

# Revision Notes on Chemical Coordination and Integration

## Properties of hormones

- (a) These are secreted by endocrine gland (biogenic in origin).
- (b) Their secretions is released directly into blood (except local hormones *e.g.* gastrin).
- (c) These are carried to distantly locate specific organs, called target organ.
- (d) These have specific physiological action (excitatory or inhibitory). These co-ordinate different physical, mental and metabolic activities and maintain homeostasis.
- (e) The hormones have low molecular weight *e.g.* ADH has a molecular weight of 600–2000 daltons.
- (f) These act in very low concentration *e.g.* around  $10^{-10}$  molar.
- (g) Hormones are non antigenic.
- (h) These are mostly short-lived. So have a no camulative effect.
- (i) Some hormones are quick acting *e.g.* adrenalin, while some acting slowly *e.g.* ostrogen of ovary.
- (j) Some hormones secreted in inactive form called Prohormone *e.g.* Pro-insulin.
- (k) Hormones are specific. They are carriers of specific information to their specific target organ. Only those target cell respond to a particular hormone for which they have receptors.

## Origin of different endocrine glands

| Endocrine glands       | Weight  | Origin   |
|------------------------|---------|----------|
| Pituitary              | 0.5 gm  | Ectoderm |
| Pineal                 | 5.0 mg  | Ectoderm |
| Thymus (up to 12 yrs.) | 20.0 gm | Mesoderm |
| Thyroid                | 25.0 gm | Endoderm |
| Parathyroid            | 20.0 mg | Endoderm |
| Adrenal cortex         | 4.0 gm  | Mesoderm |
| Adrenal medulla        | 1.0 gm  | Ectoderm |
| Testes                 | –       | Mesoderm |
| Ovary                  | –       | Mesoderm |
| Pancrease              | 60.0 gm | Endoderm |

## Pituitary Gland (Hypophysis)

(1) Pituitary is known as hypophysis cerebri, its name pituitary was given by vesalius.

(2) Muller's gland of amphioxus and subneural gland of hardmania is homologous to pituitary of vertebrates.

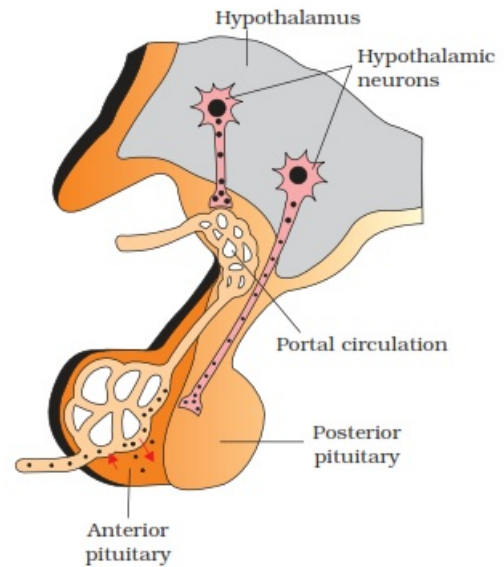
## Parts and component

### (1) Adenohypophysis (Anterior lobe)

- (i) Pars distalis
- (ii) Pars tuberalis
- (iii) Pars intermedia

### (2) Neurohypophysis (Posterior lobe)

- (i) Pars nervosa
- (ii) Infundibulum



## Hypothalamus

(i) **Position and Structure:** Hypothalamus is the floor of diencephalon. It is formed of masses of grey matter, called hypothalamic nuclei, containing neurosecretory cells. It is connected with anterior pituitary lobe by blood capillaries of hypophyseal portal system and with the posterior pituitary lobe by axons of its neurons, both passing through the pituitary stalk.

(ii) **Hormones of hypothalamus:** Neurosecretory cells of hypothalamus secrete neurohormones called releasing factors (RF) or inhibiting factors (IF). These neurohormones are carried by hypophyseal portal system to adenohypophysis (primary target organ) and stimulate or inhibit the release of trophic hormones from adenohypophysis. These neurohormones are proteinous in nature and formed of 3 – 20 amino acids.

## Neurohormones of Adenohypophysis

| Neurohormones  | Physiological effects                          |
|--|--|
| (1) TSH-RF<br>(Thyroid Stimulating Hormone – Releasing Factor)     | Increased ACTH secretion from adenohypophysis. |
| (2) ACTH-RF<br>(Adrenocorticotrophic Hormone-Releasing Factor)     | Increased ACTH secretion from adenohypophysis. |
| (3) STH-RF<br>(Somatotrophic Hormone-Releasing Factor)             | Increased STH secretion from adenohypophysis   |
| (4) SOMATOSTATIN (GROWTH INHIBITING HORMONE)                       | Decreased STH secretion from adenohypophysis.  |
| (5) GTH-RF<br>(Gonadotrophic Hormone-Releasing Factor)             |  |
| (i) FSH-RF<br>(Follicular Stimulating Hormone-Releasing Factor)    | Increased FSH secretion from adenohypophysis.  |
| (ii) LH-RH (In female)<br>(Luteinising Hormone – Releasing Factor) | Increased LH secretion from adenohypophysis.   |

|   |   |
|---|---|
| or ICSH-RF (In male)                                      |   |
| (Interstitial Cells stimulating Hormone-Releasing Factor) |   |
| (6) Prolactin-Releasing hormone (P-RH)                    | Increased secretion of prolactin or leutotrophic hormone. |
| (7) Prolactin-Inhibiting hormone (P-IH)                   | Increased secretion of prolactin or leutotrophic hormone. |
| (8) MSH-RF  |   |
| (Melanophore Stimulating Hormone-Releasing Factor)        | Increased MSH secretion from intermediate pituitary lobe. |
| (9) MIF   |   |
| (Melanophore Inhibiting Factor)                           | Decreased MSH secretion from intermediate pituitary lobe. |

## Thyroid gland

(1) The name "thyroid" was introduced by Thomas Wharton (1656).

(2) It is derived from Greek "Thyreos" a shield.

(3) **Location:** This is the largest endocrine gland of our body. It is located in our neck upon the ventral aspect of larynx (sound box or Adam's apple) and a few anterior most tracheal rings. It is a dark brown and H-shaped bilobed gland.

(4) **Hormones of thyroid:**

Thyroid gland secretes two iodinated hormones.

(a) **Thyroxine:** It is an iodine containing (6% iodine) amine hormone which is derived from tyrosine amino acid. Chemically thyroxine is tetraiodothyronine though also found as tri-iodothyronine. Secretion of thyroxine is inversely proportional to the blood level of thyroxine (feedback mechanism).

(b) **Thyrocalcitonin (TCT):** It is a long peptide hormone secreted by parafollicular by cells of thyroid gland (C-cells). Its secretion is regulated by increased plasma level of calcium by feedback mechanism.

(5) **Irregularities of thyroid gland**

(a) **Hypothyroidism:** (Decreased secretion of thyroxine from thyroid gland).

(b) **Hypersecretion of thyroid hormones (Hyperthyroidism or thyrotoxicosis) :** This may also be a genetic defect, but usually it is provided by chronic infections (influenza, rheumatism, tonsillitis, tuberculosis, measles, whooping cough, etc.) pregnancy, intake of large doses of iodine, over-eating, etc. It results into a considerable increase in glucose and oxygen consumption by cells and the rate of oxidative metabolism in the mitochondria.

## Parathyroid gland

(1) **Hormones of parathyroid:** Active hormone secreted by parathyroids is parathormone (PTH), also called Collip's Hormone (Phillips collip, 1925).

(2) **Irregularities of parathormones**

(a) **Hypoparathyroidism** (Hyposecretion of parathormone)

(b) Hyperparathyroidism (Hypersecretion of parathormone)

## Pancreas

(1) Hormones of pancreas and their role:

(a) **Insulin:** Insulin regulates how the body uses and stores glucose and fat.

**Difference between diabetes mellitus and diabetes insipidus**

| S.No. | Diabetes mellitus  | Diabetes insipidus  |
|-------|--|---|
| 1.    | It is due to deficiency of insulin.                        | It is due to deficiency of ADH.                                   |
| 2.    | The blood sugar becomes high and glucose appears in urine. | The blood glucose is normal and glucose does not appear in urine. |
| 3.    | There is high blood cholesterol and ketone body formation. | There is no such phenomenon.                                      |

(b) **Glucagon:** This is secreted by the alpha cells of islets of Langerhans. Its function is to elevate glucose level in blood when glucose is deficient.

(c) **Somatostatin and Pancreatic polypeptide:** Modern physiologists have postulated that the D and F (PP) cells of pancreas respectively secrete somatostatin (SS) and pancreatic polypeptide (PP). Somatostatin resembles the growth hormone inhibitory hormone (GHIH) secreted by hypothalamus.

## Thymus gland

(1) Function of thymus glands

(a) Thymus is haemopoietic, as well as, an endocrine gland.

(b) The major function of thymus is to secrete thymosin hormone, thymic humoral factor (THF), thymic factor (TF), thymopoietin.

(c) Thymus is essential in neonatal (newly born) infant and postnatal child for normal development of lymphoid organs and cellular immunity.

## Gonads

(1) The gonads are the sex glands, the testes and the ovary.

### (i) Testes

The testis form part of the male reproductive system, and is the gland where sperm and testosterone are produced.

**Functions of Testes**

(a) It stimulates the male reproductive system to grow to full size and become functional.

(b) It stimulates the formation of sperms (spermatogenesis) in the seminiferous tubules.

(c) It also determines the male sexual behaviour sex urge, aggressive behaviour.

(d) Under its effect protein anabolism increases.

## (ii) Ovary:

The ovary is a ductless reproductive gland in which the female reproductive cells are produced.

### List of hormones their chemical nature and functions

| Name of endocrine gland   | Name of hormone and its chemical nature  | Functions  |
|---|--|--|
| (1) Neurosecretory cells of Hypothalamus (Supraoptic Nucleus and Paraventricular Nucleus) | (1) Oxytocin and vasopressin nanopeptide.  | (1) Milk ejection and parturition (oxytocic effect).<br>(2) Vasoconstriction and antidiuretic (vasotocin) effects. |
|   | (2) Gonadotropin releasing hormones  | Stimulates FSH and LH synthesis.   |
|   | (3) Other releasing hormones e.g. TSHRH, MSHRH, ACTHRH, GHRH etc. Proteinaceous                          | Stimulate TSH, MSH, ACTH GH secretions from pituitary.   |
| (2) Pituitary   |  |  |
| (a) Neurohypophysis (Pass Nervosa)  | Store and release Oxytocin and Vasopressin.  | Hormone release is related to physiological state and requirements.  |
| (b) Adenohypophysis (contains diverse cell types)   | Proteinaceous or glycoprotein  | Affect growth, development differential pubertal changes and other metabolic mechanism.                            |
| (3) Pineal  | Melatonin-derived from the amino acid tyrosine   | (1) Antagonist to FSH / LH<br>(2) Regulates biological / circadian rhythms.  |
| (4) Thyroid gland (amine hormone) having - NH <sub>2</sub> group)                         | (a) Thyroxine, iodinated amino acid called tyrosine (T <sub>2</sub> , T <sub>3</sub> , T <sub>4</sub> ). | (a) Controls basal metabolic rate (BMR). All organ / system of body respond to thyroxine.                          |
|   | (b) Thyrocalcitonin (Peptide)  | (b) Facilitates Ca <sup>+2</sup> absorption  |
| (5) Parathyroid gland   | Parathormane, Peptide  | Ca <sup>+2</sup> and PO <sup>-4</sup> metabolism.  |
| (6) Thymus  | Thymosine (polypeptide)  | Anti-FSH and LH; delays puberty  |
| (7) Islets of Langerhans (= Endocrine pancreas)   |  |  |
| (i) α-cells   | (i) Glucagon   | (i) Gluconeogenesis / Glycogenolysis   |
| (ii) β-cells  | (ii) Insulin   | (ii) Glycogenesis  |
| (iii) δ-cells   | (iii) Secretin   | (iii) Gastric functions  |
|   | Isolated by Banting polypeptide  |  |
| (8) Adrenal gland   |  |  |
| (a) Adrenal medulla (Amine hormone have   | (a) Catecholamines (epinephrine = adrenaline, and norepinephrine =                                       | (a) Stresses = emergency = Fright, Fight and Flight Hormone  |

|   |  |   |
|---|--|---|
| - NH <sub>2</sub> )   | noradrenaline (derived from tyrosine)  | (3F) accelerates cardiac functions muscle activity etc.   |
| (b) Adrenal cortex  | (b) Mineralcorticoids and glucocorticoids and traces of androgen and estrogen steroids derived from cholesterol                    | (b) Electrolyte and carbohydrate metabolism.  |
| (9) Ovary<br>(a) Granulosa cells steroid, fat soluble have sterol group derived from cholesterol            | Estrogen (Steroid)<br>Estrone, estradiol   | (a) Secondary sex character primary action on uterine endometrium mitogenic.  |
| (b) Corpus luteum   | Estrogen and Progesterone (Steroid)  | (a) Secreted during luteal phase of menstrual cycle in human female and oestrous cycle of other mammals. Prepares uterine endometrium for receiving blastocytes for implantation. Progesterone is also called pregnancy hormone and is anti-FSH and anti-LH/anti-LTH. |
| (c) Placenta temporary endocrine gland formed during pregnancy  | (a) Steroid secreted are estrogen and progesterone<br>(b) Relaxin-Polypeptide  | (a) Maintenance of pregnant state prevents lactogenesis folliculogenesis, and Ovulation.<br>(b) Act on pubic symphysis and enlarges the birth canal to facilitate birth. Acts synergistically with oxytocin during this process (parturition)                         |
| (10) Testis<br>(i) Sertoli cells<br>(=sustentacular cells)  | Inhibin - Polypeptide  | Inhibits FSH action and attenuates spermatogenesis decrementally  |
| (ii) Leydig cells<br>(=Interstitial cells)  | (ii) Estradiol-Steroid Androgens (e.g. Testosterone) Steroid androstenedione)  | (i) Pubertal changes in male<br>(ii) Secy. sex characters in male<br>(iii) Sex drives<br>(iv) Spermatogenesis   |
| (11) Gastro-intestinal hormones (secreted by cells of mucosa of stomach and intestine) also called hormones |  | Stimulates gastric juices secretion from gastric gland, movement of sphincters of stomach and increased movement of stomach   |
| (a) Pyloric stomach (Argentophil cells) Intestine   | Gastrin<br>(i) Secreten<br>(ii) Cholecystokinin (CCK)<br>(iii) Enterogastrone<br>(iv) Duodenin<br>(v) Enterokin<br>(vi) Villikinin | (i) Stimulates secretion of succus entericus<br>(ii) Bile released from gall bladder<br>(iii) Inhibits gastric secretin<br>(iv) Stimulates secretion of mucous from Brunner's gland<br>(v) Stimulate intestinal gland<br>(vi) Stimulate villi movement                |