Endocrine System
Ch. 45

A caterpillar changing into a butterfly through metamorphosis or an insect molting, an octopus changing color to blend into its background, a male cichlid changing color and getting larger to guard its territory, a young girl becoming a woman and a college athlete taking anabolic steroids. All of these are examples that involve changes in growth, reproduction and metabolism. Each event is carefully controlled by the coordination of two systems: the nervous and endocrine systems. Transmission of messages and coordination of systems involves both chemical messages in the form of hormones sent from the endocrine system throughout the blood stream and impulses transmitted through neurons from the nervous system.

Endocrine system:
- Helps to control internal chemical composition and volume
- Ensures successful growth and development
- Functions in gamete production, fertilization, embryo development and nourishment, delivery.
- Regulates metabolism
- Regulates response to environmental changes (starvation, dehydration, temperature)

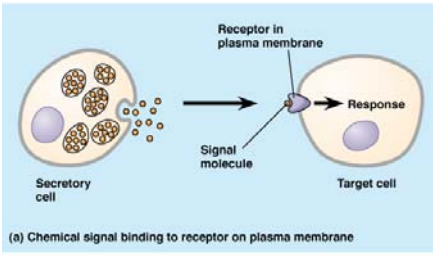
Two types of glands in the body.

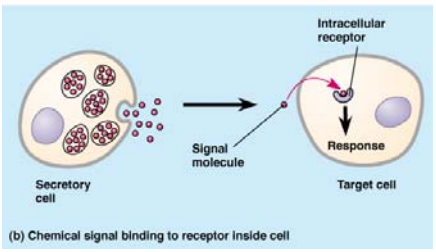
Exocrine glands (not part of endocrine system)

Secrete products into ducts which empty into lumens of organs/structures.
Ex. Sweat & oil glands, digestive glands

Endocrine glands

Secrete products (hormones) into bloodstream
Glands include: pituitary, thyroid, adrenals, pineal, thymus. Organs with endocrine tissues: pancreas, ovary, testes, kidney, stomach, small intestine.





Endocrine glands secrete ***hormones*** that are the chemical messengers that are transported in the blood and elicit a response. Remember that these signals will be detected by plasma membrane proteins such as G-linked receptors, tyrosine-kinase receptors, or gated ion channel receptors. Steroid hormones can interact directly with the genome to initiate transcription of a gene after they have crossed the plasma membrane and bound to a receptor protein in the cytoplasm.

Fluctuations in homeostasis are monitored and relayed to endocrine gland. Amount and duration of hormone secretion is regulated by body's need so <u>there is no overproduction or underproduction of hormone (***usually***)</u>. Regulated by negative feedback. Hypersecretion and hyposecretion of hormones can occur, creating a loss of homeostasis.

Hormone	Hyposecretion	Hypersecretion
Insulin→	Diabetes	Hypoglycemia
Growth hormone →	Pituitary dwarfism	Gigantism

Hormone is carried by blood to **Target Cell**. Target cell will respond to hormone through the association of the hormone with receptors (integral proteins) if it has the appropriate receptor molecule (2,000 – 10,000 receptors/cell).

Hormones are effective in very small quantities.

MAJOR STRUCTURES IN THE ENDOCRINE SYSTEM:

Hypothalamus:
- Receives information from the external environment (sound, taste, smell) and internal environment (monitors water concentrations, temperature of blood and hormone concentrations).
- When the hypothalamus detects changes in the body, it releases hormones that stimulate or inhibit specific cells in the anterior pituitary gland [releasing or inhibiting hormones]. This is the link between the nervous system and the endocrine system!
- Produces two hormones (antidiuretic hormone [ADH] and oxytocin) which are stored in the posterior pituitary.

Pituitary Gland:

- Sometimes referred to as the "master gland". Connected to the hypothalamus.
- Stores ADH and oxytocin produced by the hypothalamus.
- Produces and releases a number of other hormones that influence other glands throughout the body.
- Release of hormones from the pituitary is controlled by the releasing and inhibiting hormones of the hypothalamus.
- Growth hormone (GH) released from anterior lobe of pituitary stimulates uptake of amino acids by cells throughout body and promotes protein synthesis.

Effects of Hormones:

The degree of affect on a target cell depends on number of receptors and concentration of hormone.

1) Synergistic effects:

a) The effects of two or more hormones complement each other. Response is "summation" of individual effects.
   i) Ex. Milk production and secretion
      (1) Requires estrogens, progesterone, prolactin, and oxytocin.

2) Antagonistic effects:

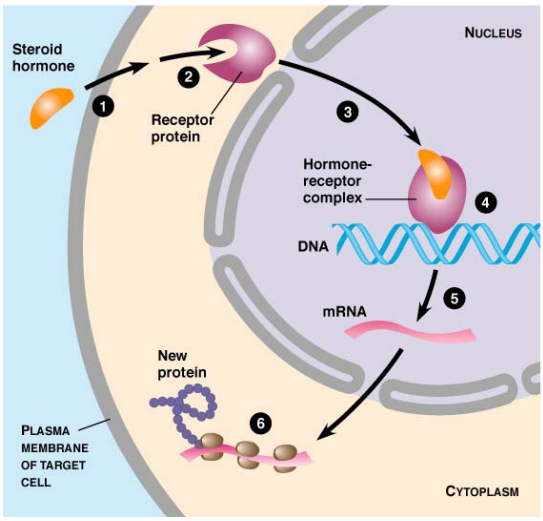
a) Effect of one hormone opposes the other.
   i) Ex. Calcitonin lowers blood calcium levels and parathyroid hormone raises it.
   ii) Ex. Insulin lowers blood sugar and glucagon raises it.

Hormones are grouped in three general classes:

A. Steroids (ex. Aldosterone, androgens)

- Derived from cholesterol through biochemical reactions. Defects in synthetic pathways lead to hormonal imbalances.
- Fat-soluble (therefore can move through plasma membrane); they are not stored by cells, and the rate of synthesis controls them.

Pass through the plasma membrane and act in a two step process. Steroid hormones bind, once inside the cell, to the nuclear membrane receptors, producing an activated hormone-receptor complex. The activated hormone-receptor complex binds to DNA and activates specific genes, increasing production of proteins.



B. Amines (epinephrine & norepinephrine, thyroid hormones)

- Modified from amino acid tyrosine.
- Water soluble (cannot move through plasma membrane)

C. Proteins and Peptides (protein chains [oxytocin, calcitonin])

- Vary in size; synthesized during dehydration synthesis
- Water soluble (cannot move through plasma membrane)

Nonsteroid hormones (first messenger) do not enter the cell but bind to plasma membrane receptors, generating a chemical signal (second messenger) inside the target cell. Second messengers (including **cyclic AMP**) activate other intracellular chemicals to produce the target cell response. This is a **signal-transduction pathway!!**

Cyclic AMP synthesized from ATP
Once converted, it activates other enzymes