

# **Lect. No. 5**

## **Endocrine System**

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# Principles of the Endocrine System

- The **endocrine system** consists of:
  - Endocrine cells which are hormone-secreting cells and
  - **Endocrine glands** which are hormone-secreting organs.
- Specific **target cells** respond to specific hormones.

1. Controls the processes involved in physiological equilibrium.
2. Includes tissues or glands that secrete hormones into blood.
3. Secretion of most hormones is regulated by a negative feedback system.
4. The number of receptors for a specific hormone can be altered to meet the body's demand & sensitivity:
  - a. Down-regulation:** is the decrease of hormone receptors which decreases the sensitivity to that hormone
  - b. Up-regulation:** is the increase in number of receptors which causes the cell to be more sensitive to a particular hormone.

# Hormones Functions & Actions

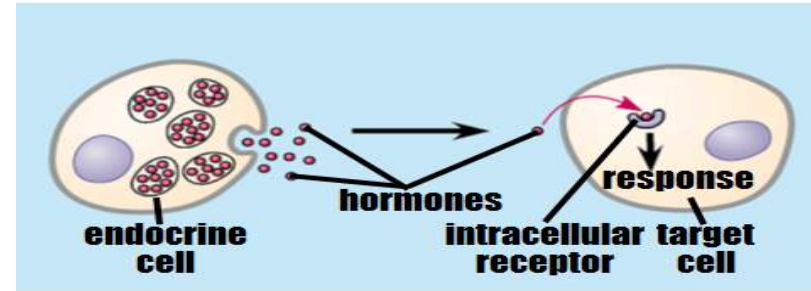
- **Primary Functions**

- Homeostasis
- Growth and Development
- Reproduction
- Energy Metabolism
- Behavior
- **Hormone Action:** “Lock and Key” approach: describes the interaction between the hormone and its specific receptor.

# Classification of Hormones

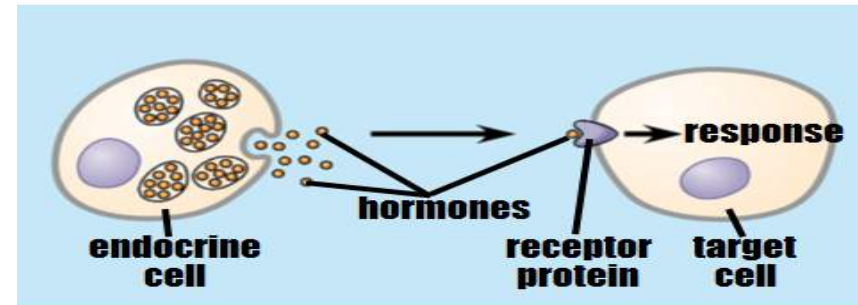
## **Steroid Hormones: Characters:**

1. Lipid soluble.
  2. Diffuse through cell membranes.
  3. Received by intracellular receptors.
  4. Enters the nucleus to bind with the cells DNA which then activates certain genes (Direct gene activation).
- **Secreting glands:** Adrenal cortex, Ovaries, Testes, Placenta.



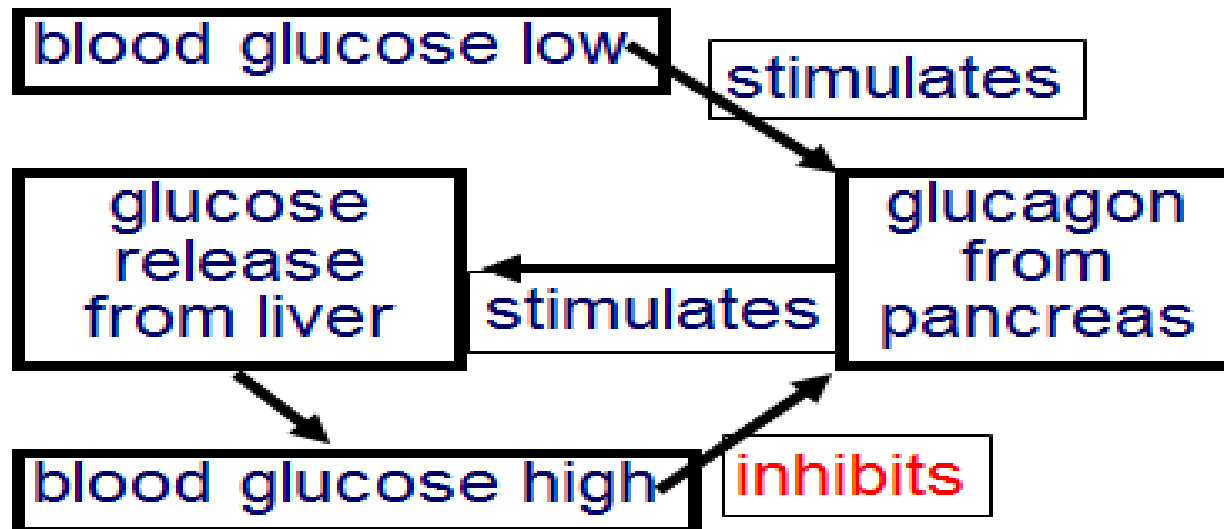
## **Nonsteroid Hormones: Characters:**

1. Not lipid soluble
  2. Received by receptors external to the cell membrane.
  3. This triggers an enzyme reaction which lead to the formation of a second messenger (cAMP).
- **Secreting glands:** Thyroid gland, Parathyroid gland, Adrenal medulla, Pituitary gland, pancreas.



# Negative Feedback

- It is the primary mechanism through which the endocrine system maintains homeostasis.
- Secretion of a specific hormone is turned on or off by specific physiological changes (similar to a thermostat) (Ex. glucose levels & insulin response)



# The Endocrine Glands and Hormones

## Pituitary Gland

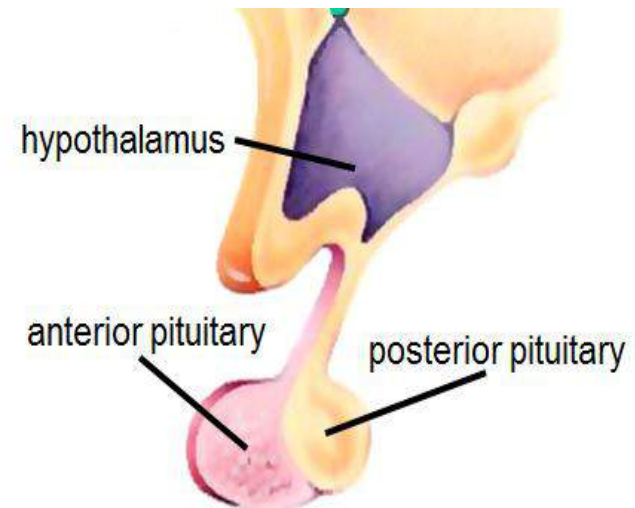
- A marble-sized gland at the base of the brain.
- Controlled by the hypothalamus or other neural mechanisms.

### Posterior Lobe

- Antidiuretic hormone: responsible for fluid retention
- Oxytocin: contraction of the uterus

### Anterior Lobe

- Exercise appears to be a strong stimulant to the hypothalamus for the release of all anterior pituitary hormones
- Adrenocorticotropin
- Growth hormone \*
- Thyropin
- Follicle-stimulating hormone
- Luteinizing hormone \*
- Prolactin



## Thyroid-Stimulating Hormone (TSH)

- Acts on the thyroid gland, stimulating it to release T3 & T4
- These thyroid hormones increase glucose catabolism and body heat production.
- Negative feedback mechanism involved in regulating levels.

- **Adrenocorticotrophic Hormone (ACTH)**

- Acts on the adrenal cortex, stimulating it to secrete glucocorticoids (e.g., cortisol).
- Glucocorticoids promote the synthesis of glucose from noncarbohydrate sources such as amino acids, and fatty acids
- Negative feedback mechanism involved in regulating levels.

# Growth Hormone (GH)

- Acts on the liver, stimulating it to release several polypeptide hormones.
- Stimulates amino acid uptake and protein synthesis in target cells.
- Ultimately stimulates cell growth (cell size and number), especially in muscle and bone.
- Also stimulates fat breakdown.

## Gigantism Hypersecretion of GH



## Dwarfism

hyposecretion of GH



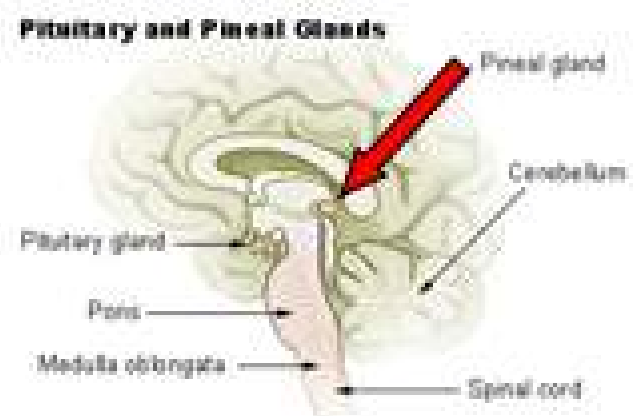
Little People Big World



# Pineal Gland

Produces **melatonin** (synthesized from serotonin, a derivative of tryptophan)

- Secreted directly in CSF to blood
- High levels at night make us sleepy; low level during day
- Pineal gland is stimulated by darkness and inhibited by light
- Function in regulating circadian rhythms (sleep, body temp, appetite) → biological clock



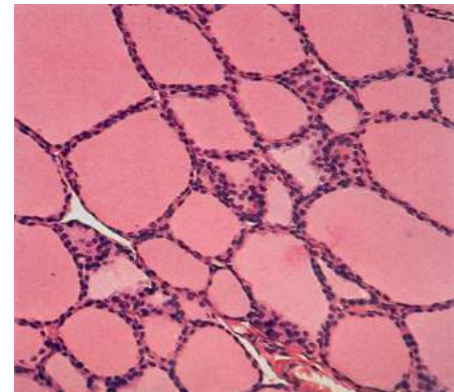
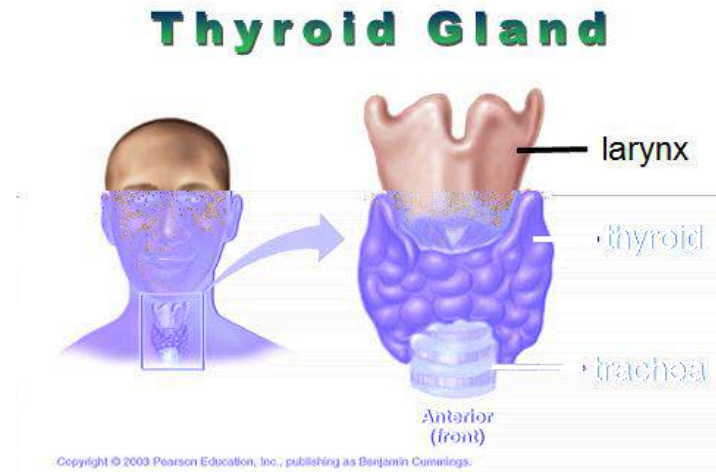
# Thyroid Gland

- Located along the midline of the neck. It selectively uptake iodine to produce T3 & T4
- Secretes nonsteroid hormones

1. Triiodothyronine (T3)
2. Thyroxine (T4)
3. Calcitonin

- **Functions:**

1. Regulates metabolism & cellular respiration
2. Increases protein synthesis
3. Promotes glycolysis,
4. Gluconeogenesis, glucose uptake
5. Lowering  $\text{Ca}^{++}$  levels in blood & causing  $\text{Ca}^{++}$  reabsorption in bones.



# Thyroid Disorders

- Hyperthyroidism (Grave's, Goiter)
- Hypothyroidism (Cretinism, Myxedema)

Exophthalmos- hyperthyroidism



## Myxedema

hyopsecretion of T3 & T4



After thyroid treatment

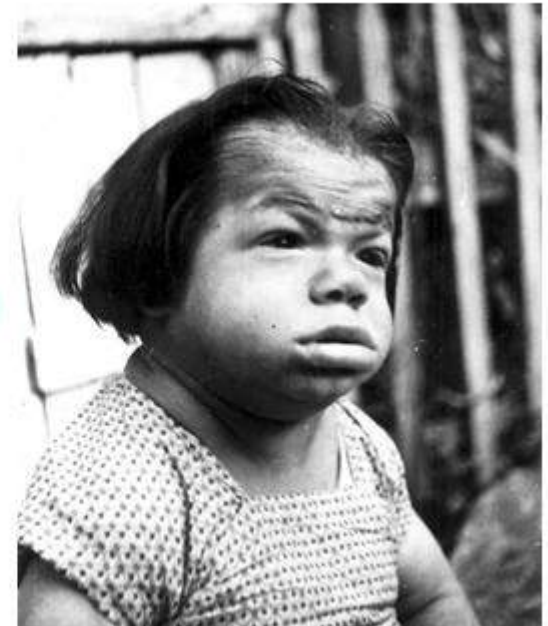
# Goiter

Lack of iodine in diet  
hyopsecretion of T3 & T4



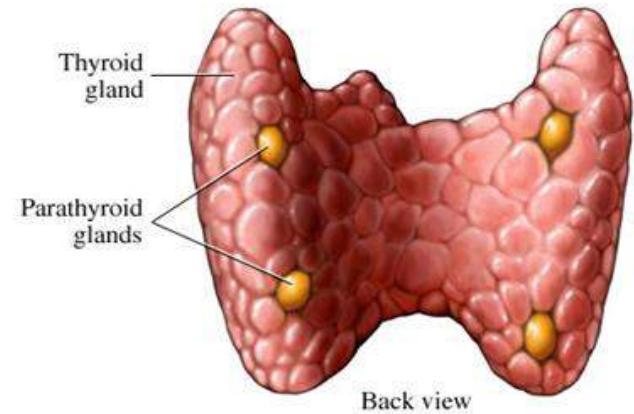
# Cretinism

hyopsecretion of T3 & T4



## Parathyroid Glands

1. Secretes parathyroid hormone
2. Regulates plasma calcium (osteoclast activity)
3. Regulates phosphate levels



### **PTH release:**

- 1) stimulates osteoclasts
- 2) enhances reabsorption of  $\text{Ca}^{++}$  by kidneys
- 3) increases absorption of  $\text{Ca}^{++}$  by intestinal mucosal cells

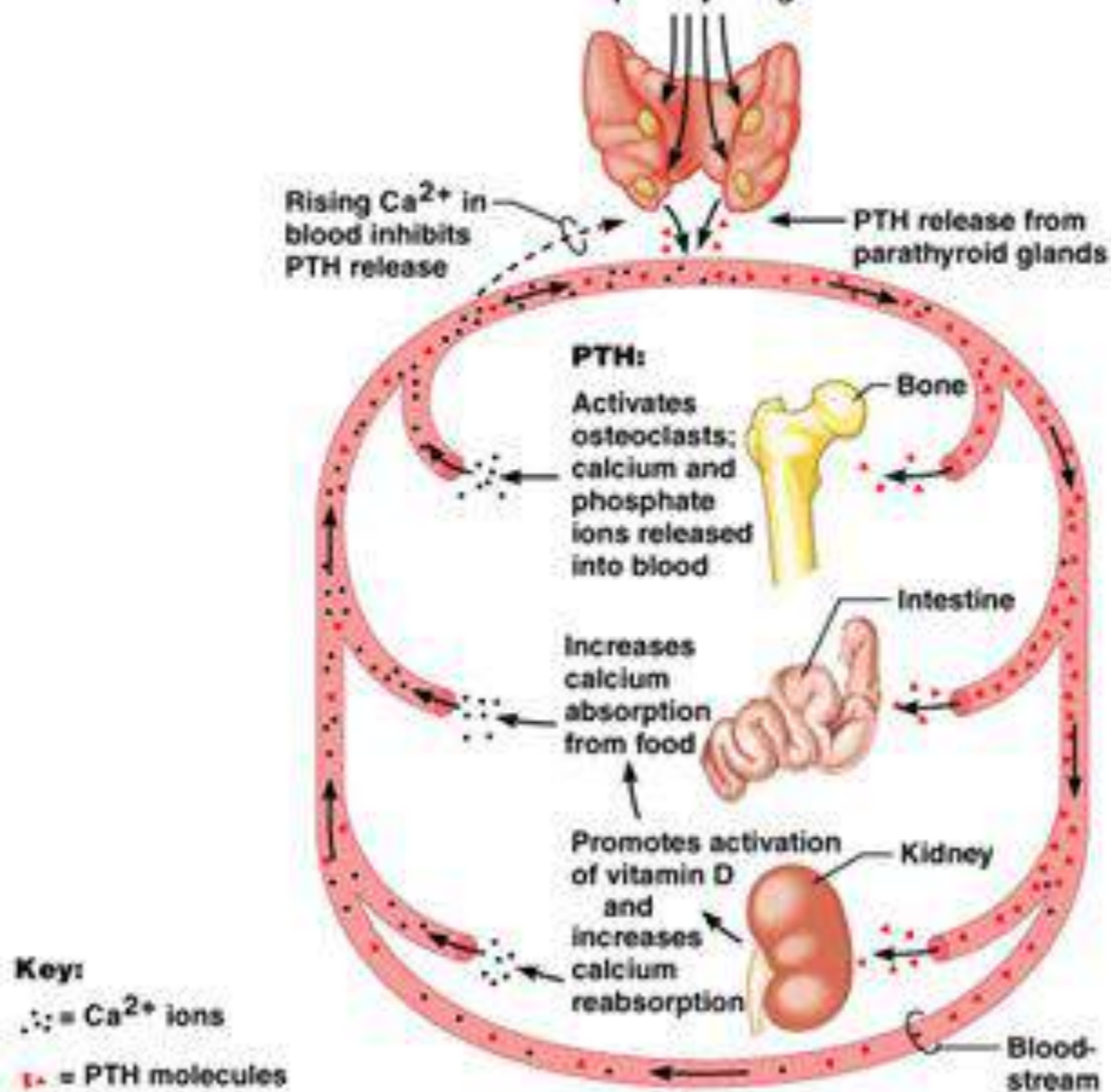


**Hyperparathyroidism**- too much  $\text{Ca}^{++}$  drawn out of bone; could be due to tumor

**Hypoparathyroidism**- most often follow parathyroid gland trauma or after removal of thyroid— tetany, muscle twitches, convulsions; if untreated → respiratory paralysis and death

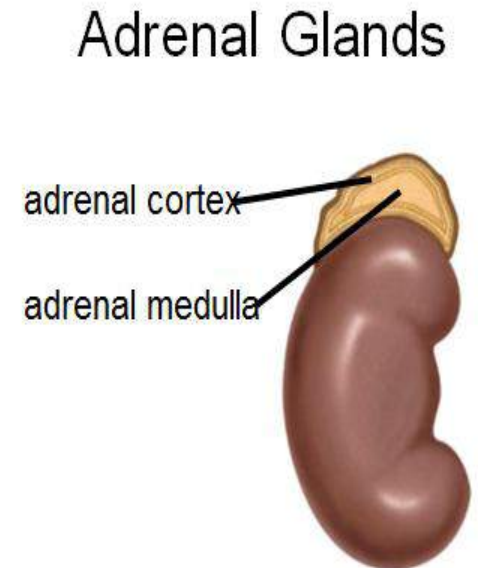
# PTH Effects

Hypocalcemia (low blood calcium)  
stimulates parathyroid glands



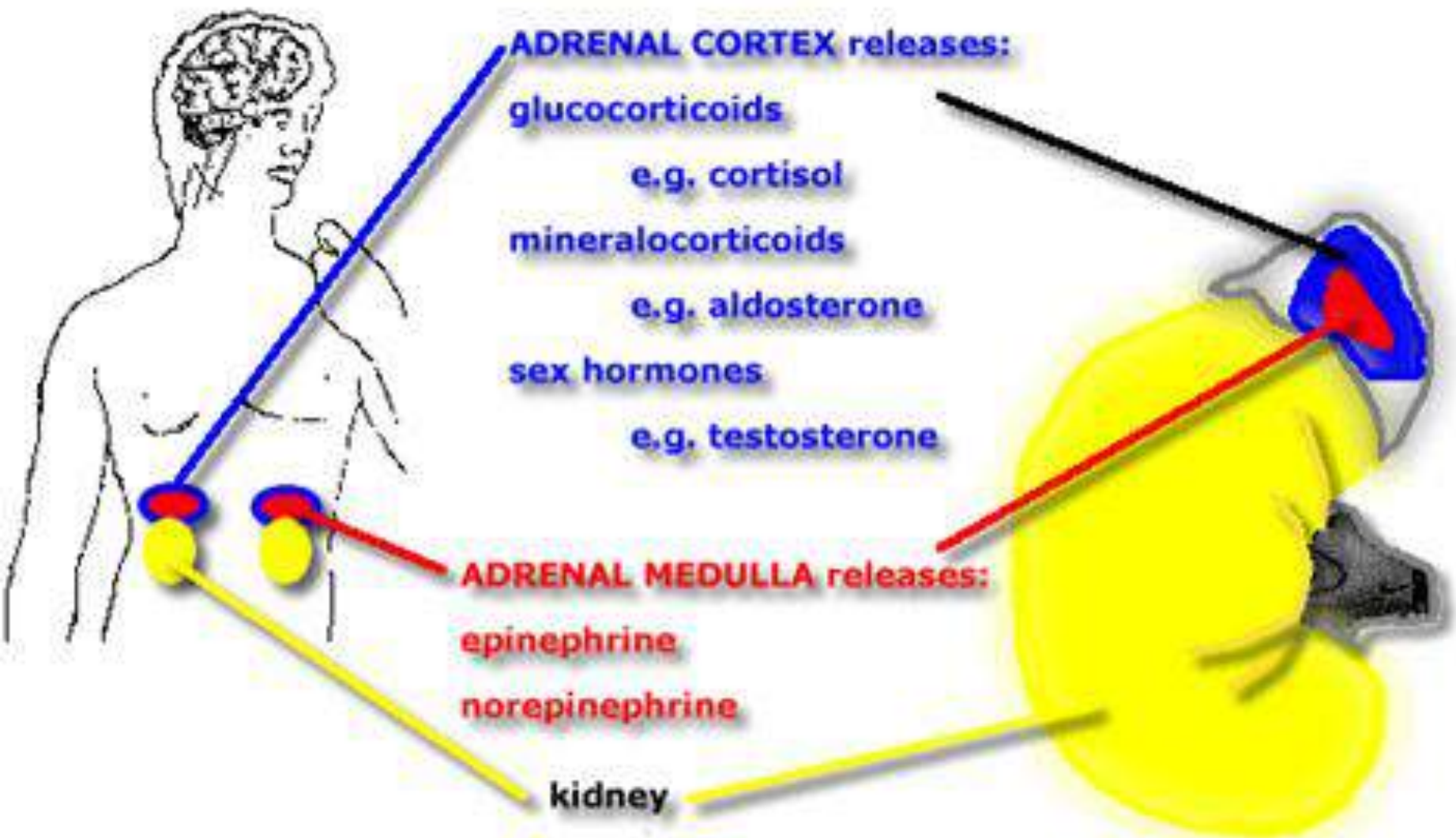
# Adrenal Gland - Adrenal Medulla

- Situated directly at the top of each kidney and stimulated by the sympathetic nervous system
- Secretes the **catecholamines**
  - Epinephrine (Adrenalin): elicits a fight or flight response
    - Increase heart rate H.R. and blood pressure B.P.
    - Increase respiration
    - Increase metabolic rate
    - Increase glycogenolysis (convert glycogen to glucose in the liver)
    - Vasodilation
  - Norepinephrine (Nor adrenalin) -
    - Increase blood pressure



# Adrenal Cortex

- Secretes over 30 different steroid hormones (**corticosteroids**)
- Mineralocorticoids: Aldosterone - maintains electrolyte balance-increase reabsorption of Na and water by the kidney
- Glucocorticoids: Cortisol-Stimulates gluconeogenesis
  - Mobilization and use of free fatty acids
  - Glucose sparing
  - Anti-inflammatory agent
- Gonadocorticoids (Sex Hormones): testosterone, estrogen, progesterone – Onset of Puberty & sex drive.

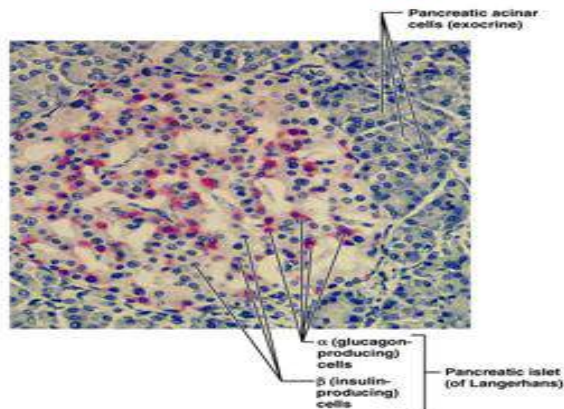




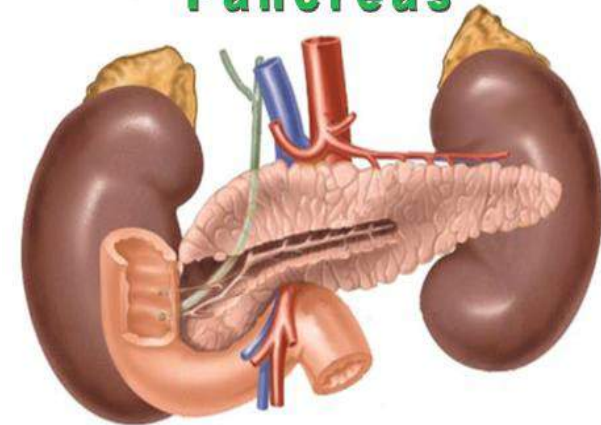
# Pancreas

- Located slightly behind the stomach
- Secretion of: **1. Insulin**: reduces blood glucose
  - Facilitates glucose transport into the cells
  - Promotes glycogenesis
  - Inhibits gluconeogenesis
- 2. Glucagon**: increases blood glucose

## Islets of Langerhan



## Pancreas



# Insulin

- Produced by the  $\beta$  cells of the Islets of Langerhan
- Catalyze oxidation of glucose for ATP production
- Lowers blood glucose levels by promoting transport of glucose into cells.
- Stimulates glucose uptake by the liver and muscle cells.
- Stimulates glycogen synthesis in the liver and muscle cells.
- Also stimulates amino acid uptake and protein synthesis of muscle tissue

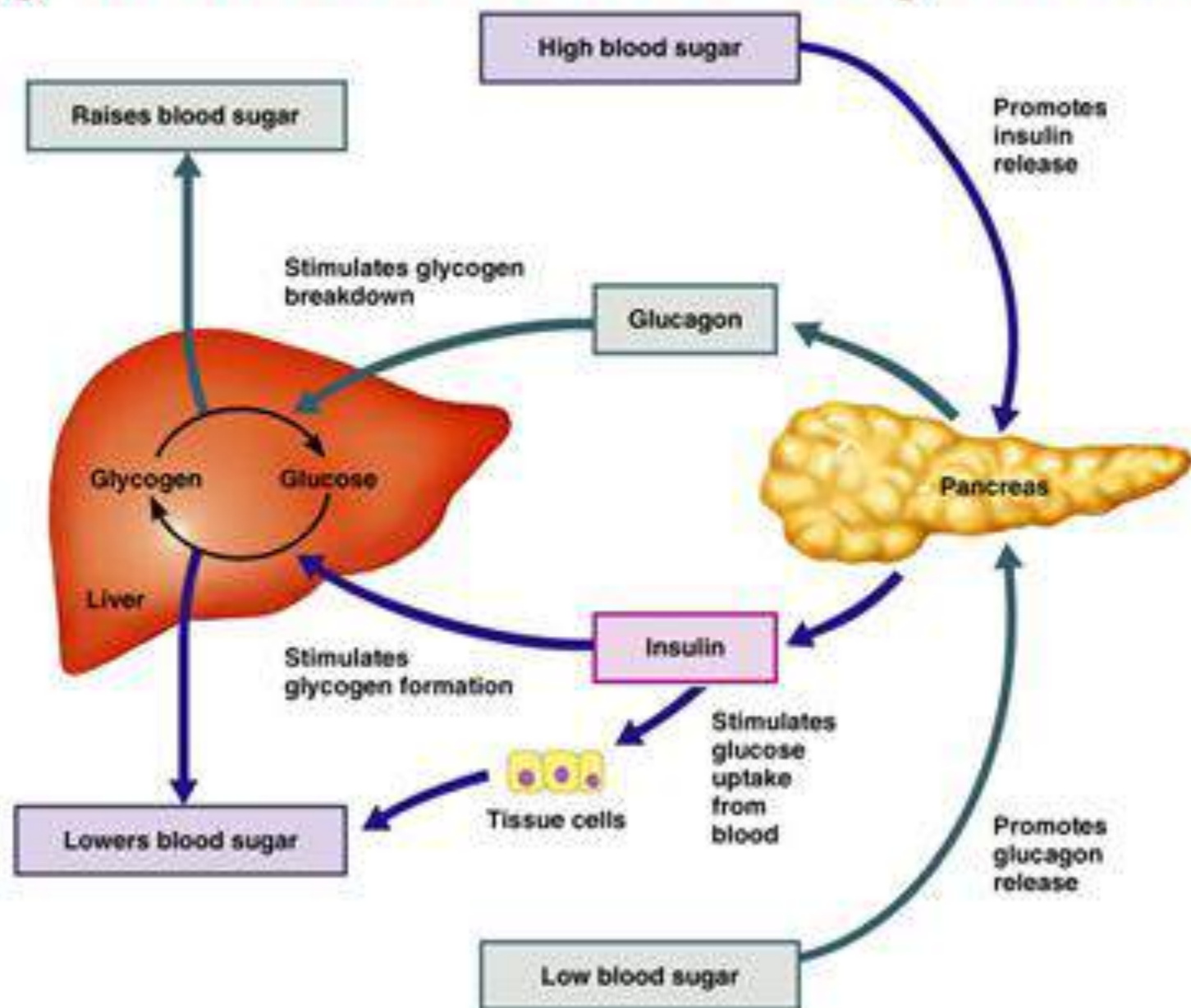
# Glucagon

- Produced by the  $\alpha$  cells of the Islets of Langerhans
- Stimulates change of glycogen to glucose in the liver.
- Synthesis of glucose from lactic acid and non carbohydrate molecules such as fatty acids and amino acids
- Causes  $\uparrow$  in blood glucose concentration

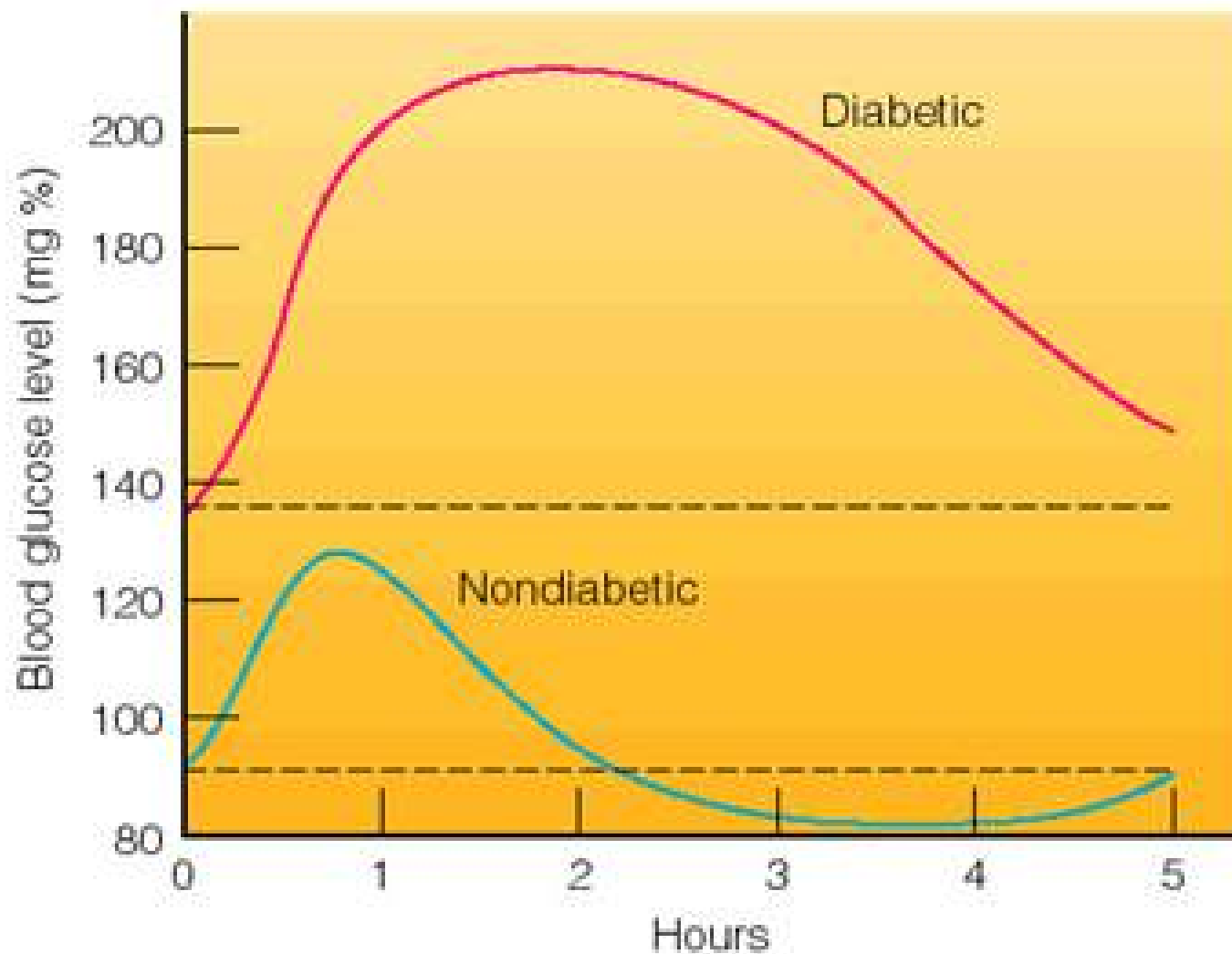
*hypoglycemic*- low blood sugar $\uparrow$ ; deficient in glucagon

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# Regulation of Blood Sugar Levels



# Diabetes Melitus



## Type I Diabetes

hyposalcretion of insulin  
insulin dependant  
juvenile onset

## Type II Diabetes

late onset (adult)  
insensitivity of cells to insulin  
manage by exercise & diet

# Gonads & Kidneys

- **Gonads**
- Testes (testosterone) = sex characteristics  
muscle development and maturity
- Ovaries (estrogen) = sex characteristics  
maturity and coordination
- **Kidneys**
- Erythropoietin - regulates red blood cell  
production