Endocrine system

Dr. Neven Makram Aziz

- Endocrine glands ductless glands secrete chemical messengers (hormones) into the blood.
- Exocrine glands secrete secretions through a duct into the digestive tract (enzymes, bile) or skin surface (sweat).

✓ Hormones can be chemically classified into three groups: -

- Steroids: Hormones that are lipids synthesized from cholesterol (sex hormones and adrenocortical hormones as cortisol).
- Polypeptide and proteins (non-steroids): Hormones that are chains of amino acids (Hypothalamic, Pituitary, Pancreatic and Parathyroid hormones).
- Amino acid-derived: Hormones that are modified amino acids. Thyroid hormones and adreno-medullary hormones as catecholamines.

Mechanism of hormonal action:

- **Lipophilic (hydrophobic) as steroidal and thyroid hormones.** - **Membrane permeable.** - **Receptor in cytoplasm or nucleus (as thyroid hormone).** **<u>Mechanism</u> by increase enzymes formation- slow mechanism.** **- Diffuse through plasma membrane and bind receptors in cytoplasm or nucleus. Enter nucleus Forms "hormone-receptor complex" H-R complex binds as transcription factors to chromosome to activate/inactivate gene(s).**	- **Hydrophilic as non-steroidal hormones.** - **membrane impermeable.** - **Receptor in the cell membrane.** **<u>Mechanism</u> by increase enzymes activity- rapid mechanism.** **- Hormone (A) binds to receptor on cell surface. Activates G- protein that activates adenylate cyclase converting ATP to cAMP. cAMP activates protein kinases, which produce final effect. cAMP and cGMP are second messengers.**

Thyroid gland

Thyroid hormones: T_3 (triiodothyronine) and T_4 (thyroxine). It is regulated by thyroid stimulating hormone (TSH) from anterior pituitary. Stress and cold weather increase TSH secretion.

✓ Actions:

1. Increased oxygen consumption by the cells resulting in an increase in the metabolic activity of all tissues (Calorigenic action). Due to this calorgenic action T_3 & T_4 increase:

- Appetite and food intake with increased rate of the food digestion and absorption.
- Increase rate and depth of respiration.
- Increase heart rate, cardiac output, and pulse pressure (↑SBP with ↓ DBP).

2. Help mental (myelination of nerve fibers), physical (bone, teeth, muscle & skin) and sexual growth (are essential for gonadal hormones to exert their action).

3. Metabolism

- Protein: increased the protein synthesis but, if excess it produces catabolic reaction.
- Fat: lipolysis and decreased cholesterol level.
- Carbohydrate: stimulates glucose uptake and utilization by the tissues, insulin hormone secretion, liver glycogenolysis, gluconeogenesis and intestinal absorption of glucose.
- Vitamins: necessary for the hepatic conversion of carotene to vitamin A.

➢ Disorders:

1- Hyperthyrodism: It occurs in adult due to Adenoma or autoimmune (Grave's disease).

1. Goiter (Enlargement of the thyroid gland).
2. Exophthalmos (Characteristic sign).
3. Increased the metabolic rate with increased the heat production leading to heat intolerance (Hot sweating).
4. Fine tremors.
5. Increased heart rate (Tachycardia).
6. Dyspnea.
7. Hyperphagia (over-eating) with loss of the body weight (due to increased metabolic activities of all tissues).

2- Hypothyrodism

- Cretinism: Before puberty (since birth; congenital or genetic). Symptoms and signs appear within 6 months after birth when the mother's milk insufficient for the infant's need. They include:

1. Delayed all milestones of the development (sitting, standing, walking, speaking……etc).
2. Mental retardation.
3. Dwarfism.
4. Swollen eye lids and enlarged protrusion tongue.
5. Deficient sexual development.

N.B. Treatment should start soon after birth, once the clinical picture has developed; it is usually too late to prevent permanent mental defects.

- Myxoedema is the hypothyroidism in adults (After puberty).

Causes:

1. Primary causes in the thyroid itself (as endemic goiter = iodine deficiency - excess goitrogens (cabbage cauliflower) in diet - thyroiditis – surgical removal of thyroid).
2. 2nd cause in the pituitary and hypothalamus as in the panhypopituitarism.

Manifestations:

1. Non pitting edema.
2. Cold intolerance and increased body weight.
3. Decrease heart rate (Bradycardia).
4. Anemia due to bone marrow depression.
5. Decreased celebration and slow thinking.
6. Slow speech and sluggish reaction (Hoarsy sound due deposition of myxematous tissue on vocal cords).
7. Skin pale, yellow, dry and cold.

2. Calcitonin : A hormone secreted from the para-follicular cells of the thyroid gland (calcium lowering hormone). Its secretion is regulated by plasma calcium level.

- ✓ Functions: It decreases blood calcium level by decreasing bone resorption (by inhibiting osteoclasts) and increasing calcium deposit in bone by stimulating osteoblasts. In addition, it decreases calcium and increase phosphate reabsorption by the renal tubules.

Tetany

It is a state of increased of neuromuscular excitability due to decreased the ionized calcium in the blood (Normal calcium level 9-11 mg %).

Causes: 1- **Hypocalcaemia** due to hypoparathyroidism, vitamin D deficiency, decreased calcium intake or increased need as in pregnancy and renal failure as it decreases calcium reabsorption.

2- **Alkalosis** (caused by hyperventilation or excessive vomiting) as it precipitates the calcium lead to decrease in the ionized calcium.

Types: -

1- Manifest tetany: Calcium level below 7mg % and it is characterized by:

- Skeletal muscles show twitches.
- Tonic contraction of pharyngeal and diaphragm that lead to asphyxia and cyanosis.
- Carpopadel spasm in the hands (Obstetrician hand; flexion of wrist and metacarpo-phalangeal joints, extension of inter-phalangeal joints and adduction of thumb into the hand).

2- Latent tetany: Calcium level between 7 – 9 mg %. Manifestations of tetany are absent at rest. They appear when there is increased in the body need for calcium or exposure to stress (as in pregnancy, lactation, emotions and hyperventilation).

Pancreas

Endocrine gland that consists of pancreatic islets that contain alpha, beta and delta cells.

Beta cells: Secrete Insulin

The primary stimulus for insulin secretion is a rise in the blood glucose level.

✓ **Functions:**

1- Decreased blood glucose level by increase glucose utilization by most tissues and glycogen formation in the muscle and liver cells.

N.B. insulin doesn't increase glucose uptake in RBCs, brain cells except satiety center, intestinal cells and renal tubular cells.

2- **Increased protein synthesis** due to its anabolic action. Insulin is essential for normal growth.

3- It is the **only lipogenic hormone** promoting fat synthesis. It increases triglyceride synthesis and decreased its breakdown.

4- Increased Na^+-K^+ ATPase increased Na^+ extracellular and K^+ Intracellular → hyperpolarization.

✓ **Disorders:**

Diabetes mellitus (DM)

➢ **Causes:**

1- Absolute insulin lack due to degeneration of the beta cell of pancreas (type I DM, Juvenile type).

2- Relative lack of insulin (type II DM) that is caused by:

- Insulin resistance in obesity and it is usually occurring after 40 years.
- Excess GH ***(Pituitary diabetes)*** or excess cortisol ***(Adrenal diabetes)***.

➢ **Manifestations:**

1. Hyperglycemia and glucosuria.
2. Polyuria that is caused by glucosuria (osmotic diuresis).
3. Polydipsia as polyuria causes dehydration, resulting in an increased thirst sensation and drinking a large volume of water.
4. Increased protein catabolism: Generalized muscle weakness, delay wound healing and in young person → growth retardation.
5. Increase lipolysis → Increased ketone bodies → Acidosis → Decreased synaptic transmission → **Coma** - Increased acetate → Increased cholesterol synthesis → **Atherosclerosis and hypertension**.
6. Hyperphagia: decreased glucose utilization inhibits the satiety center causing an increased activity of the feeding center. In spite of increase food intake there is loss of weight due to increases lipolysis (more fat is used as a source of energy).