Endocrine System

Endocrine System

- Maintains homeostasis, especially of things that do not require immediate adjustment
- Its effects are exerted over longer periods of time for things that require duration rather than speed e.g. growth, metabolism, reproduction
- Its cells are NOT interconnected and must communicate via chemical messengers through the blood
- The endocrine system acts with the nervous system to coordinate all systems of the body
    - The endocrine system acts slowly, the nervous system acts fast
- Endocrine tissues may act on one or multiple organs

Chemical Messengers

- Affect the activity of cells, tissues and organs by
    - Controlling the rate of enzymatic reaction
    - Controlling ion and molecular transport across the membrane
    - Controlling gene expression and protein synthesis
- Chemical messengers include
    - Neurotransmitters
        - Released by axon terminals of neurons into synaptic junctions and act locally on cells
    - Autocrines
        - Secreted by cells into the extracellular fluid and act on the same cells that released them
    - Paracrines
        - Secreted by cells into the extracellular fluid and act on neighbouring cells of a different type
    - Endocrine Hormones
        - Released by glands or specialised cells into the **blood** and act on cells at another location
        - Allow for longer distance communication between cells
    - Neuroendocrine Hormones
        - Released by neurons into the **blood** and act on cells at another location
        - Allow for longer distance communication between cells
    - Cytokines
        - Peptides that when released into the extracellular fluid can act as autocrines, paracrines or endocrine hormones

Major Organs and Tissues of the Endocrine System

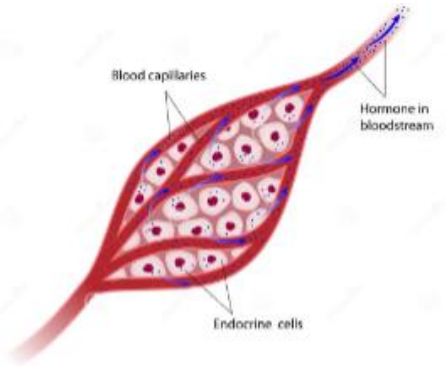
- Hypothalamus
    - Releases ADH, oxytocin etc.
- Pituitary Gland
    - Anterior lobe releases ACTH, TSH, GH etc.
    - Posterior lobe releases oxytocin, ADH
- Thyroid Gland
    - Releases thyroxine, calcitonin etc.
- Adrenal Glands
    - Adrenal medulla releases epinephrine, norepinephrine
    - Adrenal cortex releases cortisol, corticosterone etc.
- Pancreas
    - Releases insulin, glucagon
- Pineal Gland
    - Releases melatonin
- Parathyroid Gland
    - Releases parathyroid hormone

Structure of Endocrine Tissues

- Are highly vascularised to carry out their functions

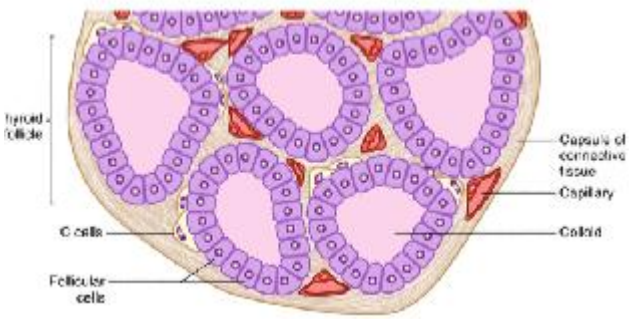
Trabecular Endocrine Tissue Structure

- Anastomosing strands of cells forming a “disorganised” network
- Separated by loose connective tissue with numerous capillaries
- Hormones are stored inside the cells
- All endocrine tissues are trabecular endocrine structure, except the thyroid gland



Follicular Endocrine Tissue Structure

- Multiple follicles with rings of a simple one layered epithelium surrounding a lumen with a fluid filled cavity (colloid)
- Hormones are produced and stored in the lumen
- Capillaries exist between the follicles
- Only the **thyroid gland** is a follicular endocrine structure



Hormone Action and Regulation

Hormones

- Are molecules that enable communication between cells, eliciting a physiological response
- A substance formed in one part of the body, carried by bodily fluids, and effective in very low concentrations at another part of the body; an endocrine regulator

Classes of Hormones

- Peptide Hormones
    - Composed of linked amino acids
    - Hydrophilic
    - Lipophobic – must bind to cell surface receptors
    - Are secreted by the hypothalamus, pituitary gland, pancreas, parathyroid gland, gastrointestinal tract and adipose tissue
    - Synthesised in the rough endoplasmic reticulum and packaged into secretory vesicles ready for release by exocytosis following a stimulus
    - Can't enter their target cells, they bind to a membrane receptor on the cell's surface
    - E.g. insulin, growth hormone, glucagon, oxytocin, vasopressin, TSH etc.
- Steroid Hormones
    - Derived from cholesterol
    - Hydrophobic
    - Lipophilic – diffuse freely across cell membranes
    - Are secreted by the adrenal cortex, ovaries, testes and placenta
    - Are not stored, they are synthesised rapidly from cholesterol stores and diffuse out of the blood following a stimulus, bound to carrier proteins (99% of the time) (from the liver) e.g. SHBG binds with testosterone, albumin binds with thyroid hormones
    - Once **unbound**, the hormones diffuse into the cell and bind to either a cytoplasmic receptor and get taken up into the nucleus OR bind straightaway with a nuclear receptor in the nucleus
    - E.g. cortisol, aldosterone, testosterone, estrogen, progesterone, corticosterone etc.
- Amines
    - Derived from amino acids (tryptophan OR tyrosine)
    - Hydrophilic
    - Are secreted by the thyroid, adrenal medulla, pineal gland and neuroendocrine cells in the central nervous system and gastrointestinal tract
    - Synthesised in the rough endoplasmic reticulum and packaged into secretory vesicles ready for release by exocytosis following a stimulus
    - Can't enter their target cells, they bind to a membrane receptor on the cell's surface
    - E.g. T4, T3, epinephrine, norepinephrine, melatonin, serotonin, dopamine etc.

Types of Hormonal Systems

- Trophic/ Tropic
    - Increase or decrease the secretion of other hormones
    - Involves complex pathways
    - E.g. TRH (trophic) stimulates the pituitary gland to release TSH (trophic) which stimulates the thyroid gland to release thyroid hormones (non-trophic) to then regulate metabolism
    - The hormone that finally acts on the organ is non-trophic … some hormones e.g. growth hormone are trophic and non-trophic in different circumstances
- Non- Trophic
    - Directly effect a target organ or cell (non-endocrine organs)
    - Involves simple pathways
    - E.g. parathyroid hormone directly effecting bone and kidneys to increase calcium concentration in the instance of low calcium in the body

Mechanisms by Which Hormones are Released

- Humoral Stimulus
    - Stimulus by body fluids e.g. blood
    - E.g. low concentrations of calcium stimulating the parathyroid hormone to increase calcium
- Neural Stimulus
    - Stimulus by neuron signals from the nervous systems
    - E.g. preganglionic sympathetic fibres from the central nervous system stimulate the adrenal medulla to secrete epinephrine and norepinephrine
- Hormonal Stimulus
    - Stimulus by other hormones
    - E.g. TRH stimulates the pituitary gland to release TSH which stimulates the thyroid gland to release thyroid hormones to then regulate metabolism
- Some hormones can be triggered by more than one stimulus e.g. insulin from the pancreas