B.Sc Second year Zoology (Honours)

Paper-4

Classification of Hormone

A hormone is classically defines as a chemical that is secreted into the blood and acts on a distant target in very low concentrations.

Hormones can be classified according to ***source or location*** - heart, liver, pineal gland, hypothalamus, pituitary, thyroid, parathyroid, thymus, pancreas, adrenal cortex, adrenal medulla, kidney, skin, testis, ovaries, adipose tissue, and placenta.

Hormones can be divided into 3 main chemical classes:

1. Peptide and protein hormones composed of linked amino acids
2. Steroid hormones are derived from cholesterol
3. The amine hormones are derivatives of ***tryptophan or tyrosine***

Most hormones are Peptides or Proteins
If a hormone is not a steroid or a amine it is probably a peptide.
A steroid-producing cell would have extensive smooth Endoplasmic Reticulum; a protein-producing cell would have lots of Rough Endoplasmic Reticulum.
Usually made in tissues all over the body unlike steroids that are made only in a few organs

1. ***Peptide Hormone Synthesis, Storage and Release***
    1. *The initial peptide that comes off the ribosome is a large inactive protein called a* ***preprohormone. Preprohormones*** *contain the copies of the peptide hormone and a* ***signal sequence*** *that directs the protein to the lumen of the ER.*
    2. *Moving through the ER and the Golgi Complex the* ***signal sequence*** *is removed - creating a smaller inactive -* ***Prohormone***
    3. ***Post translation Modification.*** In the Golgi-apparatus the prohormone is packed in secretory vesicles with proteolytic enzymes that chop the prohormone into active and inactive fragments.

4. *The secretory vesicle is stored in the cytoplasm until the **cell receives a signal for secretion.***
5. *Vesicles move to the cell membrane and release their contents by **calcium dependent exocytosis.** All the hormones from the prohormone are released together into the extracellular fluid - **co-secretion***

2. ***Post-translation Modification of Prohormones***
    1. ***TRH -** has multiple copies of the same hormone*
    2. *Proopiomelanocortin - has three active peptides and an inactive fragment*
    3. *Proinsulin is cleaved in to active insulin and a C-Peptide. The C-peptide is used to measure endogenous secretion of Insulin in diabetics.*
3. ***Transport in the Blood and half-life of Peptide hormones***
    1. *Peptides are water soluble, dissolve easily in the extracellular fluid*
    2. *Short half-life - minutes*
4. ***Cellular Mechanism of Action of Peptide Hormones***
    1. *Lipopobic - they are unable to enter the target cell, bind to the target cell membrane receptor.*
    2. ***Signal transduction system** is activated - activation of second messenger systems may activate genes*
    3. *Most peptide hormones work through cAMP second messenger systems.*
    4. *Few peptide hormone receptors, such as **Insulin, have a tyrosine kinase** activity or work through **other signal transduction pathways***
    5. ***The** second messenger system modifies channels and modulate metabolic enzyme or transport proteins.*
    6. *Effect on target: Modification of existing proteins and induction of new proteins*

Steroid Hormones are derived from Cholesterol

All have a similar structure as they are derived from cholesterol. Steroid hormones are made only in a few organs unlike Peptide hormone synthesis. Three types of steroid hormones are made in the adrenal cortex:

- *Aldosterone - (acts on the Kidney for Sodium Potassium homeostasis)*
- *Cortisol - (acts on many tissues in Stress Response)*
- *Androgens - (acts on many tissues in female sex drive)*

The gonads produce sex steroids - estrogens, progesterone, and androgens. Pregnant women placenta is a source of steroid hormones.

1. ***Steroid Hormone Synthesis and Release***
    1. *Cells that secrete steroid hormones have large amount of smooth Endoplasmic Reticulum, the organelle in which steroids are synthesised.*
    2. *Steroids are lipophillic and diffuse across membranes, both out of the parent cell and into the target cell.*
    3. *This means that steroid producing cells cant store hormones in secretory vesicles - they* ***synthesize hormone on demand***
    4. *The steroid hormone moves out of the* ***cell by simple diffusion***
2. ***Transport in the Blood and half-life of Steroid Hormones***
    1. ***Bound to carrier proteins:*** *Steroids are* ***not water soluble*** *and need to be transported using a transport protein like albumin. Corticosteroid binding globulin is specific carrier protein for cortisol*
    2. *The binding to carrier proteins protects the hormone from enzymatic degeneration and results in an* ***extended half life. Cortisol,*** *produced by the adrenal cortex, t1/2 = 60-90 minutes. This is a long half life. Aldosterone has a short half life for a steroid hormone, about 20 minutes - suggesting that it not bound to plasma proteins as much as other steroids.*

3. ***Cellular Mechanism of Action of Steroid Hormones***
    1. ***Location of receptor:*** *cytoplasm or nucleus; some have membrane receptors also.*
    2. ***Response to receptor ligand binding:*** *Activation of genes for the transcription and translation. Usually acts as a transcription factor that activates or repressing one or more genes - the genomic effect.*
    3. *There is a lag between hormonal binding and the first new protein manufactured - the lag can be as much as 90 minutes. Consequently steroid hormones do not mediate reflex pathways that require rapid responses.*
    4. *Induction of new protein synthesis.*

5. *There are also membrane receptors for pathways of estrogens and aldosterone - that linked to signal transduction pathways - these receptors initiate rapid non-genomic responses.*

Amine Hormones are derived from One of Two Amino Acids
- derivatives of ***tryptophan or tyrosine***

The amine hormones are small molecules created from tryptophan or tyrosine.
The amine melatonin is derived from tryptophan, all the other amines hormones, catacholamines (dopamine, norepinepharine and epinepharine) and thyroid hormones are derived from tyrosine.
The catacholamines have one tyrosine and the thyroid molecules have two tyrosine molecules plus iodine.
The catacholamines are neurohormones that bind to cell membrane receptors as peptide hormones do.
The thyroid hormones, produced in the thyroid, act like steroid hormones, with intracellular receptors that activate genes.