Study Guide Endocrine System – Chapter 10

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

2. 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.

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

4. **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., Fig 10.1

5. **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.

6. **Other endocrine glands:** Kidney, small intestine, stomach and heart are other organs that secrete some hormones.

7. **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.

8. **Cellular Changes by hormone stimulus:** these include 1 or more of a) change in permeability or potential of membrane by opening ion channels b) synthesis of proteins including enzymes within the cell c) activates inactive enzymes or inhibits active enzymes d) induces secretion by cells e) stimulates mitosis

9. **Mechanism of Hormone Action:** There are separate mechanisms for amino acid based and steroid hormones. Fig 10.3

10. **Steroid/Thyroid Hormones:** 1 diffuse into the cells 2 bind to a receptor protein 3 enter nucleus 4 stimulate genes to produce proteins including enzymes 5 cellular changes.

11. **Amino Acid Based:** 1 hormones bind with a membrane receptor 2 stimulate a membrane enzyme 3 active enzyme produces a 2nd messenger – common example is c-AMP produced from ATP 4 2nd messenger stimulate many other proteins turn by turn 5 at each step many proteins get activated and impact is magnified – the result is Cascade Effect – a single or a few hormone molecules bring dramatic cellular changes. Hormone is the 1st messenger.

12. **Hormonal Transport and Degeneration** - Most hormones are hydrophilic and travel in blood dissolved in water in plasma; these include catecholamine, peptide and protein hormones.

13. Hydrophobic hormones bind to plasma proteins to get transported. These include Steroid and thyroid hormones

14. Hormones get inactivated
   a. on attachment to receptors
b. By liver and kidney

c. Extracellular enzymes

15. **Endocrine Gland Stimulus**: 3-kinds – 1 **Humoral** – changes in body fluids composition like fall in Ca\(^{2+}\) stimulate parathyroid glands to secrete PTH; 2 **Neural** – nerve impulses stimulate adrenal medulla to secrete Epinephrine; 3 **Hormonal** – hormones of hypothalamus stimulate anterior pituitary body to secrete its hormones.

16. **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.

17. **Anterior Pituitary** – secretes 5 **Tropic Hormones** = **Stimulating Hormones** that stimulate other endocrine glands. These include: Thyrotropin, Adrenocorticotropic, Growth Hormone and 2 Gonadotropin hormones. Fig 10.8

18. **Thyrotropin** = Thyroid Stimulating Hormone = TSH – stimulates thyroid gland to release its hormones T\(_4\) and T\(_3\).

19. **Adrenocorticotropic Hormone** = **ACTH** – stimulates adrenal cortex to secrete its hormones.

20. **Gonadotropins** – include 2 hormones in both sexes; 1 Follicle Stimulating Hormone = FSH – stimulate development of eggs or sperms in ovaries or testes; 2 Luteinizing Hormone = LH – stimulates egg release = ovulation in females and production of hormones by gonads in both sexes.

21. **Growth Hormone GH** – somatic growth hormone, stimulates liver to produce hormone **Somatomedins** = **Insulin-like Growth Factors** = IGFs, which are peptide hormones and bind to receptors in a variety of cells to promote amino acid absorption and protein synthesis; GH also stimulates greater growth of bones, cartilages and muscles, mobilizes fats. In children, Hypersecretion leads to **Gigantism** but hyposecretion produces **Dwarfism**. Hypersecretion in adults produces **Acromegaly** – protruding jaws, lengthening of fingers.

22. **Anterior Pituitary** also produces 1 **Non-tropic Hormone** Prolactin.

23. **Prolactin PRL** – stimulates milk production in breasts but hypersecretion in males causes development of breasts and impotence in males.

24. **Posterior Pituitary** stores and releases 2 hormones made by axons of hypothalamus.

25. **Oxytocin** – stimulates uterine contractions – birth hormone, also causes milk ejection.

26. **Antidiuretic Hormone ADH** = **Vasopressin** – stimulates kidneys to absorb more water. Hyposecretion causes **Diabetes Insipidus** – lot of urine passes and person feels very thirsty but glucose levels in blood not affected.

27. **Hypothalamus**: regulate hormone secretion by other endocrine glands by 3 mechanisms. 1. It secretes hormones to regulate anterior pituitary’s hormones. The vein collecting blood from hypothalamus supplies the blood to Anterior Pituitary. This vein is **Hypophysial Portal vein** and delivers the regulatory hormones of hypothalamus to Anterior Pituitary. This ensures fast delivery. Fig 10.6. 2. Neurons present in hypothalamus secrete hormones Oxytocin and ADH are directly released into posterior lobe of Pituitary gland. 3. Hypothalamus controls secretions of adrenal medulla through preganglionic nerve fibers of sympathetic nerve fibers and results in secretion of norepinephrine and epinephrine. Fig 10.4
28. **Thyroid Gland**: secretes **Thyroxine** = $T_4$ and **Triiodothyronine** = $T_3$ hormones having similar influence. These hormones have wide range of effects. Main influences include — 1. **Basal Metabolic Rate** = favors increased oxygen consumption and production of calories; 2. promotes normal development of brain; 3. promotes normal activity of heart, digestive system, skin and female reproductive system. Hyposecretion of Thyroxine in adults causes **Myxedema** = low metabolic rate, feeling chilled, edema, lethargy; Hyposecretion due to iodine deficiency leads to enlargement of thyroid = **Endemic Goiter**; Hypersecretion of thyroxine causes **Exophthalmic Goiter**; **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. Fig 10.10

29. **Parathyroids** — secrete Parathryoid Hormone PTH under low Ca$^{2+}$ levels and raise it by stimulating osteoclasts that break bone structure and transfer calcium to blood. Fig 10.10

30. **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 1. **Mineralocorticoids** – Aldosterone is most potent, stimulates kidneys to absorb more Na$^+$ and excrete more K$^+$ and help to maintain ionic balance of extracellular fluids; 2. **Glucocorticoids** – influence the energy metabolism of most cells, stimulated by ACTH of anterior pituitary. 3. **Sex Corticoids** – influence secondary sex characters. **Adrenal Medulla** secretes 2 hormones – Norepinephriene under normal conditions and Epinephrine under emergency conditions; both have similar effects; promote and activate Fight or Flight status; make body cope with short term stresses but the adrenal cortex hormones prepare the body to cope with long term stresses. Fig 10.12 and Table 10.3

31. **Gonads**— include Ovaries and Testes. Ovaries secrete 2 hormones; 1. **Estrogens** – promote development of female reproductive system and development of female secondary sex characters, promote growth of uterus; 2. **Progesterone** – after release of egg, ovarian follicle develops into Corpus luteum that secretes progesterone. Progesterone prepares the uterus further to support embryo and maintains pregnancy. Table 10.4

32. **Pancreas** — is a mixed gland, produces 2 antagonistic hormones 1. **Insulin** – lowers blood glucose levels and 2. **Glucagon** – promotes breakdown of glycogen in tissues and release glucose into blood. Hyposecretion 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 in it; 1st 2 symptoms are similar to **Diabetes Insipidus** – caused due to hyposecretion of ADH. Fig 10.14

33. **T1DM** — Type 1 Diabetes Mellitus is caused due to shortage of insulin

34. **T2DM** — Type 2 Diabetes Mellitus is caused due to lack of receptors in target cells; insulin levels are normal or above normal; found in 95% patients in America

35. **Pineal Gland** — lies in the epithalamus and secretes Melatonin hormone – a powerful antioxidant, it controls daily rhythms like activity or drowsiness. Its hormonal influences are not yet fully understood.

36. **Thymus** gland secretes thymosin hormone. Thymus is responsible for differentiation of T-lymphocytes and therefore promotes body defenses.

37. **Interaction between Hormones:**

38. **Antagonistic** hormones have opposite actions. Examples are Glucagon and Insulin, Calcitonin and PTH

39. **Synergistic** hormones have additive effect. Examples are GH, insulin and sex hormones favor bone formation
40. **Permissive Effect** – Some hormones require the presence of another hormone to be effective. For example, epinephrine alone is ineffective but has dramatic influences in the presence of thyroid hormone. Similarly, growth hormone is effective only in the presence of thyroid hormone.

41. **Growth and Hormones:**
   
   A. These hormones favor growth – GH, TH, Insulin, Estrogen or Testosterone
   
   B. Inhibits growth – Cortisol.

42. **Bones and Hormones**

   Favor bone growth – Insulin, GH, Insulin-like Growth Factor 1, Estrogen or Testosterone, Calcitonin.

   Favor bone resorption and decrease bone mass – Parathyroid hormone, Cortisol, Thyroid hormones (T4 and T3)