

## ENDOCRINE GLANDS

### INTRODUCTION :

- ☞ The branch of biology which deals with the study of endocrine system and its physiology is known as “**Endocrinology**”.
- ☞ “**Thomas Addison**” is known as father of Endocrinology.  
Whereas the gland with duct is called exocrine gland which secretes enzyme etc. Endocrine glands pour their secretion directly into blood. These glands lack ducts, so these glands are called ductless glands.
- ☞ Co-ordination in the body almost all the higher vertebrates is controlled by two systems **Nervous system** and **endocrine system**.
- ☞ Nervous system and endocrine system are called **Integrative system** of the body.
- ☞ Nervous system carries informations in the form of impulses to the different parts of body. High speed services are offered by this system.
- ☞ Where as, the work of co-ordination by endocrine system is done slowly by secretion of some chemical substances.
- ☞ Substances secreted by these glands are known as hormones. The meaning of word ‘hormone’ in Greek is “**to excite**” = **hormaein**.

### Differences between Nervous and Endocrine Coordination

|    | Nervous Co-ordination                                         |    | Endocrine Co- ordination<br>(Chemical Co- ordination)                   |
|----|---------------------------------------------------------------|----|-------------------------------------------------------------------------|
| 1. | Information passes as electrical impulses along nerve fibres. | 1. | Information passes as a chemical substance through the blood and lymph. |
| 2. | There is rapid transmission of information.                   | 2. | There is slow transmission of information.                              |
| 3. | Response is immediate                                         | 3. | Response is usually slow.                                               |
| 4. | Response is very exact.                                       | 4. | Response is usually widespread.                                         |
| 5. | Response is short lived.                                      | 5. | Response is long-lasting.                                               |

### HORMONE :

- ☞ The term hormone was coined by **Starling**.
- ☞ Hormones are also called “Primary messengers” or “chemical messengers”.
- ☞ First discovered hormone is **secretin**. It was discovered by **Bayliss & Starling in 1902**.  
**Source & Chemical Nature :-**Hormones are chemical messengers which are secreted by one part of body and are poured directly into the blood stream, and they reach at their target place with the help of blood .A small amount of hormone affects some specific cells or physiology of cells of organisms according to atmospheric conditions.  
**Chemical Nature of Hormone :-**  
The animal hormones may be classified into 6 categories.
  1. **Amino acid derivatives :-** The hormones epinephrine and norepinephrine from the adrenal medulla and thyroxine from the thyroid gland are derived from amino acid.
  2. **Short peptides :-** The hormones Oxytocin and vasopressin from the posterior lobe of the pituitary gland are short peptides of 9 amino acid. The melanocyte stimulating hormone (MSH) from the intermediate lobe of the pituitary gland is also short peptide of 13 amino acids.

3. **Long peptides** :- The hormones insulin from the pancreas, adrenocortico tropin (ACTH) from the anterior lobe of the pituitary gland, calcitonin from the thyroid gland are longer peptides of above 30 amino acids, parathormone from the parathyroid gland consists of 84 amino acids.
4. **Protein** :- The gonadotropic, thyrotropic and somatotropic hormones from the anterior lobe of pituitary are protein with high molecular weights.
5. **Steroids (Fat soluble)** :- The hormones like cortisol and aldosterone from adrenal cortex, testosterone from interstitial cells of testes, estrogen and progesterone from Graaffian follicles of ovary and placentas are the examplaes of steroid hormones. These hormones contain cholesterol and bile salts.
6. **Fatty acid derivative** :- Prostaglandin

### Physical & Chemical Specialities of Hormones :-

- ☞ The molecules of most of the hormones are small, and their molecular weight is low.
- ☞ Hormones are soluble in water and are easily diffusible in tissues.
- ☞ The secretion of hormone is always in very small quantity because these are most reactive substances.
- ☞ Hormones are destroyed after use i.e. hormones can not be stored in the body. Thyroxine is exception in this regards.
- ☞ Liver and kidneys separate them from blood and decompose them. The product formed after decomposition are excreted with urine. It can not be reutilized.
- ☞ Hormones are non- antigenic & non specific substances.
- ☞ Usually, hormones do not participate in the metabolic activities of target of target cells but they affect and control the activates level of these target cells. Due to the effect of hormones, not only the rate of metabolic activities effected but also the permeability of cell membrane is changed so the nature of reactions is also changed.

### Differences between Hormone & Enzyme

|    | Hormone                                                                                  |    | Enzyme                                                                                                                                        |
|----|------------------------------------------------------------------------------------------|----|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | They are produced at one site and are passed by to another site for action.              | 1. | They may act at site where they are produced or carried to another site for action.                                                           |
| 2. | They have low molecular weight.                                                          | 2. | They have very high molecular weight.                                                                                                         |
| 3. | Hormones may be steroids, proteins, peptides or amino acid derivatives.                  | 3. | Enzymes are simple proteins.                                                                                                                  |
| 4. | They are used up in their action.                                                        | 4. | They are not used up in their action.                                                                                                         |
| 5. | They are effective in low concentration. Their excess or deficiency may cause disorders. | 5. | They also act in low concentration. However, the rate of enzyme catalyzed reactions steadily increase with an increase in their concentration |
| 6. | They may act slowly or quickly.                                                          | 6. | They act slowly.                                                                                                                              |
| 7. | They may accelerate or retard the specific reactions.                                    | 7. | They speed up the reactions.                                                                                                                  |
| 8. | Hormones controlled reactions are not reversible                                         | 8. | Enzyme controlled reactions are reversible.                                                                                                   |

### Differences between Hormone & Vitamins

|    | Hormone                                                                                           |    | Vitamins                                                                                                                                            |
|----|---------------------------------------------------------------------------------------------------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | Hormones may be steroids, proteins, peptides or amino acid derivatives.                           | 1. | They are never proteins but simple organic compounds such as amines, esters, alcohol, aldehyde or organic acids.                                    |
| 2. | They are effective in low concentration. Their excess or deficiency may cause hormonal disorders. | 2. | They are needed in small quantity. Excess vitamins are excreted. Their deficiency causes malfunctioning called deficiency diseases or avitaminosis. |
| 3. | They are secreted by the animal in its own body.                                                  | 3. | They are rarely synthesized in the body. They are mostly taken with food.                                                                           |
| 4. | Hormones influence the gene to produce specific enzymes required during metabolism.               | 4. | They act as co-enzymes and help enzymes to perform their function.                                                                                  |
| 5. | They do not influence the working of those organs which have secreted them.                       | 5. | They are not produced by body organs (except vitamin D)                                                                                             |

### MECHANISM OF HORMONAL REACTIONS

#### MECHANISM OF HORMONE –Two types

- ☞ Once hormone enter into blood stream it can reach almost to any cell in the body.
- ☞ However, each hormone effects only certain kind of cells which is called as **target organ**.
- ☞ **All hormone do not act in the same way due to location of receptor.**
- ☞ Hormones are two types :
  - (i) Water soluble hormone
  - (ii) Lipid soluble hormone
- ☞ Water soluble hormone interact with a surface receptor, normally a **glycoprotein** and initiate a chain events within it where as lipid soluble hormone (Steroid hormones) readily pass through the plasma membrane to cytoplasm of the target cell. Molecular mechanism of hormones are of following types :

#### (1) At Gene level

#### (2) At Plasmalemma level

1. **AT GENE LEVEL :-** In this type of mechanism steroid hormone and Thyroxine hormones are involved.
- (a) Steroid hormones :-** In this process steroid hormones enter into target cell where they combine with receptor protein, this Receptor protein conveys the hormone from cytoplasm to nucleus. This hormone stimulates the DNA for synthesis of protein. Now DNA synthesis the m-RNA and this m-RNA goes into cytoplasm, where Ribosome synthesize the protein by translation. This new protein is an enzyme, which affects the vital activity of target cell.
- (b) Thyroxine hormone :-** The thyroid hormone thyroxine and tri-iodothyronine cause increase transcription by certain gene in nucleus. To accomplish this, These hormones first bind directly with receptor protein in nucleus. Receptor protein is located on chromosome. Advantage of intranuclear receptor the thyroxine hormone can continue they express their control function for weeks :

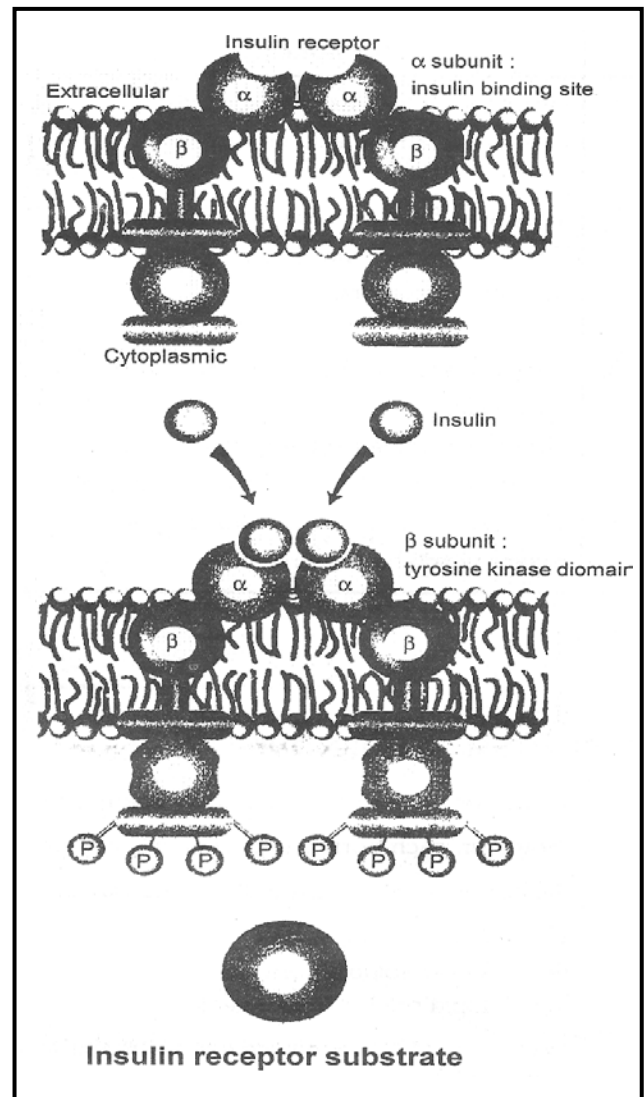
2. **PLASMALEMMA LEVEL :-**Following hormones an example of this mechanism :

(a) **Tyrosine kinase mechanism :-** A good example of this is the effect of insulin. For transport of **insulin** hormone, insulin receptor is found in cell membrane, which is made up of 4 sub-units. 2 sub-units ( $\alpha$  – Protein ) are  $\alpha$ -protein which are situated towards the outside of cell membrane this sub unit binds the insulin hormone. 2 sub-units ( $\beta$  –Protein ) protrude into the cytoplasm of the cell . The intra cellular portion of the  $\beta$  units

has **tyrosine kinase activity**. These receptors are usually less than 100 in most of our body cells but may be more than 1,00,000 as in some liver cells.

**Binding to the receptor** – Binding of insulin to the outer  $\alpha$  sub units of receptor triggers

tyrosine kinase activity of the intra cellular portion of  $\beta$ -sub units. This causes a structural change in  $\beta$ -sub units to become an activated tyrosine kinase . The activated tyrosine kinase produces autophorylation of the cytoplasmic receptor as well as phosphorylation of some cytoplasmic protein ( **Insulin receptor substrate , IRS**).



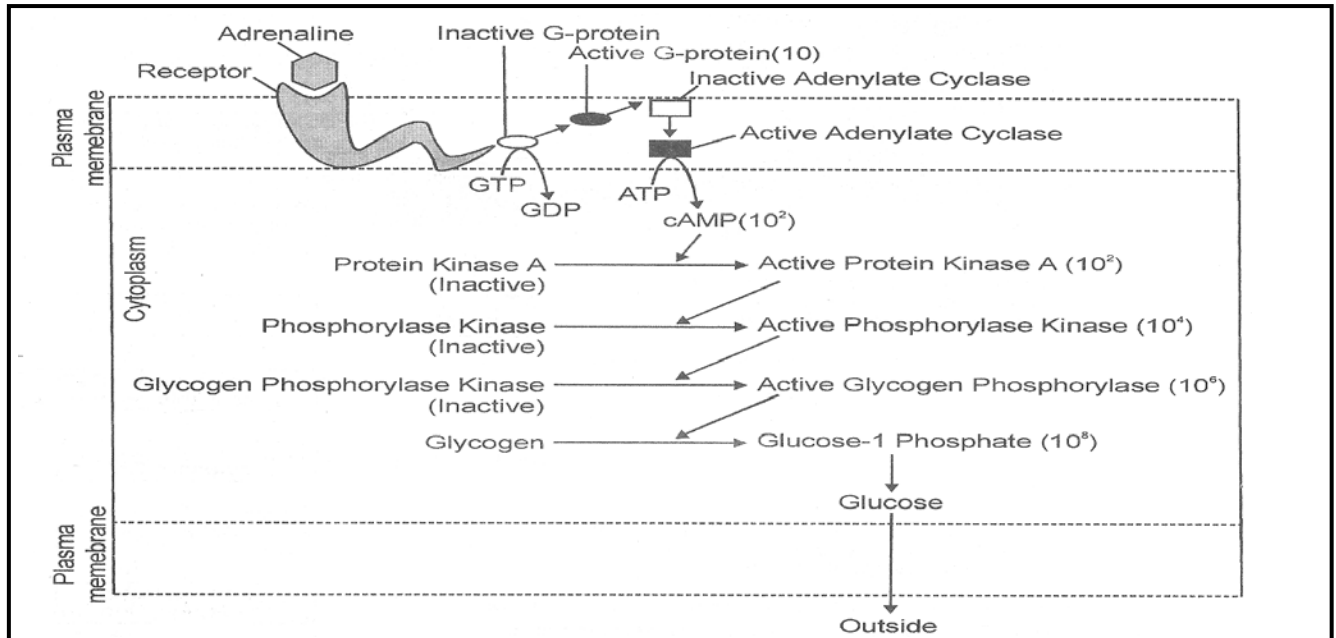
(b) **C-AMP or Second messenger system :** This C –AMP mechanism has been shown by following hormones :

- |                                      |                                       |
|--------------------------------------|---------------------------------------|
| ☞ Adreno Corticotropin (ACTH)        | ☞ Secretin                            |
| ☞ Thyroid stimulating hormone (TSH)  | ☞ Catecholamines                      |
| ☞ Luteinizing hormone (LH)           | ☞ Most hypothalamic releasing hormone |
| ☞ Follicle stimulating hormone (FSH) | ☞ Vasopressin / ADH                   |
| ☞ Parathyroid hormone (PTH)          | ☞ Glucagon                            |

In this type of mechanism when adrenaline is attached to the surface receptor protein which is found on the plasmalemma then first of all it forms a complex which is called as hormone receptor complex (HRC). A transducer protein is found on inner surface of receptor protein which is called as G –Protein . This G –Protein consists of  $\alpha$ ,  $\beta$ ,  $\gamma$  – subunit. GTP is also found on G –Protein.

- ☞ After formation HRC then GTP changes into GDP, in this process phosphate group is released which activates the G –Protein.

- ☞ After activation of G-Protein their sub units are divided into two group i- $\alpha$ -subunit and ii- $\beta$ ,  $\gamma$ -subunit ( $\beta$ ,  $\gamma$ -subunit both are does not separated with each other)
- ☞ Activated  $\alpha$ -subunit of G-Protein activate adenylate cyclase.
- ☞ Activated adenylate cyclases ATP into C-AMP on cell membrane.



- ☞ This C-AMP goes into cytoplasm where it activates the inactive protein kinase-A to active protein kinase-A.
- ☞ This active protein kinase-A changes inactive phosphorylase kinase phosphorylase kinase.
- ☞ This active phosphorylase kinase changes inactive Glycogen phorylase into active glycogen phosphorylase.
- ☞ This active glycogen phosphorylase changes glycogen into Glucose 1-Phosphate.
- ☞ Each molecule of protein kinase-A activates about 100 molecule of anzyme phosphorylase kinase and so on.
- ☞ As a result a single molecule of adrenaline releases as many as 100 million molecules of glucose within only 1 minutes (**Amplification**).

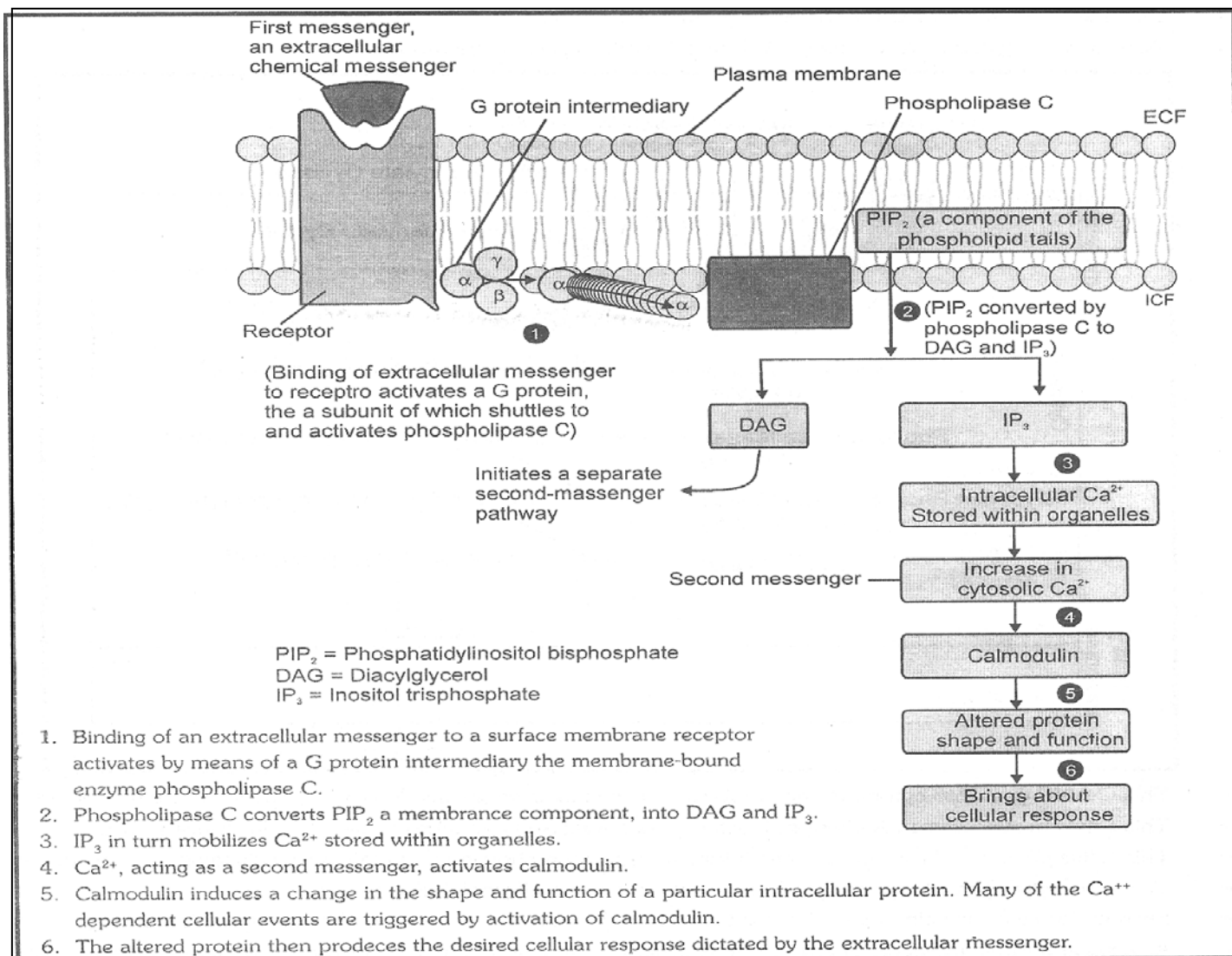
(c) **IP<sub>3</sub> & DAG Mechanism** : In this type of mechanism local hormones are involed such as prostaglandins, Acetylcholine, Somatostatin etc.

Same CAMP mechanism transducer G-protein act.

- ☞ G-protein activates enzyme phosphodiesterase
- ☞ phosphodiesterase (Phospholipasec) Enzyme breaks phosphotidyl insitol bisphosphate into inositol triphosphate (IP<sub>3</sub>) and diacylglycerol (DAG).
- ☞ IP<sub>3</sub> is water soluble and diffuses into cytoplasm, IP<sub>3</sub> specially mobilized Ca<sup>++</sup> ion endoplamic reticulam and the Ca<sup>++</sup> ion promote smooth muscle contraction and change in secretion by secretory cell and change in ciliary action.

- ☞ DG remain in the membrane where it activates an enzyme called protein kinase C, which in turn, activates many other enzyme, Activated protein kinase C plays on important role in cell division and cell proliferation.

The action of lipid soluble hormone are slower and last longer then the action of water soluble hormone.



### SPECIFIC TERMS

**Chalones** → The hormones which are secreted from one endocrine gland to stimulate other endocrine gland is called as Chalones.

**Autocide** → The hormones which are secreted from one endocrine gland to target organ is called as Autocoide.

**Diabetogenic** → The hormone which mainly affects or stimulates carbohydrate metabolism is called as Diabetogenic.

**Ketogenic** → The hormones ,which mainly affects or the fat metabolism.

**Calorigenic** → The hormone, which mainly affects the basal metabolic rate (BMR) is called as Chlorigenic.