**Endocrine System** Chapter 11

Hormones – information molecules

**Ductless glands** = endocrine glands; **Hormones** are the secretions of endocrine glands.

Endocrine glands lack anatomical continuity of other systems and are scattered widely in whole body. All hormones have one common feature – all travel through blood to the Target Cells.

**Specificity**: Only target cells have receptors to bind with hormone and only target cells show cellular changes on the attachment of the hormone.

Main Endocrine Glands

**Main endocrine glands**: Pituitary gland – inferior to hypothalamus in brain, Thyroid – a bilobed gland just inferior to larynx in throat, Parathyroid – 2 pairs of small glands embedded on posterior side of thyroid lobes, Adrenal – 2 glands lie superior to kidneys, Thymus – most active in childhood – lies superior to heart

**Dual functional endocrine glands** = Hypothalamus – part of brain and secretes many hormones, Pancreas – lies in the fold of duodenum secretes digestive enzymes through duct = exocrine and also secretes hormones = endocrine, Gonads – testes in males and ovaries in females produce sperms or eggs carried by ducts and produce hormones.

Hormones are chemicals

**Chemistry of Hormones** – hormones belong to 2 major categories;

- **Amino acid based** – amino acid derivatives like thyroxine, peptides like Oxytocin, protein like Growth hormone
- **Steroids** – synthesized from cholesterol by gonads or adrenal cortex.

Mechanism of Hormonal Action – Peptide/Protein (hydrophilic) hormones

- bind with a membrane receptor
- stimulate a 2nd messenger – common example is c-AMP produced from ATP
- 2nd messenger stimulate many other proteins turn by turn and help amplify the effect to bring dramatic cellular changes. Hormone is the 1st messenger.

Mechanism of Hormonal Action – Steroid/Thyroid (hydrophobic) hormones

- diffuse into the cells
- bind to a receptor protein mostly inside nucleus
- stimulate genes to produce proteins including enzymes and induce cellular changes.

Recap 1 Endocrine System

1. All hormones travel through ---- to their ----- cells.
2. All hormones are present in blood but act only their target cells due to presence of ------- .
3. Chemically 2 main groups of hormones are ----- and ------------.
4. Receptors for non-polar/ hydrophobic (steroid) hormones lie mostly ----------.
5. Receptors for amino acid based (peptide and protein) hormones lies mostly ------- ------.
6. ------- hormones act by producing a 2nd messenger inside the cell.

**Hypothalamus**

Hypothalamus regulates hormone secretion by other endocrine glands by 3 mechanisms.

It secretes hormones to regulate anterior pituitary’s hormones. The vein collecting blood from hypothalamus supplies the blood to Anterior Pituitary. This vein is Hypophyseal Portal vein and delivers the regulatory hormones of hypothalamus to Anterior Pituitary. This ensures fast delivery.
Neurons present in hypothalamus secrete hormones Oxytocin and ADH are directly released into posterior lobe of Pituitary gland.

Hypothalamus controls secretions of adrenal medulla through preganglionic nerve fibers of sympathetic nerve fibers and results in secretion of norepinephrine and epinephrine.

**Pituitary Gland**

**Pituitary gland** = Hypophysis lies in sella turcica of Sphenoid bone. **Anterior Lobe** – glandular part secretes hormones for 6 targets; **Posterior Lobe** – neural part secretes 2 hormones, produced by axons of hypothalamus; Infundibulum = stalk – neural tissue hangs pituitary gland from hypothalamus.


Posterior Pituitary stores and releases 2 hormones produced by hypothalamus 1. ADH 2. Oxytocin

**Recap 2 Endocrine System**

1. Anterior pituitary secretes _______ for thyroid; _______ hormone for adrenal gland; _______, and _________ hormones for gonads; _______ for body; and _______ hormone for breasts.
2. Hypothalamus secretes _______ to promote secretion of GH; and _______ to inhibit secretion of GH.
4. Hypothalamus directly controls secretion of hormones by posterior pituitary gland by releasing hormones through its ____________.
5. Hypothalamus directly controls secretion of hormones by adrenal medulla through ---- nerve fibers.
6. Gonadotropin hormone is produced by _______ _______.
7. Gonadotropin RH is produced by ___________________.
8. _______ is released by posterior pituitary and regulates child birth and milk release.
9. _________ is secreted by posterior pituitary gland and increases blood pressure and makes kidney absorb water from urine.
10. Ant. pituitary ➔ ACTH ➔ _______________.
11. Ant. Pituitary ➔ TSH ➔ _______________.

**Thyroid Gland**

**Thyroid hormones** (T4 and T3) have similar influence. Iodine is essential part of these hormones.

Functions:
Increase Basal Metabolic Rate = favors increased oxygen consumption and production of calories
Promote normal development of brain and working of all organs

Hyposecretion (low) of Thyroid hormones in adults causes Myxedema = low metabolic rate, feeling chilled, edema, lethargy. Hyposecretion due to Iodine deficiency leads to enlargement of thyroid = Goiter

Hypersecretion (excess) of thyroid hormones causes high burning of calories, lean body, restlessness and bulging eyes

**Calcitonin** – secreted under high Ca^{2+} level in blood and inhibits osteoclasts and favors bone growth and lowers the calcium level in blood. Calcitonin is antagonist to PTH.
Parathyroid Glands

**Parathyroids** – secrete Parathyroid Hormone PTH under low Ca\(^{2+}\) levels and raise it by stimulating osteoclasts that break bone structure and transfer calcium to blood.

**Adrenal Glands (Stress hormones)** – adrenal cortex = outer part is glandular and Medulla = inner part is a knot of parasympathetic nervous tissue

**Adrenal Cortex** secretes corticoid hormones

Aldosterone stimulates kidneys to absorb more Na\(^+\) and excrete more K\(^+\) and help to maintain ionic balance of extracellular fluids

Cortisol – makes glucose available from proteins and fats. **Cortisol prepares the body to cope with long term stresses.**

**Sex Corticoids** – influence male secondary sex characters.

**Adrenal Medulla** secretes 2 hormones – Norepinephrine under normal conditions and Epinephrine under emergency conditions; both have similar effects; **promote and activate Fight or Flight status and make body cope with short term stresses.**

**Pineal Gland** – lies in the epithalamus

It secretes Melatonin hormone – a powerful antioxidant

it controls the daily rhythms like activity or drowsiness.

**Pancreas** – is a mixed gland, produces 2 antagonistic hormones Insulin – lowers blood glucose levels and Glucagon – promotes breakdown of glycogen in tissues and release glucose into blood.

Hyposcretion of Insulin causes Diabetes Mellitus, has high blood levels of glucose. 3 main symptoms are excessive urination, excessive thirst and excessive hunger. Glycosuria – urine has glucose.

T1DM is caused due to shortage of insulin

T2DM is caused due to lack of receptors in target cells; insulin levels are normal or above normal; found in 95% patients in America

**Gonads – Ovaries and Testes**

**Ovary** – Intact follicles secrete Estradiol, main female sex hormone

Ruptured follicles change to Corpus luteum

Corpus luteum secretes Progesterone

**Testes** – Interstitial Cells secrete Testosterone, main male hormone

**Interaction between Hormones**

Antagonistic hormones have opposite actions. Examples are

Glucagon – increase glucose in plasma and Insulin lowers glucose in plasma

Calcitonin lowers Ca\(^{2+}\) in plasma and PTH increases Ca\(^{2+}\) in plasma

**Growth and Hormones:**

These hormones favor growth – GH, TH, Insulin, Estrogen or Testosterone,

Inhibits growth – Cortisol.

**Bones and Hormones**

Favor bone growth – GH, Sex hormones, Calcitonin and Insulin.

Favor bone resorption and decrease bone mass – PTH and Cortisol

Recap 3 Endocrine System
1. High level of \( \text{Ca}^2+ \) in plasma causes release of  

2. Low level of \( \text{Ca}^2+ \) in plasma causes release of  

3. Hormone secreted during short term stress is  
   and secreted during long-term stress is  

4. Insulin lowers level in blood; promotes synthesis; and greater growth of bones.  

5. Name the antagonist hormone; insulin  
   ；  
   - calcitonin;  

6.  and  are hormones with iodine.  

7. causes development of breasts and milk production.  

8. causes the release of milk, induces labor and stimulates baby’s birth.  

9. Hypersecretion of GH before puberty causes  
   ; after puberty causes  

10. Enlargement of thyroid gland called goiter can be produced by --deficiency.  

11. Diabetes mellitus is abnormally high plasma glucose level can be caused due to deficiency of  
    hormone  
   or inability of receptors to bind to this hormone = Type --.