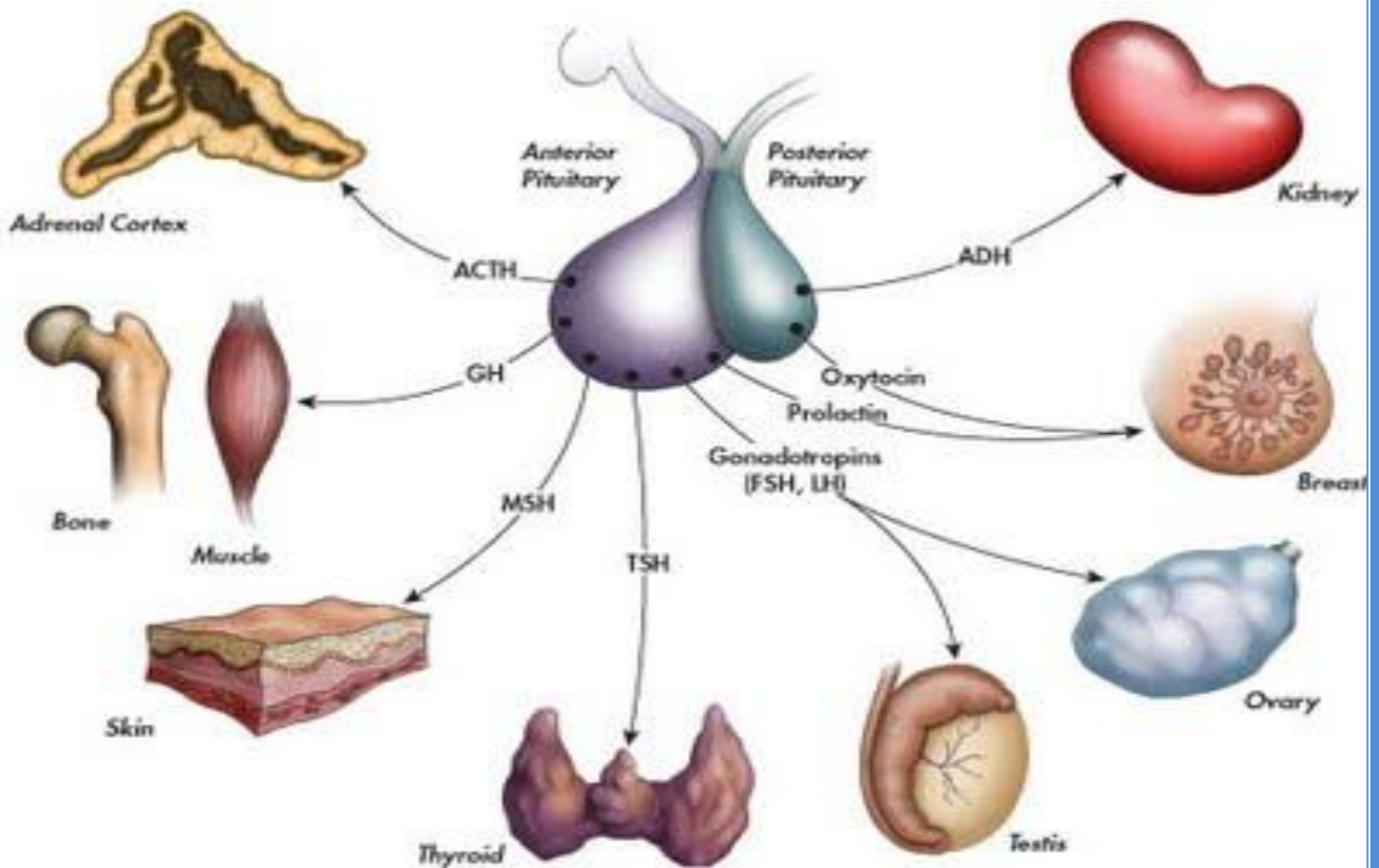


1st Lecture

Introduction to the Endocrine system



PHYSIOLOGY TEAM - 430

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This Lecture is done by:

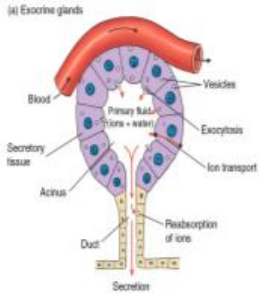
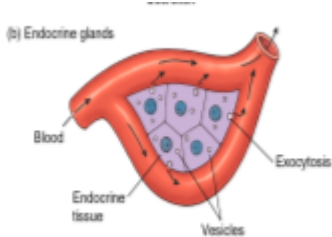
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Introduction to the Endocrine system

- Classification of glands:**

1. EXOCRINE GLANDS	2. ENDOCRINE GLANDS
<p>Ducts + lumen and surface Their secretions are released through ducts onto an organ's lumen and surface.</p> 	<p>Chemical messengers + bloodstream Their secretions are released directly into the bloodstream rather than through a duct.</p> 

- Definition of Hormone:**

Hormone is a chemical substance released in a small amount by group of cells directly to the blood stream in response to stimulus to cause physiological response at the target tissues.

Note: Some hormones have effect on many tissues (e.g. GH), while others are specific for one type of tissues (e.g. ACTH)

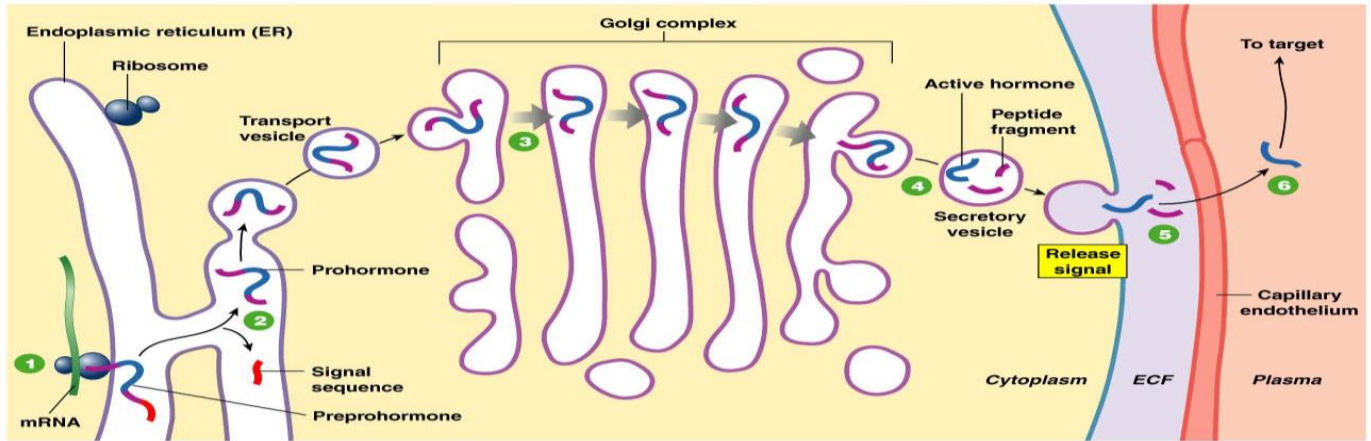
- Chemical classification of hormones:**

1. PROTEINS AND POLYPEPTIDES	2. STEROIDS	3. AMINES
<ul style="list-style-type: none"> • Synthesized from amino acids • They're stored in secretory vesicles until needed • Examples, hormones secreted by the pituitary gland, the pancreas (insulin and glucagon), the parathyroid gland (parathyroid hormone), and many others. 	<ul style="list-style-type: none"> • Derived from cholesterol • They diffuse across the cell membrane (lipophilic), so they're not stored. • Examples, hormones secreted by the adrenal cortex (cortisol and aldosterone), the ovaries (estrogen and progesterone), the testes (testosterone), and the placenta (estrogen and progesterone). 	<ul style="list-style-type: none"> • Derived from tyrosine • Examples, hormones secreted by the thyroid gland (thyroxine and triiodothyronine) and the adrenal medullae (epinephrine and norepinephrine 'catecholamines')

- **Synthesis of hormones:**

- 1. Synthesis of protein hormones:**

- Synthesized as preprohormone → post-translational modification to prohormone → then hormone.



- 2. Synthesis of steroid hormones:**

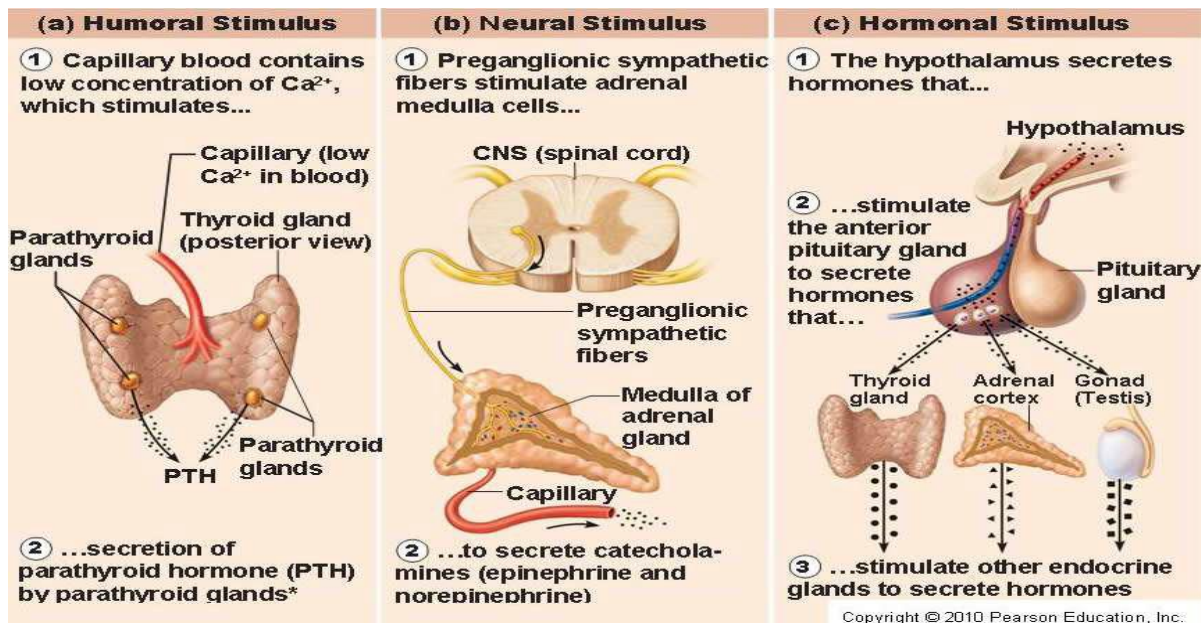
- Steroid hormones are synthesized and secreted by the adrenal cortex, the gonads, and the placenta.
- All steroid hormones are derivatives of cholesterol, so they're lipophilic and can diffuse across the cell membrane easily and enter the interstitial fluid and then the blood. Therefore, they're NOT stored.
- On-demand synthesis (SER)
- Usually bound to carrier proteins

- 3. Synthesis of amines hormones:**

- Derived from tyrosine or tryptophan.
- 3 groups:
 1. Tryptophan → Melatonin
 2. Tyrosine → Catecholamines (behave like PEPTIDE hormones)
 3. Tyrosine → Thyroid hormones (behave like STEROID hormones)

- **Classification of stimuli:**

1. **Humoral stimuli:** secretion of hormones in direct response to changing in blood levels of ions and nutrients.
2. **Neural stimuli:** nerve fibers stimulate hormone release
3. **Hormonal stimuli:** release of hormones in response to hormones produced by other endocrine glands



- **Transport of hormones:**

1. **Water Soluble:**

- Hydrophilic peptides and catecholamines.
- They're dissolved in plasma and transported from their sites of synthesis to target tissues.

2. **Lipid soluble:**

- Steroids and thyroid hormones
- They're transported:
 - 1) bound to plasma proteins (90%), which helps to:
 - Provide reservoirs
 - Greatly slows hormone clearance from plasma
 - 2) (10%) free fraction of hormone that act on receptors.

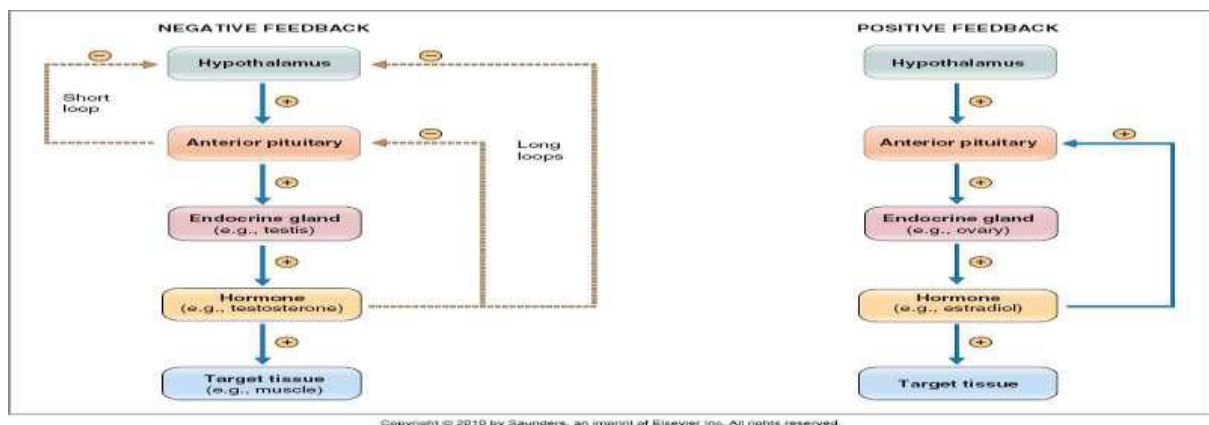
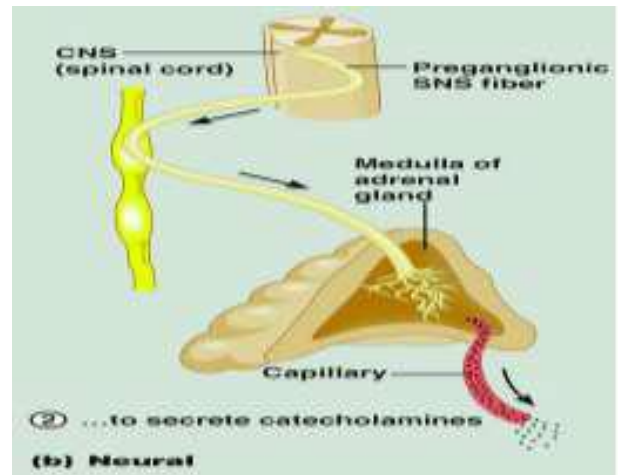
- **Regulation of hormone secretion:**

1. **Neural mechanism:**

Direct stimulation of secretion by the nervous system

2. **Feedback mechanism:**

- This means, depending on the concentration of a hormone in the blood, the gland either will secrete more or stop secretion
- There are two types of feedback mechanisms: -ve & +ve
- ✓ Negative feedback mechanism: if the hormone concentration in blood was high, the gland will stop the secretion of that hormone
- ✓ Positive feedback mechanism: it is uncommon, and it means that the hormone can stimulate its gland to secrete more of itself (e.g. oxytocin)



- **Autocrines:** chemicals that exert their effects on the same cells that secrete them
- **Paracrines:** locally acting chemicals that affect cells other than those that secrete them

- **Mechanism of hormone action:**

- **Protein hormones:**

- ✓ Adenyl cyclase system
- ✓ Phospholipase C system
- ✓ Tyrosine kinase system

- **Steroid hormones:**

- ✓ Act on the genetic machinery of the cell

- **Target tissue:**

- Hormone (1st messenger)-receptor interaction → Enzyme activation → Release of the second messenger → Effects on cellular function

- **Receptors:**

1. Hormonal receptors are large proteins
2. 2000-100,000 receptors/cell
3. Receptors are highly specific for a single hormone

- **Receptor's Location:**

- 1) On the surface of cell membrane (proteins, peptides and catecholamine hormones)
- 2) In the cell cytoplasm (Steroids)
- 3) In the cell nucleus (thyroid hormones)

- ✓ **Hydrophilic hormones:** can't enter the cell → hence; they only bind on an outer surface receptor → resulting in a fast response
- ✓ **Lipophilic hormones:** (steroid and thyroid) can enter the cell → often lead to gene activation → Therefore, they result in a slower response

- **Regulation of hormone receptors:**

Receptors do not remain constant, either they are Inactivated/destroyed or Reactivated/manufactured

- 1) **Dose-response relationship:** the higher the hormone's concentration, the more response from receptors
- 2) **Sensitivity:** the hormone concentration that produces 50% of the maximal response. If more hormones are required to produce 50% of response, then there's a decrease in sensitivity, and vice versa
- 3) **Number and affinity:** response of receptors can be changed by down-regulation or up-regulation

- **Down-regulation:**

- ✓ Decrease synthesis
- ✓ Increase degradation
- ✓ Inactivation
- ✓ E.g.: T3, progesterone

- **Up-regulation:**

- ✓ Increase synthesis
- ✓ Decrease degradation
- ✓ activation
- ✓ Estrogen, GH, prolactin

- **Interactions of hormones at target cells:**

Multiple hormones can affect a single target simultaneously. A hormone can influence the activity of another hormone at a given target cell in one of three ways:

- 1) Synergism:**

It occurs when more than one hormone produces the same effects in a target cell, and their combined effects are amplified

E.g.: glucagon, cortisol and epinephrine

- 2) Permissiveness:**

One hormone allows another hormone to have its full effect

It occurs especially during growth and development

E.g.: Thyroid hormone has permissive effect on growth hormone action

- 3) Antagonism:**

It means that one hormone decreases the action of the other

E.g.: Glucagon /insulin

- **Hormone concentration in the blood:**

- **Concentrations of circulating hormone in blood reflect:**

- ✓ Rate of release

- ✓ Speed of inactivation and removal from the body

- **Two factors control the concentration of a hormone in the blood:**

- ✓ The rate of its secretion

- ✓ The rate of its removal (metabolic clearance)

- **Hormones are cleared by:**

- ✓ Metabolic destruction by tissues

- ✓ Binding with tissues

- ✓ Excretion by the liver into bile

- ✓ Excretion by the kidney into urine

- ✓ Liver enzyme systems and degrading enzymes

- Clearance of protein-bound hormones (lipophilic hormones) is slower than clearance of peptide hormones (hydrophilic hormones)