MODULE 1 – CHAPTER 17

ENDOCRINE SYSTEM

Questions	Answers
Describe the similarities and differences between the nervous and endocrine systems.	**Similarities:** - Both use structures in the brain: when the hypothalamus detects changes in body temp = nervous function. When the hypothalamus sends hormones to the pituitary gland that regulate the secretion of hormones from the pituitary = endocrine - Both systems may use the same molecules as neurotransmitters - Work to regulate critical body processes - Both neurotransmitters and hormones can affect their target through receptors linked to G proteins Differences: - Mode of transport: endocrine = transmitted in bloodstream (hormones), nervous = realised directly onto their target cells - Speed of response: nervous system responds faster than the endocrine system - Duration of response: nervous system typically activates its targets quickly and only for as long as action potentials are sent to the target. Endocrine tends to have longer-lasting effects
How does an endocrine gland differ from an exocrine gland?	**Endocrine:** - Secrete very small amounts of chemical messengers (hormones) into the interstitial fluid - Hormones diffuse into the blood to be transported to their target. Circulate through the bloodstream to specific sites (target tissues) **Exocrine:** - Have ducts that carry their secretions to the outside of the body such as the stomach or intestine - Examples: saliva, sweat, breast
What are the three general characteristics of hormones?	1. **Stability:** concentrations are stable in the bloodstreams, some more than others. Larger, more complex hormones are more stable. 2. **Communication:** Must be able to interact with their target tissue in a specific manner to activate a coordinated set of events 3. **Distribution:** transported by the blood to many locations and have the potential to activate any cell in the body
Is hormone secretion generally regulated by negative-feedback or positive-feedback?	- Most hormones are regulated by **negative-feedback** mechanisms, whereby the hormone's secretion Is inhibited by the hormone itself once blood levels have reached a certain point and there is adequate hormone to activate the target cell - Some hormones use **positive feedback** mechanisms such as when they are stimulated by a tropic hormone, they promote their target cell. This stimulates even more secretion of the original hormone
Where does the spinal cord begin and end? How many	- Extends from the brain at the level of the foramen magnum down to the level of the second lumbar vertebra.

Adrenal glands:
- Produces a diverse set of hormones
- Near the superior poles of the kidneys
- Lie behind the peritoneum, surrounded by abundant adipose tissue
- Enclosed by a connective tissue capsule and have well-developed blood supply
- Composed of an inner medulla and an outer cortex

Composed of smaller cells and forms three indistinct layers
Zona gomerulosa: located beneath the capsule, composed of small clusters of cells, and secretes aldosterone
Zona fasciculata: thickest part of the adrenal cortex, secrets cortisol. Cells form long columns, or fascicles, that extend from the surface toward the medulla of the gland
Zona reticularis: deepest layer, secrets androgens and is a thin layer of irregularly arranged cords of cells

Hormones of Adrenal Medulla:
Secretes two major hormones:
- Epinephrine – 80%
- Norepinephrine – 20%

Secretion of adrenal medullary hormones prepares the individual for physical activity and is a major component of the fight-or-flight response
This response results in reduced activity in organs not essential for physical activity, as well as increased blood flow and metabolic activity in organs that participate in physical activity
Epinephrine and norepinephrine increase the heart's rate

1. Epinephrine increases blood glucose levels
2. Epinephrine also increases the breakdown of glycogen in muscle cells
3. Epinephrine increases lipid breakdown in adipose tissue

Epinephrine and norepinephrine are rapidly metabolised, excreted or taken up by tissues

Hormones of the Adrenal Cortex:

1. Mineralocorticoids: regulate ion balance in the blood. Major secretory products of the zona glomerulosa of the adrenal cortex. Aldosterone is secreted under low blood pressure conditions, returned blood pressure to its normal range through modification of kidney functions
2. Glucocorticoids: helps to provide energy for cells by stimulating the increased use of lipid and proteins. Required for the maturation of tissues, such as fetal lungs and for the development of receptor molecules in target tissues for epinephrine
3. Adrenal androgens: steroid hormones that cause the development of male secondary sex characteristics. Most androgens are secreted by the reproductive system

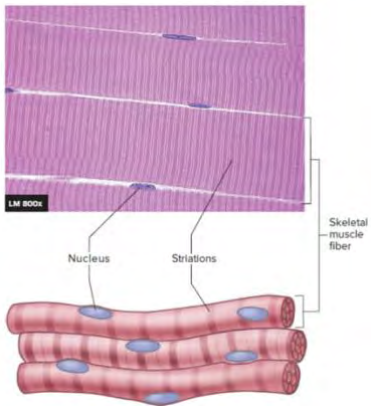
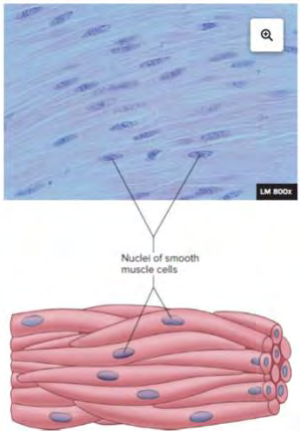
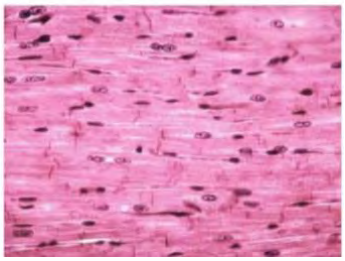
Pancreas:
- Both an exocrine and an endocrine gland
- Exocrine portion consists of acini, which produce pancreatic juice, and a duct system, which carries the pancreatic juice to the small intestine
- The endocrine part, consisting of pancreatic islets secretes hormones that enter the plasma of the blood
- Pancreas lies behind the peritoneum
- Between 500,000 and 1 million pancreatic islets are dispersed among the ducts and acini of the pancreas

Each islet is composed of:

1. Alpha: (20%) secret glucagon
2. Beta: (75%) secrete insulin
3. Delta: secrete somatostatin

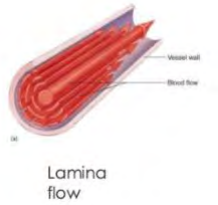
MODULE 3 – CHAPTER 9/10

MUSCULAR SYSTEM

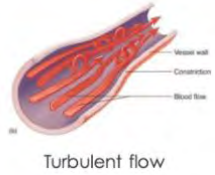
Learning outcomes	Answers
Summarise the functions of the muscular system, explain the four functional properties of muscle tissue and summarise the major characteristics of each muscle type.	**Functions:** - Movement of the body - Maintenance of posture - Respiration - Production of body heat - Communication - Constriction of organs and vessels - Contraction of the heart **4 functional properties of muscle tissues:** 1. **Contractility**: ability of muscle to shorten or contract 2. **Excitability**: capacity of muscles to respond to electrical stimulus 3. **Extensibility**: a muscle can be stretched beyond its normal resting length and still be able to contract 4. **Elasticity**: ability of muscle to spring back to its original length **Characteristics of each muscle type:** **Skeletal:** - 40% body weight - Responsible for locomotion, respiration, posture, mastication, facial expressions - Attached to bone - Cell shape: very long and cylindrical – multiple nuclei   **Smooth:** - Found in hollow organs and tubes (bronchioles, gut, blood vessels, iris of the eye) - Cell shape: spindle-shaped, single nucleus (centrally located) **Types**: visceral and multiunit **Cardiac:** - Only in the heart - To move blood - Cell shape: cylindrical and branched – single nucleus 
Describe the components of a skeletal muscle including connective tissues, fascicle arrangement, blood supply and innervation.	**Connective tissues:** - Epimysium: forms a connective tissue sheath that surrounds each skeletal muscle - Perimysium: subdivides each whole muscle into numerous visible bundles of muscle fibres called **fascicles**

Describe veins and venules	**Venules and veins:** **Venules:** - Very small veins that drain capillary network - Endothelial cells and basement membrane with a few smooth muscle cells - As diameter of venules increases, amount of smooth muscle increases **Veins:** - Smooth muscle cells form continuous layer; addition of tunica adventia - Have valves (to prevent backflow), thin walls and large lumens - Are very compliant: ~ 24x more compliant that arteries - Capacitance vessels of the circulation (hold a lot of blood at very low pressure)

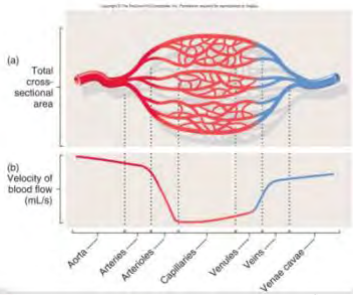
Factors affecting blood flow
Blood flow
Laminar flow:
- Streamlined; interior of blood vessel is smooth and of equal diameter along its length
- Outermost layer moving slowest and centre moving fastest



Turbulent flow
- Interrupted
- Rate of flow exceeds critical velocity
- Partially responsible for heart sounds
- Sounds due to turbulence not normal in arteries and is probably due to some constriction; increases the probability of thrombosis



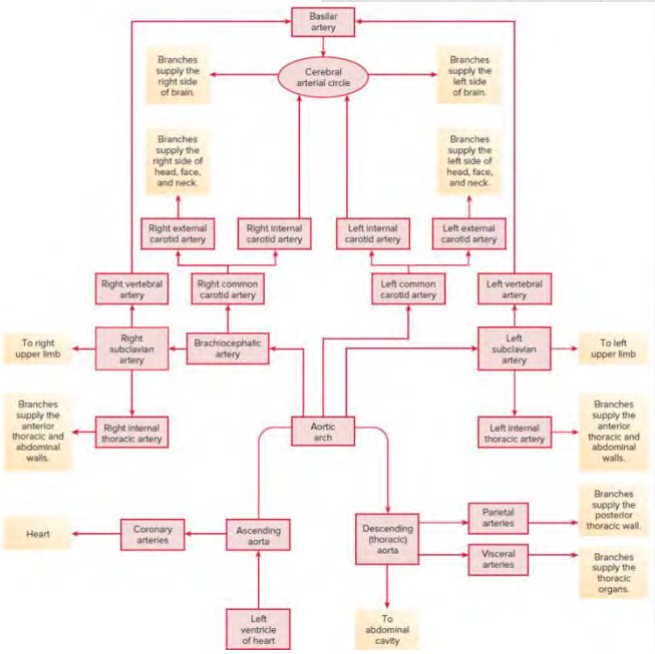
Velocity of blood flow:
- Relates to diameter and is inversely proportional to the total cross-sectional area of a blood vessel category



what makes blood flow?
F (blood flow) = volume of blood flow per unit time (e.g., ml/min)
- Directly proportional to pressure differences and inversely proportional to resistance

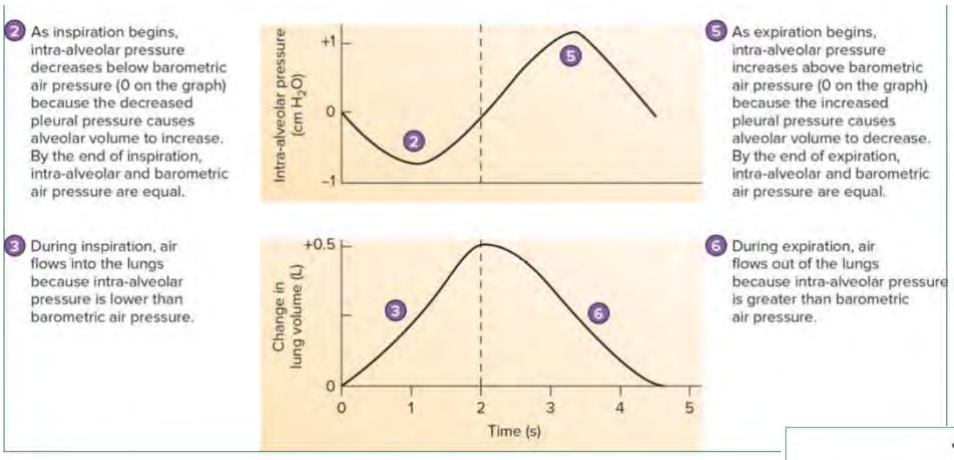
Flow = (P1-P2)/R
- P1 = pressure in vessel at point one
- P2 = pressure in vessel at point 2
- R = resistance to flow

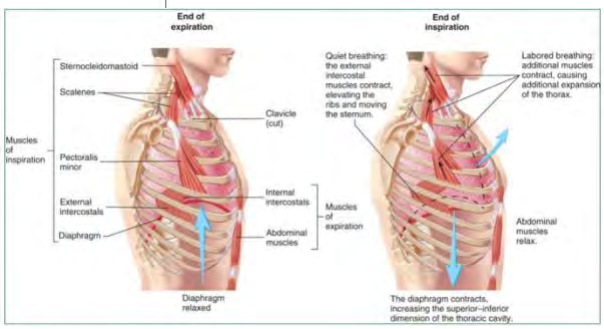
Resistance = 128vl/pi D4
- V = viscosity
- L = vessel length
- D = Vessel diameter



What affects blood flow:
Pressure differences created by the heart
Heart pumps – amount of blood pumped/min = Cardiac output (CO)
- When the heart pumps it pumps blood at high pressure (aorta ~100mmHg)
- Blood has less pressure the further away it gets from the heart, so by the time it's in the veins, the blood is not at a low pressure
- Blood leaving the heart = high pressure
- Blood coming back to the heart = low pressure

Dynamics of Normal Breathing Cycle



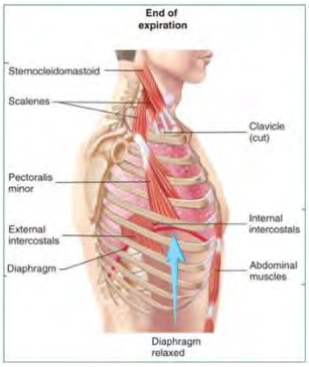


Forced inspiratory (heavy)

- Muscle of inspiration: diaphragm and external intercostal muscles
- Accessory muscles: sternocleidomastoid, scalene, pectoralis minor)
- Give added lift to the ribcage during inspiration

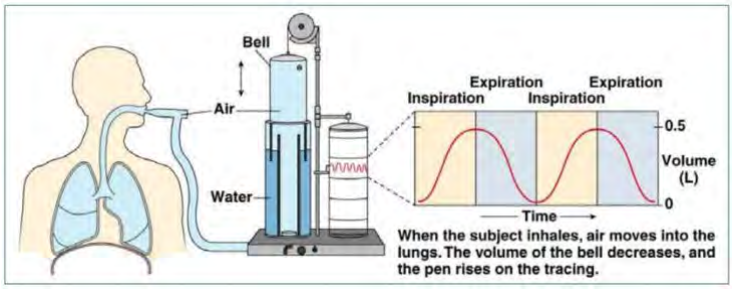
Forced Expiration:

- Forced expiration is active
- Muscles assist lung rebound
- Muscles of expiration – abdominal muscles, internal intercostals



Measurement of lung volumes

- Measured by spirometer
- Spirometer = an instrument consists of a hollow bell inverted over water, which is used to evaluate respiratory function
- Spirogram is a graph that records inspiration and expiration



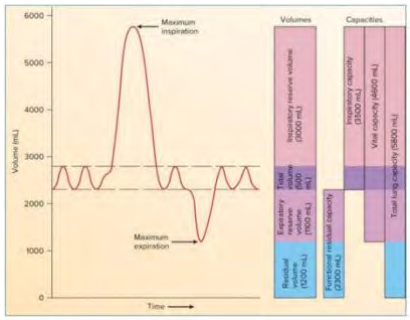
Static lung volumes and capacities:

Capacities:

- These measurements are kept relatively constant by the anatomical framework of the lungs and thorax

Volumes:

- These measurements are variable with effort



Respiratory performance and volume relationships:

- During breathing at rest, only a small proportion of the total lung volume is exchanged
- Tidal volume is typically about 500ml: only the first 350ml enters the alveolar spaces
- However, this can alter when breathing is deeper and more forceful
- The total volume of the lungs can be dived into static volumes and capacities
- If you examine respiratory effort more closely and apply time to your measurements, you can measure the dynamic volumes and capacities of the lungs

- Hard palate: anterior, supported maxilla and palatine bone
- Soft palate: posterior, consists of skeletal muscle and connective tissue
- Uvula: projects from posterior of soft palate

Palatine tonsils: lateral walls of fauces

Tongue:

Muscular:
- Free anterior surface and attached posterior surface

Covered with:
- Moist stratified squamous epithelium
- Intrinsic muscles: change shape
- Extrinsic muscles: protrude/retract tongue, move side to side

Lingual frenulum:
- Attached tongue inferiorly to floor of oral cavity

Anterior part:
- Papillae: some of which have taste buds

Posterior part:
- No papillae and few scattered taste buds
- Lymphoid tissue embedded in posterior surface – lingual tonsils

Functions:
- Moves food in moth
- Speech and swallowing

Mastication:

Chewing:
- Incisors and canines bite or cut off food
- Molar-type teeth grind food

Muscle involved:
- Masseter
- Temporalis
- Medial and lateral pterygoids

Elevation of mandible:
- Temporalis, masseter, medial pterygoids

Depression of mandible:
- Lateral pterygoids

Protraction, lateral and medial excursions:
- Pterygoids & masseter

Retraction:
- Temporalis

Mastication reflex:
- Medulla oblongata
- Descending pathways from cerebrum provide conscious control
- Controls basic movement involved in chewing

Absorption of nutrients: carbohydrate transport

Absorption INTO epithelial cell:

- Glucose and galactose: secondary active transport
- Fructose: facilitated diffusion

Movement OUT of epithelial cell into bloodstream:

- By facilitated diffusion

Absorption of nutrients: amino acid transport

Absorption INTO epithelial cell:

- active transport with Na+ of H+ ions

Movement OUT of epithelial cell into bloodstream:

- diffusion

absorption of nutrients: lipid transport

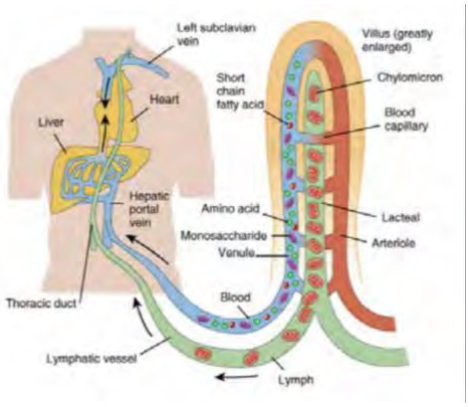
- emulsified
- lipase → FFA + monoglyceride
- transferred to mucosa
- micelle is cluster of: bile salts + lecithin + FFAs + MGs + cholesterol + fat soluble vitamins with hydrophilic periphery and hydrophobic core
- components diffuse into enterocyte

within mucosal cell:

- FFA + glycerol
- Fat droplets
- Exocytosis

Absorption in the small intestine:

- 90% total
- Mostly duodenum and jejunum
- Ultimately depends upon cell membrane transport processes
- Gut lumen → mucosa → blood caps. → HPV → liver
- Gut lumen → mucosa → lacteals → lymphatic vessels → thoracic duct → L. Subclavian vein → liver



Absorption of vitamins:

- Fat soluble vitamins (A, D, E & K): travel in micelles and absorbed by simple diffusion
- Water soluble vitamins: absorbed by diffusion
- Vitamin B12 combines with intrinsic factor before it is transported into cells: terminal ileum, receptor mediated endocytosis

Absorption of electrolytes:

Sources of electrolytes:

- GI secretions and ingested food and liquids

Enter epithelial cells by diffusion or secondary active transport:

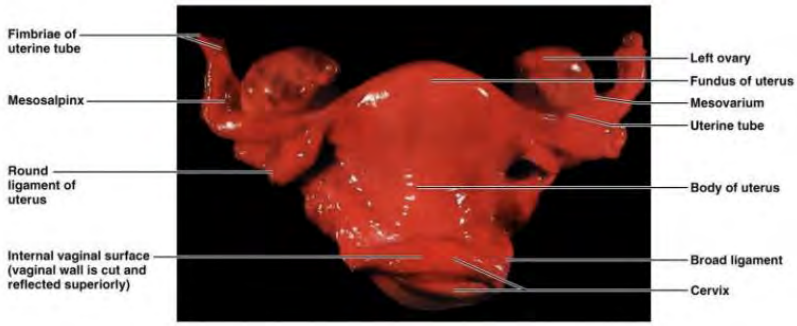
- Sodium potassium – facilitated diffusions
- Chloride, iodine & nitrate
- Iron, magnesium & phosphate
- Ca2+ absorption required vitamin D & PTH

Absorption of water:

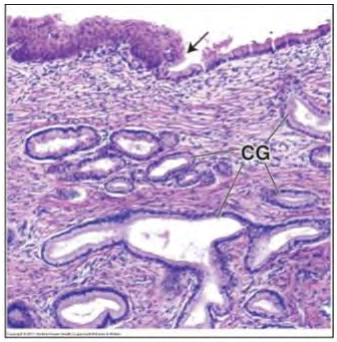
- 9 litres of fluid enter GI tract each day
- Small intestine reabsorbs 8 litres
- Large intestine reabsorbs 90% of that last litre
- Absorption is by osmosis through cell membranes, into vascular capillaries inside villi

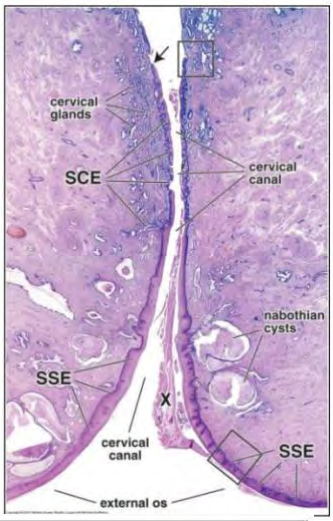
The cervix:

the portion projecting into the vagina is referred to as the ectocervix
the ectocervix opening is called the external os
the passageway between the external os and the uterine cavity is referred to as the cervical canal – narrow



- Endocervix simple columnar epithelium continuation with uterine endometrium
- Mucosal glands: cyclic changes. At ovulation, oestrogen induces thinning and 10-fild increasing in volume of secretion. Reduced vaginal pH. Enables sperm through
- Normally the external os is full of mucus that is thick and acidic, this blocked sperm from entering, preventing pathogens entering
- During pregnancy the cervix is blocked by a special antibacterial mucosal plug which prevents infection. The mucus plug comes out as the cervix dilates



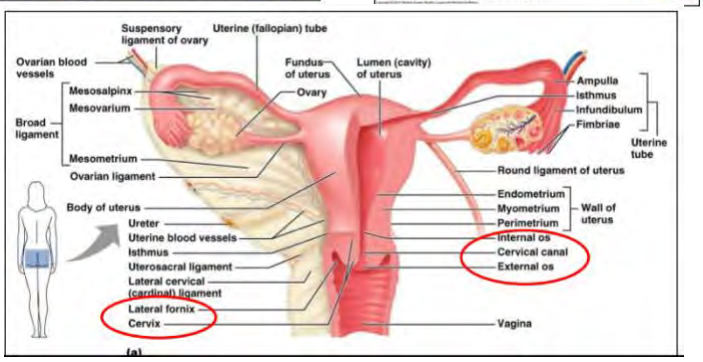


Epithelium: transitional zone:

Cervical canal: simple columnar
Vagina: stratified squamous

Uterus (womb)

- Pathway for sperm deposited in the vagina to reach the uterine tubes
- Site of implantation for fertilised ovum, development of the foetus during pregnancy
- Source of menstrual shedding when implantation does not occur
- The uterus has a blood supply from the internal iliac artery called the uterine artery that also supplies the cervix and vagina with arterial blood



3 parts:

- Fundus
- Body
- Cervix

Broad ligament: lateral margins of uterus to pelvic wall
Round: uterus through the inguinal canals to labia major
Uterosacral: attach lateral wall of uterus to sacrum
Pelvic floor: sling

Perimetrium: outer serous membrane
Myometrium: smooth muscle, thick, contracts during delivery. Cervix: more rigid and less contractile than rest of uterus
Endometrium: mucus membrane, spiral glands

- **Functional layer/** stratum functionalis – hormone responsive
- **Basal layer/** stratum basalis – not hormonal responsive