

## **BMS302 ESE NOTES**

### **Module Three: Endocrinology Topic One: General Endocrine Function**

#### **describe the basic concepts of endocrinology**

- The endocrine system releases hormones into the blood.
- Hormones act slowly compared to neurons
- Hormones travel around the body and effect activities via specific receptors on target organs.
- The activated receptors trigger changes in the activity of enzymes in the target cells resulting in a biochemical response.
- Conversion of a hormonal message into an activated signal pathway and in turn a biochemical response is called signal transduction.

Hormones act on the target cell in one of three ways:

- Effecting protein biosynthesis (inducing or repressing)
  - Steroid and thyroid hormones
- Affecting the activity of enzymes
  - Peptide hormones
- Affecting the permeability of cell membranes
  - Eg. ADH increasing permeability to water.

#### **list the major endocrine glands and the hormones produced**

- Pituitary Gland
  - Anterior Pituitary
    - Follicle stimulating hormone (FSH)
    - Luteinizing hormone (LH)
    - Thyroid stimulating hormone (TSH)
    - Adrenocorticotropic hormone (ACTH)
    - Prolactin (PRL)
    - Growth hormone (GH)
  - Posterior Pituitary
    - Antidiuretic hormone (ADH)
    - Oxytocin (OT)
- Thyroid Gland
  - Thyroxine (tetraiodothyronine T4)
  - Triiodothyronine (T3)
  - Calcitonin
- Parathyroid Glands
  - Parathyroid hormone (PTH)
- Adrenal Glands
  - Adrenal medulla
    - Epinephrine
    - Norepinephrine
    - Dopamine

- Adrenal cortex
  - Mineralcorticoids
    - Aldosterone
  - Glucocorticoids
    - Cortisol
  - Androgens
- Pancreas
  - Glucagon
  - Insulin
- Gonads
  - Ovaries
    - Oestrogen
    - Progesterone
  - Testes
    - Testosterone

**list the major structural groups of hormones and identify which hormones fall into each structural group ones**

- Peptide/Protein
  - Eg insulin, hGC, TSH, FSH, LH
  - Vary in size, can be divided into subunits
  - H<sub>2</sub>O soluble, large, charged
  - Cannot penetrate membranes ∴ receptors are usually on plasma membranes
  - Subclass – glycoproteins – have a carbohydrate attached. Undergo post synthesis glycosylation.
  - Synthesis of peptide hormones normally involves one cell type and one organ.
- Steroids
  - Eg. Cortisol, androgens, progesterone, Vit D3
  - Small and lipid soluble ∴ they can penetrate membranes – receptors are cytosolic and nuclear.
  - Circulate in plasma bound to proteins (eg cortisol binding globulin)
  - Because they are small they can be lost by the kidney if not bound to a protein.
  - If protein levels are low (for example in malnutrition or liver failure) steroid transport can be affected.
  - Are all synthesized from cholesterol
  - Are mostly synthesized in the adrenals and gonads
  - Complete biosynthesis of steroids can involve more than one cell or organ. Eg. Vitamin D3 occurs in skin, liver and kidney.

- Amines
  - Eg. Thyroxines, adrenaline, noradrenaline
  - Characteristics lie between peptide and steroid hormones.
  - All synthesized from tyrosine.
  - Some have nuclear receptors (thyroxines) while others have plasma membrane receptors.

**NB.**

- One function – multiple hormones
  - For example in the control of plasma glucose level several processes are involved – dietary intake, glycolysis, gluconeogenesis, glycogenesis etc.
  - These processes are controlled by insulin, glucagon, catecholamines, cortisol and the thyroid hormones
- One hormone – multiple functions
  - For example PTH controls CMP metabolism in bone, GIT and kidney
  - Insulin is a storage hormone and controls carbohydrate, protein, lipid and sodium metabolism.

### **describe the factors that govern hormonal synthesis**

- Basal
  - Basic amounts produced all the time
  - Some hormones are continually produced even in the absence of a trophic or haemostatic challenge
- Stimulation
  - If the level of a circulating substrate or metabolite changes, a hormone is released in response.
    - Low Ca++ increases PTH release
    - High glucose increases insulin release
  - Increased level of a trophic factor or hormone (trophic = hormones controlling other hormones)
    - ONE releasing factor or hormone gives rise to ONE trophin that gives rise to ONE hormone
      - TRH – TSH – Thyroid hormones
    - ONE releasing factor or hormone gives rise to ONE trophin that gives rise to TWO hormones
      - CRF – ACTH – Cortisol AND androgens
    - ONE releasing factor or hormone gives rise to TWO trophins that give rise to TWO hormones
      - GnRH – FSH and LH – Oestrogen and progesterone.

- Feedback
  - Acts like a thermostat
  - Endocrine cells need to know both when to secrete a hormone, and when to stop secreting.
  - Changes in the level of a circulating metabolite or hormone will either stimulate or inhibit the release of the hormone that controls it.
  - Feedback can be negative or positive.
  - Feedback occurs at two levels
    - Substrate
      - Eg glucose controls insulin – high glucose stimulates insulin secretion (positive feedback). Calcium controls PTH – high calcium inhibits PTH secretion (negative feedback).
    - Hormonal
      - Eg TSH control of thyroxine synthesis and secretion.

### **describe the mode of synthesis, storage, release and transport of hormones**

#### **SYNTHESIS**

- Protein/Polypeptide hormones
  - Synthesized as part of larger proteins – this is a storage mechanism as when the hormone is required only cleaving is required for its release
  - Cleaving produces the active molecule
  - The precursor is known as a pro-hormone
  - An even larger pre-pro-hormone can come before this pro-hormone in some cases.
- Steroid hormones
  - Synthesised from cholesterol which is synthesised from acetate

#### **STORAGE**

- Protein/Polypeptide hormones
  - Stored as secretory granules in the endocrine cell cytoplasm
  - These granules can be stained in histochemistry tests
- Steroid hormones
  - Not stored but are instead synthesised on demand

#### **RELEASE**

- Protein/Polypeptide hormones
  - Very big molecules so are released by exocytosis.
- Steroid hormones
  - Small and lipid soluble so diffuse out of the endocrine cell into the extracellular fluid.