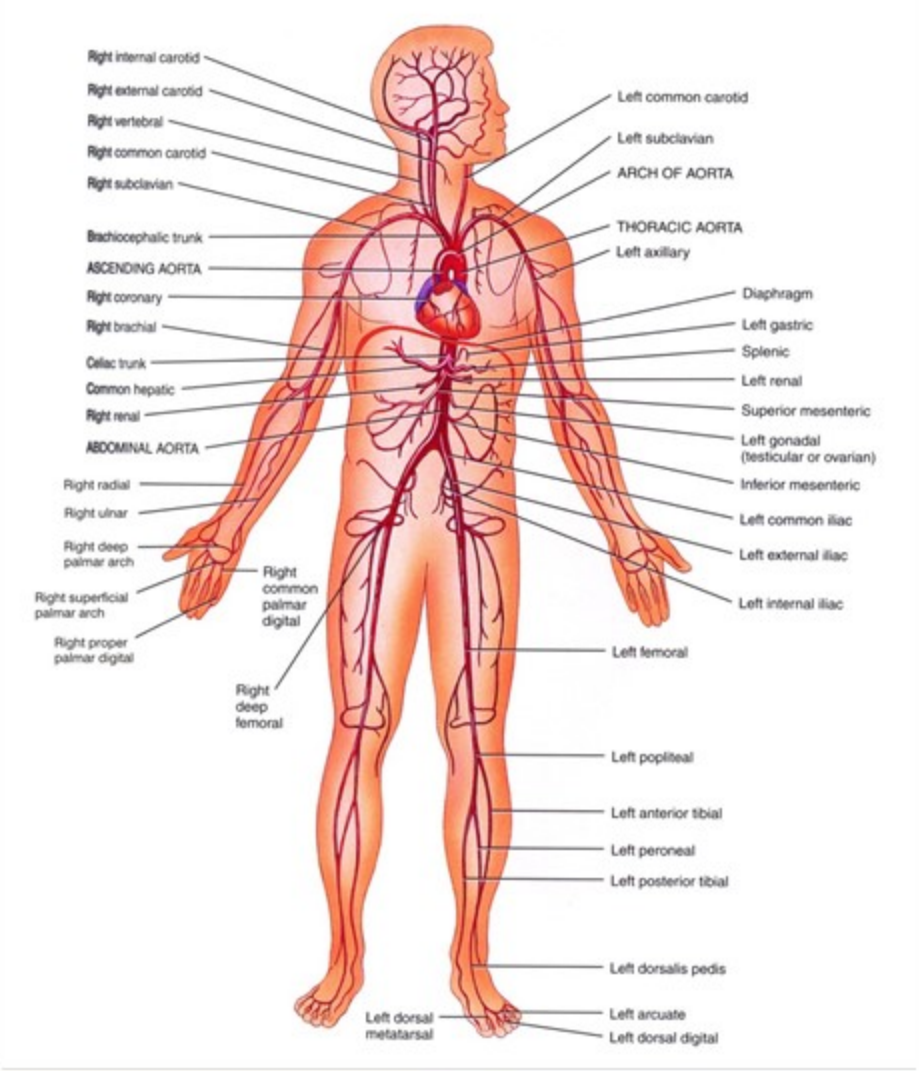
Blood cells


Origin, development, and structure of blood cells.
Pluripotent stem cell
Myeloid stem cell
Lymphoid stem cell
CFU-E
CFU-Meg
CFU-GM
Pre-B cells
Prothymocyte
Proerythroblast
Megakaryoblast
Monoblast
Myeloblast
Eosinophilic myeloblast
Basophilic myeloblast
B lymphoblast
T lymphoblast
Nucleus ejected
Reticulocyte
Megakaryocyte
Red blood cell
Platelets
Monocyte
Neutrophil
Eosinophil
Basophil
B lymphocyte
T lymphocyte
Macrophage
Plasma cell

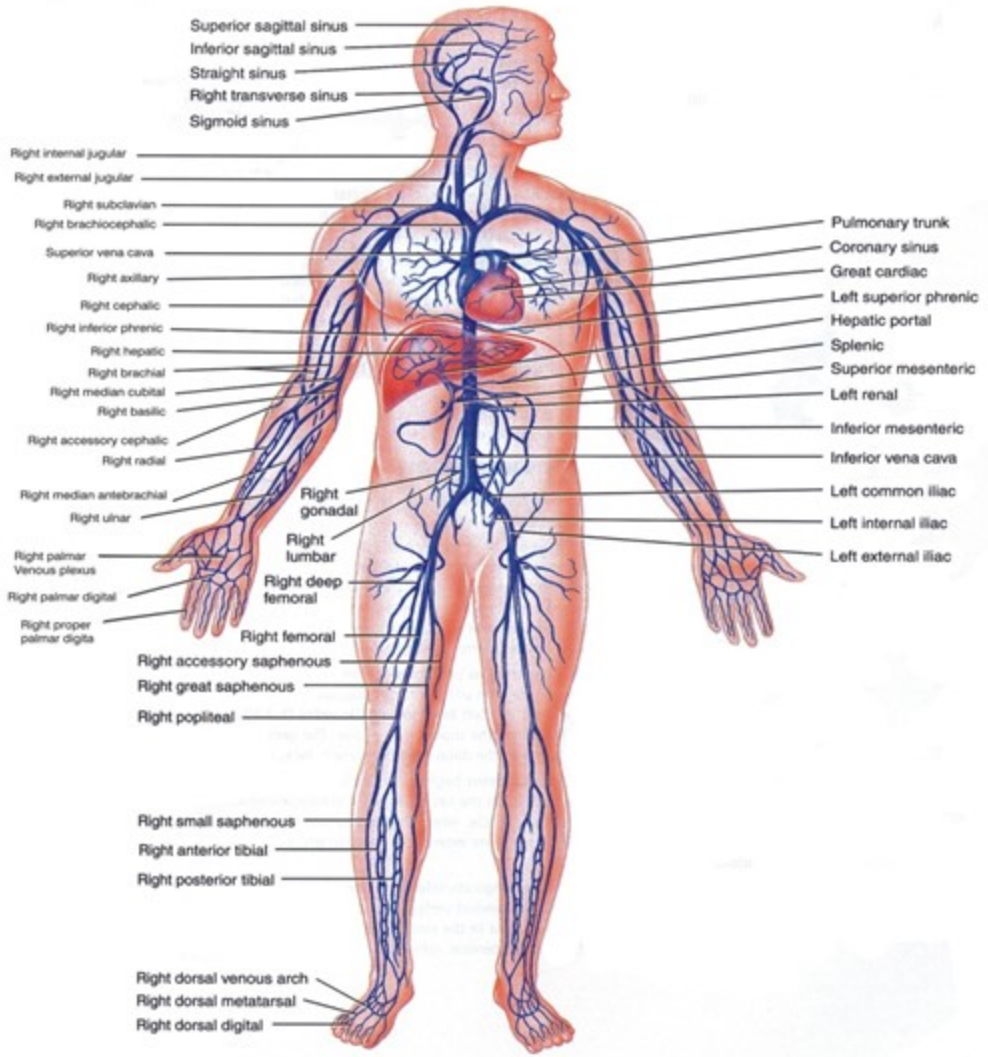
Cardiovascular System

- **Blood Vessels**
  - ***Arteries*** carry blood away from the heart
  - ***Veins*** bring the blood back to the heart
  - ***Capillaries*** link arteries and veins

Arteries


Right internal carotid
Right external carotid
Right vertebral
Right common carotid
Right subclavian
Brachiocephalic trunk
ASCENDING AORTA
Right coronary
Right brachial
Celiac trunk
Common hepatic
Right renal
ABDOMINAL AORTA
Right radial
Right ulnar
Right deep palmar arch
Right superficial palmar arch
Right proper palmar digital
Right common palmar digital
Right deep femoral
Left common carotid
Left subclavian
ARCH OF AORTA
THORACIC AORTA
Left axillary
Diaphragm
Left gastric
Splenic
Left renal
Superior mesenteric
Left gonadal (testicular or ovarian)
Inferior mesenteric
Left common iliac
Left external iliac
Left internal iliac
Left femoral
Left popliteal
Left anterior tibial
Left peroneal
Left posterior tibial
Left dorsalis pedis
Left arcuate
Left dorsal digital
Left dorsal metatarsal

Veins

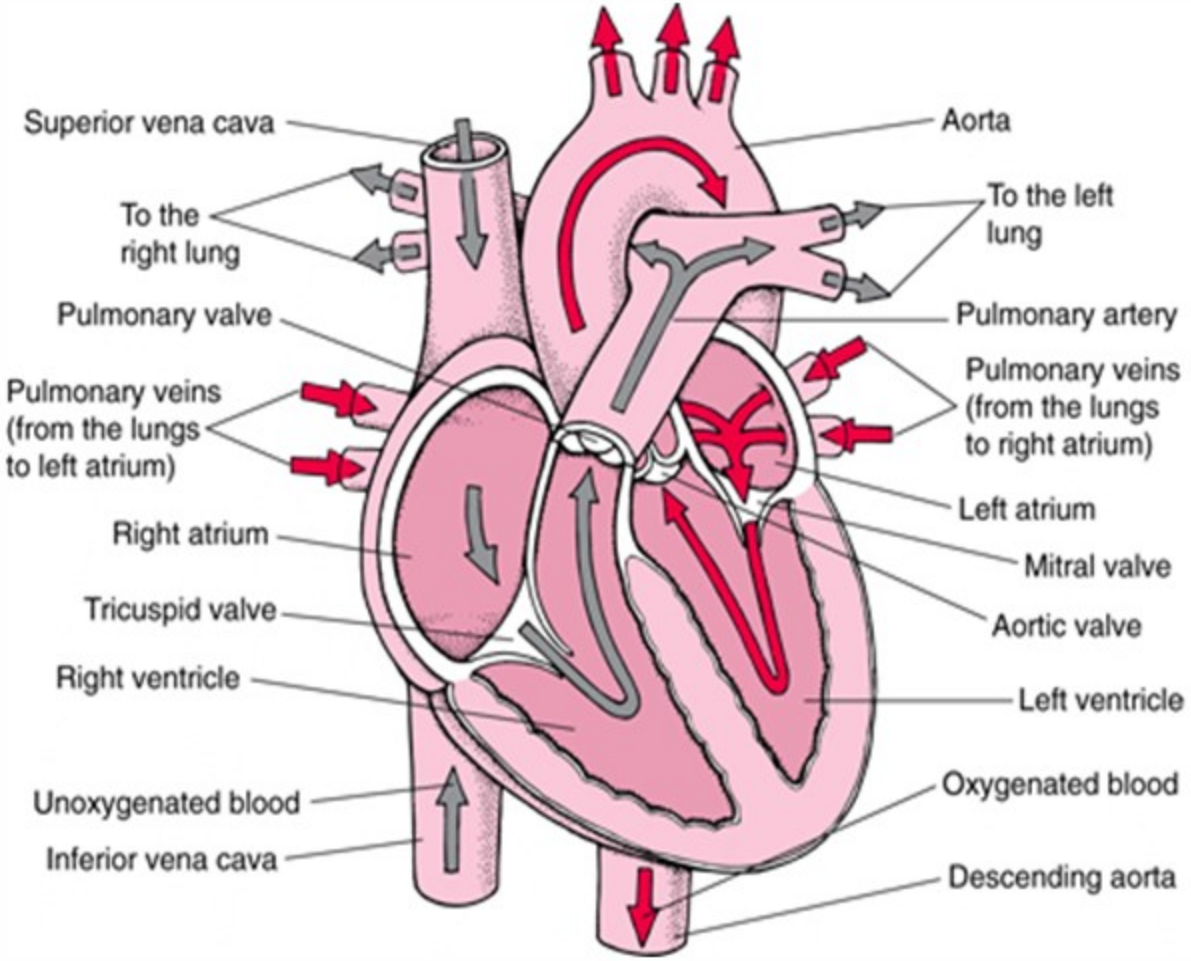

Superior sagittal sinus
Inferior sagittal sinus
Straight sinus
Right transverse sinus
Sigmoid sinus
Right internal jugular
Right external jugular
Right subclavian
Right brachiocephalic
Superior vena cava
Right axillary
Right cephalic
Right inferior phrenic
Right hepatic
Right brachial
Right median cubital
Right basilic
Right accessory cephalic
Right radial
Right median antebrachial
Right ulnar
Right palmar Venous plexus
Right palmar digital
Right proper palmar digita
Right gonadal
Right lumbar
Right deep femoral
Right femoral
Right accessory saphenous
Right great saphenous
Right popliteal
Right small saphenous
Right anterior tibial
Right posterior tibial
Right dorsal venous arch
Right dorsal metatarsal
Right dorsal digital
Pulmonary trunk
Coronary sinus
Great cardiac
Left superior phrenic
Hepatic portal
Splenic
Superior mesenteric
Left renal
Inferior mesenteric
Inferior vena cava
Left common iliac
Left internal iliac
Left external iliac

Cardiovascular System

Heart

- Cone shaped, hollow muscular organ
- Divided into a right and left side by a partition (septum)
- Each side divided into an upper chamber called the **atrium** and a lower chamber called the **ventricle** by an atrioventricular valve
- Cardiac cycle

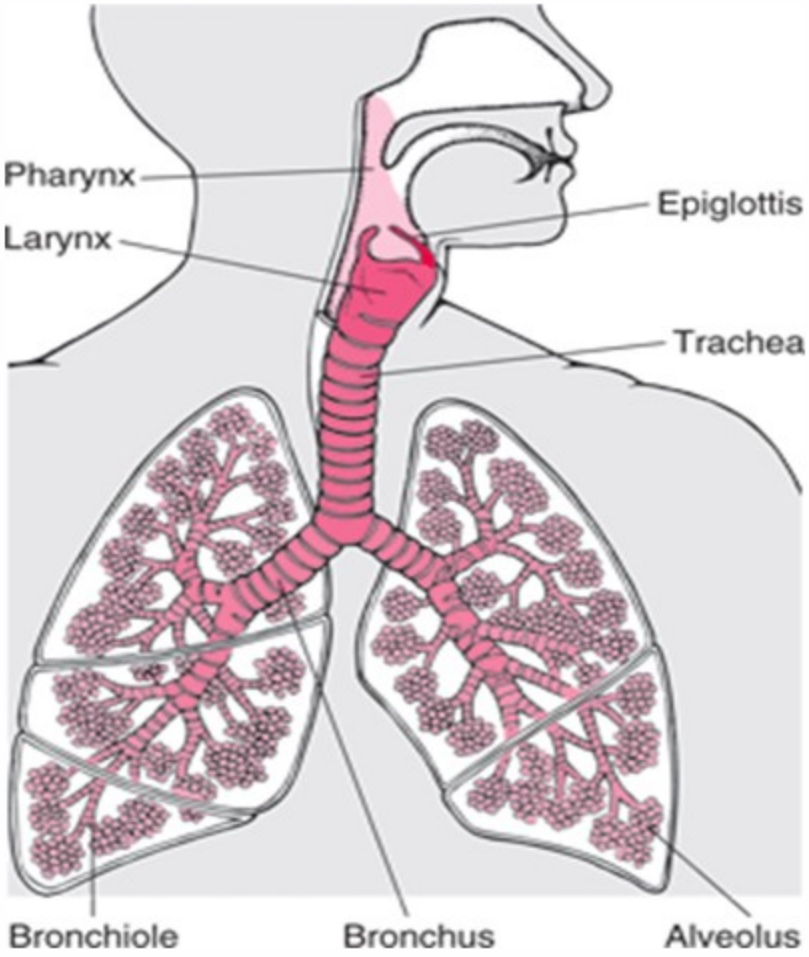
Heart


Superior vena cava
Aorta
To the right lung
To the left lung
Pulmonary valve
Pulmonary artery
Pulmonary veins (from the lungs to left atrium)
Pulmonary veins (from the lungs to right atrium)
Left atrium
Right atrium
Mitral valve
Tricuspid valve
Aortic valve
Right ventricle
Left ventricle
Unoxygenated blood
Oxygenated blood
Inferior vena cava
Descending aorta

Respiratory System

- Responsible for the intake of oxygen and removal of carbon dioxide
- Parts
  - Nose
  - Pharynx
  - Larynx
  - Trachea
  - Bronchi (one bronchus to each lung)
  - Bronchioles and smaller airways
  - Lungs & their covering i.e. pleura

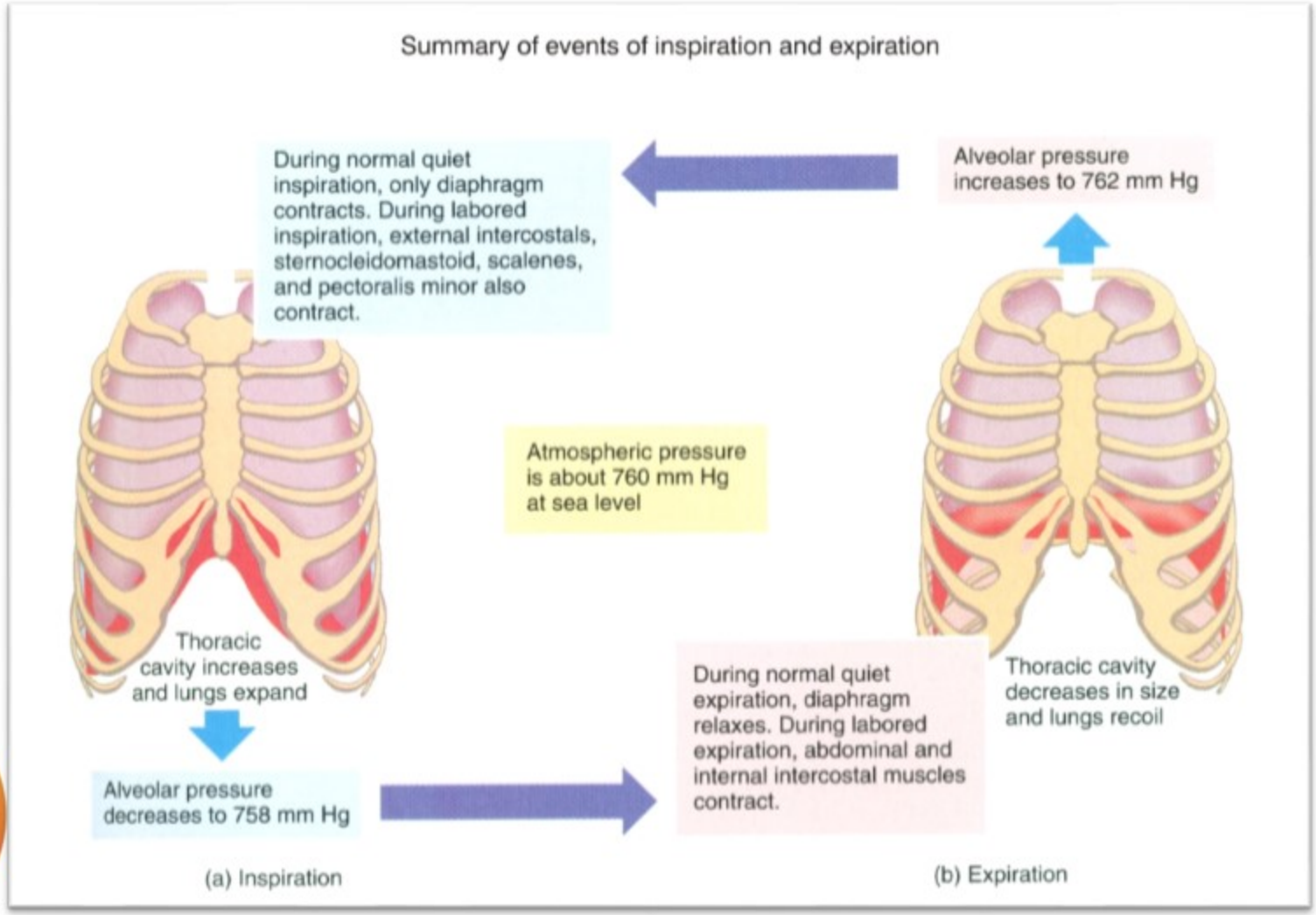
Lungs and Airways



Respiratory System

- **Respiratory cycle**
  - Inspiration: process of expanding the chest to draw in the atmospheric air into the lungs
  - Expiration: process of expelling the air out of the lungs
  - Pause

Respiratory Cycle



Exchange of Gases

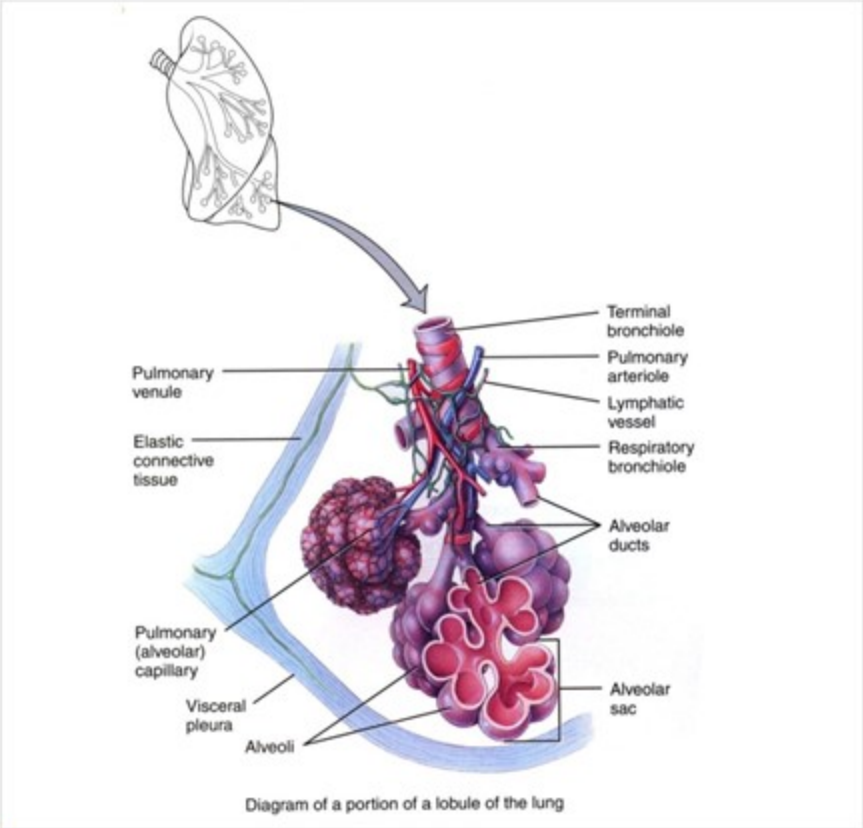
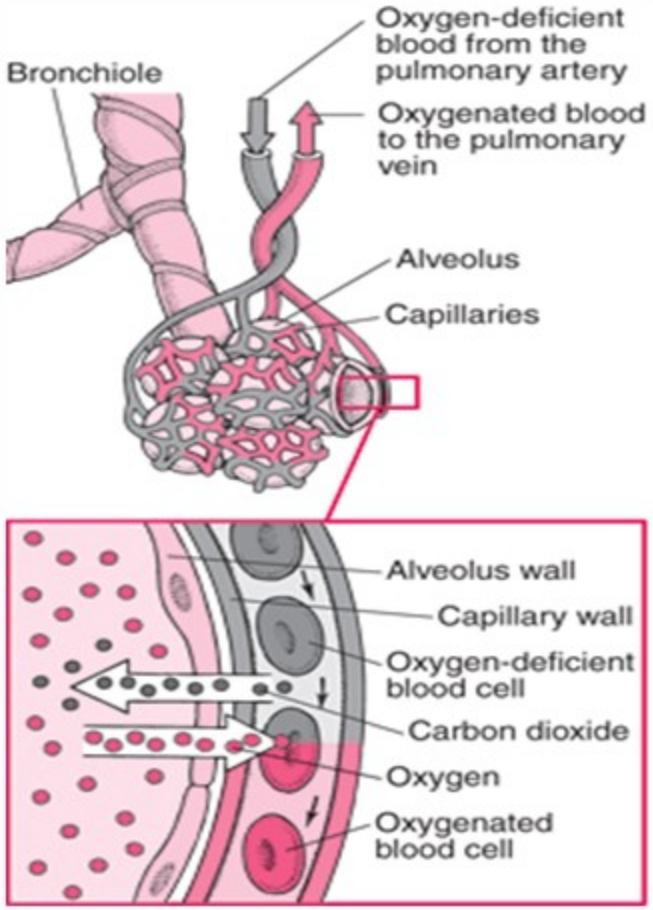


Diagram of a portion of a lobule of the lung

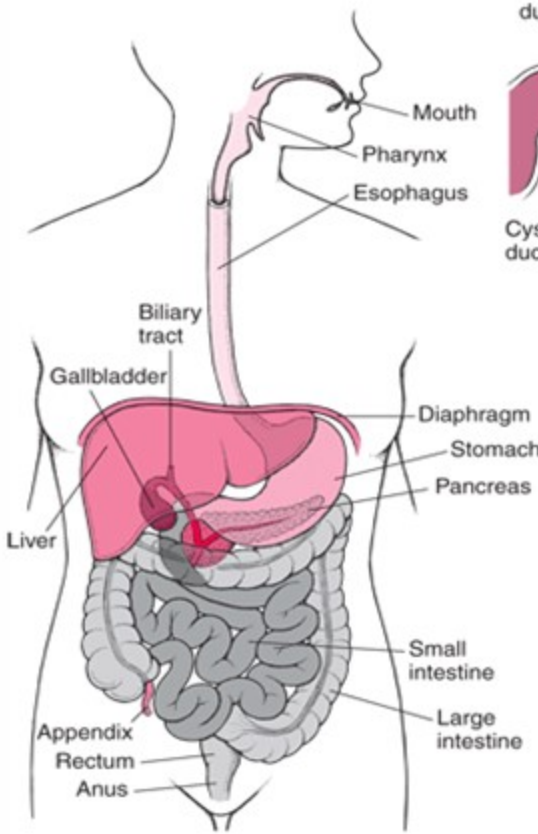


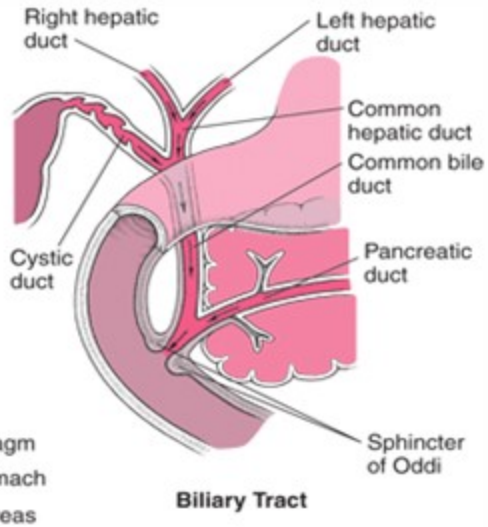
Digestive System

The digestive system is involved in the digestion and absorption of the food

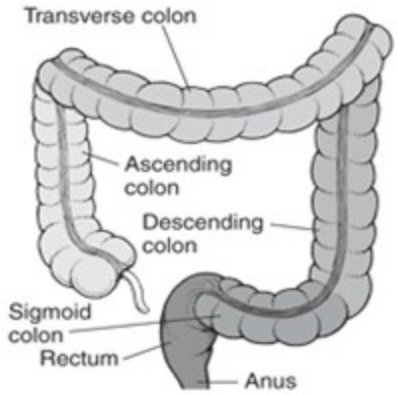
- **Alimentary Canal**
  - Mouth, pharynx, oesophagus, stomach, small- and large intestines, rectum, and anal canal
- **Accessory Organs**
  - Salivary glands, liver, gall bladder, and pancreas

Digestive System





Biliary Tract



Large Intestine

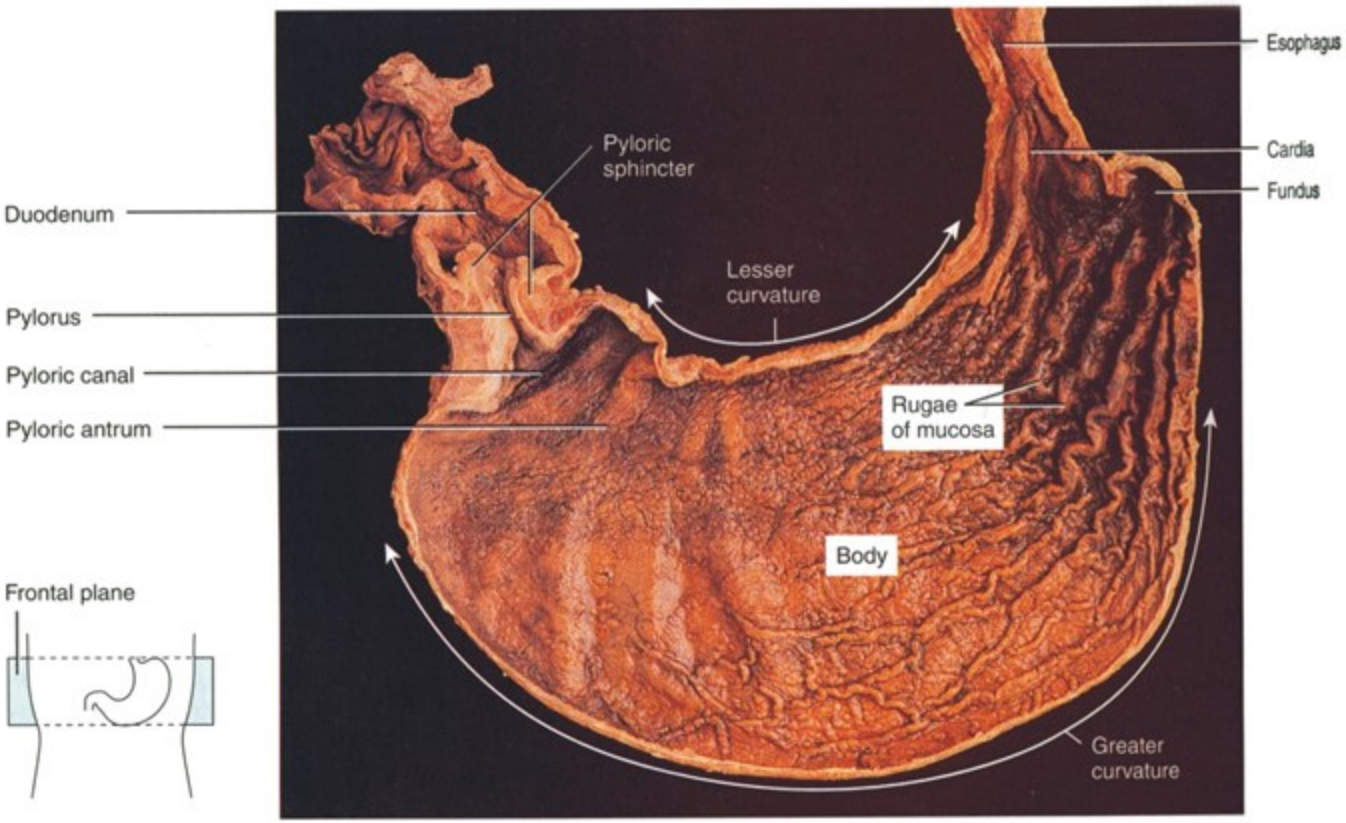
Digestive System

- **Ingestion** - activity of consuming food by mouth
- **Digestion** - mechanical breakdown of food by chewing and chemical breakdown by enzymes present in:
  - Saliva from the salivary glands
  - Gastric juice from the stomach
  - Intestinal juice from the small intestine
  - Pancreatic juice from the pancreas
- **Absorption** - nutrients from digested food absorbed and circulated to all parts of the body
- **Elimination** - undigested and unabsorbed portion of food excreted as faeces

Digestive System

- Mouth
- Salivary Glands
  - parotid, submandibular, and sublingual
- Pharynx
- Oesophagus
- Stomach
  - Fundus, body, pyloric canal
  - Gastric juice - hydrochloric acid, pepsinogen, intrinsic factor, and mucus

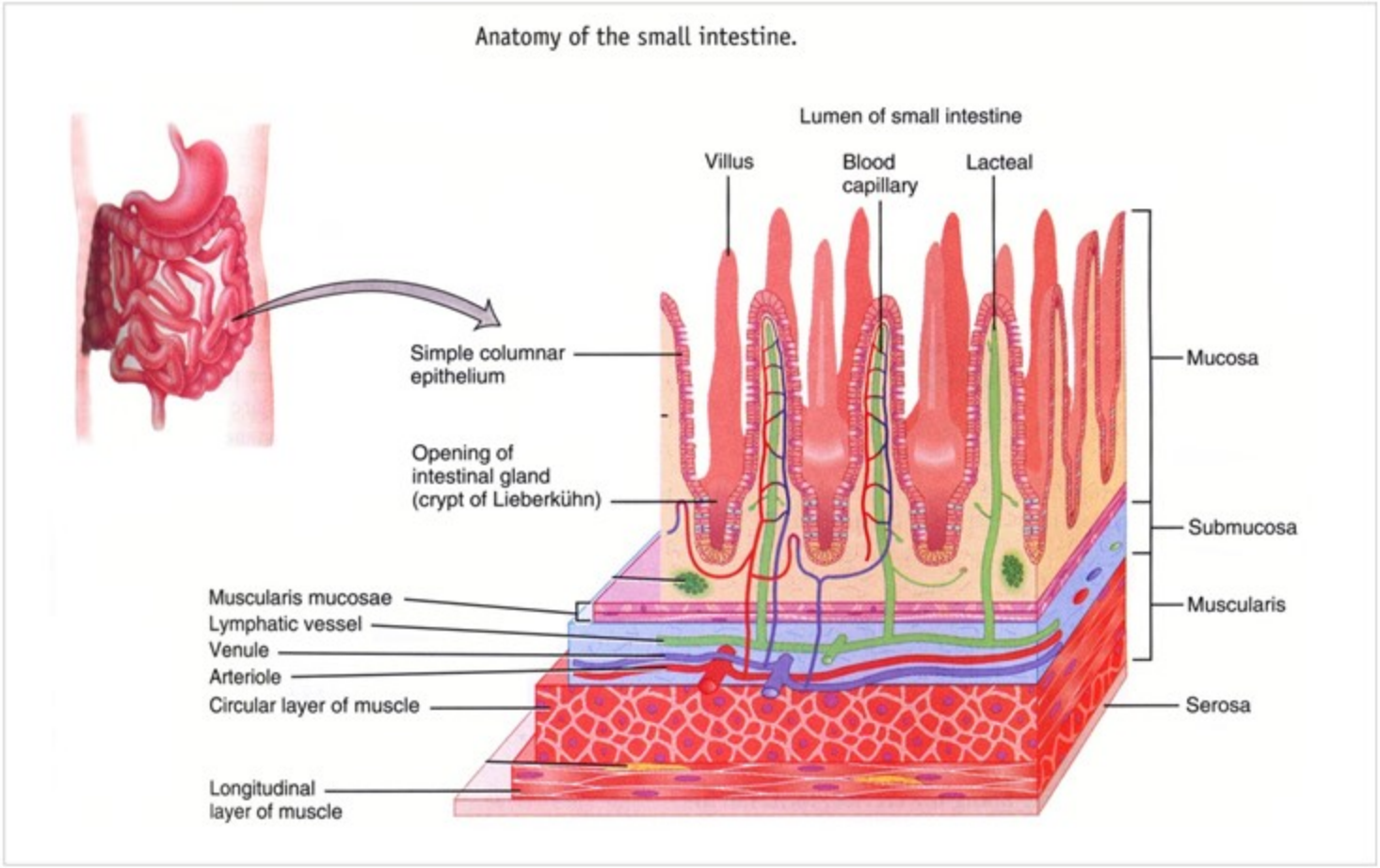
Stomach


Frontal section of the internal surface
Esophagus
Cardia
Fundus
Pyloric sphincter
Duodenum
Lesser curvature
Pylorus
Pyloric canal
Pyloric antrum
Rugae of mucosa
Body
Frontal plane
Greater curvature

Digestive System

- Pancreas
  - Pancreatic juice, insulin
- Liver
  - Metabolism of carbohydrates, fats, and proteins
  - Inactivation of drugs, toxins, and poisons
- Small intestine
  - **Duodenum, jejunum,** and **ileum**
  - Intestinal juice
  - Villi or 'brush border'

Small Intestine



Digestive System

- Chemical digestion of proteins

Proteins in food

↓ Pepsin (gastric juice)

Peptones

↓ Trypsin and Chymo-trypsin (pancreatic juice)

Polypeptides

↓ Peptidases (villi)

Amino acids

Digestive System

- Chemical digestion of carbohydrates

Polysaccharides (starches)

↓ Amylases (pancreatic and intestinal juice)

Disaccharides (sugars)

↓ Maltase, lactase, sucrase (villi)

Monosaccharides (glucose)

Digestive System

- Chemical digestion of fats

Fats in food

↓ Bile salts (bile)

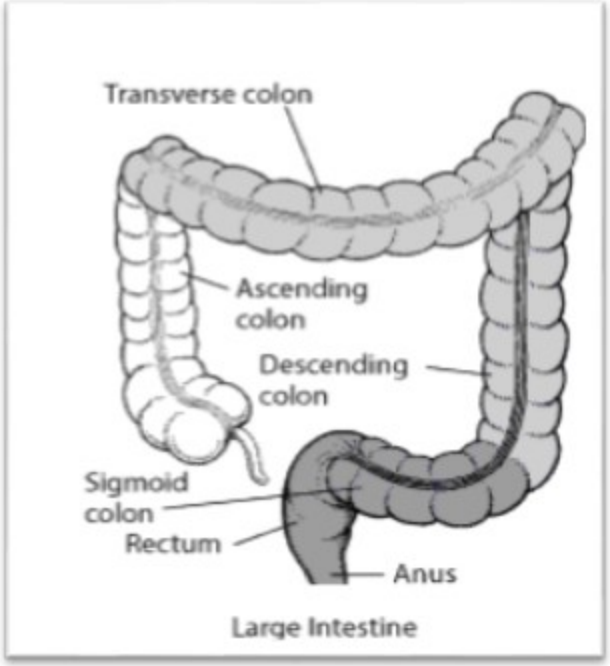
Emulsified fats

↓ Lipases (pancreatic juice and villi)

Fatty acids and glycerol

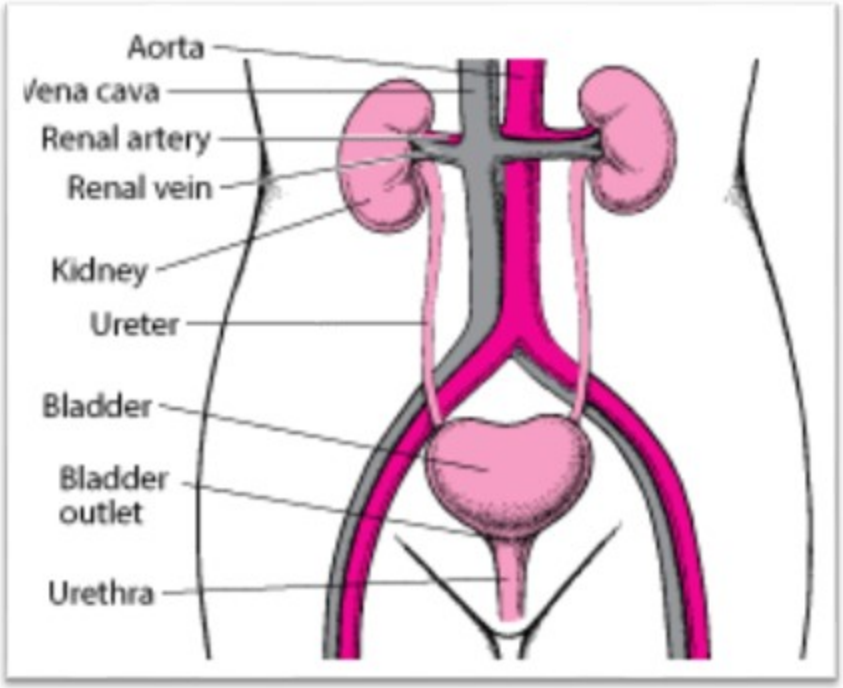
Digestive System

- Large intestine
  - Caecum
  - Colon
  - Rectum
  - Anal canal
- Absorption of water
- Undigested and unabsorbed material passed out of the body as **faeces**



Urinary System

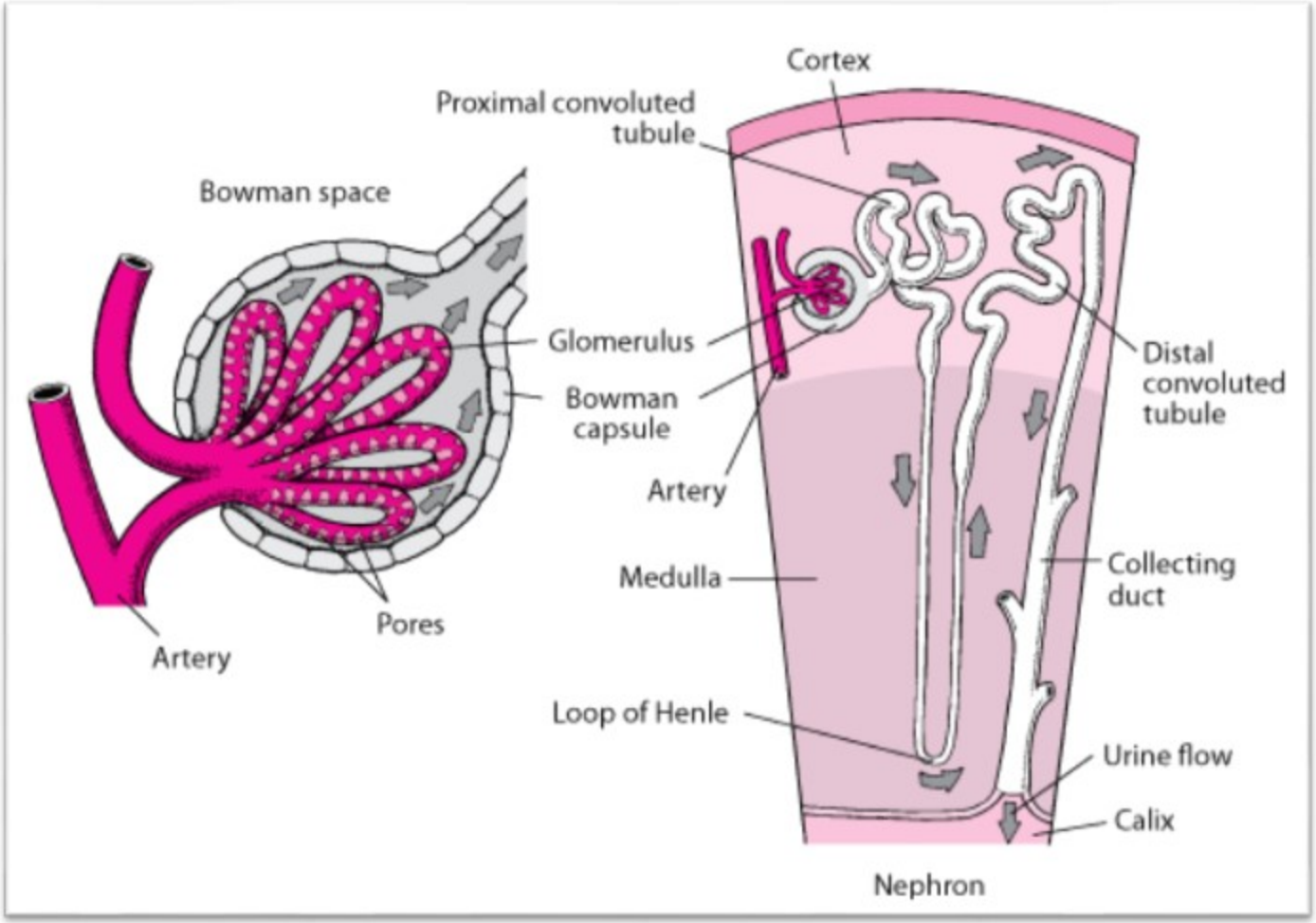
- Major excretory system of the human body
- Consists of
  - Kidneys
  - Ureters
  - Urinary bladder, and
  - Urethra



Urinary System

- Kidneys
  - Bean-shaped organs located at the back, one on either side of the vertebral column
  - Functional units known as ***nephron***
    - Glomerulus
    - Glomerular (Bowman's) capsule
    - Renal tubule
  - Collecting ducts - papillary ducts - ureters

Nephron


Cortex
Proximal convoluted tubule
Bowman space
Glomerulus
Bowman capsule
Artery
Pores
Artery
Distal convoluted tubule
Medulla
Collecting duct
Loop of Henle
Urine flow
Calix
Nephron

Urinary System

- **Formation of urine**
  - Simple filtration - minerals, glucose, urea, uric acid, drugs and drug metabolites
  - Selective reabsorption - sodium, glucose
  - Secretion - urea, ammonia
- **Composition of urine**
  - Water - 96 %
  - Urea - 2 %
  - Uric acid, creatinine, ammonia etc. - 2 %

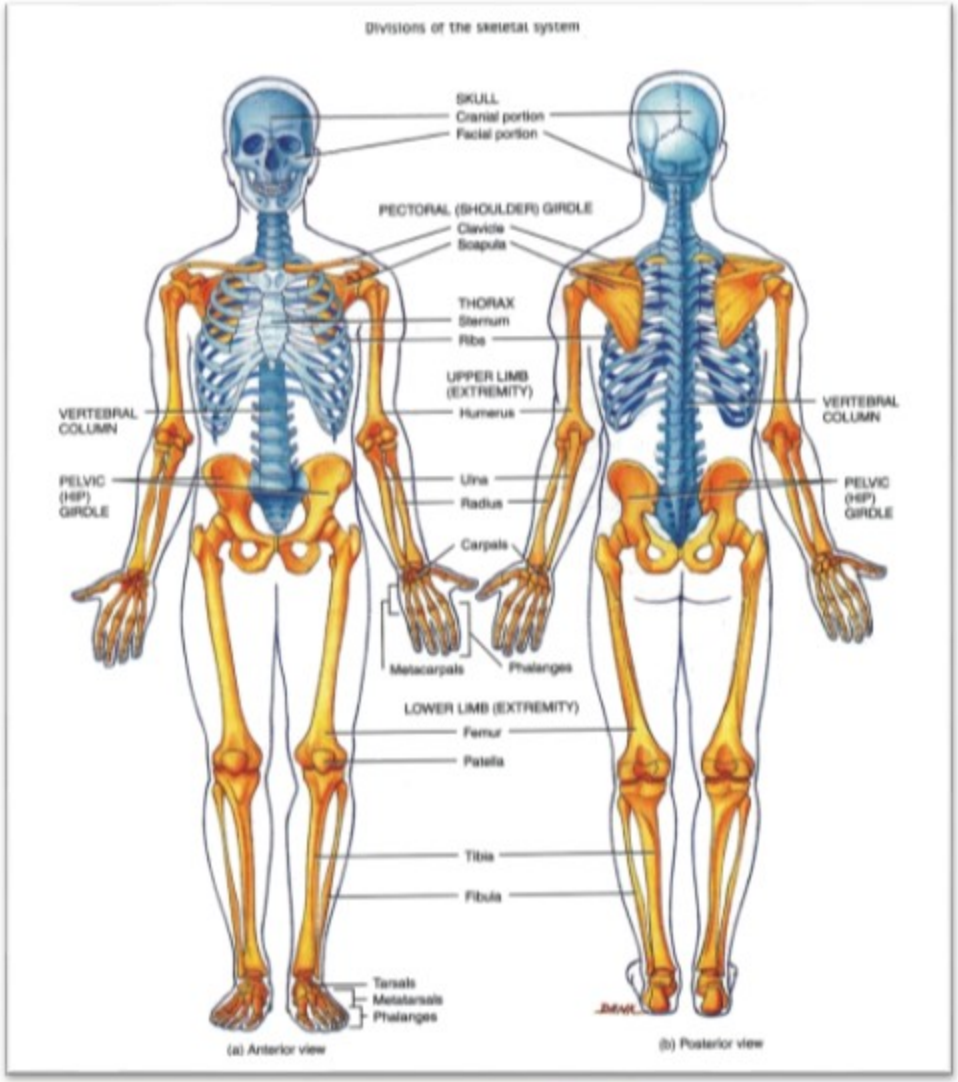
Urinary System

- Ureter
- Urinary bladder
  - Micturition reflex
- Urethra

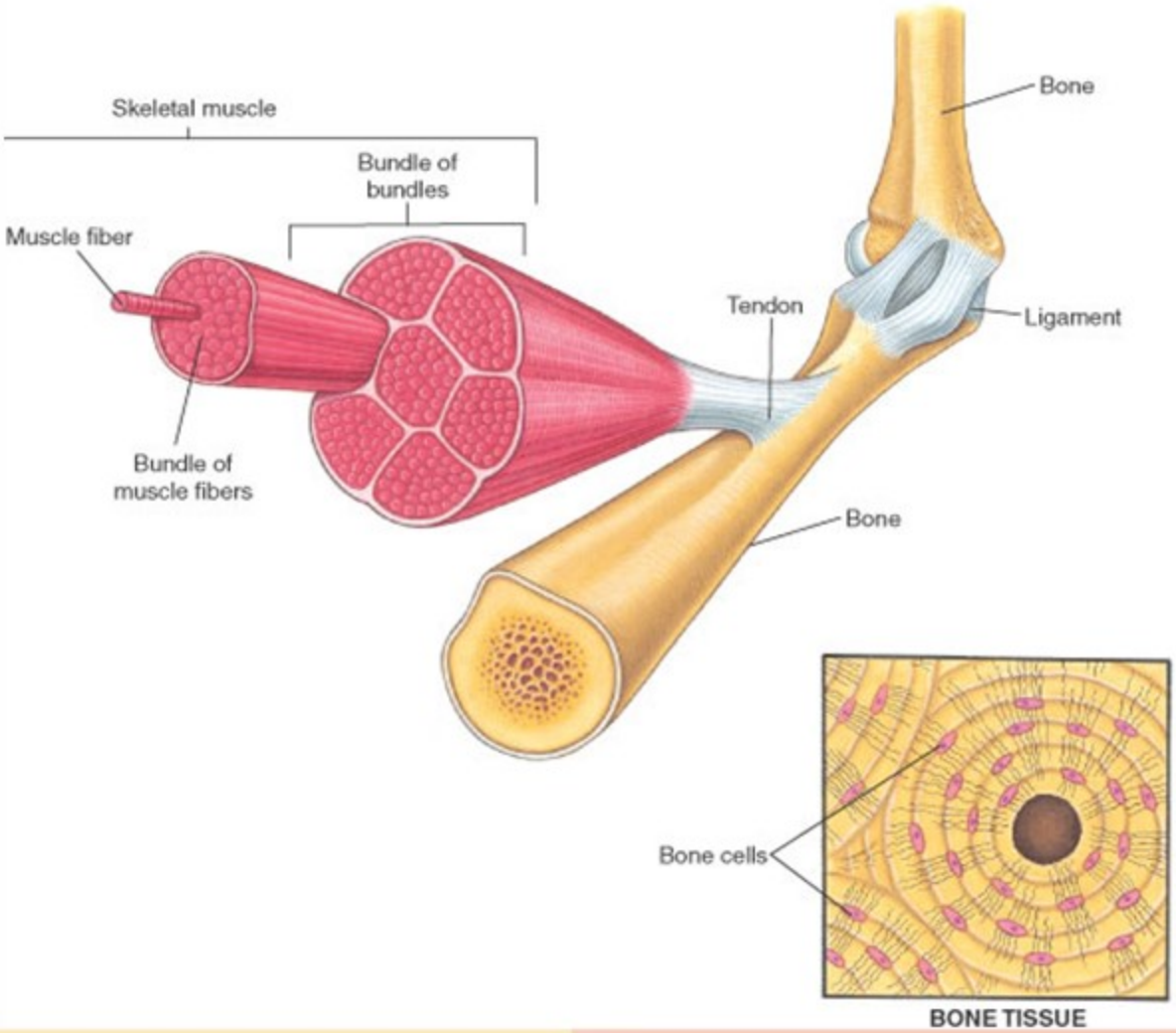
Musculoskeletal System

- Provides the supporting framework
- Involved in the body movements
- **Axial skeleton** consists of the ***skull, vertebral column, sternum (breast bone),*** and ***ribs***
- **Appendicular skeleton** consists of the bones of upper and lower limbs, a pair each of ***scapula, clavicle (collar bone),*** and the ***pelvic bones – ileum, ischium,*** and the ***pubis***

Skeleton


Divisions of the skeletal system
SKULL
Cranial portion
Facial portion
PECTORAL (SHOULDER) GIRDLE
Clavicle
Scapula
THORAX
Sternum
Ribs
UPPER LIMB (EXTREMITY)
Humerus
VERTEBRAL COLUMN
PELVIC (HIP) GIRDLE
Ulna
Radius
Carpals
Metacarpals
Phalanges
LOWER LIMB (EXTREMITY)
Femur
Patella
Tibia
Fibula
Tarsals
Metatarsals
Phalanges
(a) Anterior view
(b) Posterior view

Musculoskeletal System



Musculoskeletal System

- **Bones**
  - One of the hardest tissues
  - Made up of water (25 %), collagen fibers (25 %), and crystallized mineral salts, mainly calcium phosphate (***hydroxyapatite***) and some calcium carbonate
  - Bone marrow - production of various blood cells

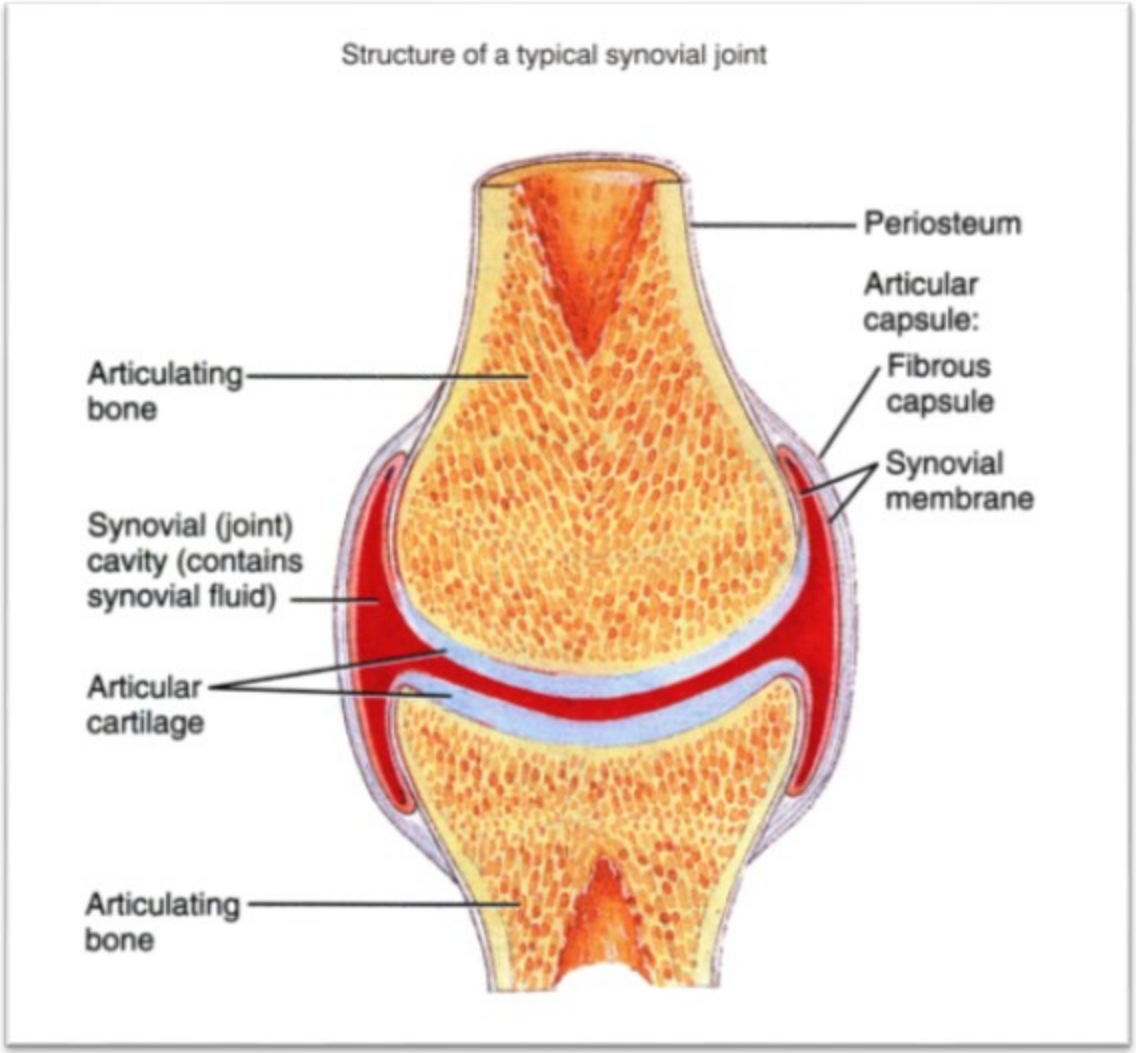
Musculoskeletal System

- Types of bones – long, short, flat, irregular
- Functions of bones
  - Support
  - Protection
  - Movements
  - Production of blood cells
  - Storage of minerals

Musculoskeletal System

- **Joints** - point of contact between two bones
  - Types
    - Fibrous - joints between skull bones
    - Cartilaginous - intervertebral joints
    - Synovial – articular cartilage, synovial fluid
- **Bursa** - small fluid-filled sacs between a bone and overlying skin (such as in the elbow, knee)
- **Ligaments** - surround joints and bind them together, help strengthen and stabilize joints

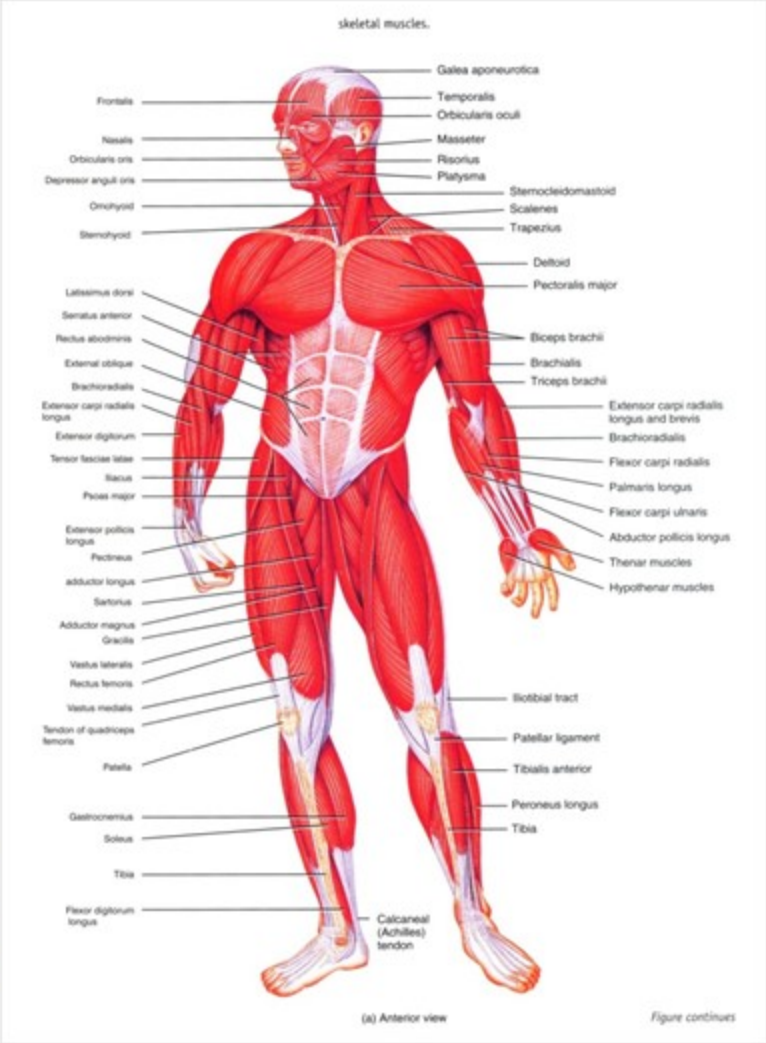
Synovial Joint

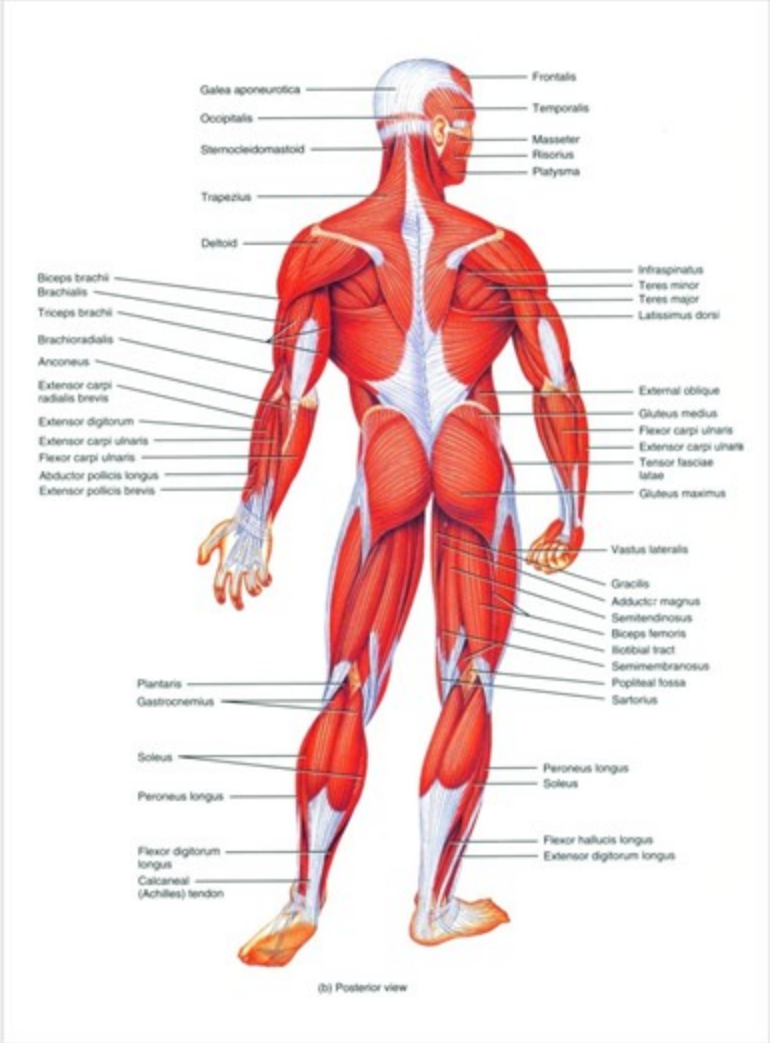


Musculoskeletal System

- Skeletal muscles
  - Attached to bony skeleton
  - Produce movement of body
  - ‘Voluntary’ muscles

Skeletal muscles





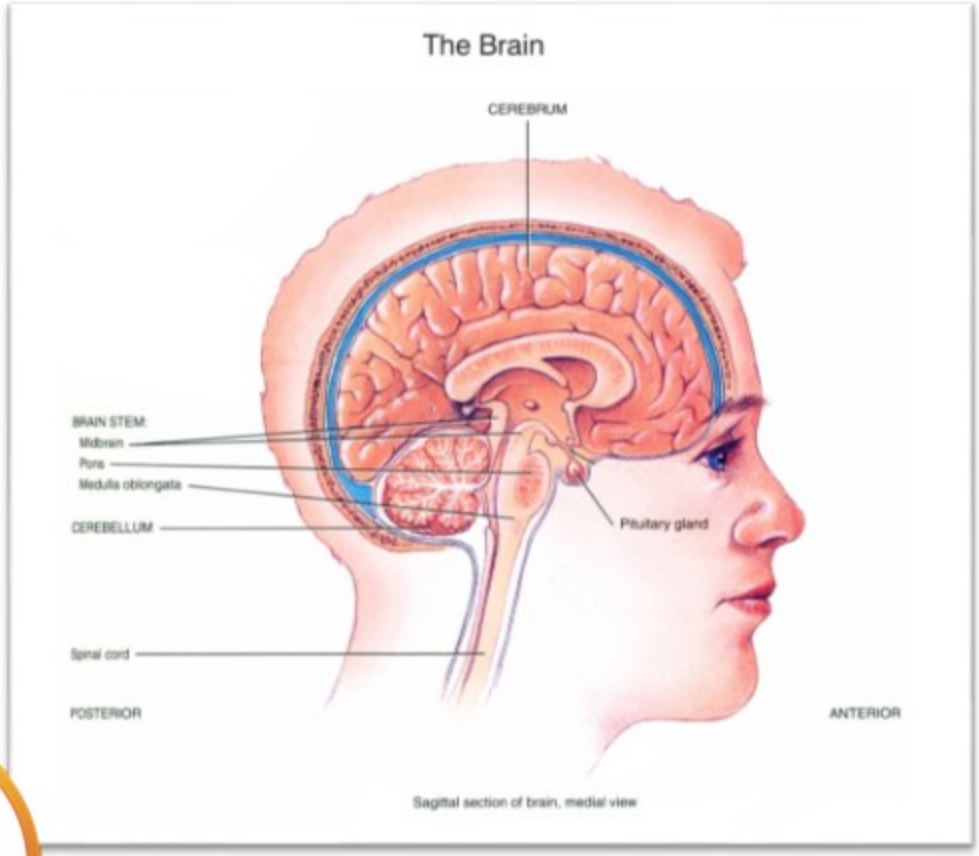
Nervous System

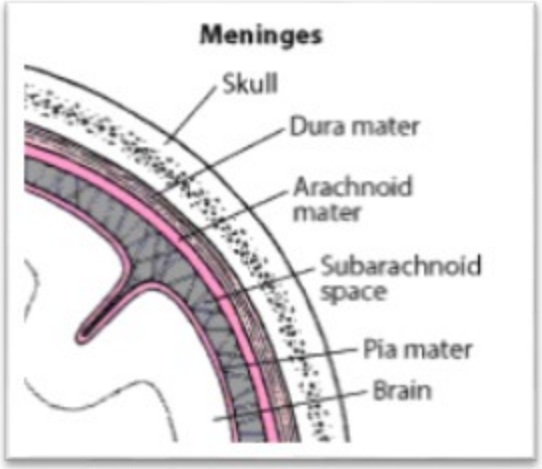
- Complex, highly organized network of billions of nerve cells
- Involved in the co-ordination & control of body functions and responses to internal as well as outside information
- Maintains the equilibrium ('balance') of internal environment of the body
- Responsible for perceptions, behaviour, memories and voluntary and most of the involuntary movements

Nervous System

- Central nervous system
  - Brain
  - Spinal cord
- Peripheral nervous system
  - Cranial nerves
  - Spinal nerves
  - Autonomic nervous system

Brain


The Brain
CEREBRUM
BRAIN STEM:
Midbrain
Pons
Medulla oblongata
CEREBELLUM
Pituitary gland
Spinal cord
POSTERIOR
ANTERIOR
Sagittal section of brain, medial view


Meninges
Skull
Dura mater
Arachnoid mater
Subarachnoid space
Pia mater
Brain

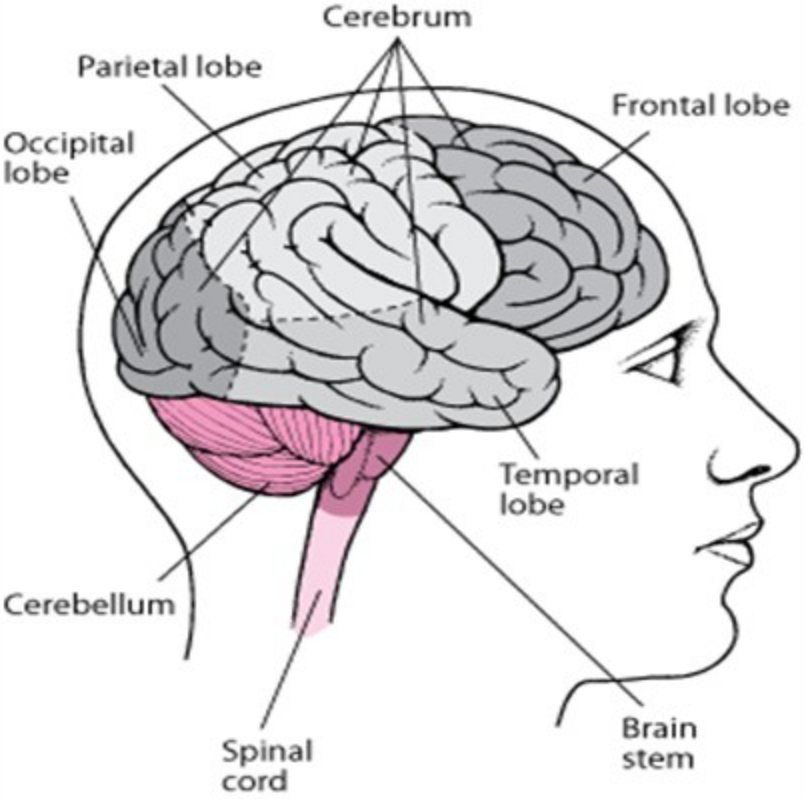
Nervous System

- Brain
  - Center for registering sensations, correlating them with one another and with previously stored information, making appropriate decisions, and taking action
  - Center for intellect, emotions, behaviour, and memory
- Parts - cerebrum
  - brain stem (midbrain, pons, medulla oblongata),
  - cerebellum

Nervous System

- **Cerebrum**
  - made up of two halves the ***right*** and ***left hemispheres*** that are connected to each other by a band of nerve fibers called ***corpus callosum***
  - Outer layer made up of neurons called '***cerebral cortex'*** or gray matter
  - Inner layer made up of nerve fibers, called white matter

Brain


Cerebrum
Parietal lobe
Frontal lobe
Occipital lobe
Temporal lobe
Cerebellum
Spinal cord
Brain stem

Nervous System

- Midbrain
  - Relay center for sensory & motor impulses
  - Nerve centers for control of the movement of eyes and head & neck
- Pons
  - Nerve fibers connecting two halves of cerebellum and brain & spinal cord
  - Nerve centers for nerves carrying sensory inputs from head & face, including taste and balance
  - Motor control of the muscles for chewing, and for secretion of saliva & tears

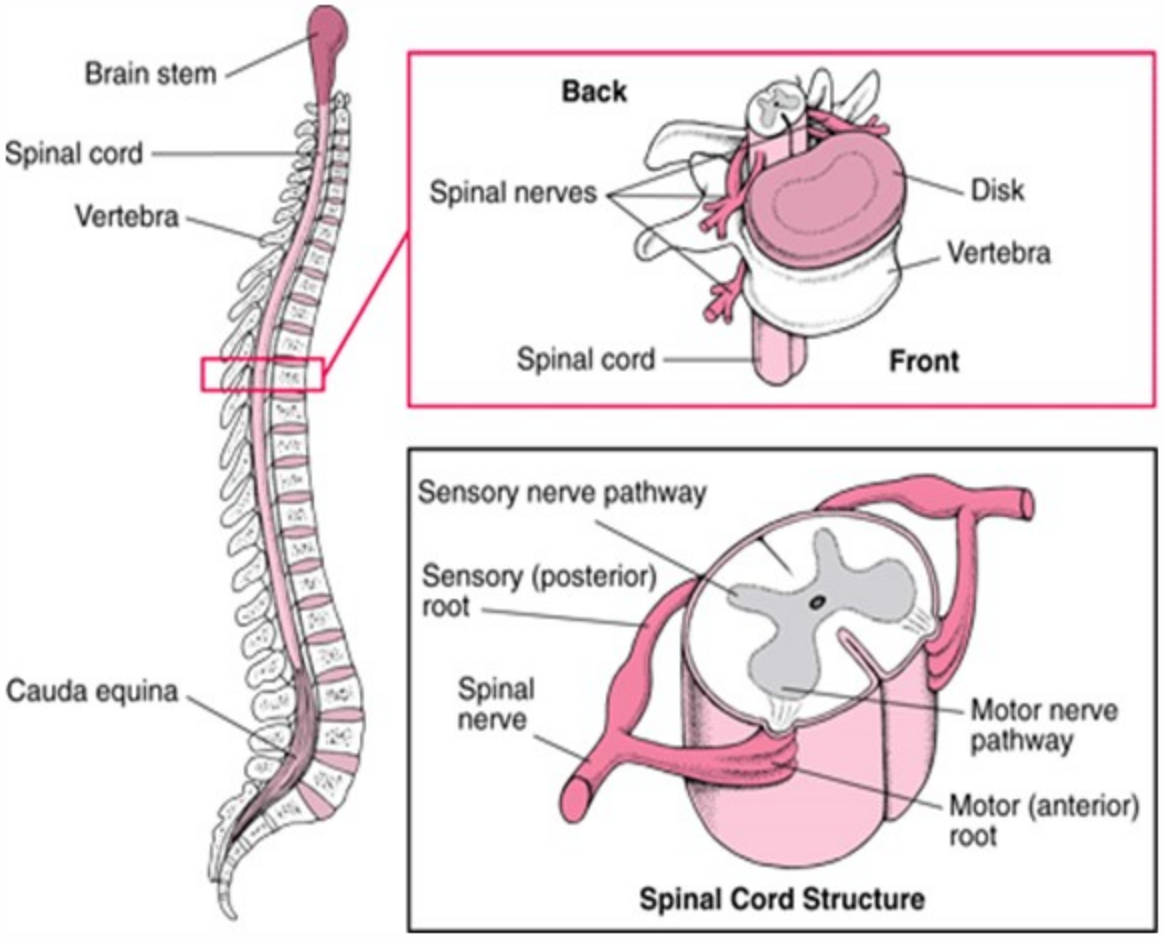
Nervous System

- **Medulla oblongata**
  - Nerve cells regulating vital body functions like beating of heart and respiration
  - Nerve cells coordinating reflex actions such as swallowing, coughing, sneezing, and vomiting
- **Cerebellum**
  - Ensures smooth and coordinated body movements
  - Also involved in the regulation of body posture and balance

Nervous System

- **Spinal cord**
  - Link between the brain and the rest of the body
  - Functions
    - Transmits various sensations such as touch, pain, pressure, vibration, heat, and cold
    - Spinal neurons control the skeletal muscles of the arms, legs, and the trunk resulting in precise, voluntary movements
    - ***Spinal reflexes***

Spinal Cord


Brain stem
Spinal cord
Vertebra
Cauda equina
Back
Spinal nerves
Disk
Vertebra
Spinal cord
Front
Sensory nerve pathway
Sensory (posterior) root
Spinal nerve
Motor nerve pathway
Motor (anterior) root
Spinal Cord Structure

Nervous System

- **Cranial nerves**
  - Olfactory
  - Optic
  - Oculomotor
  - Trochlear
  - Trigeminal - ophthalmic, maxillary, and mandibular branches
  - Abducens
  - Facial
  - Vestibulocochlear
  - Glossopharyngeal
  - Vagus
  - Accessory
  - Hypoglossal

Nervous System

- **Spinal nerves**
  - Cervical - 8 pairs
  - Thoracic - 12 pairs
  - Lumbar - 5 pairs
  - Sacral - 5 pairs
  - Coccygeal - 1 pair
- ***Posterior root*** contains sensory axon that carries the sensory information e.g. touch, pain, and temperature
- ***Anterior root*** contains motor axon that carries the motor impulses from brain to the skeletal muscles

Nervous System

- **Autonomic nervous system**
  - Operates without conscious control or awareness
  - Involved in regulating respiration, cardiovascular function, digestion, hormone secretion etc.
  - Components - the ***sympathetic nervous system*** and the ***parasympathetic nervous system***

Autonomic Nervous System

Physiological effects of sympathetic system activation	Physiological effects of parasympathetic system activation
Heart rate, force of heart contraction, and blood pressure increase	Decrease in the rate and force of heart contraction
The airways widen allowing faster movement of greater amounts of air into and out of lungs	Decrease in the diameter of airways
Organs involved in the physical effort viz. skeletal muscles, cardiac muscle, lungs etc. receive greater blood flow while kidneys and digestive system get a reduced blood supply	Increased activity of digestive system allowing digestion and absorption of energy-supplying food

Autonomic Nervous System

Physiological effects of sympathetic system activation	Physiological effects of parasympathetic system activation
Breakdown of glycogen to glucose in the liver cells	Increased glycogen synthesis in the liver cells
Intestinal peristalsis and secretion of digestive juices slow down or even stop	Increased glycogen synthesis in the liver cells
Inhibition of urination and defaecation	

Synapse

- Junction of two neurons
- Acts as a relay station - signals passed or blocked selectively as needed
- Nerve endings called presynaptic terminals have many vesicles that contain neurotransmitters
- Synaptic cleft is the gap between presynaptic terminal and the postsynaptic receptor

Synapse

- When an electrical impulse arrives at the presynaptic terminal the neurotransmitter is released into the synaptic cleft
- Neurotransmitter binds with receptor and causes stimulation or inhibition of the cell function
- Neurotransmitter is then rapidly removed from synaptic cleft by diffusion, enzymatic inactivation or reuptake into the presynaptic terminal

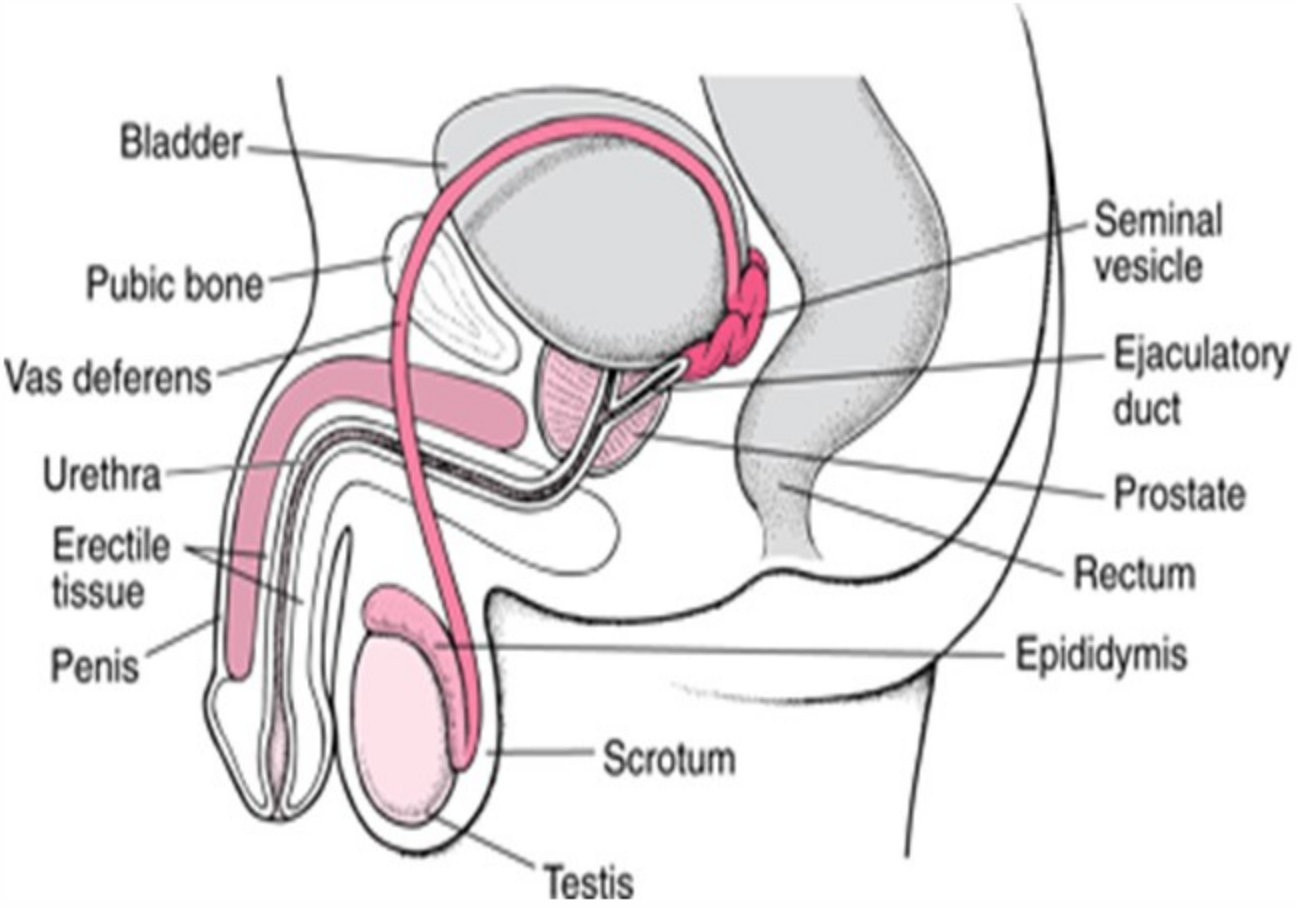
Neurotransmitters

- More than 30 neurotransmitters proved or postulated
- Examples
  - Acetylcholine, noradrenaline
  - Dopamine, serotonin
  - GABA, glycine
  - Hormones

Male Reproductive System

- The **penis** and the **urethra** are part of the urinary and reproductive systems
- The **scrotum, testes (testicles), vas deferens, seminal vesicles**, and **prostate** comprise the rest of the reproductive system
- **Testes** have two primary functions:
  - Producing sperm
  - Producing testosterone

Male Reproductive System

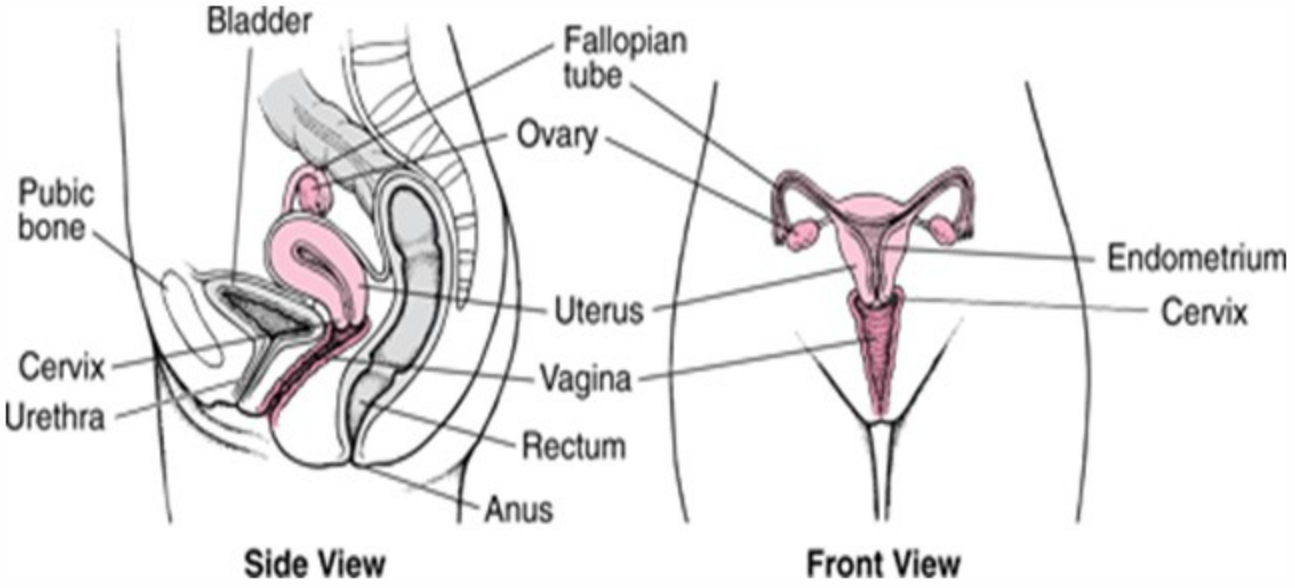


Male Reproductive System

- **Prostate** lies just under the bladder and surrounds the urethra
  - Walnut-sized in young men, the prostate enlarges with age
  - When prostate enlarges too much, it can block urine flow through the urethra
- **Seminal vesicles,** located above the prostate, join with the vas deferens to form the ejaculatory ducts, which travel through the prostate
  - Prostate and the seminal vesicles produce fluid that nourishes the sperm

Female Reproductive System

- Female reproductive system consists of the external genital organs and internal genital organs



Female Reproductive System

- External genital organs include the **mons pubis, labia majora, labia minora**, Bartholin glands, and **clitoris**
  - Area containing these organs is called the **vulva**
- Internal genital organs include **vagina, uterus, Fallopian tubes** and **ovaries**

Menstrual Cycle

- Menstruation is the shedding of the lining of the uterus (endometrium) accompanied by bleeding
- Menstrual cycle begins with the first day of bleeding, which is counted as day 1
- Menstrual cycles normally range from about 25 to 36 days
- Menstrual bleeding lasts 3 to 7 days, averaging 5 days

Menstrual Cycle

- Menstrual cycle is regulated by **Luteinizing hormone** (LH) and **Follicle-stimulating hormone** (FSH) produced by pituitary gland
- LH & FSH promote ovulation and stimulate the ovaries to produce estrogen and progesterone
- **Estrogen** and **progesterone** stimulate the uterus and breasts to prepare for possible fertilization

Menstrual Cycle