

## **Hormones**

A hormone is a chemical messenger that is synthesized in one organ and transported by the circulatory system to act on another tissue.

Hormone : Greek term - arouse to activity

**Control Mechanisms of body** – (1) Nervous system – fixed system of communication  
(2) Endocrine system – mobile messaging system

### ***Why it is endocrine system?***

- *Collection of glands of an organism that secrete substances (chemicals) directly into the circulatory system to be carried towards distant target organs*
- *In comparison to exocrine system – which produce and secrete substances onto an epithelial surface by way of a duct/lumen.*
- Examples of exocrine glands: sweat, salivary, mammary, ceruminous, lacrimal, sebaceous, mucous secreting glands.
- Composite/mixed gland – Pancreas & Liver

A **chemical messenger** is any compound that serves to transmit a message.

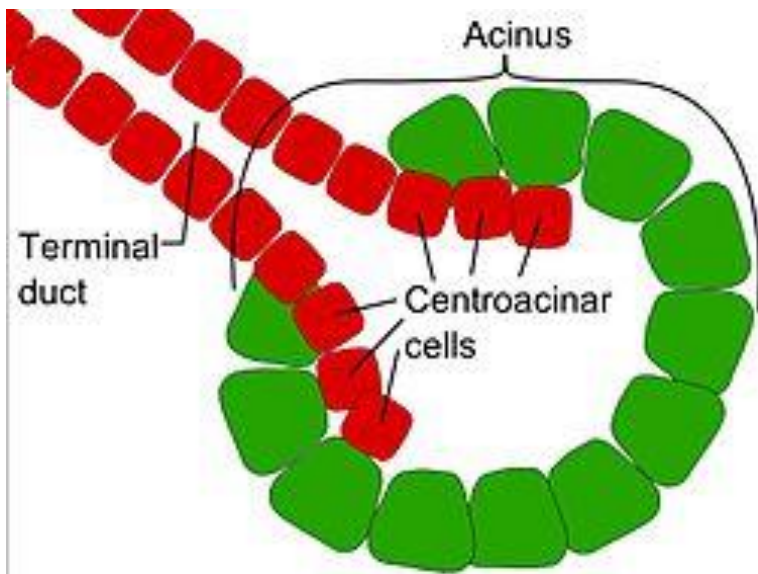
### **Types:**

- (1) Hormone: Long range chemical messenger
- (2) Neurotransmitters: communicates to adjacent cells (secreted by nerve terminals)
- (3) Neuropeptides: a protein sequence which acts as a hormone or neurotransmitter
- (4) Pheromone - a chemical factor that triggers a social response in members of the same species

### Difference between Endocrine & Neural system:

- (1) Electric signals (nerve impulses) originate in cell body – travel through the axon to the axon terminals very rapidly.
- (2) Release of neurotransmitters from axon terminal that diffuse to target cells (muscles)
- (3) The target cells are micrometers away.

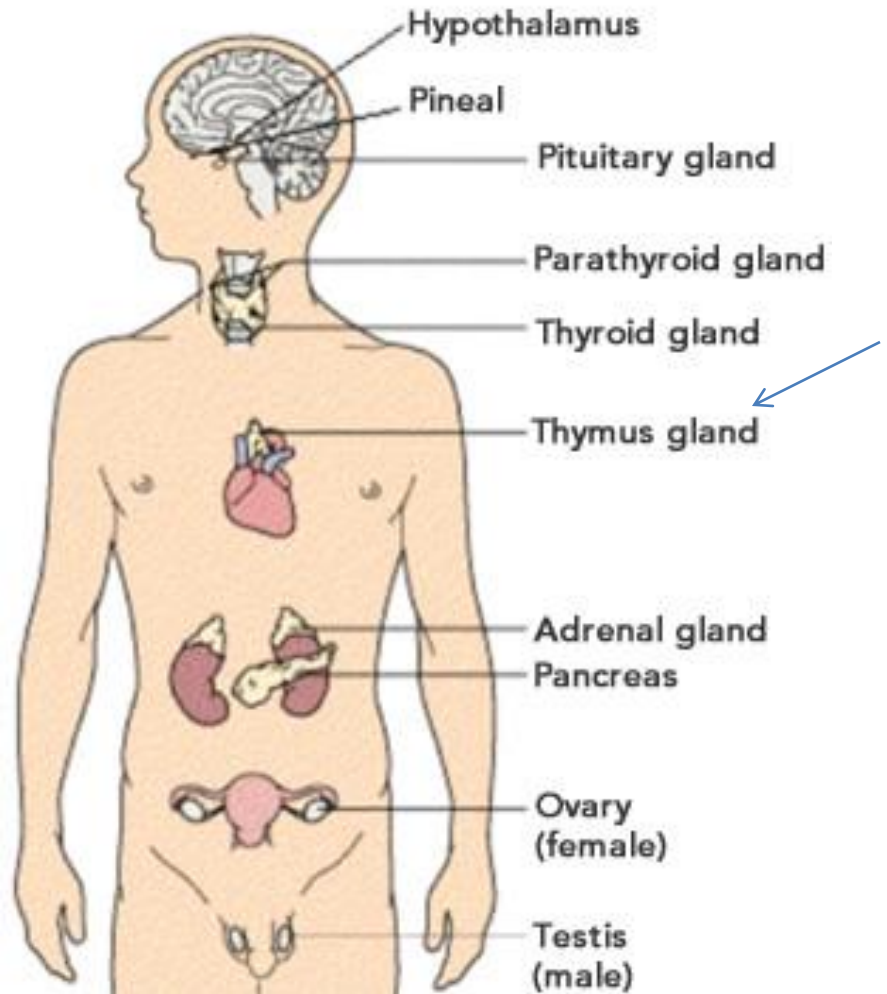
- (1) Hormones (chemical messengers) originate in a cell– travel through blood to target tissues.
- (2) The target cells are meters away.



### Properties of endocrine system

- ductless
- Vascularity
- presence of intracellular vacuoles or granules that store the chemicals
- slow to initiate
- prolonged in their response, lasting from a few hours up to weeks.

## The Endocrine System



Many other organs that are part of other body systems, such as bone, kidney, liver & heart have secondary endocrine functions.

**Paracrine signaling** : cell-cell communication in which a cell produces a signal to induce changes in nearby cells, altering the behavior or differentiation of those cells. Signaling molecules known as paracrine factors diffuse through ECF over a relatively **short distance** (local action)

(eg. Prostaglandins)

**Autocrine signaling**: cell signaling in which a cell secretes a hormone or chemical messenger (called the autocrine agent) that binds to the receptors on that same cell, leading to changes in the cell.

(eg. cytokine interleukin-1 in monocytes)

### **THE TARGET CELL CONCEPT**

- Among 200 differentiated cells - few produce hormones
- 75 trillion cells in a human are targets of one or more of the <50 known hormones.
- **any cell in which the hormone (ligand) binds to its receptor, whether or not a biochemical or physiologic response has yet been determined.**

### **Factors affecting the action of hormones/hormone responsiveness**

1. **Concentration of a hormone at the target cell**
2. **Target cell response**

1. The rate of synthesis and secretion of the hormones.
2. The proximity of the target cell to the hormone source (dilution effect).
3. The dissociation constants of the hormone with specific plasma transport proteins (if any).
4. The conversion of inactive or sub-optimally active forms of the hormone into the fully active form.
5. The rate of clearance from plasma by other tissues or by digestion, metabolism, or excretion.

1. The number, relative activity, and state of occupancy of the specific receptors on the plasma membrane or in the cytoplasm or nucleus.
2. The metabolism (activation or inactivation) of the hormone in the target cell.
3. The presence of other factors within the cell that are necessary for the hormone response.
4. Up- or down-regulation of the receptor consequent to the interaction with its ligand.
5. Post-receptor **desensitization** of the cell, including down-regulation of the receptor.
6. Intracellular targets differ between cells with same receptors.

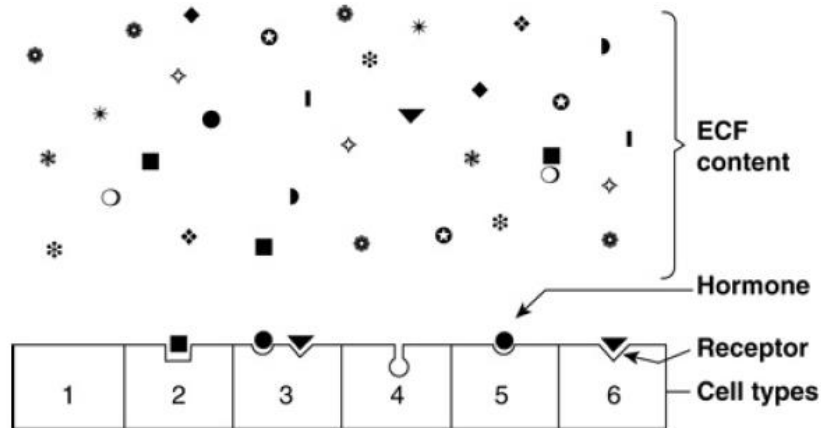
### *How a cell distinguishes between a hormone and other chemicals?*

**Normal range : atto- to nanomolar range ( $10^{-15}$  to  $10^{-9}$  mol/L**

**cell-associated recognition molecules called receptors on target cells.**

Properties:

- (1) Specificity i.e. displaceable by agonist or antagonist only – Structural complementarity
- (2) Saturable
- (3) Binding should occur within the concentration range of the expected biologic response.

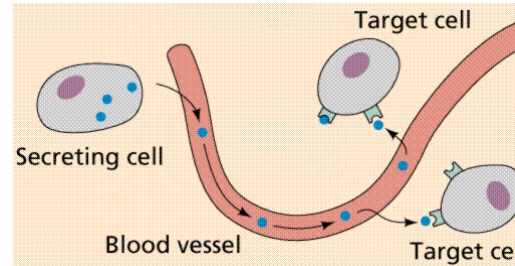
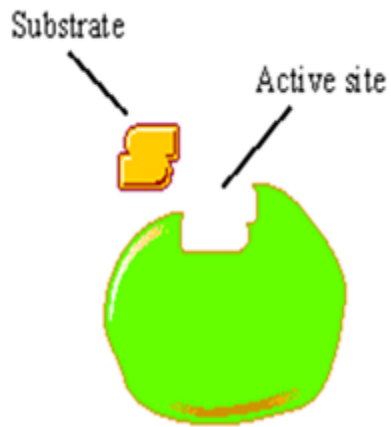


## Specificity and selectivity of hormone receptors

Structurally similar hormones will have different effects when they bind to different receptors.

High affinity allows cellular response at low levels of hormone.

Hormone-receptor binding is quantified by Scatchard Analysis (Bound hormone RL vs total hormone added RL+L) –  $K_d$  & affinity & number of binding sites



### *What is the difference between a hormone and an enzyme?*

1. Hormones are the biomolecules which trigger a specific biological reaction while enzymes are the biomolecules which speed up the rate of a biological reaction.
2. All enzymes are proteins (except ribozymes) while hormones are proteins, steroids, terpenoids, phenolics or amines.
3. Enzymes function at the site of origin while hormones undergo polar translocation to target glands (site of action) from the site of synthesis.
4. Enzymes remain unchanged chemically and can be reutilized after their actions are complete while the chemical composition of hormones are changed at the end of the reactions.