„NON SIBI, SED OMNIBUS"

MEDICAL UNIVERSITY - PLEVEN
FACULTY OF MEDICINE
Physiology

Lecture № 5

Introduction to endocrinology - chemical structure, synthesis, secretion, transport, and mechanism of action of hormones. Pituitary hormones and their control by the hypothalamus. Thyroid metabolic hormones

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Lecture structure

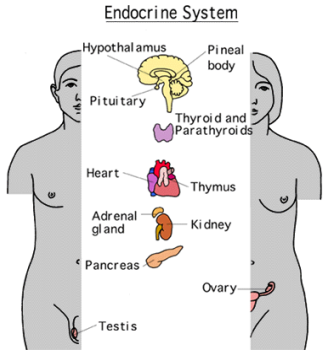
Introduction to Endocrinology

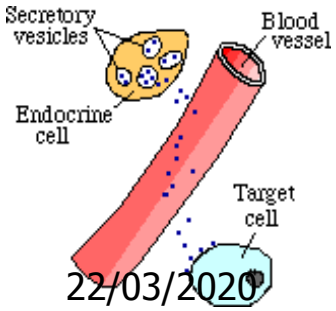
The Pituitary Hormones

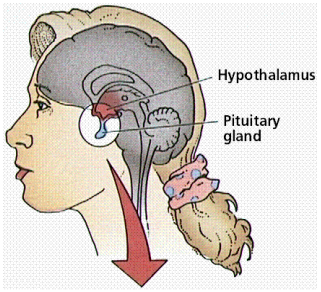
The Thyroid Metabolic Hormones

❖ Introduction to endocrinology - chemical structure, synthesis, secretion, transport, and mechanism of action of hormones

- Endocrine system
- General principles of hormonal regulation
- Hormones:
  - chemical structure
  - synthesis, storage and release
  - transport in the blood
  - biological half-life and clearance
  - cellular mechanism of action (receptors)
  - physiological effects
  - regulation





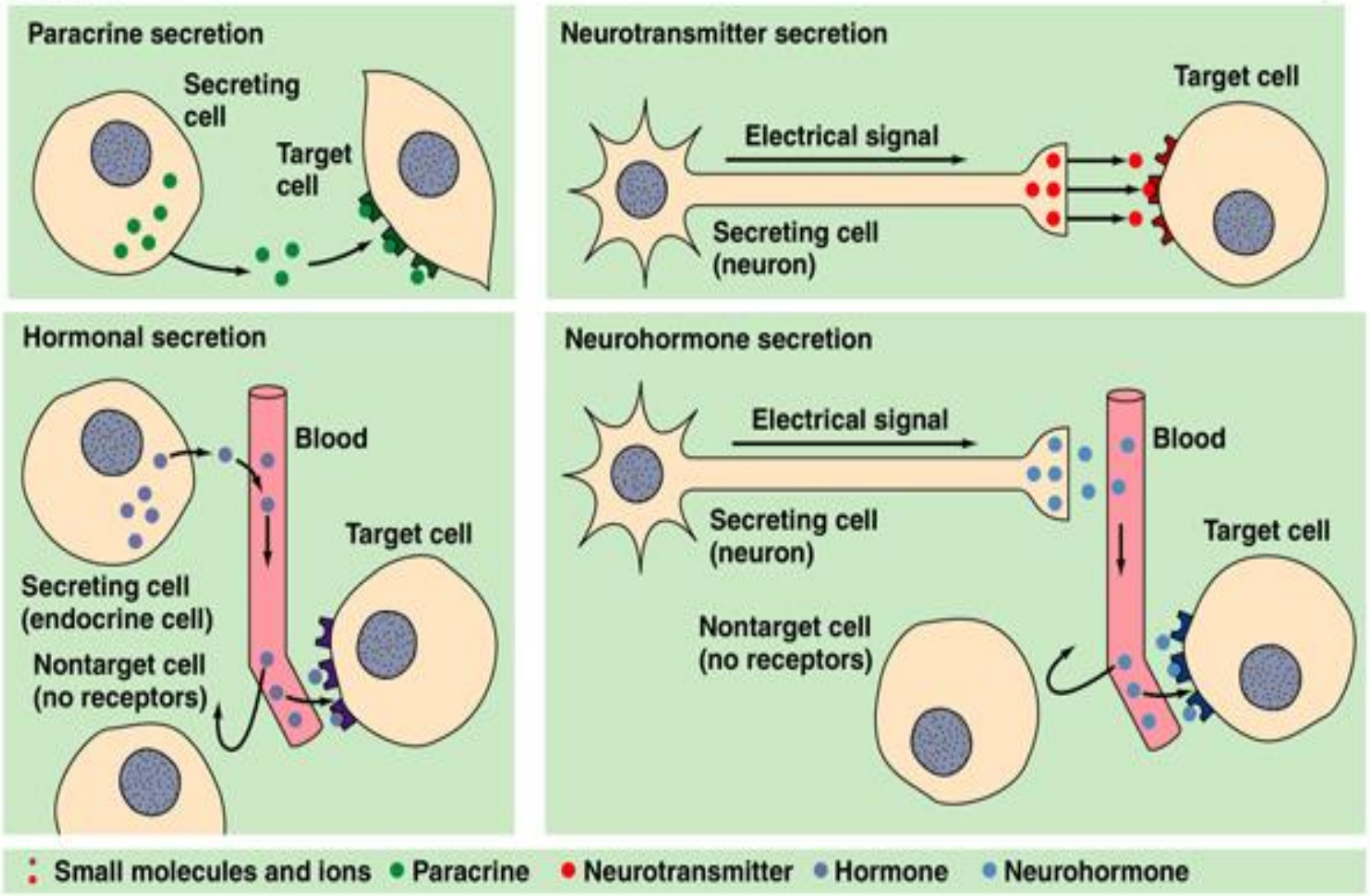


Coordination of Body Functions by Chemical Messengers

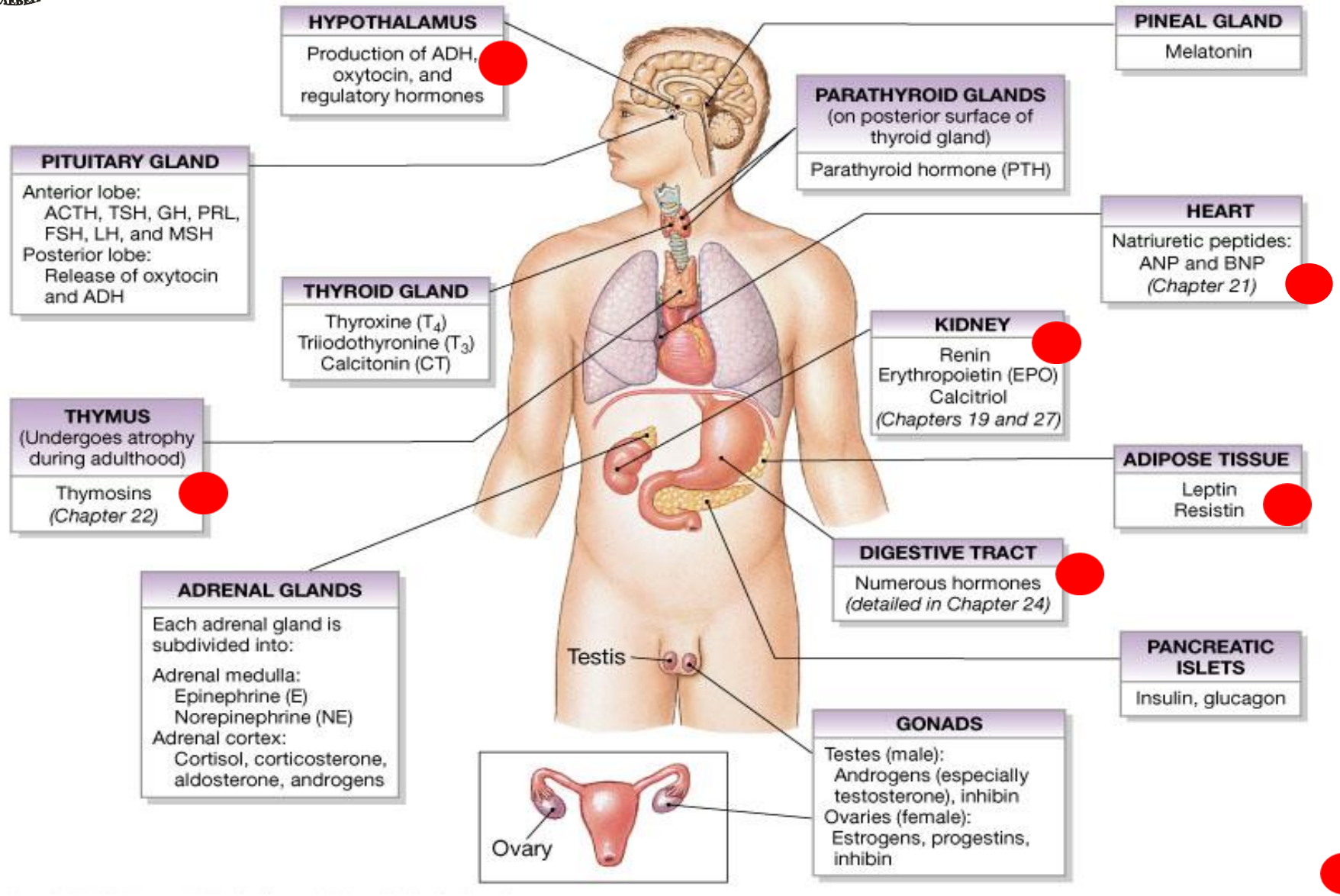
- **Autocrine**: *autocrines,* secreted in the ECF, act on the same cell by binding to the cell surface receptors
- **Paracrine**: the secreted *substances* diffuse in the ECF and affect neighboring cells of a different type
- **Neural**: *neurotransmitters*, released by axon terminals into the synaptic junction, act locally
- **Endocrine**: *hormones*, released by glands or specialized cells into the blood, act at another location
- **Neuroendocrine**: *neuroendocrine hormones,* secreted by neurons in the blood, act at another location
- **Cytokines**: *peptides,* secreted in the ECF, act as autocrines, paracrines, or endocrine hormones

Coordination of Body Functions by Chemical Messengers

Figure 3-21



The Endocrine System



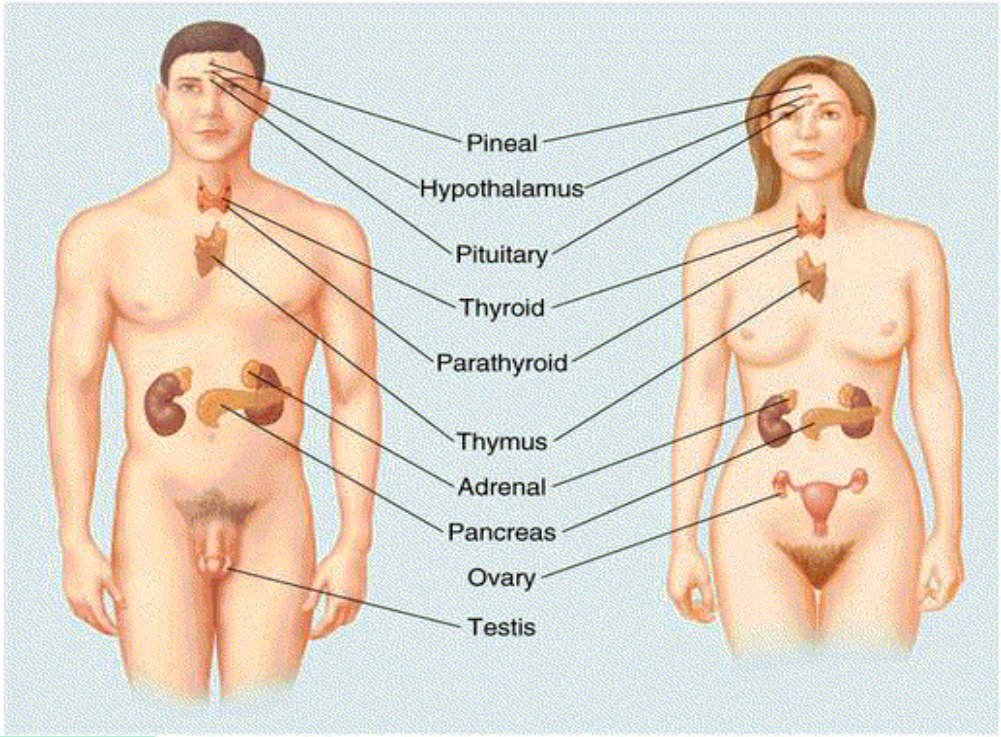
Endocrine Signaling: Hormone Definition

- **Hormones are:**
  - Biologically active substances,
  - synthesized by endocrine glands or specialized cells in non endocrine organs
  - released into the circulating blood,
  - reach **ALL** cells of the body,
  - affect only **SOME** cell types and tissues that have specific receptors for them - **target cells/tissues** (at another location of the body). The particular receptor has to "hear" the hormone signal

Some hormones:

affect many different types of cells (GH, thyroxine),
others – only one specific target tissue (ACTH, TTH)

► Endocrine Glands



Effects:

More diffuse

Slow/Fast onset of secretion

Different duration of action

metabolism

growth and development

water and electrolyte balance

reproduction and behavior

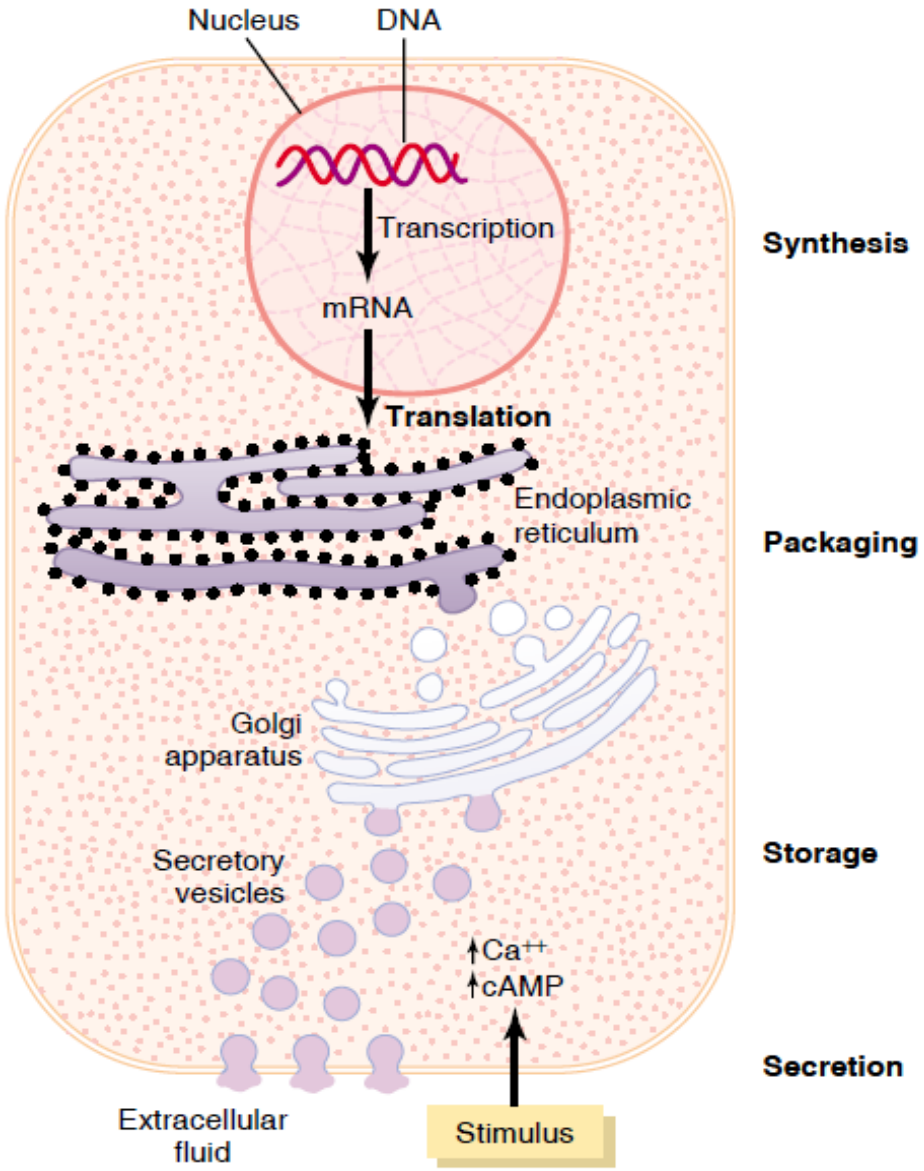
Chemical Structure of Hormones - Hormone Types

- **Proteins and polypeptides** (100 AA) - hormones by the anterior and posterior pituitary gland, pancreas, etc.
  - **Polar, water soluble**
- **Steroid hormones** – derivatives of cholesterol - from the adrenal cortex and sex hormones
  - **Lipid soluble (nonpolar)**
- **Derivatives of the amino acid tyrosine** - secreted by the thyroid gland and adrenal medullae

Synthesis, Storage and Secretion of the Polypeptide and Protein Hormones

- **Most of the hormones in the body**
- Synthesized on the rough end of the endoplasmic reticulum
- **Preprohormone, Prohormone/prehormone**: large molecule, precursor to hormone, usually inactive and can be modified (often cut) to become active
- **Golgi apparatus** – packed into secretory vesicles
- **Stored** in the secretory vesicles in the cytoplasm of the cell **until needed** – active hormones and inactive fragments
- **Secretion – exocytosis**
- **Water-soluble**
  - **transported** to target tissues in **free form**
  - can not cross the membrane – bind with **membrane receptors**
- **Membrane mechanism of action** – **second messengers**

Synthesis and Secretion of Peptide Hormones



Synthesis, Storage and Secretion of the Steroid Hormones

- Chemical structure – similar to that of cholesterol. Most of them **synthesized from cholesterol**
- Steroid-producing cells have large stores of cholesterol that can be mobilized for hormone synthesis **after a stimulus**
- Steroid-producing cells **do not store the hormones**
- **Secretion – simple diffusion.** Once synthesized, they diffuse across the cell membrane first in the interstitial fluid and then in the blood
- **Lipid soluble**
- **Transported** in the blood **bound to plasma proteins**
- **Intracellular mechanism of action – intracellular receptors**

Feedback Control of Hormone Secretion

- Small concentrations of hormones – **pg, µg/ml**
- Small rates of secretion - from **µg** to **mg/daily**
- **Negative feedback** – self-limiting effect to inhibit further secretion of the hormone; or decreased activity of the target tissue
- **Positive feedback** – the hormone effect causes additional secretion of the hormone (LH)
- **Cyclic variations** in hormone release: influenced by seasonal changes, daily, stages of development or aging, sleep

Transport of Hormones in the Blood

- **Water-soluble hormones (peptides/proteins and catecholamines)**
  - dissolved in the plasma
  - freely circulating
  - degraded by enzymes
  - rapidly removed from bloodstream
- **Steroid and thyroid hormones**
  - bound to transport proteins – *inactive*
  - slower clearance from the plasma
  - remain longer in the circulation - hours or days

catecholamines
thyroid hormones
Derivatives of the AA tyrosine

"Clearance" of Hormones from the Blood

Metabolic clearance rate = Rate of disappearance of hormone from the plasma/Concentration of hormone in each milliliter of plasma

Two factors can increase or decrease the concentration of the hormone in the blood

- The **rate of hormone secretion** into the blood
- The **rate of removal of the hormone** from the blood – *metabolic clearance rate*
  - Metabolic destruction by the tissues - Enzymes
  - Binding with tissues
  - Excretion by the liver into the bile
  - Excretion by the kidneys into the urine

Mechanism of Action of Hormones: Hormone Receptors

Hormone **receptors** at target cells:

- **Very specific** - for a single hormone
- Often **high affinity** (bond strongly)
- **Location** of receptors: *in* or *on the surface of the cell membrane*, *in the cell cytoplasm*, *in the cell nucleus*
- Hormone-receptor complex initiates a **cascade of reactions**, with each stage more powerful effect (minute [hormone] can have a large effect)

Regulation of Receptors

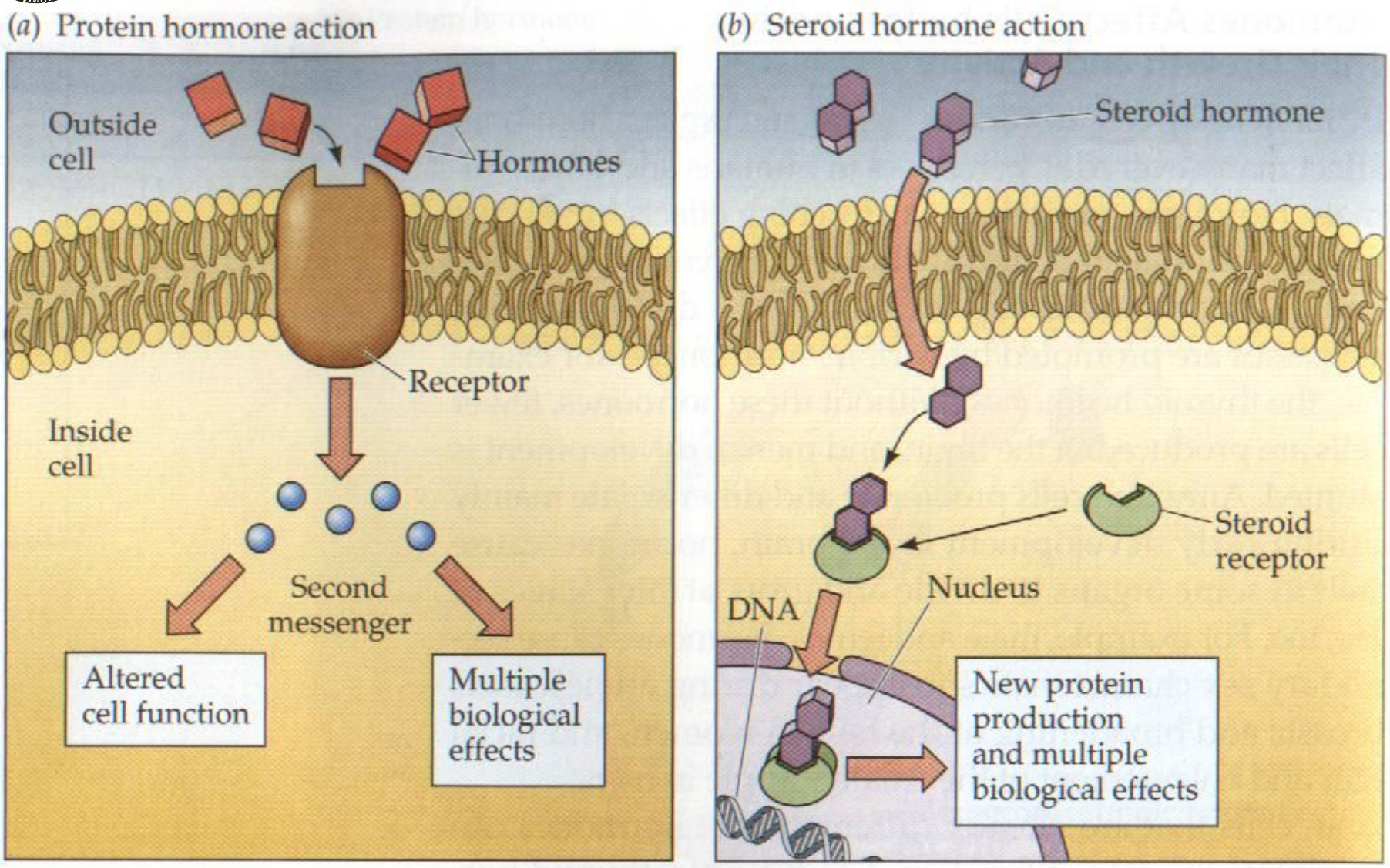
- The number of receptors – not constant; vary from day to day, or even from minute to minute
- Receptor proteins – inactivated, destroyed or reactivated and newly manufactured
- Hormones determine the sensitivity of the target tissue by regulating the **number** or **sensitivity** of receptors (2000 - 100 000)
- **Up-regulation:**
  - The stimulating hormone can lead to more receptor proteins on target cells (usually through gene expression) and a greater response by the target cell

Regulation of Receptors (continue)

- **Down-regulation** (**desensitization**):
  - Prolonged, continuous exposure to high [hormone] can lead to diminished response
  - Decrease in number of receptors on target cells - inactivated or destroyed through endocytosis, lysosomes, protein degradation

Pulsatile secretion of hormone (in spurts, over time) may prevent down-regulation of receptors

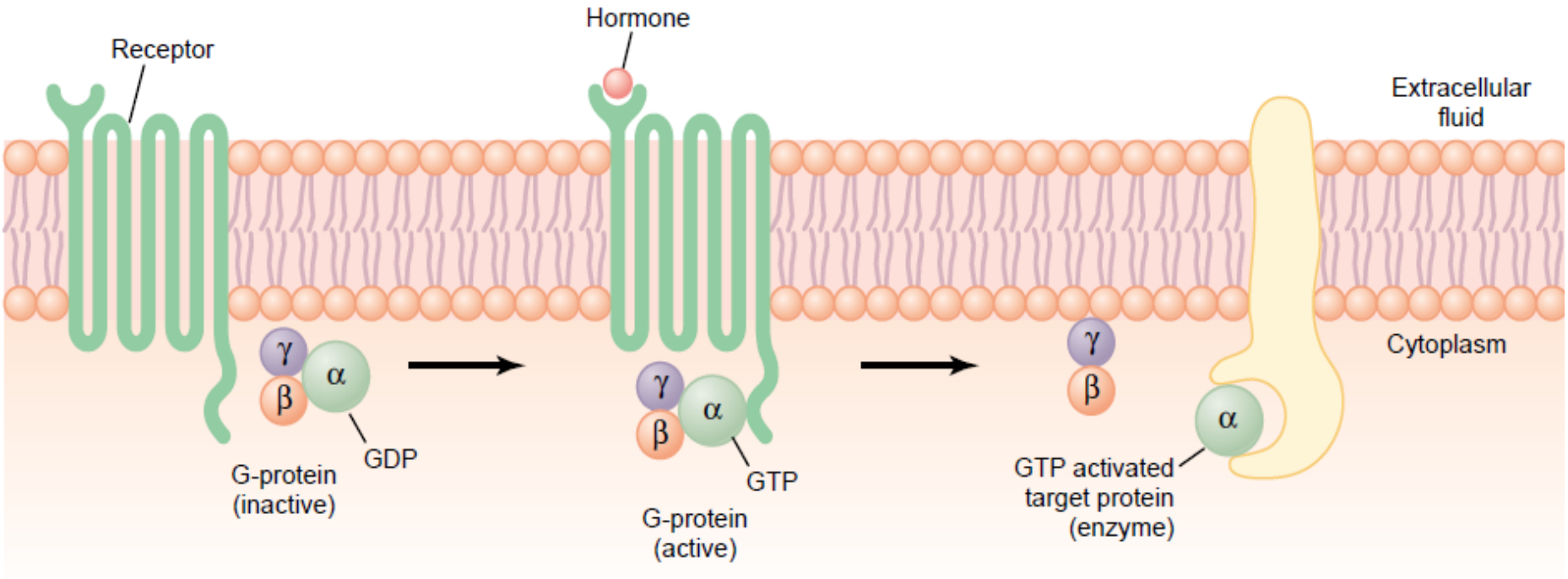
Mechanism of Action of Hormones



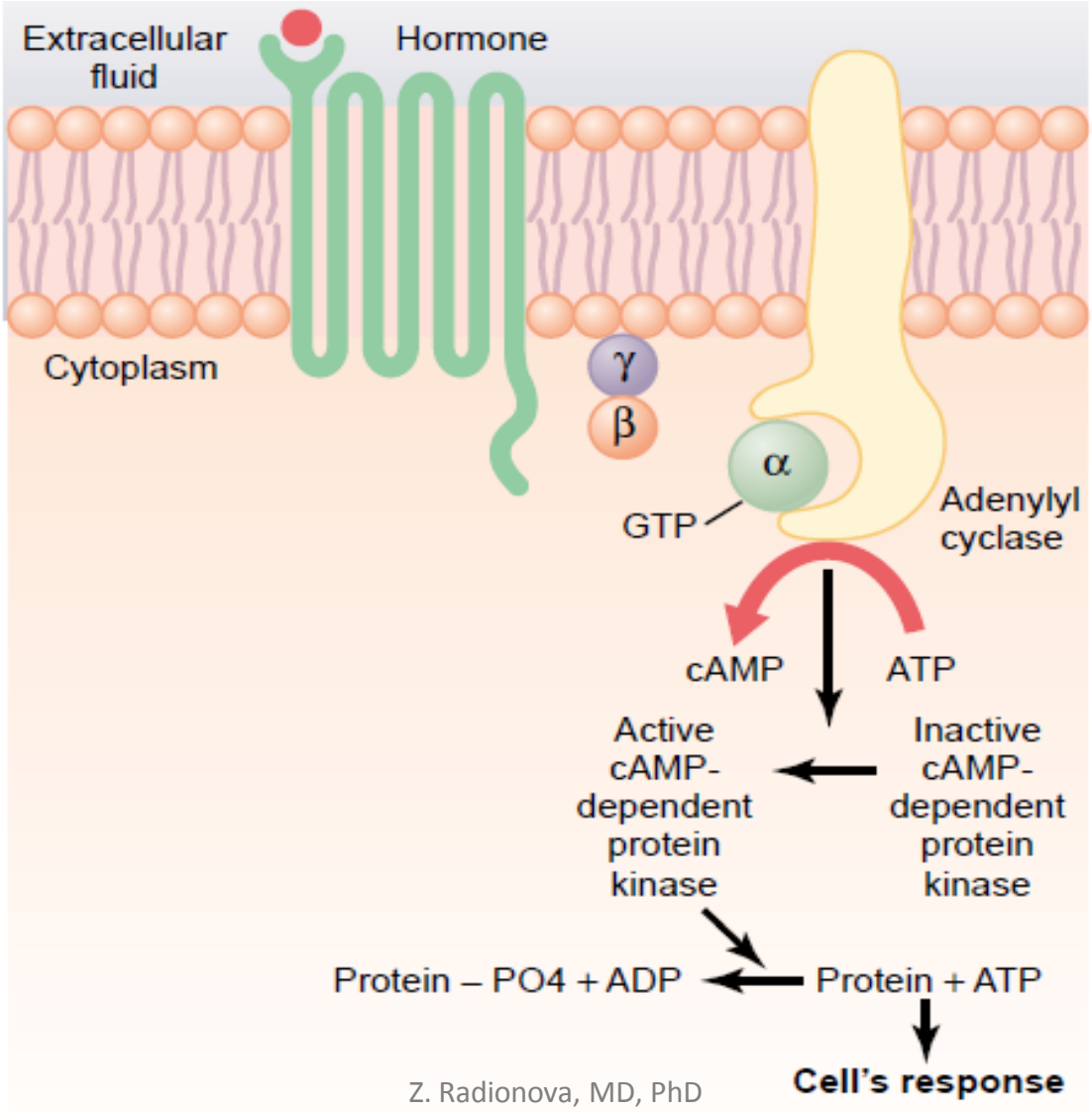
Intracellular Signaling After Hormone Receptor Activation

- **Second messenger/Membrane** - receptors for peptide hormones, catecholamines, eicosanoids are ***on*** or ***in*** the cell membranes of target cells
  - Ion channel-linked receptors – cell permeability
  - G protein-linked receptors - cell functions
  - Enzyme-linked receptors - activate intracellular enzymes (adenylyl cyclase) – cAMP, cGMP, Ca ions, calmodulin, phospholipid breakdown products serve as **second messengers**
- **Intracellular** - thyroid and steroid hormones cross the membrane and bind to receptors in the cytoplasm or nucleus
  - Activate genes

Mechanism of Activation of a G Protein-Coupled Receptor

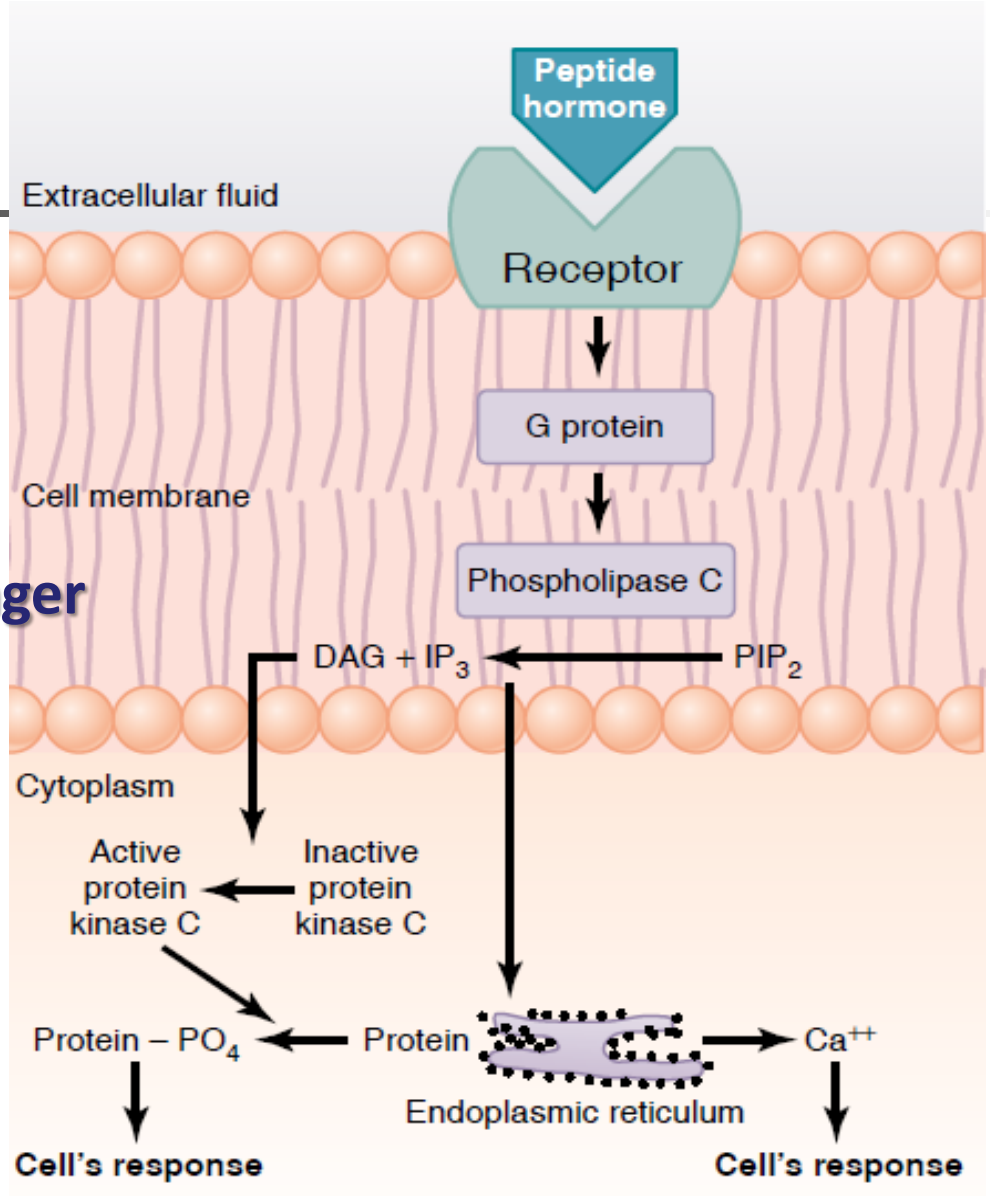


Adenylyl Cyclase – cAMP Second Messenger System



G Protein-Linked Hormone Receptor

Cell Membrane Phospholipid Second Messenger System



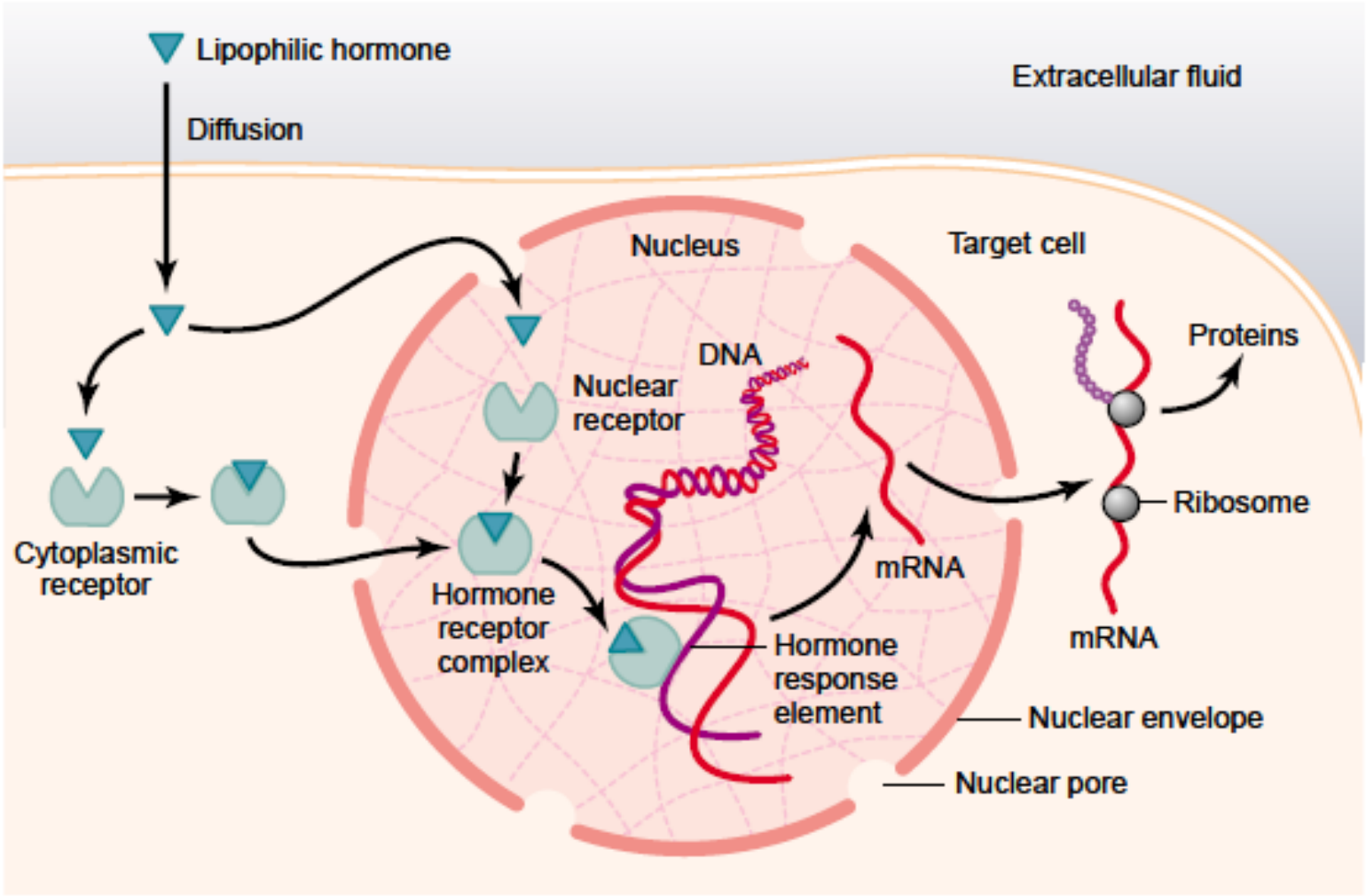
DAG – diacylglycerol

IP3 – inositol triphosphate

PIP2 – phosphatidyl-inositol biphosphate

Figure 18.3

Intracellular Hormone Receptors and Activation of Genes



Effect of Hormones

- **Effect of hormones depends on:**
  - **blood levels**
  - **number** of receptors on target cells
  - **affinity** (sensitivity) of receptors for hormones

- **Blood levels of hormones depend on:**
  - **gene expression**
  - **half-life of hormone** - is general term for time required for the [molecule] to be reduced to half of reference level
  - for lipophilic hormones: **how much is bound to protein carriers**

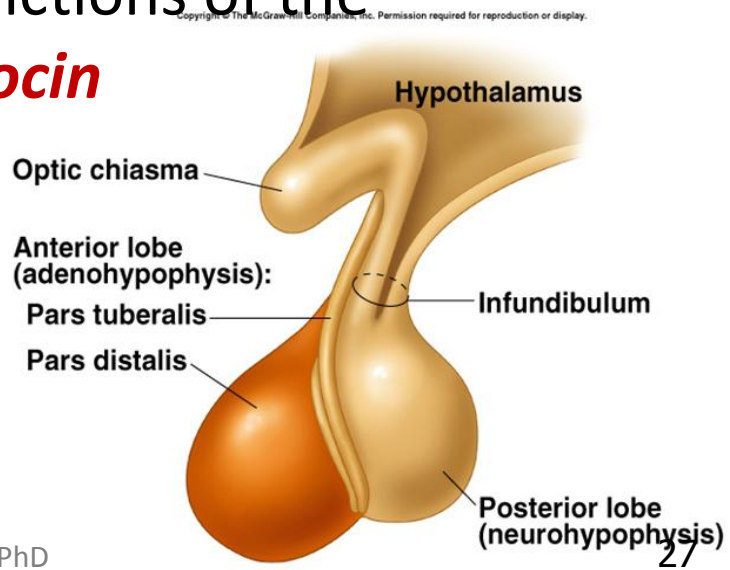
For each gland the following PLAN must be applied

1. Location and functional morphology of the gland (not the detailed structure of the gland but just that one that is related to the function)
2. Hormones produced by the gland
3. **Chemical structure** of the hormones (to which group of hormones they belong)
4. **Synthesis, storage, secretion** of the hormones
5. **Transport** of the hormones in the plasma (free or bound to transport proteins)
6. **Specific receptors** for the hormones. Target tissues or organs
7. **Mechanism of action** of hormones (membrane or intracellular)
8. Physiologic effects (**functions**) of the hormones
9. Clearance of the hormones
10. **Regulation** of the hormones. Stimuli for secretion of the hormones
11. Diseases caused by hyperfunction or hypofunction of the gland

❖ II. Pituitary Hormones and Their Control by the Hypothalamus

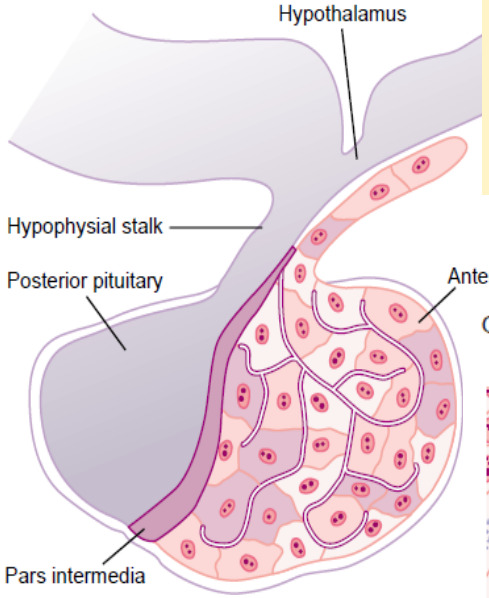
- Function of the **anterior pituitary gland**. Control of pituitary secretion by the hypothalamus. Physiological functions of ***growth hormone***

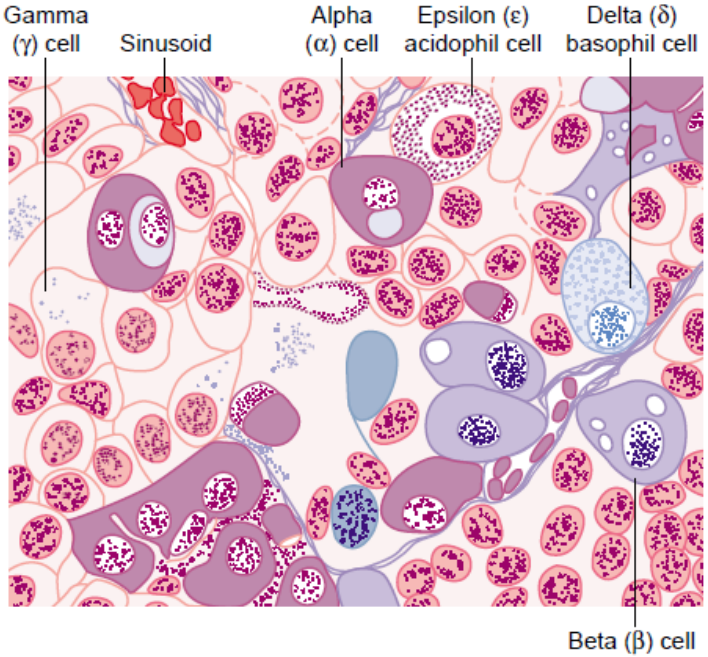
- The **posterior pituitary gland** and its relation to the hypothalamus. Physiological functions of the ***antidiuretic hormone*** and ***oxytocin***



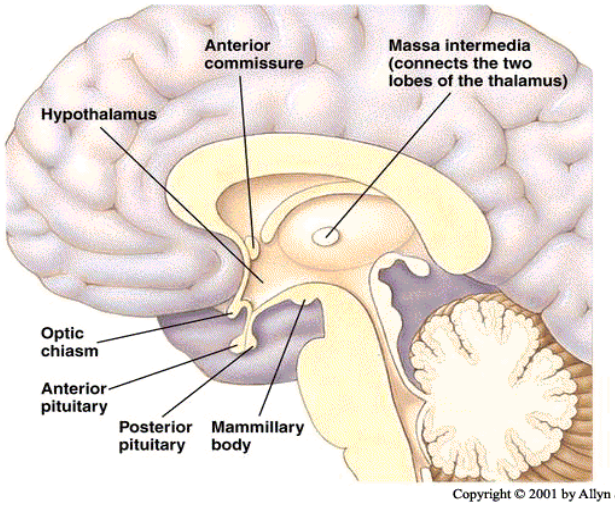
Pituitary Gland (Hypophysis) In Diencephalon

1 cm
0,5 - 1 g
Lies in the sella turcica





► Posterior and Anterior Pituitary



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- **Somatotropes** – human GH, hGH, 30-40%
- **Corticotropes** – ACTH, 20%
- **Thyreotropes** - TTH
- **Gonadotropes** - LH, FSH
- **Lactotropes** - prolactin (PRL)

Each of them – 3-5%

Anterior Pituitary

- Derived from epithelial tissue
- Connected to the hypothalamus by a portal system of fenestrated capillaries - **hypothalamic-hypophysial (pituitary) portal system**
- Controls growth of many other endocrine glands ("master gland"). Trophic effects:
  - High blood hormone concentration causes target organ to hypertrophy
  - Low blood hormone concentration causes target organ to atrophy
- **HT** : **HP** : **peripheral gland** compose an ***axis***
- Secretes **six** hormones – ***TTH, ACTH, LH, FSH, GH, prolactin***

Posterior Pituitary

- Derived from nervous tissue – glial-type of cells
- Connected to **HT** through **nerve tracts** that originate in the supraoptic and paraventricular nuclei
- Two protein hormones released: **oxytocin** & **antidiuretic hormone (vasopressin) (ADH)**

Hypophysis - Important:

- Hormones released from the posterior pituitary are *synthesized in the hypothalamus*
- Hormones released from the anterior pituitary are dormant unless directed to be released by the hypothalamus via *Releasing Factors*

Hypothalamic Control over the Endocrine System

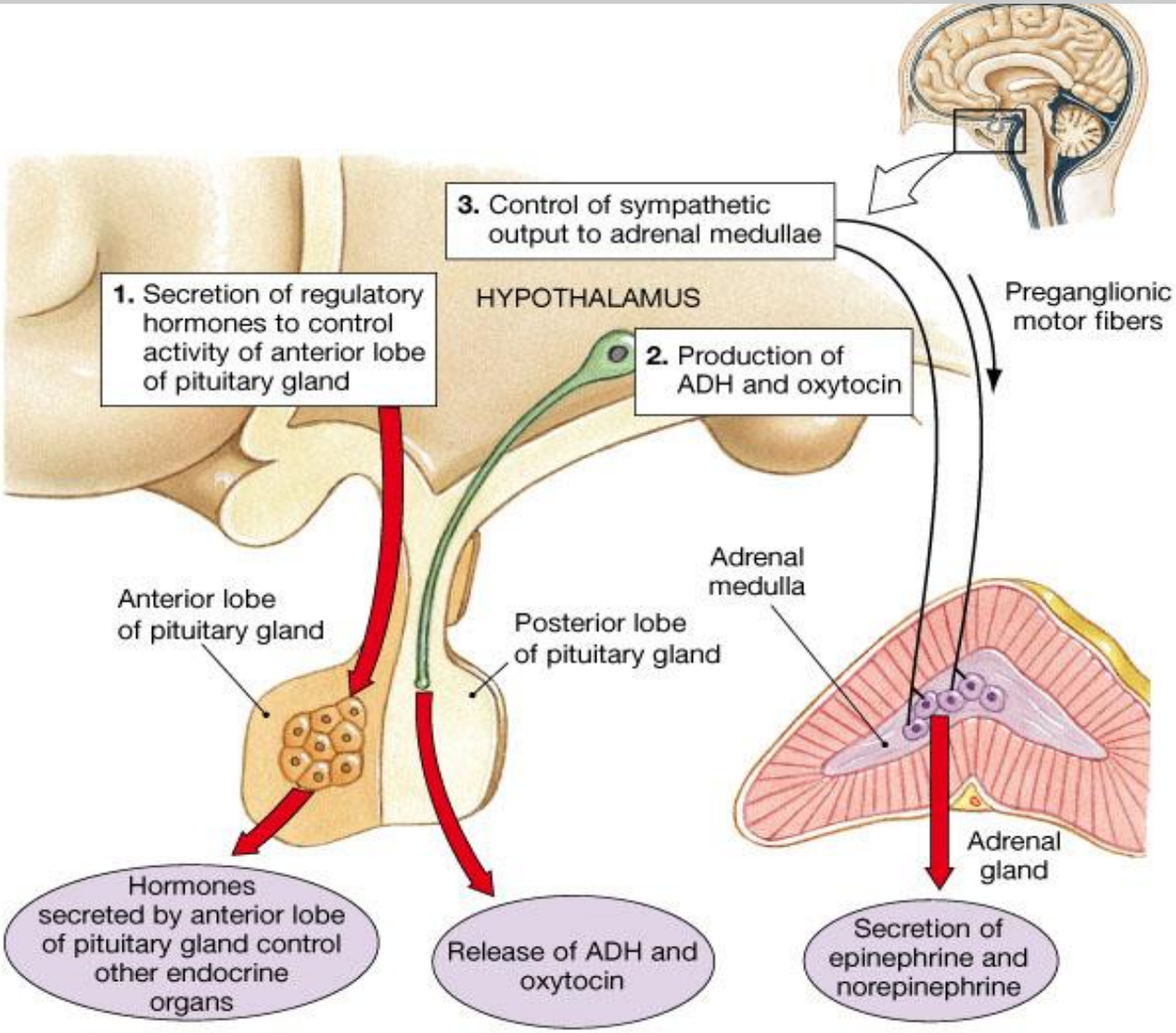
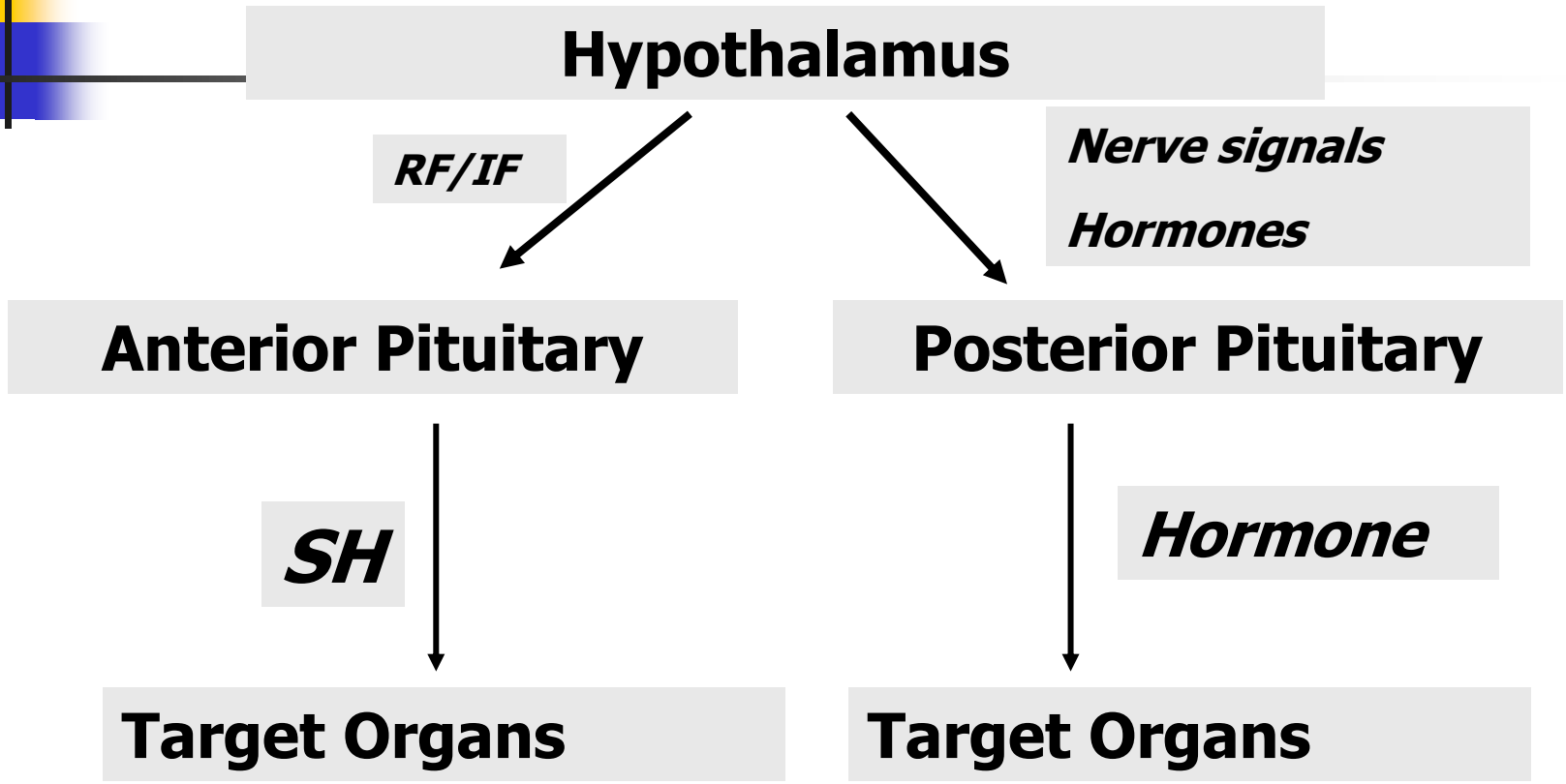


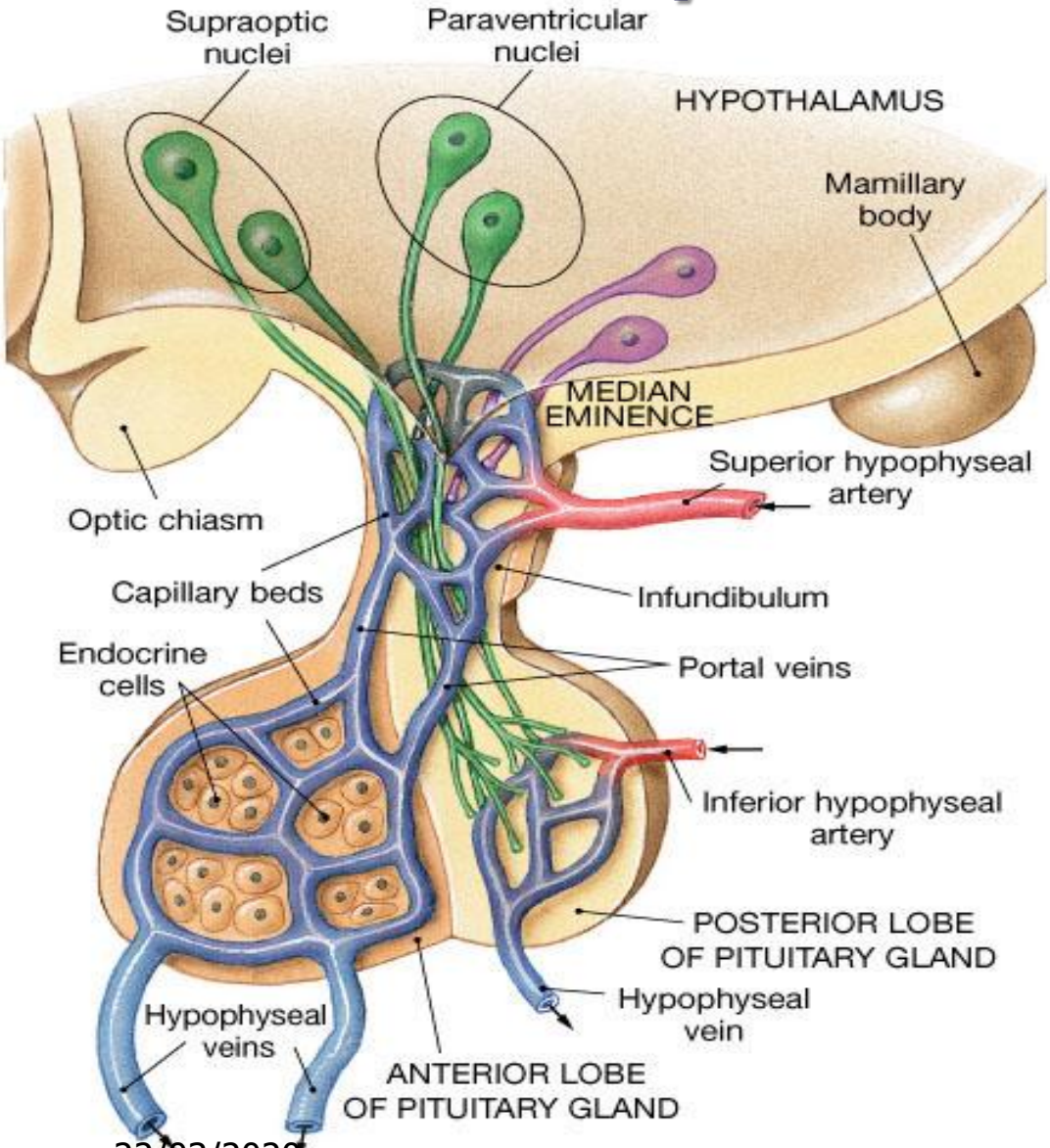
Figure 18.5

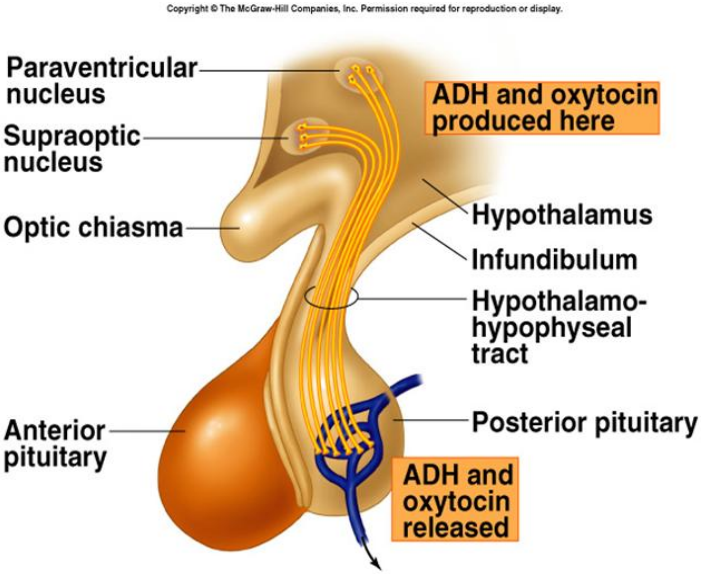
Pituitary & all Hormones are Under the Control of the Hypothalamus



RF = Releasing Factor, IF = Inhibitory Factor, SH = Stimulating Hormone

The Hypothalamic-Hypophyseal Portal System and the Hypothalamo-Hypophyseal Tract





Pituitary Hormones

- Protein hormones
- Secreted by exocytosis
- Transported in free form
- All bind to **membrane receptors** and use cyclic AMP as a **second messenger**
- Effects ……
- Negative feedback mechanism of control

Hypothalamic Hormones:

Gonadotropin RF (GnRH)	Corticotropin RF (CRH)	Thyrotropin RF (TRH)	Growth Hormone RF(GHRH)/IF	Prolactin IF (PIH)

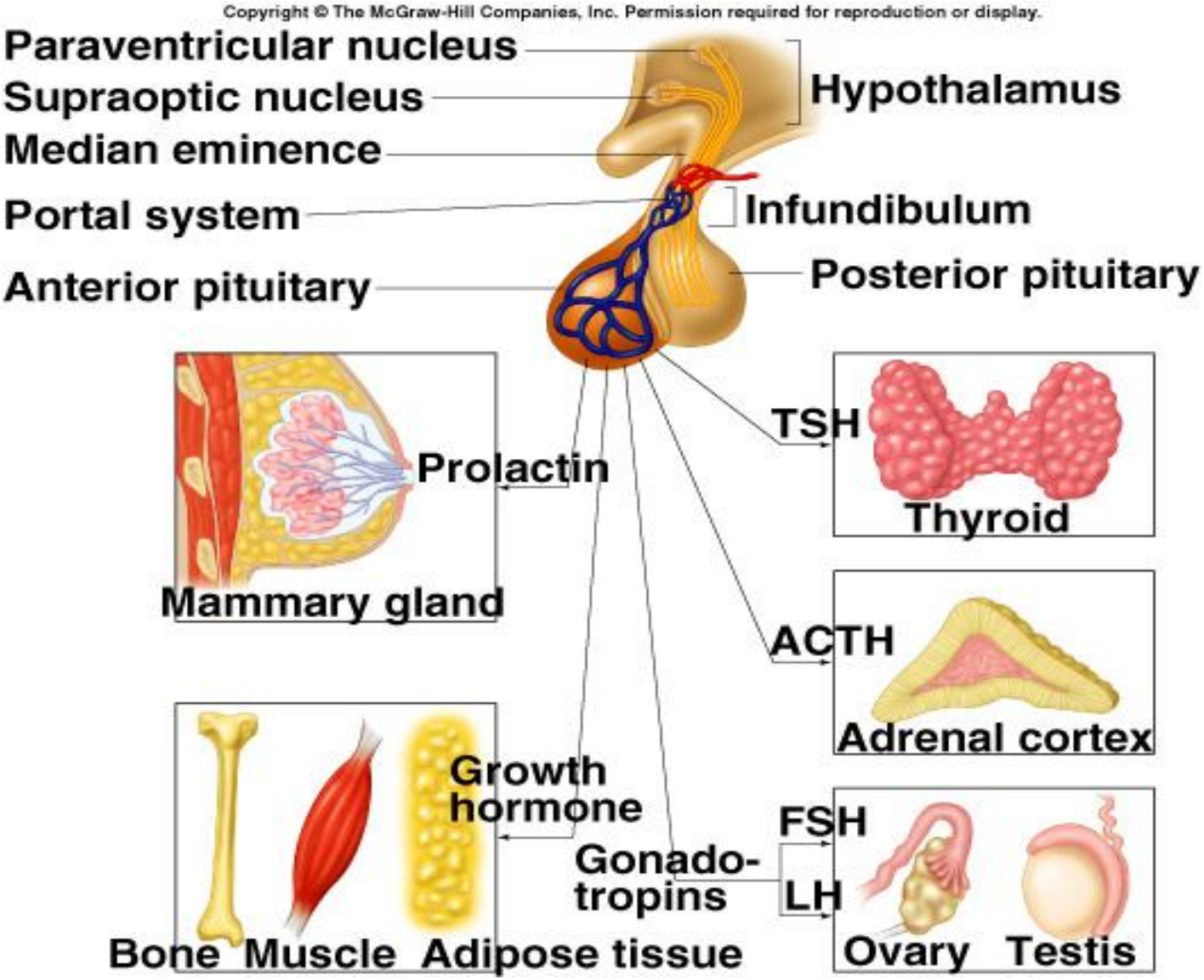
Pituitary Hormones:

Follicle SH luteinizing Hormone	Adrenocorticotropin Hormone (ACTH)	Thyrotropin SH	Growth Hormone	Prolactin

Target Gland or Structure:

Ovaries & Testes (androgens, estrogen)	Adrenal Gland (cortisol)	Thyroid Gland (thyroxine)	Cells of body; Bones	Breasts

Anterior Pituitary



Hormones of the Adenohypophysis

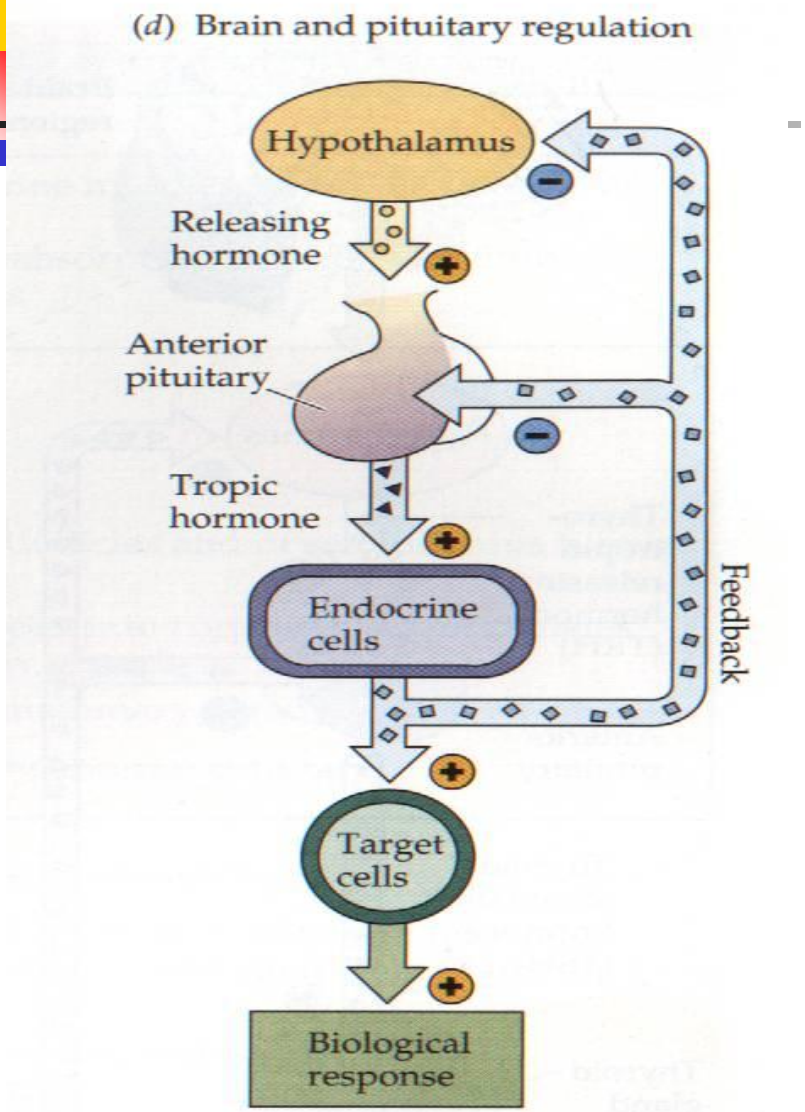
- **Thyroid stimulating hormone (TSH)**
  - Triggers the release of thyroid hormones
  - *Thyrotropin-releasing hormone* promotes the release of TSH
- **Adrenocorticotropic hormone (ACTH)** (adrenocorticotropin, corticotropin)
  - Stimulates the release of glucocorticoids by the adrenal gland
  - *Corticotropin-releasing hormone* causes the secretion of ACTH
- **Follicle stimulating hormone (FSH)**
  - Stimulates follicle development and estrogen secretion in females and sperm production in males
- **Luteinizing hormone (LH)**
  - Causes ovulation and progestin production in females and androgen production in males

Gonadotropin-releasing hormone (GNRH) promotes the secretion of FSH and LH

Hormones of the Adenohypophysis
(continue)

- **Prolactin (PH)**
  - Stimulates the development of mammary glands and milk secretion and production
    - Prolactin-inhibiting hormone
- **Growth hormone (GH or somatotropin)**
  - Stimulates cell growth and replication
  - Negative feedback control - somatomedins
    - Growth-hormone releasing hormone (GH-RH)
    - Growth-hormone inhibiting hormone (GH-IH) somatostatin

Regulation of Anterior Pituitary



- Mostly through **negative feedback** inhibition from target organs to hypothalamus or directly to anterior pituitary

  Example: TSH -> T4 ---l TSH

- So, once a certain amount of hormones are made, they shut off the system producing them!

1. Growth Hormone

- Protein hormone
- Also called **somatotropic hormone, somatotropin**
- Pulsatile secretion – 70% during the slow wave sleep
- Decreased secretion with age (decreased muscle and bone tissue)
- Controlled by the HT GHRH and GHIH

2. Functions of Growth Hormone

- Increases protein synthesis in muscle and increases lean body mass; in chondrocytes and increases linear growth - growth of all tissues, increased cell size and mitosis
- Generates the production of 4 **somatomedines** in the liver (**insulin-like growth factors – IGFs**) IGF C
- The IGF receptor has tyrosine kinase activity
- Direct actions of GH – metabolic effects
  - Increases rate of protein synthesis in tissues and increases protein deposition (AA transport)
  - Decreases glucose uptake (diabetogenic)
  - Increases lipolysis, increased FA in the blood
  - Increases production of IGF

4. Regulation of Growth Hormone Secretion

Factors That Stimulate or Inhibit Secretion of Growth Hormone

Stimulate Growth Hormone Secretion	Inhibit Growth Hormone Secretion
Decreased blood glucose	Increased blood glucose
Decreased blood free fatty acids	Increased blood free fatty acids
Starvation or fasting, protein deficiency	Aging
Trauma, stress, excitement	Obesity
Exercise	Growth hormone inhibitory hormone (somatostatin)
Testosterone, estrogen	Growth hormone (exogenous)
Deep sleep (stages II and IV)	Somatomedins (insulin-like growth factors)
Growth hormone–releasing hormone	

5. Abnormalities of Growth Hormone Secretion

Panhypopituitarism – decreased secretion of all AP hormones

During childhood GH is at maximum

1. too little: **pituitary dwarfism**
2. too much: **gigantism**, often accompanied by **acromegaly** (continued growth of extremities of bones and soft tissues)

Makes hands, feet, jaw, nose, and eye sockets (orbits) enlarged

Acidophilic tumors

Physiological Functions of ADH

- Neurons of the supraoptic nucleus manufacture **antidiuretic hormone (ADH) (vasopressin)**
- Regulates the serum osmolality by increasing the water permeability of the late distal tubules and collecting ducts (V2 receptors with cAMP)
- Constriction of vascular smooth muscle - elevates blood pressure (V1 receptors with IP3)
- **Stimuli for ADH secretion**: increased serum osmolality, volume contraction, pain, nausea, hypoglycemia, nicotine, opiates

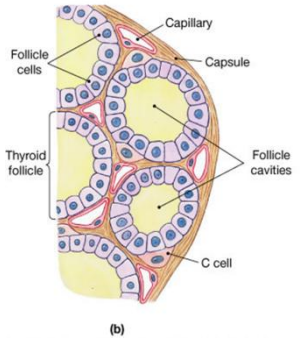
Oxytocin

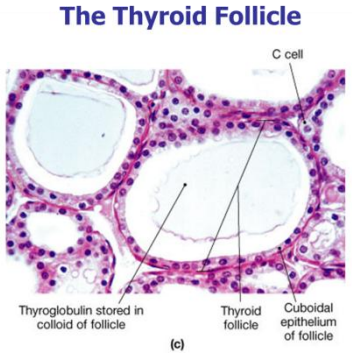
- Neurons of the paraventricular nuclei of the HT manufacture **oxytocin**
- The hormone involved in inducing labor during childbirth - stimulates contractions of the uterus during parturition
- Stimulates contractions of the myoepithelial cells in the mammary gland - milk-ejection reflex from the alveoli into the ducts
- Regulation: suckling, dilation of the cervix, and orgasm increase its secretion

❖ III. THE THYROID GLAND Functions of the Thyroid Metabolic Hormones

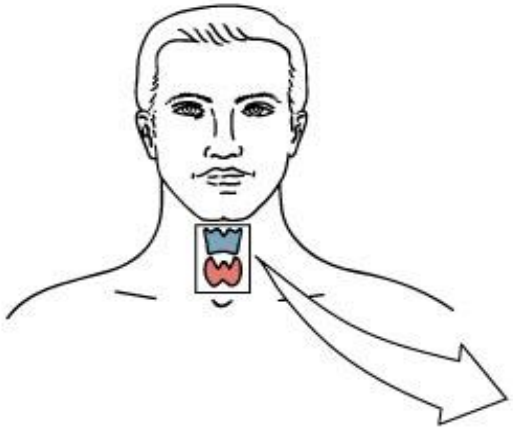
Plan

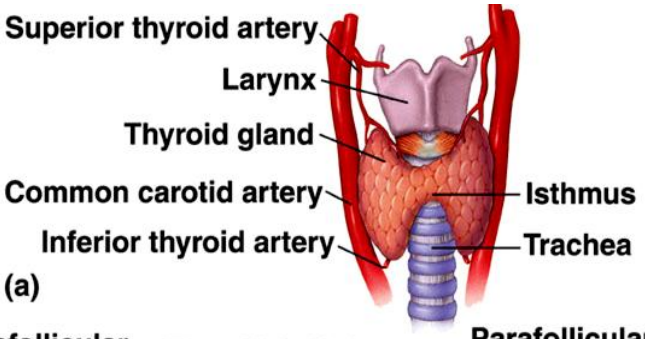
- Location and Functional Morphology of the Thyroid Gland
- Chemical Structure of the Metabolic Thyroid Hormones
- Synthesis and Secretion of Hormones
- Transport to Tissues
- “Clearance” of Hormones from the Blood
- Hormone Receptors
- Mechanism of Action
- Physiological Functions/Effects
- Regulation of Hormone Secretion
- Diseases of the Thyroid: Hyper- and Hypothyroidism

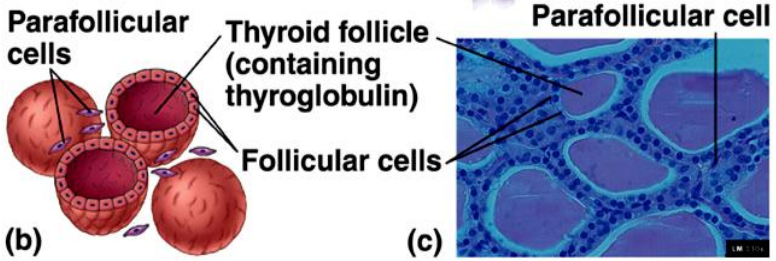


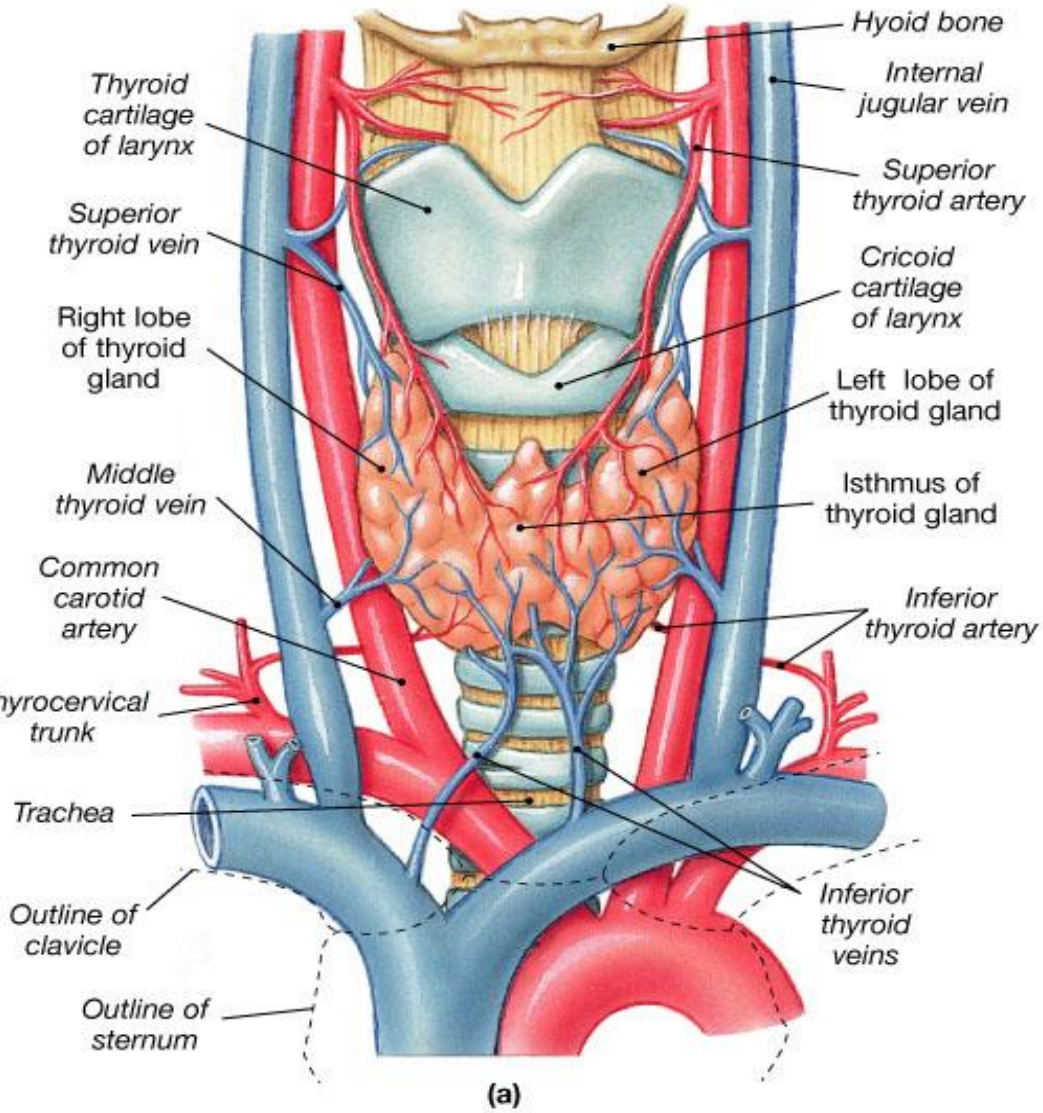


The Thyroid Gland









Physiological Anatomy of the Thyroid Gland

- The thyroid gland is a double-lobed structure shaped like a shield and lies just below the Adam's apple in the front of the neck
- Thyroid gland contains numerous **follicles** filled with colloid and lined with cuboidal epithelial cells
- **Thyroglobulin** is the major constituent of **colloid**
- Releases several hormones such as **thyroxine (T4) triiodothyronine (T3), calcitonin**
- Blood supply – 5 X the weight of the gland/1'

Thyroid Hormone Synthesis and Secretion

1. The iodide (I^-) pump (iodide "trapping")

- Is present in the thyroid follicular epithelial cells
- Actively transports I^- from the blood into the thyroid cells for subsequent incorporation into thyroid hormones (**Na+/I- symporter**)
- Concentrates the I^- to about 30 times its concentration in the blood
- The most important factor that regulates the rate of iodide trapping is the TSH

2. Formation and secretion of thyroglobulin by the thyroid cells

Thyroglobulin (glycoprotein) is synthesized on the ribosomes of the thyroid follicular cells, is packaged in secretory vesicles on the Golgi apparatus, and is then extruded into the follicular lumen. Contains 70 tyrosine AA

3. Oxidation of the iodide ion (I-) to iodine (Io, I_3)

Is catalyzed by a **peroxidase enzyme** in the apical follicular cell membrane. **I2** is the reactive form, which will be "organified" by combination with tyrosine

4. Organification of I_2 (iodine)

At the junction of the follicular cells and the follicular lumen, tyrosine residues of thyroglobulin react with I_2 to form **monoiodotyrosine (MIT)** and **diiodotyrosine (DIT)**

5. Coupling reaction

- While still part of thyroglobulin, two different coupling reactions involving MIT and DIT occur
- If two molecules of DIT combine, **thyroxine (T4)** is formed
- If one molecule of DIT and one molecule of MIT combine, **triiodothyronine (T3)** is formed

6. Storage of thyroglobulin

- Is stored in the follicular lumen for later release of the thyroid hormones

7. Release of T3 and T4 from the thyroid gland - Stimulation of thyroid cells by TSH

- When the cells are stimulated, iodinated thyroglobulin must first be taken back into the follicular cell. Lysosomal enzymes then digest thyroglobulin, releasing T3 and T4 into the circulation

- Leftover MIT and DIT are deiodinated by **thyroid deiodinase**. The I_2 that is released is reutilized for synthesis of more thyroid hormones. Therefore, deficiency of thyroid deiodinase mimics I_2 deficiency

8. Binding of T3 and T4

- In the circulation, most of the T3 and T4 is bound to **thyroxyne-binding globulin** (TBG). Some are attached to transthyretin or albumin

9. Conversion of T4 to T3 and reverse T3

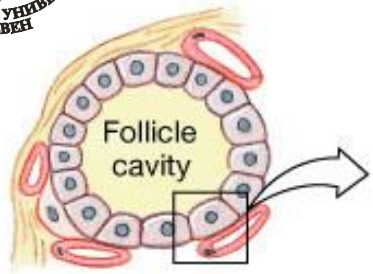
- in the peripheral tissues T4 is converted to T3 or to reverse T3
- T3 is more biologically active (three to four times more potent) than T4, and reverse T3 is inactive. Thus, conversion of T4 to T3 is an activation step.

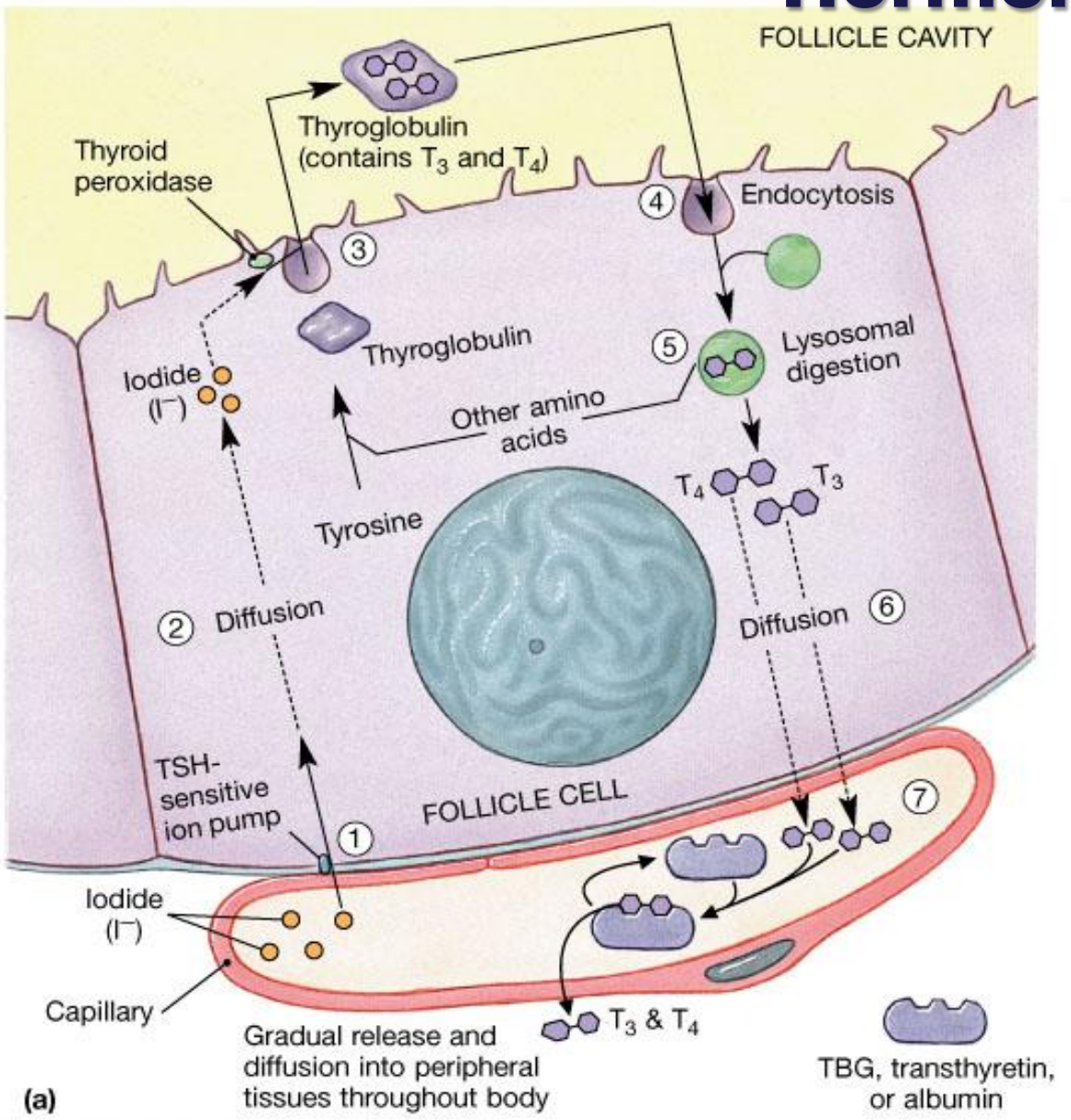
T3 and T4: T3 more effective, T4 more abundant

T4 - 93%
High affinity to plasma-binding Pt
Latent period: 2-3 days
Maximal activity: 10-12 days
Some activity – to 2 months

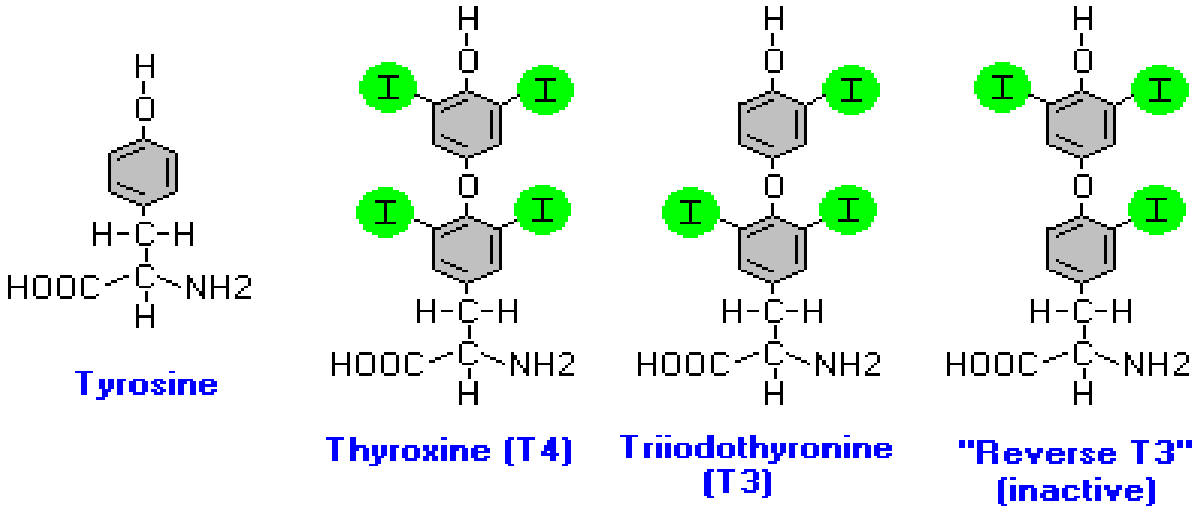
T3 - 7%
Lower affinity to plasma-binding Pt
Latent period: 6-12 hours
Maximal activity: 2-3 days

Synthesis and Secretion of Thyroid Hormones





Chemical structure of thyroid hormones



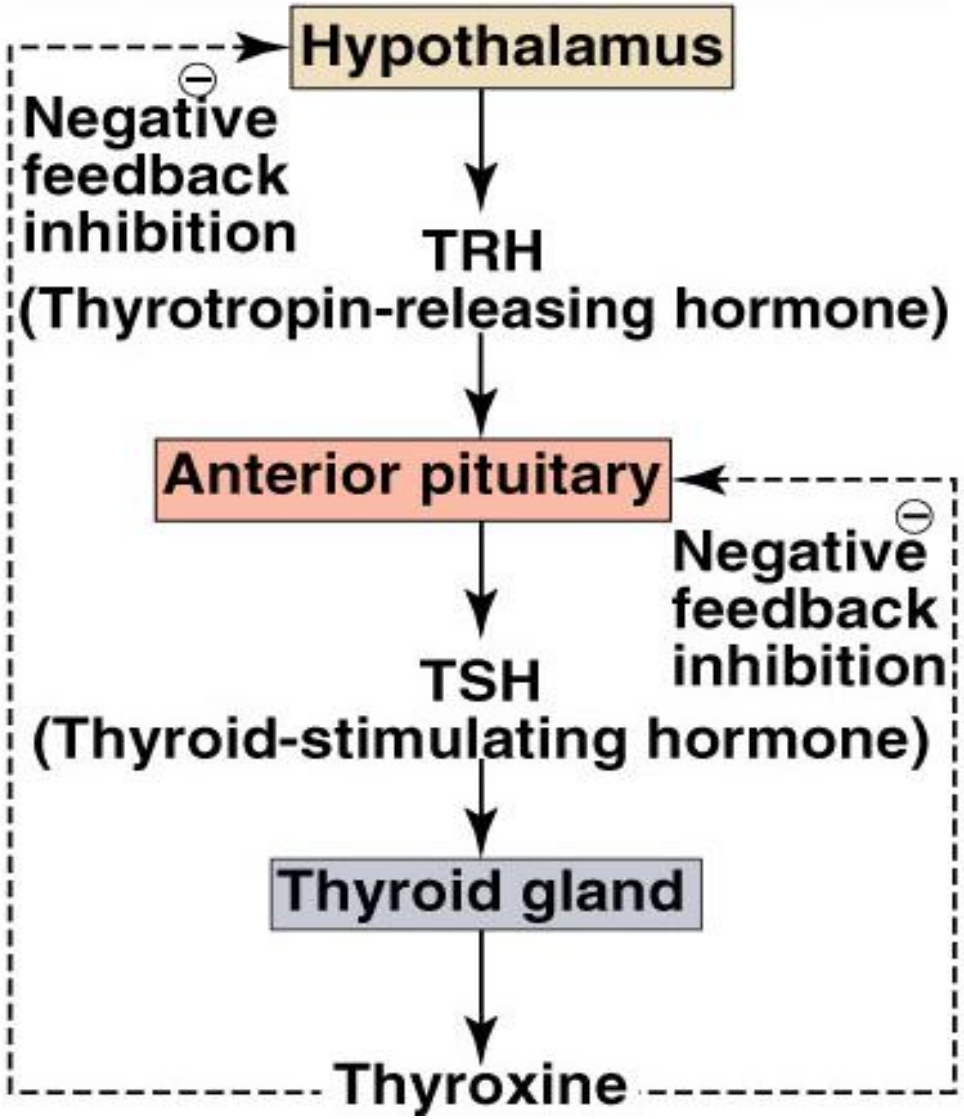
- Derivatives of the AA tyrosine
- Circulation – bound to plasma proteins (inactive)
- Half-life of the protein-bound thyroid hormones – 1-6 days
- Mechanism of action – intracellular – nuclear receptors

The Hypothalamo-Pituitary-Thyroid Axis

- **Thyrotropin releasing hormone (TRH) from the hypothalamus**
  - Hypothalamic origin, transported via the portal circulation to the anterior pituitary gland where it ultimately leads to exocytosis of TSH

- **Thyroid-stimulating hormone from the anterior pituitary**
  - TSH increases both synthesis and secretion of thyroid hormones via a **cAMP**. Chronic elevation of TSH causes hypertrophy of the thyroid gland
  - Using negative feedback control, T3 and T4 inhibit the secretion of TSH from the anterior pituitary by decreasing the sensitivity of the secretory cells to TRH

Regulation of Thyroxine Secretion



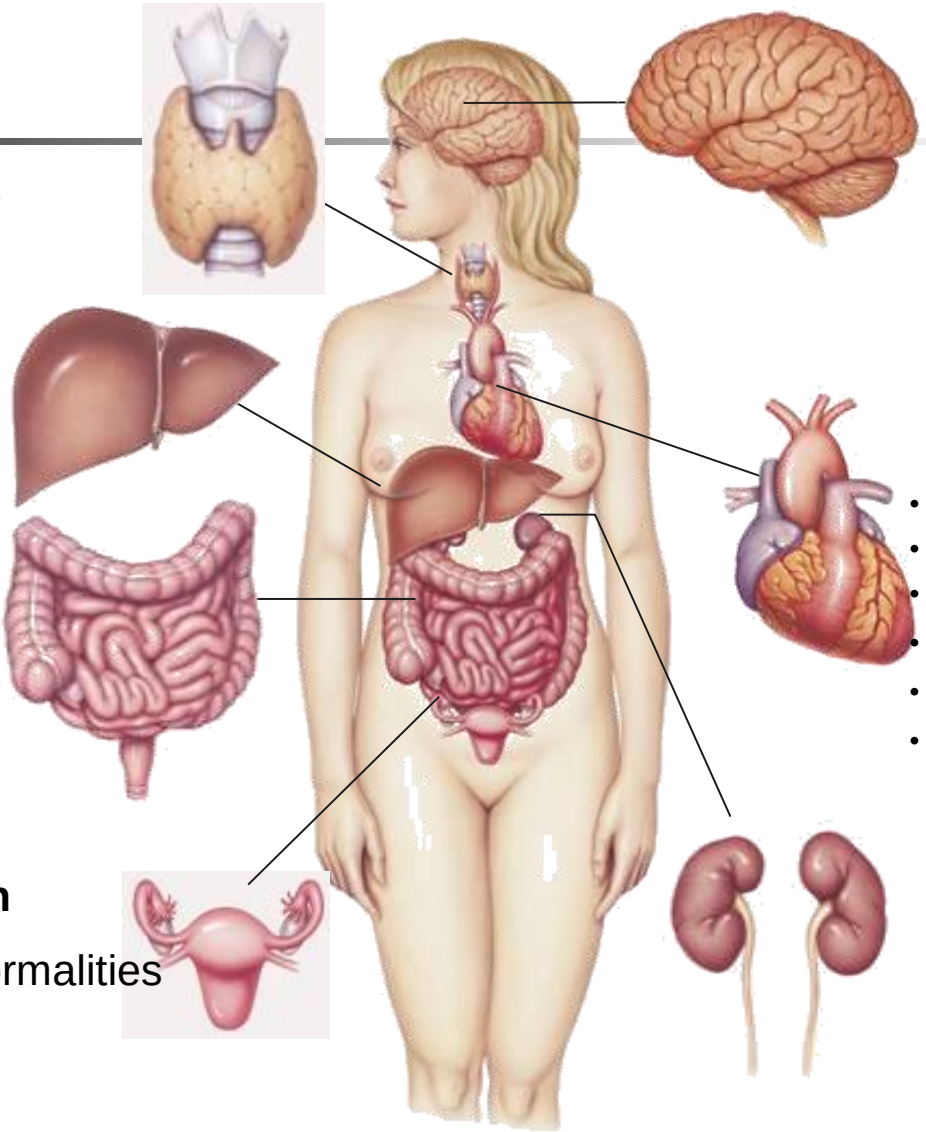
Thyroid Hormones: T3 and T4

- **Body cells:**
  - Stimulate protein synthesis - activate nuclear transcription of genes
  - Increase the metabolic rate - calorigenic effect
  - Stimulate Na+/K+ ATPase, increase active transport
  - Bound to mitochondria increase their size, number and activity, stimulate the use of glucose and oxygen for ATP production
  - Stimulate growth (facilitate the effects of GH)

Actions of Thyroid Hormones: T3 and T4

- Growth – stimulate bone formation (synergistically with GH & somatomedin), bone maturation as a result of ossification
- Development, growth and activity of CNS: in perinatal period w/o T3 & T4 – mental retardation
- Basal metabolic rate
- Autonomic nervous system – effects similar to ß–adrenergic stimulation
- Cardiovascular system
- Respiratory system
- Metabolism regulation

Physiologic Functions of the Thyroid Hormones



Effect on Sleep

Liver

- Decreased Cholesterol, Phosholipids, Triglycerides
- Elevated FA

Intestines

- Increased GI Activity and Secretion of Digestive Juices

Sexual Function

- Menstrual Abnormalities
- Affect Libido

Muscle Tremor

Brain

- Increased Rapidity of Cerebration

Respiratory System

- Increased Ventilation Rate

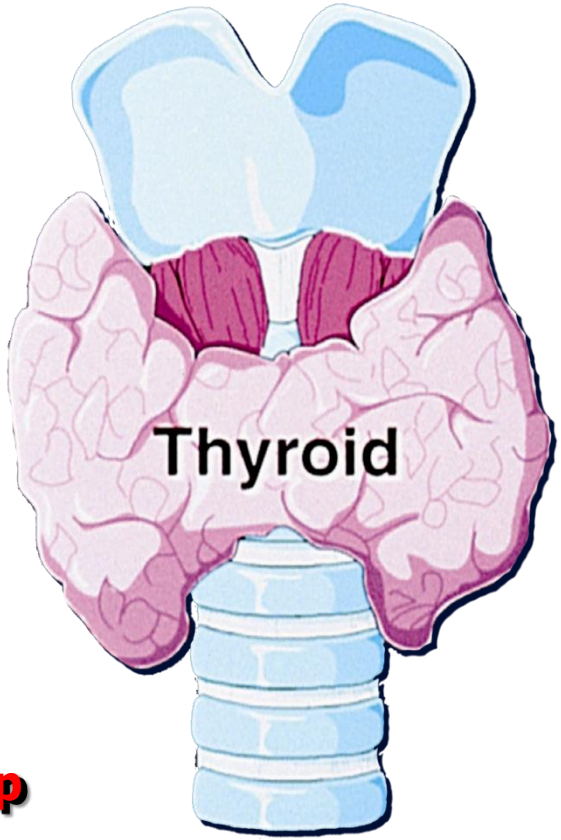
Heart

- Increased Blood Flow
- Increased Heart Rate
- Normal Blood Pressure (sRR)
- Increased Heart Strength
- Increased Stroke Volume
- Increased Cardiac Output

Metabolism

- Increased: Lipolysis
- Glycogenolysis
- Gluconeogenesis
- Glucose Absorption
- Catabolic Effect

When the Thyroid Doesn't Work



Hyperthyroidism

- Too Much Thyroid Hormone
- Metabolism Speeds Up

Hypothyroidism

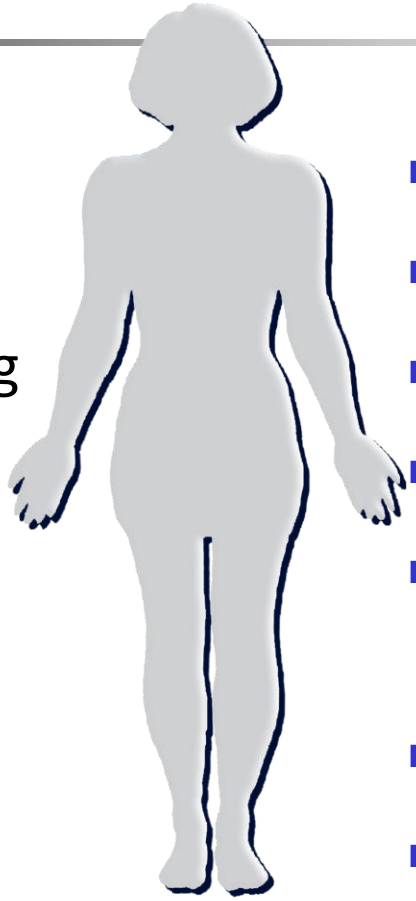
- Too Little Thyroid Hormone
- Metabolism Slows Down

Two Common Types of Thyroid Disease

- Hyperthyroidism
- Hypothyroidism

Signs and Symptoms of Hyperthyroidism

- Nervousness
- Irritability
- Difficulty Sleeping
- Bulging Eyes
- Unblinking Stare
- Goiter
- Rapid Heartbeat



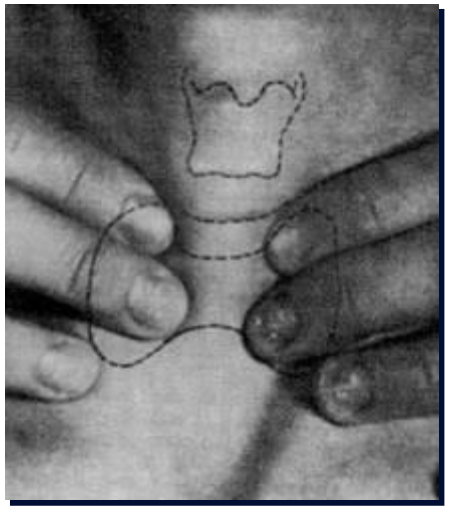
- Increased Sweating
- Heat Intolerance
- Unexplained Weight Loss
- Scant Menstrual Periods
- Frequent Bowel Movements
- Warm, Moist Palms
- Fine Tremor of Fingers

Signs and Symptoms of Hypothyroidism

- Tiredness
- Forgetfulness/Slower Thinking
- Moodiness/ Irritability
- Depression
- Inability to Concentrate
- Thinning Hair or Hair Loss
- Loss of Body Hair
- Dry, Patchy Skin
- Weight Gain
- Cold Intolerance
- Elevated Cholesterol

- Puffy Eyes
- Swelling (Goiter)
- Hoarseness/ Deepening of Voice
- Persistent Dry or Sore Throat
- Difficulty Swallowing
- Slower Heartbeat
- Menstrual Irregularities/ Heavy Period
- Infertility
- Constipation
- Muscle Weakness or Cramps

Diagnosing Thyroid Disease



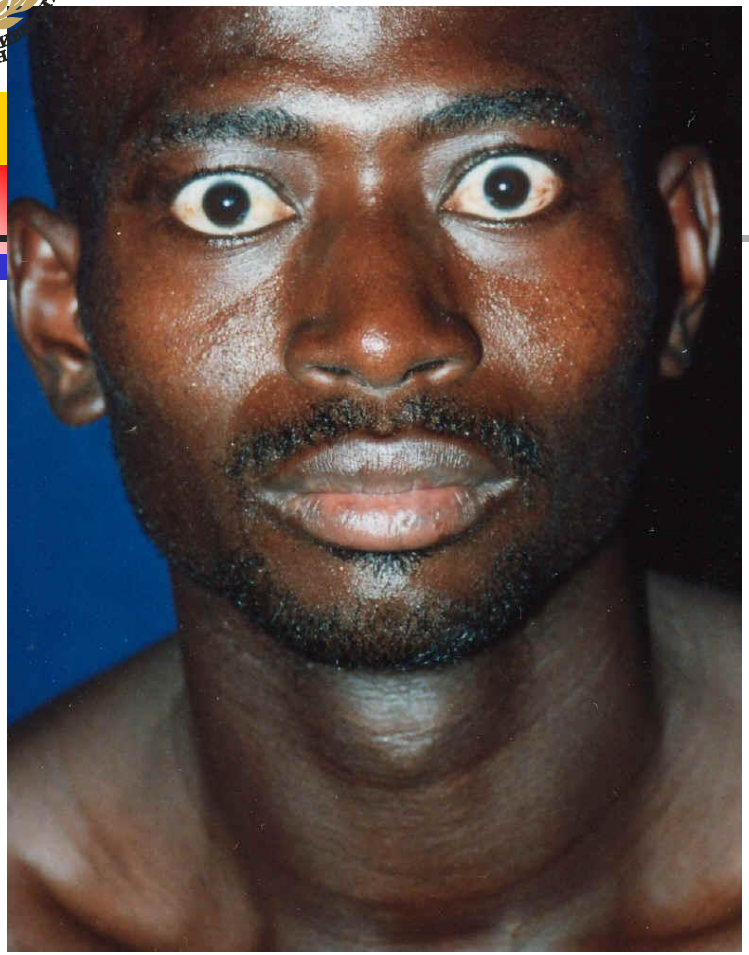
- Family and personal medical history
  - Hypothyroidism may be Hereditary
- Physical exam
  - MD Observes the Patient
  - Palpates the thyroid
  - Interviews patient
- Laboratory Tests
  - **TSH Test**
  - **Free T4**

Graves' Disease

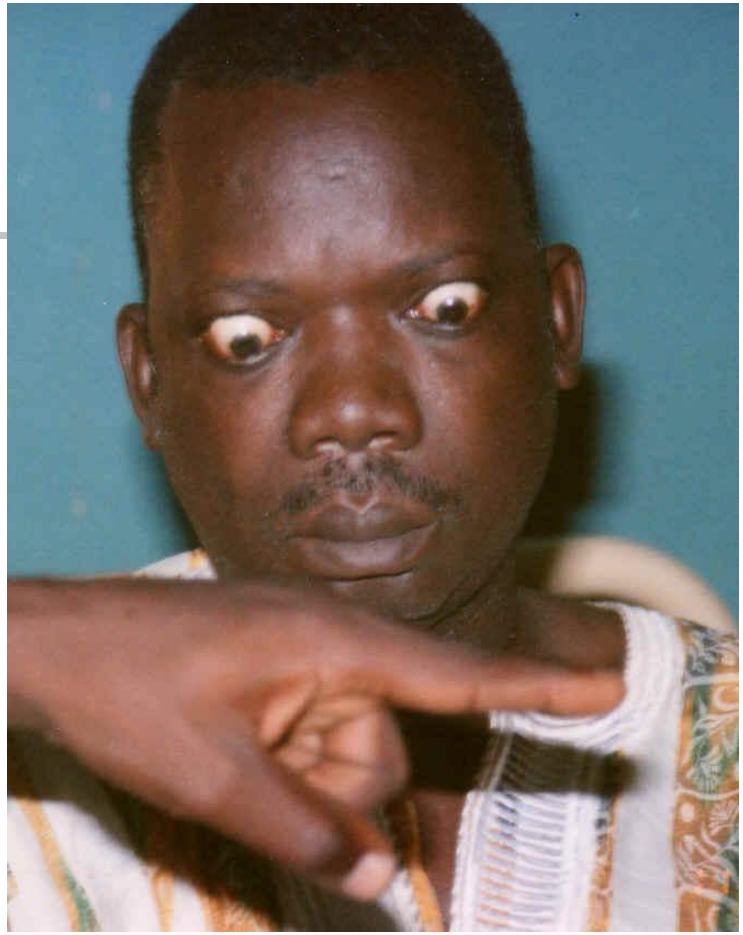
- Autoimmune disease
- The immune system of an individual attacks cells in the thyroid gland resulting in hyperthyroidism
- The most common cause of hyperthyroidism (60-80%) of all cases
- Females are affected more frequently than men 10:1.5
- Incidence peaks from ages 20-40

Diseases of the Thyroid

- **Hyperthyroidism**
  - refers to overactivity of the thyroid gland leading to excessive synthesis of thyroid hormones and accelerated metabolism in the peripheral tissues. The secretion of thyroid hormone is no longer under the regulatory control of the hypothalamic-pituitary axis.
  - **Causes of Hyperthyroidism** (Toxic Goiter, Thyrotoxicosis, Graves' Disease, Thyroid Adenoma): increased gland, hyperplasia
- **Hypothyroidism –** endemic goiter (dietary iodide deficiency), idiopathic nontoxic colloid goiter, **myxedema, Hashimoto's disease, Cretenism**



Exopthalamos in Graves Disease



Lid Lag in Graves Disease