THIRD EDITION

HUMAN PHYSIOLOGY

AN INTEGRATED APPROACH

The Endocrine System

glands

Hormones

we have no bad Hormons an increase or derease in them cause ilness

Homeostasis التوازن

control

What is the Function?!

Regulation / growth + development / Reproduction / metabolism

Endocrine system + Nervous system

Complete each other

Dr. Howard D. Booth, Professor of Biology, Eastern Michigan University

Endocrine glands versus Exocrine glands

glands (Secretory cells / organs)

- **Exocrine glands**: These glands have ducts + they empty their content into cavity / Lumen.
  (Are not Related to the endocrine system.)
  - ➢ produce non-hormonal substances and have ducts to transport them to their final destination
    (Produce massive amount)
  - ➢ Swaet and Sliva
    (Lumen, Cavity, Surface of the body)

- **Endocrine glands**: One which produce (hormones) / they don't have ducts
  (the endocrine system.)
  (chemicals)
  - ➢ produce hormones and are lack ducts. They release their hormones into blood ⇝ then to the rest parts of the body
    (Release their secretions directly into blood)
    (from blood to the rest of the body)
  - ➢ Insulin, adrenalin
    (From pancreas)

. Examples about exocrine glands:

. Salivary glands → Release saliva $\xrightarrow[\text{duct}]{\text{through}}$ to release it into the Oral cavity

. Pencreas → duct that emptys into duodenum → gastro intestant gland.

. Sweat glands → duct which release content on the body's surface.

Pencreas
- exo → secret enzymes + Bicarbonate + fluid
- endo → insulin + glucagon into Blood
  - insulin: Decrease
  - glucagon: Increase

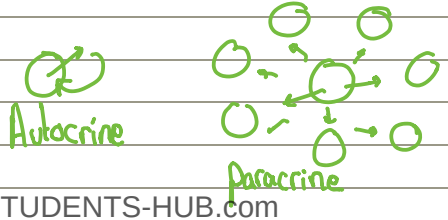
. We have chemicals that are produced + not secretive through ducts + not into blood → they are similar to Hormons.

a) Autocrine:
A chemical compound Released from a cell, effect the same cell. (have it's one Receptors)

b) Paracrine:
Chemical released from one single cell → effect the neighboring cells.

C) Phermons:
Chemical secreted by 1 individual of species to effect another individual from the same species.

they use it for perfums → . Female perfums: Period
. Men perfums: tobacco, Sweat



Hormones

Target most body cells producing diverse effects and their control include:

- ***Reproduction***
- ***Growth and Development***
- ***Maintenance of Electrolyte, Water and Nutrient Balance of the Blood***
- ***Regulation of Cellular metabolism and energy balanc***
- ***Mobilization of body defence***

Autocrines Paracrines Phermones

Characteristics of Hormones

Any chemical compound that is not secreted by gland or into the blood is not a hormone

- ✓ **Made in gland(s) or cells** (Secretory Cells)
- ✓ **Transported by blood**
- ✓ **Distant target tissue receptors**: does not effect tissues in place but effect tissues at a distance
- ✓ **Exert their effect at very low conc.** In Picomoles (their Receptor is too sensitive to low conc.) (directly to the receptors)
  - enzymes → High conc.
- ✓ **Activates physiological response** Have physiological effects.
- ✓ **Have receptors** → to perform their Response
- ✓ **Must be terminated** → neurotransmitter, Protein

to be called a hormone it must has all these Charstaristics

Chemistry of Hormones

We have 2 main Categorys of hormones

- **Amino acid based** (Hydrophilic)

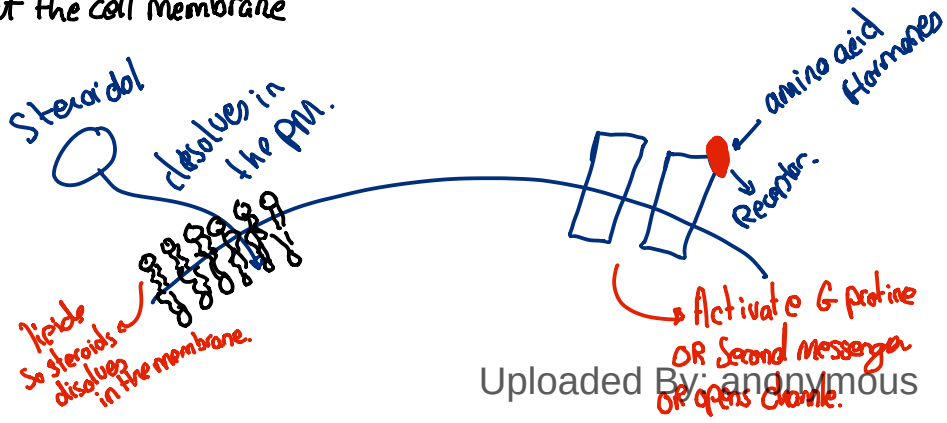
  Vary from simple amino acid derivatives (thyroxine) to peptides to proteins

- **Steroids** (Steroidal based) (Hydrophobic)

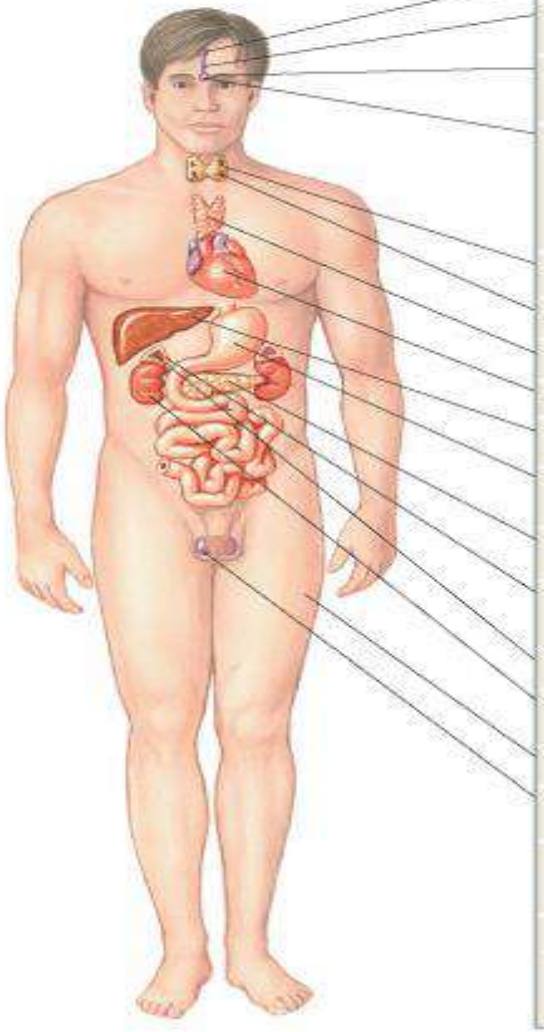
  Synthesized from cholesterol → We can't stop it from going into the cell. Produced Upon need.

→ What is the differace between amino acid based and Steroids ?

1) Receptors for steroidal Hormones must be located inside the cell
   whereas amino acid Based Hormones → Receptors are Located at the cell membrane
2) Steroidal hormone cannot be stored in the cell
   while amino acids can be stored in vessicals.



Summary of the Endocrine System



Location	Gland or cell?	Chemical class
Pineal gland	Gland	Amine
Hypothalamus	Clusters of neurons	Peptides
Posterior pituitary	Extensions of hypothalamic neurons	Peptides
Anterior pituitary	Gland	Peptides
Thyroid	Gland	Iodinated amines Peptide
Parathyroid	Gland	Peptide
Thymus	Gland	Peptides
Heart	Cells	Peptide
Liver	Cells	Peptides
Stomach and small intestine	Cells	Peptides
Pancreas	Gland	Peptide
Adrenal cortex	Gland	Steroids
Adrenal medulla	Gland	Amines
Kidney	Cells	Peptide Steroid
Skin	Cells	Steroid
Testes (male)	Glands	Steroids Peptide
Ovaries (female)	Glands	Steroids Peptide
Adipose tissue	Cells	Peptide
Placenta (pregnant females only)	Gland	Steroids Peptide

Summary of the Endocrine System Cont.

Hormone	Target	Main Effect
Melatonin	Unclear in humans	Circadian rhythms. Other effects uncertain
Trophic hormones (see Fig. 7-13) See posterior pituitary	Anterior pituitary	Release or inhibit pituitary hormones
Oxytocin (OT) Hypothelamus	Breast and uterus	Milk ejection; labor and delivery; behavior
Vasopressin (ADH) → Hypothalamus ✓. Prolactin (PRL) Growth hormone (GH, somatotropin) Corticotropin (ACTH) Thyrotropin (TSH) Follicle stimulating hormone (FSH) Luteinizing hormone (LH)	Kidney Breast Many tissues Adrenal cortex Thyroid gland Gonads Gonads	Water reabsorption Milk production Growth and metabolism Cortisol release Thyroid hormone synthesis and release Egg or sperm production; sex hormone production Sex hormone production; egg or sperm production
Triiodothyronine and thyroxine (T_3, T_4) Calcitonin (CT)	Many tissues Bone	Metabolism, growth and development Plasma calcium levels (minimal effect in humans)
Parathyroid hormone (PTH)	Bone, kidney	Regulate plasma calcium and phosphate levels
Thymosin, thymopoietin	Lymphocytes	Lymphocyte development
Atrial natriuretic peptide (ANP)	Kidneys	Increase sodium excretion
Angiotensinogen Insulin-like growth factors (IGF)	Adrenal cortex, blood vessels, brain Many tissues	Aldosterone secretion, increase blood pressure Growth

Summary of the Endocrine System Cont.

Hormone	Target	Main Effect
Gastrin, cholecystokinin (CCK), secretin, and others	GI tract and pancreas	Assist digestion and absorption of nutrients
Insulin, glucagon, somatostatin (SS), pancreatic polypeptide	Many tissues	Metabolism of glucose and other nutrients
Aldosterone Cortisol Androgens	Kidney Many tissues Many tissues	Na^+ and K^+ homeostasis Stress response Sex drive in females
Epinephrine, norepinephrine	Many tissues	Fight-or-flight response
Erythropoietin (EPO) 1,25 Dihydroxy-vitamin D_3 (calciferol)	Bone marrow Intestine	Red blood cell production Increase calcium absorption
Vitamin D_3	Intermediate form of hormone	Precursor of 1,25 dihydroxy -vitamin D_3
Androgen Inhibin	Many tissues Anterior pituitary	Sperm production, secondary sex characteristics Inhibit FSH secretion
Estrogens and progesterone Ovarian inhibin Relaxin (pregnancy)	Many tissues Anterior pituitary Uterine muscle	Egg production, secondary sex characteristics Inhibit FSH secretion Relaxes muscle
Leptin	Hypothalamus, other tissues	Food intake, metabolism, reproduction
Estrogens and progesterone (P) Chorionic somatomammotropin (CS) Chorionic gonadotropin (CG)	Many tissues Many tissues Corpus luteum of ovary	Fetal and maternal development Metabolism Hormone secretion

1: Primary Endocrine Organs

Major endocrine organs:

- Hypothalamus and pituitary gland ✓
- Pineal gland
- Thyroid gland and parathyroid glands
- Thymus
- Adrenal glands
- Pancreas
- Gonads

When we talk about the endocrine organs are the ones which release Hormones → Traffic Hormons: effect the release of other Hormones.

① Hypothalamus and Pituitary Gland

- **Hypothalamus in brain**
- **Pituitary gland**
  - **Anterior lobe**
  - **Posterior lobe**
- **Infundibulum** → the connection Between hypothalamus and Pituitary gland.

Primary endocrine Organs:

. Hypothalamus and pituitary gland: Hypothalamus is Directly connected to the pituitary gland

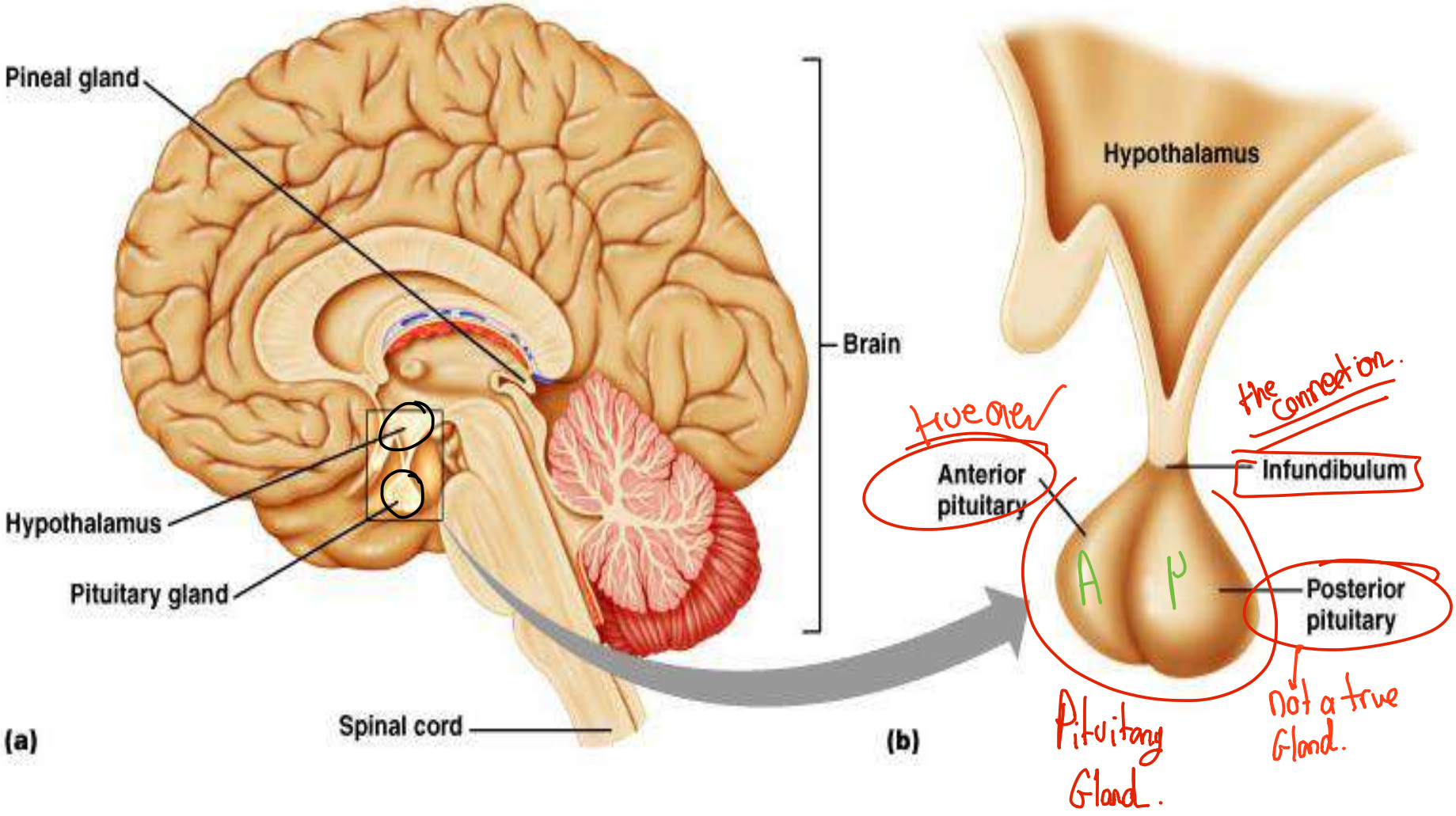
↳ the connection between Hypothalamus and pituitary gland

↳ Infundibulum

Anterior Lobe

Posterior Lobe

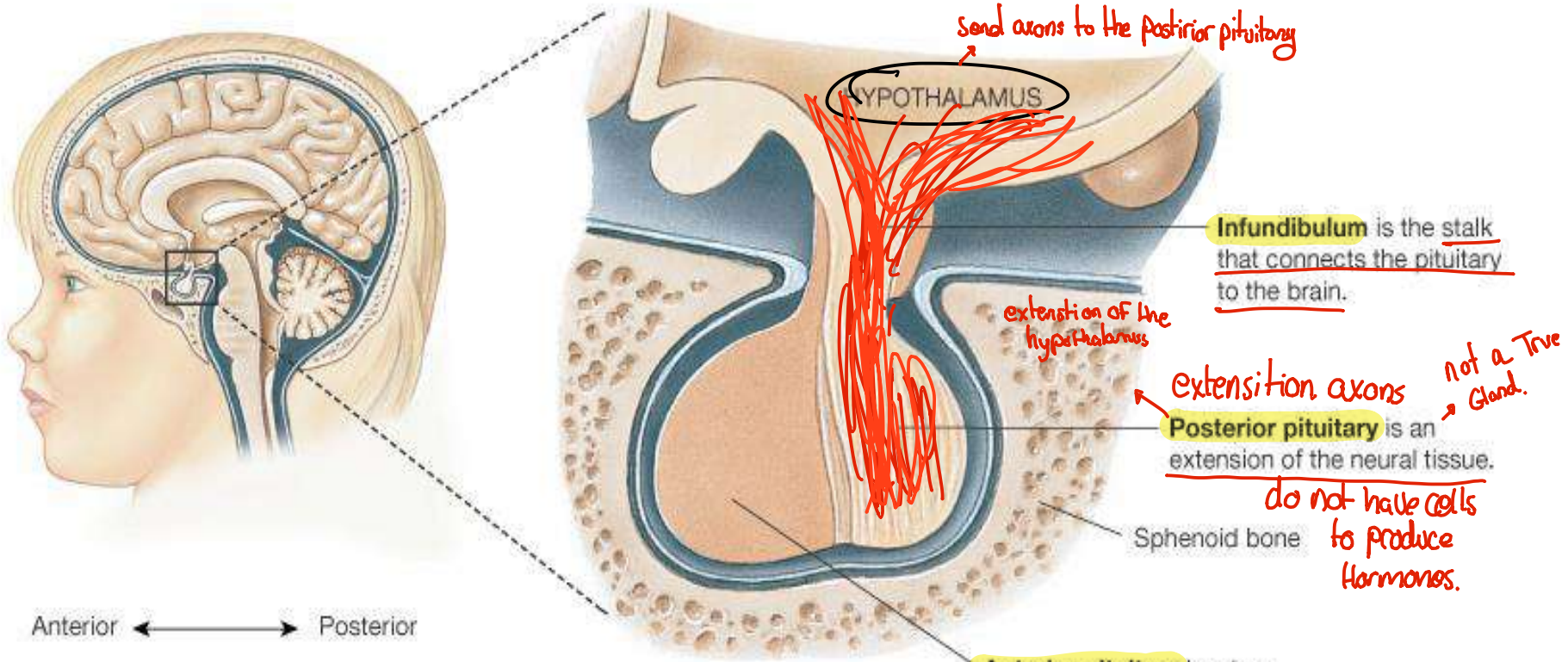
Hypothalamus & Pituitary Gland



Pituitary gland anatomy

Positrior Pituitary is not a true gland → Extensition of hypothalamus

Send axons to the positrior pituitary



what we understand → neurosecretory cells that Release Hormones → located in Hypothala

Release their content into blood but not in the hypothalamus Area in the positrior pituitary

Neural Connection to Posterior Pituitary

- Hormones by Hypothalamus:
  Oxytosen + ADH Hormone.

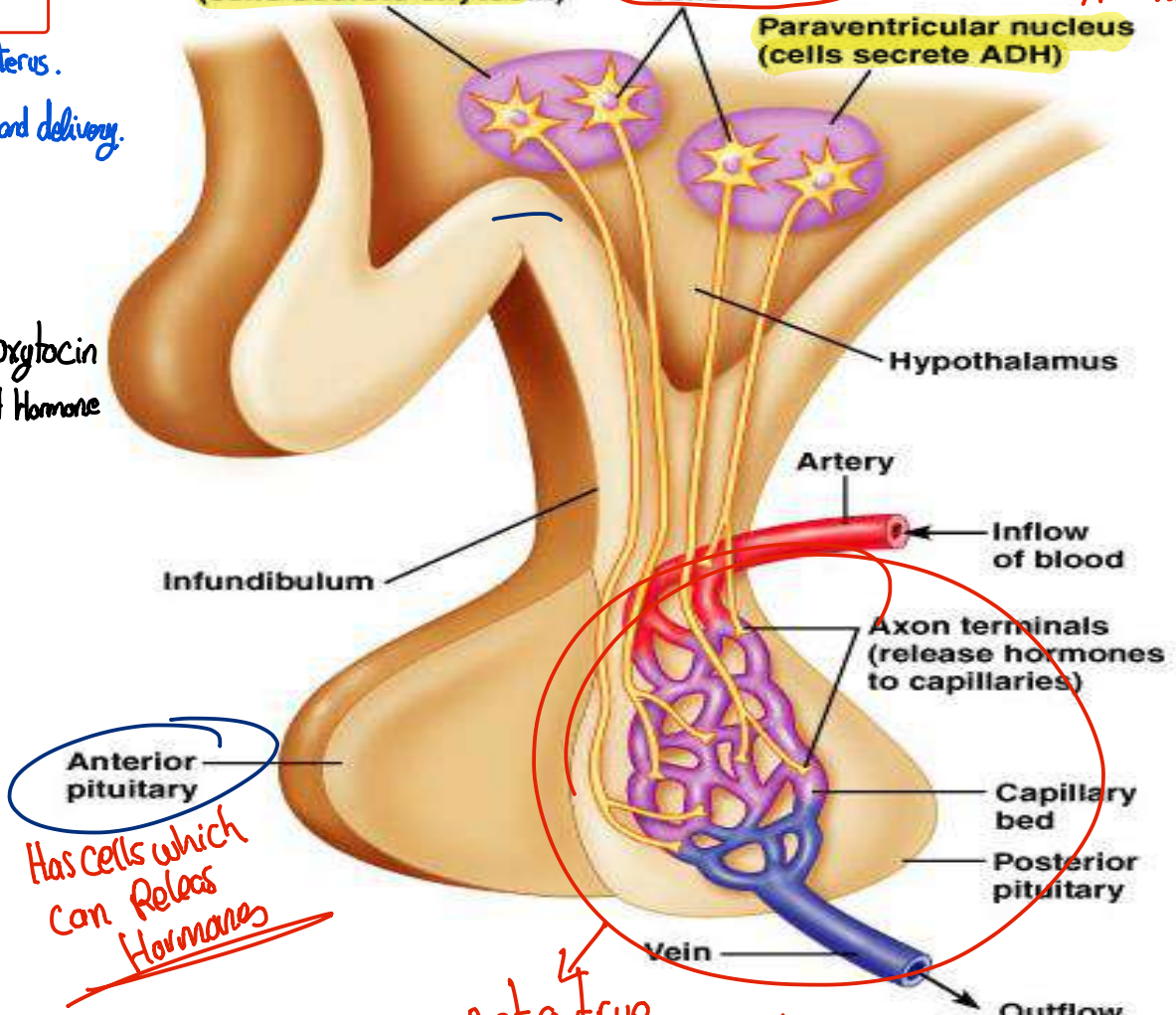
Oxytosen → Targets Breast and uterus.
→ milk ejection + labor and delivery.

ADH Hormone → Target Kidney
→ Water absorbtion.

Supraoptic nucleus: Cells Secret oxytocin
Paraventricular nucleus: Cells secret ADH Hormone

Hypothalamus doesn't store the hormones when we need them it Releases them.

Release content into blood but not in the hypothalamus area → In the Posterior Pituitary



Has cells which can Relase Hormones

not a true gland // neural tissue.

Hormones of Posterior Pituitary

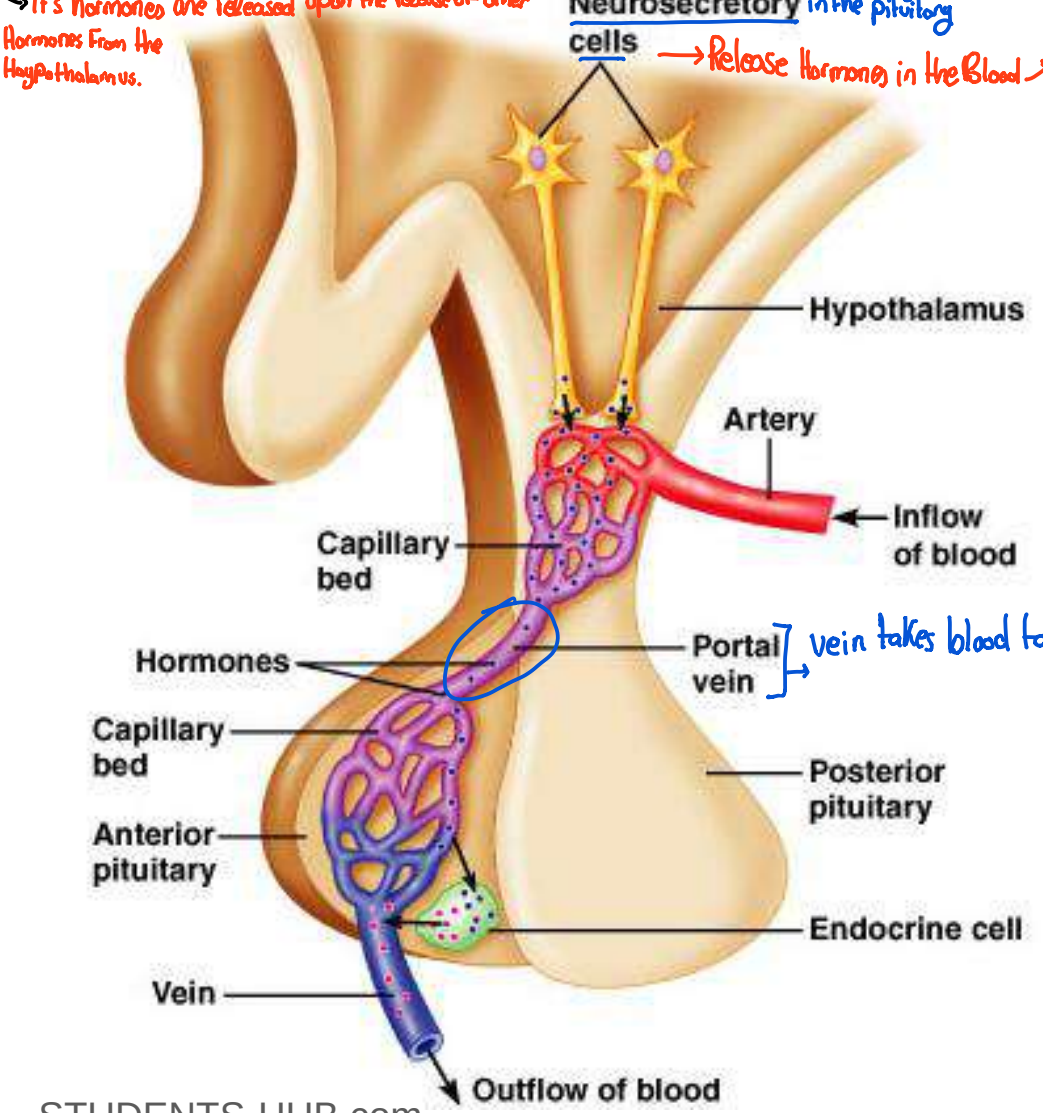
- **Antidiuretic Hormone (ADH or vasopressin)** ~~> Kidneys
  - Paraventricular nucleus
  - Water balance and osmolarity
- **Oxytocin**
  - Supraoptic nucleus
  - milk ejection + labor and delivery.

Blood Connection to Anterior Pituitary

Anterior pituitary has a complicated system
↳ it's hormones are released upon the release of other Hormones From the Hypothalamus.

Neurosecretory cells → Release Hormones in the Blood
Release in low conc. → effect only the Hormone in the pituitary

So blood has to circulate until it gets in the anterior pituitary and then effecting cells in the anterior pituitary to Release their content



Portal vessels- link two capillary beds

↳ it's important because it moves blood From one section to another section before it goes to Heart why? Because we have a very low conc. of Hormones Released From hypothalamus.

In capillaries is where exchange occurs between blood and tissue

GnRH
From hypothalamus
↓
LH + FSH
↓
go to blood
↓
That Target
Gonads
↙ Ovaries ↘ Testis
Sex Hormone Production and ova or Sperm Production.

Tropic Hormones

↳ take action for the release of other Hormones.

Tropic Hormones are Hormones Realesed From a gland effecting other glands to Release Hormones.

Affect release of another hormone

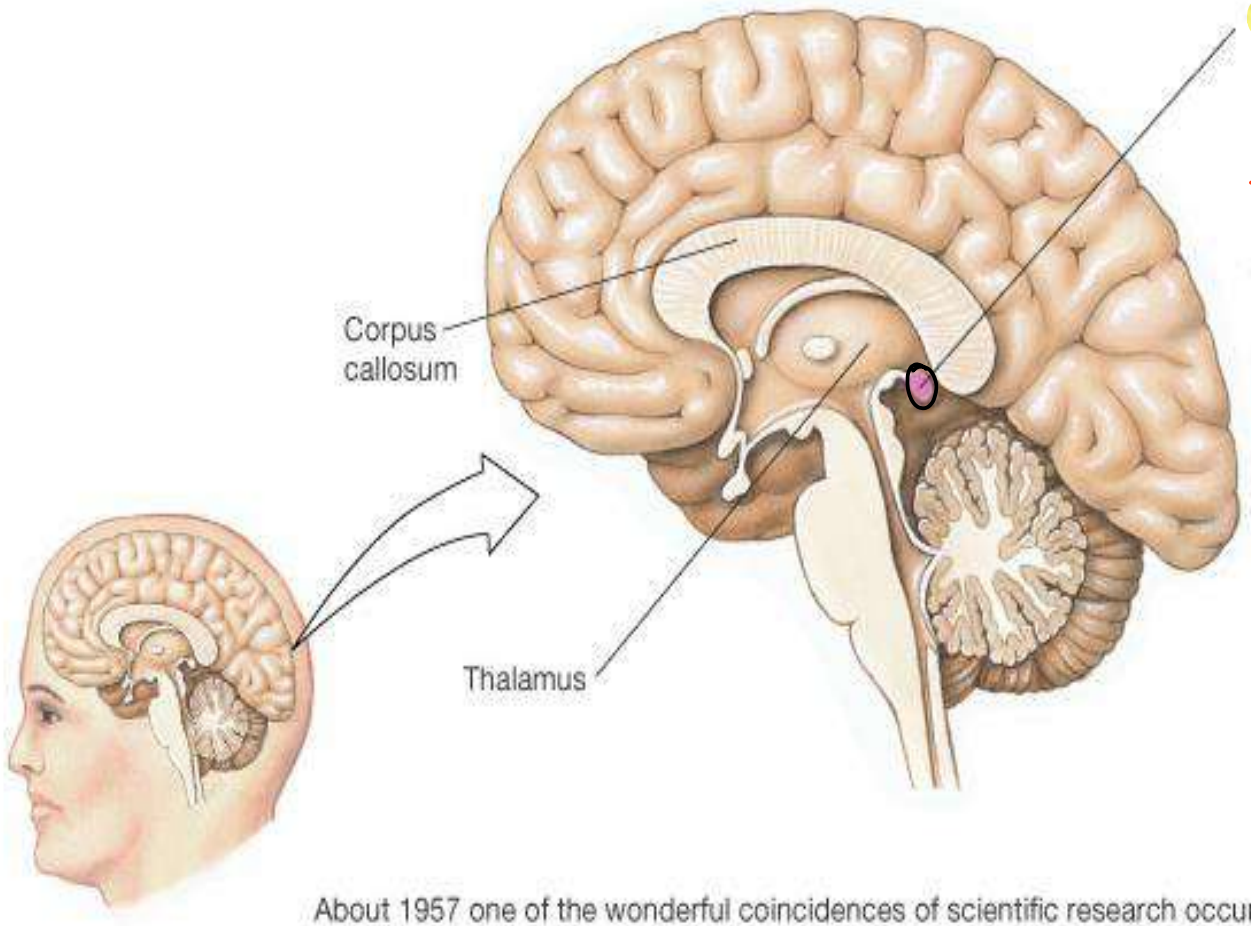
↳ From hypothalamus to antirior pituitary / From anterior pituitary to Gonads.

- **Releasing hormones**
- **Inhibiting hormones**

GNRH Released From Hypothalamus → Affects the Anterior pituitary so it release LH + FSH (Tropic Hormone) ⇝ Affects Gonads ⇝ Egg/Sperm Production by Releasing Sex Hormones.

Pineal Gland & Melatonin

THE PINEAL GLAND



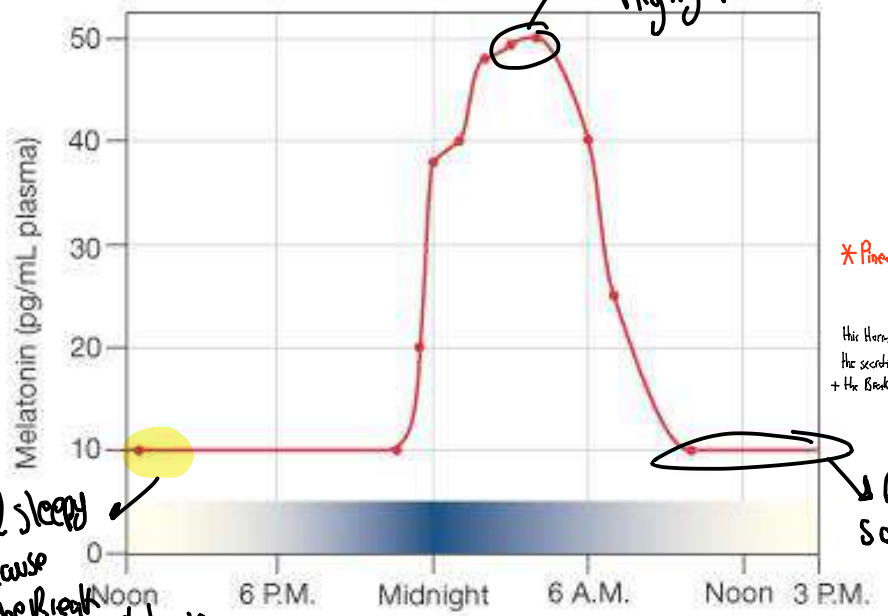
The pineal gland is a pea-sized structure buried deep in the brain of humans. Nearly 2000 years ago, this "seat of the soul" was thought to act as a valve that regulated the flow of vital spirits and knowledge into the brain. By 1950, however, scientists had decided that it was an evolutionary remnant with no known function.

About 1957 one of the wonderful coincidences of scientific research occurred. An investigator heard about a factor in beef pineal glands that could lighten the skin of amphibians. Using the classical methodology of endocrinology, he obtained pineal glands from a slaughterhouse and started making extracts. His biological assay consisted of dropping pineal extracts into bowls of live tadpoles to see if their skin color blanched. Several years and hundreds of thousands of pineal glands later, he had isolated a small amount of melatonin.

Pineal Gland

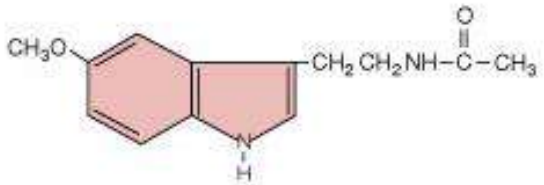
- **Glandular tissue in brain**
- **Secretes melatonin**
  - **Function unknown**
  - **May be involved in circadian rhythms** body clock (**A *circadian rhythm* is a roughly-24-hour cycle in the physiological processes of living beings)**
- Influences the antioxidant activity
- Other roles need research: SAAD & sexual behavior

Pineal Gland and Melatonin



Melantonin is the "darkness hormone," secreted at night as we sleep. It is the chemical messenger that transmits information about light-dark cycles to the brain center that governs the body's biological clock.

(Adapted from J. Arendt, *Clin. Endocrinol.* 29:205-229, 1988.)



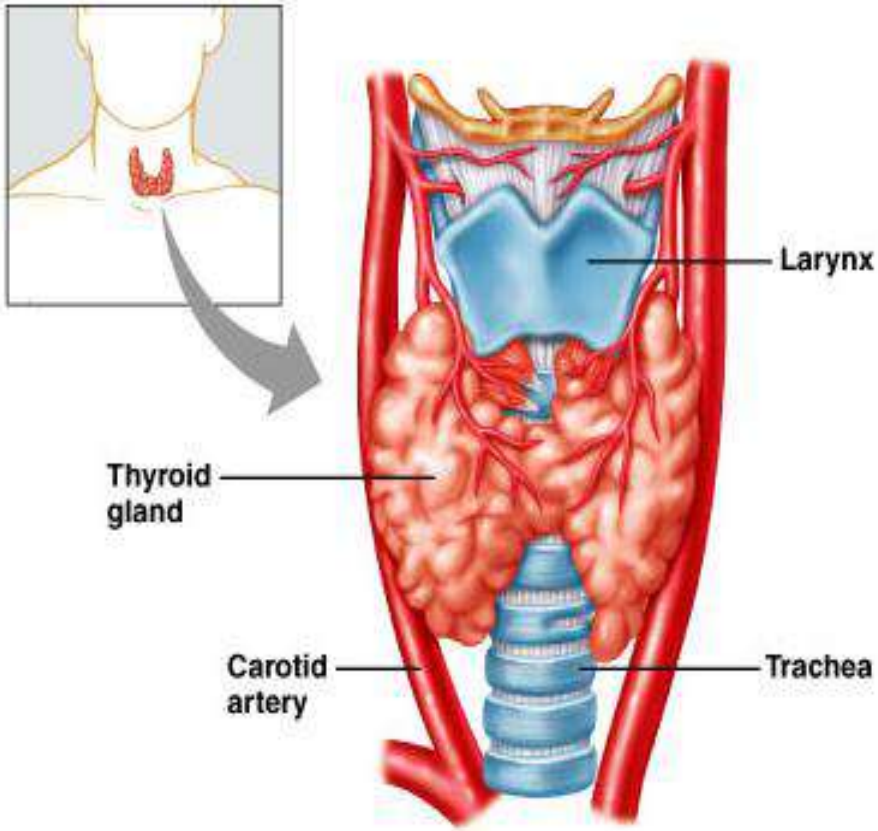
Melatonin is an amine hormone derived from the amino acid tryptophan.

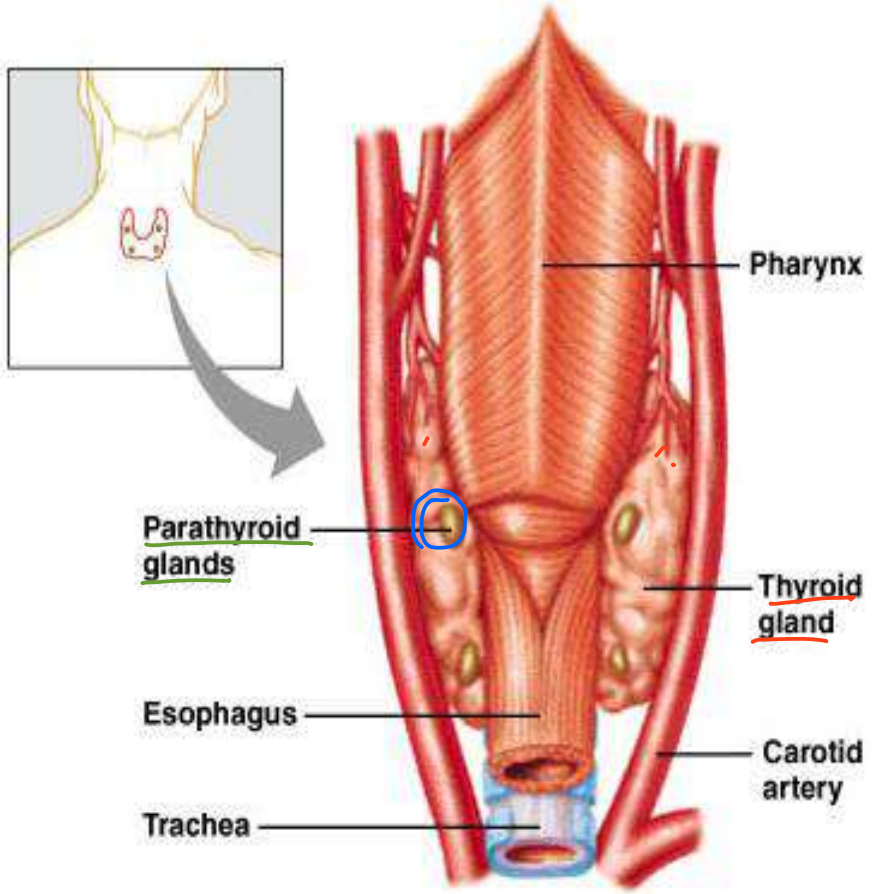
Ten years ago scientists and the popular press were trying to link melatonin to sexual function, the onset of puberty, seasonal affective depressive disorder (SADD) in the darker winter months, and sleep-wake cycles. At that time, the only function supported with scientific evidence was the hormone's ability to help shift timing of the body's internal clock, making it useful in overcoming jet lag. Now there is evidence that melatonin is a powerful antioxidant that has the potential to protect the body from the damage caused by free radicals. For a recent review, see "Melatonin: lowering the high price of free radicals," *News in Physiological Sciences* 15: 246-250, Oct. 2000 (http://nips.physiology.org).

Thyroid and Parathyroid Glands

* Thyroid Gland is located at → Inferior to larynx + Anterior to trachea + Midial to Arms + Superior to lungs

* Parathyroid → Located on the posterior side of thyroid gland.





Hormones of the Thyroid Gland

- **Two thyroid hormones**
  - T_4, tetraiodothyronine
  - T_3, triiodothyronine

  → Produced by thyroid gland
  - **Regulate metabolism** → the role of T_3 and T_4
- **Calcitonin** + Parathyroid hormon (PTH)
  - **Regulates calcium levels in blood**

→ What effect would you expect to have if we have Hypothyroidism OR Hypoparathyroidism OR Hyperthyroidism OR Hyperparathyroidism?

1) Hypothyroidism: this is a situation where the thyroid doesn't release enough thyroid Hormone to the blood stream which slows down metabolism → makes you feel tired OR gaining weight and unable to tolerate temperature

2) Hypoparathyroidism: Low secretion OR Decrease in activity of PTH → Lead to the decrease of blood's calcium + Increase in blood Phosphorus → (Irregular Heart Beats).

3) Hyperthyroidism: You may feel nervous, moody, weak OR tired → High metabolism + High Calcium Conc. → Irregular Heart Beats.
   ↳ Increase in the secretion of t_3 t_4 and Calcitonin.

4) Hyperparathyroidism: Increase in blood's calcium → non Regulated Heart Beats → Memory loss.

Parathyroid Hormone (PTH)

Regulates calcium levels in blood

Thymus

An organ located in the upper anterior portion of the chest cavity just behind the sternum

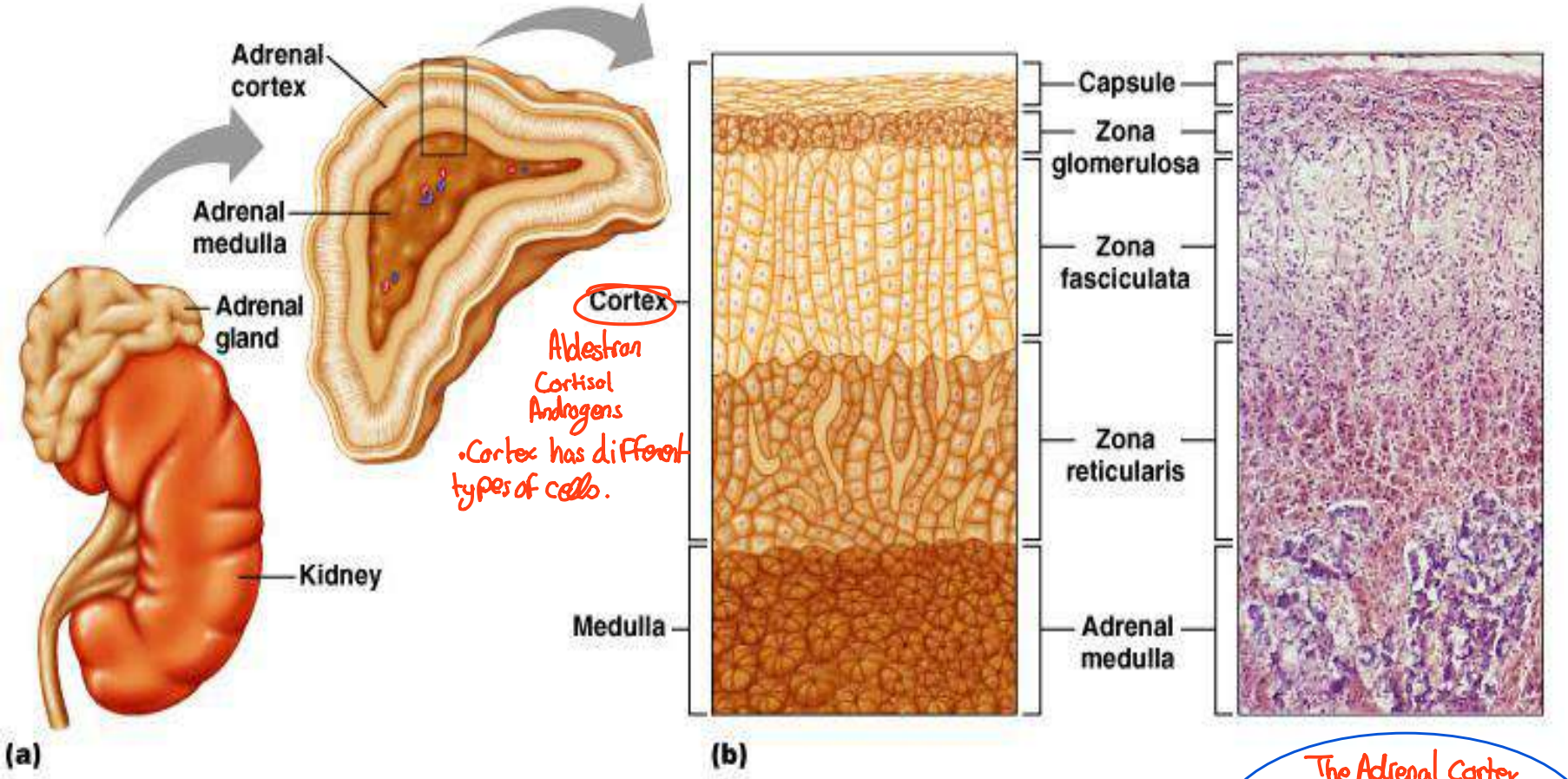
Posterior to

- **Secretes thymosin**
- **Regulates T cell function**

↳ Immune cells.

Thymus is more important for children.

Adrenal Glands



Aldestron
Cortisol
Androgens
•Cortex has different types of cells.

* Adrenal Gland is divided into Adrenal Cortex and Adrenal medula

~> loclization: Below the liver, Posterior to inferior Venacava, Anterior to diaphragm, Up of the Kidneys.

The Adrenal Cortex and the Adrenal medulla Release different types of Hormones.

Hormones of the Adrenal Gland: Adrenocorticoids

~> these Hormones Are Secreted From Cortecal Area) Cortex

1. **Mineralocorticoids (aldosterone)** →
   - secreted from zonae glomerulosa
   - regulates sodium and potassium levels

Kidneys system: Ajiotinsin Renal Aldestrone
↳ group of Hormones → work together → ↑ Pressure
↳ Helps in the Reapsorption of Sodium which ↑ pres. in the case when a person loses a lot of liquids.

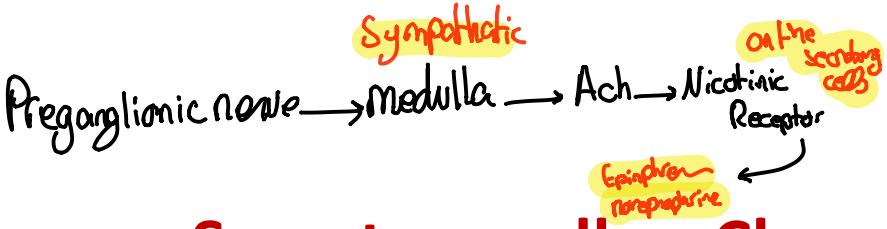
2. **Glucocorticoids (cortisol)** ~> effects the Bones and lower the immunity if it was in Higher Conc.
   - secreted from zonae fasciculata and reticularis
   - regulates body's response to stress ~> Slow down immune system → gives pleasure.
   - regulates metabolism

* increase the apetite which Release more glucose → in moving organs from one to other they use Cortizol

3. **Sex hormones (androgens)** ~> testotrone.
   - secreted from zonae fasciculata and reticularis
   - regulate reproductive function

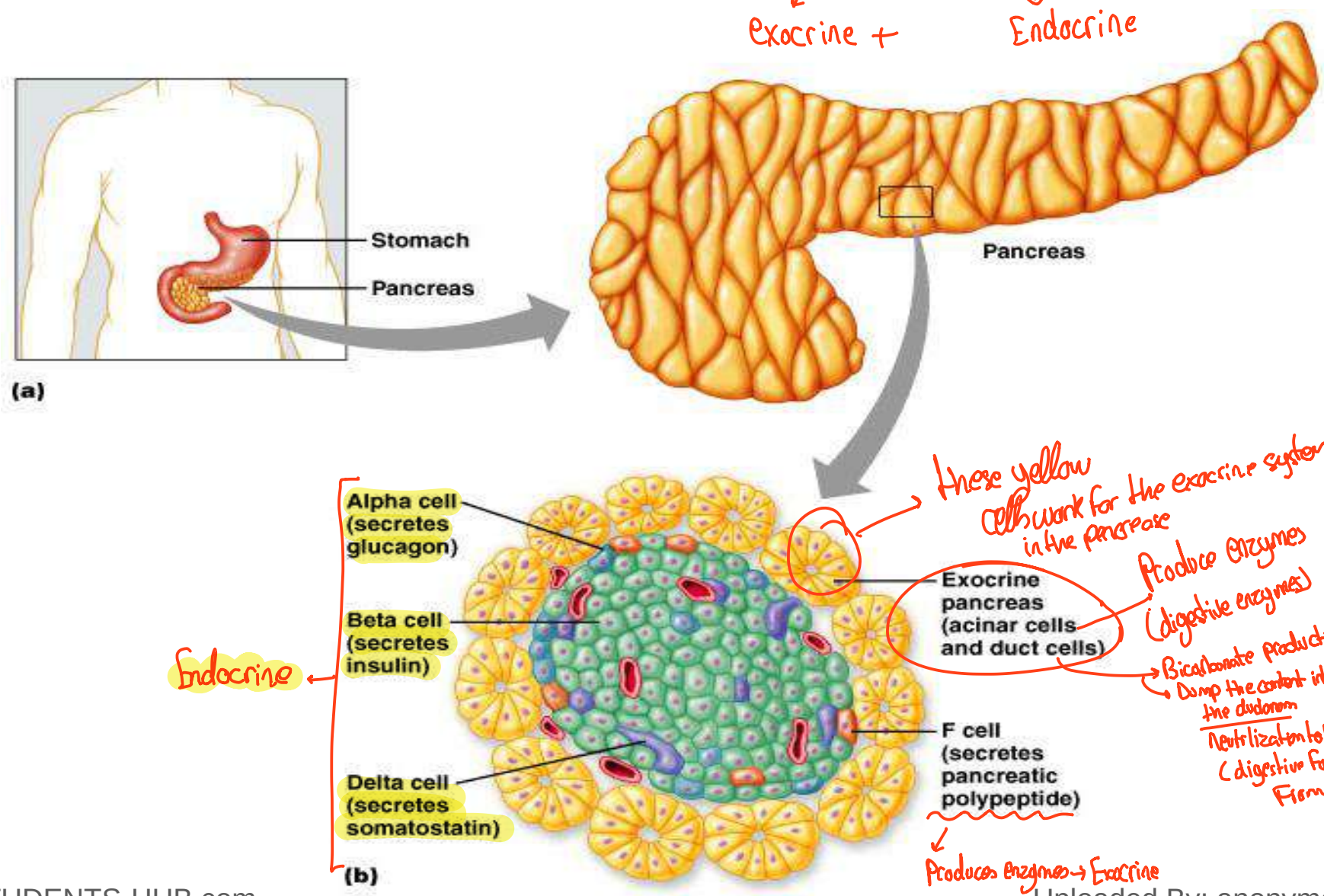
~> Testostrone: Produced for female in low conc. → Body Hair growth + Sex drive + growth and development of sex organs.

Adrenal Medulla



- **Secretory cells = Chromaffin cells**
  - **80% epinephrine**
  - **20% norepinephrine**
  - **<1% dopamine**
- **Under neural control**

Anatomy of the Pancreas



Exocrine Pancreas

Acinar and duct cells secrete fluid

and enzymes into digestive tract

Endocrine Pancreas

Islets of Langerhans

- **Alpha cells** - **glucagon**
- **Beta cells** - **insulin**
- **Delta cells** - **somatostatin**
- **F cells** - **pancreatic polypeptide** → we have some of them used for the endocrine system also.

Gonads

Male and Female Reproductive organs.

- **Male - testes**
  - we have Leydig cells → Interstitial cells + Interstitial cells → Produce testosterone
  - Testosterone
  - Androstenedione

* the conc. of test. is much higher in the Gonads than in the adrenal gland.

- **Female - ovaries**
  - Estradiol — Family of estrogens → Pregnancy Hormone (Maintain pregnancy)
  - Progesterone
  - Placenta of pregnant female (For Pregnant women) → estrogens and progesterone

(Non pregnant / Pregnant)

- Estrogen → Reproductive development in Female
  Produced by placenta during Pregnancy
  the secretion of it is Regulated by FSH
  Formation Sex characteristics
  enlargment of uterus + Breast during pregnancy.

- Progestrone (Pregnancy Hormone): 1. Prepares uteus for pregnacy
  2. Ovulation → Secreted by Ovaries
  3. Regulated LH
  4. Stimulate the grauth of mammary cells

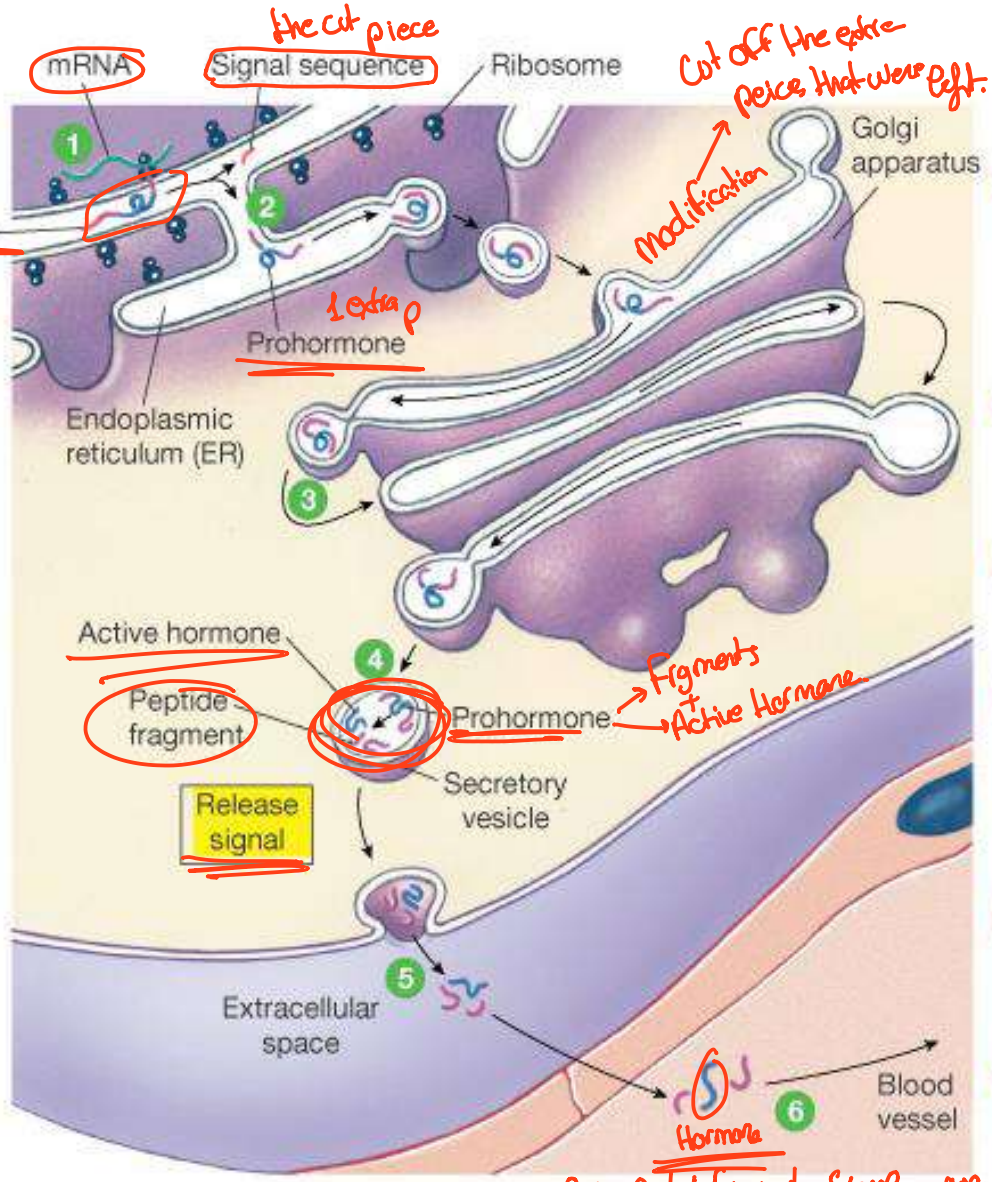
* Embryo Releases Hormone at the first weeks → HCG (Human chorionic gonadotropin) (it is Released to protect the embryo ... Release ...) — if it was presented in Urine → Pregnancy

II. Secondary Endocrine Organs

- **Heart** - **atrial natriuretic peptide (ANP)** → targets Kidneys → to Increase Sodium excretion.
- **Kidneys** - **Erythropoietin** (EPO) → Bone marrow → Red Blood cell Production
- **GI tract** - several
  - Assit digestion and Absorption of nutrients
    - **Cholecystokinin (CCK)** → Helps in digestion + Reduce Aptite.
    - **Secretin** → Regulates gastric Acid, Regulation of pancreatic Bicarbonate + Osmoregulation.
    - **Gastrin** → Enhancing gastric mucosal growth, Gastric Motility + Secretion of HCl into the stomach.
- **Liver** - **insulin-like growth factors (somatomedins)** → Helps in growth + development
- **Skin & Kidneys** - **calcitriol** → Prevent low levels of calcium + Bone Disease.

is used to treat Hypoparathyroidism
metabolic bone disease in people who have chronic kidney failure + not Reciving dailysis.

Protein and Polypeptide Hormones: Synthesis and Release



1. Messenger RNA on the ribosomes of the ER binds amino acids into a peptide chain called a **preprohormone**. The chain is directed into the ER lumen by a **signal sequence** of amino acids.
2. Enzymes in the ER chop off the signal sequence, creating an inactive **prohormone**.
3. The prohormone passes from the ER through the Golgi apparatus.
4. Secretory vesicles containing enzymes and prohormone bud off the Golgi. The enzymes chop the prohormone into one or more active peptides plus additional peptide fragments.
5. The secretory vesicle releases its contents by exocytosis into the extracellular space.
6. The hormone moves into the circulation for transport to its target.

* How do Amino Acid Based Hormones Are produced?

↳ what is the main organelle do you expect to find in the cell?

Ribosomes → On the Rough ER (Attached)

↳ what is the difference between attached and Free Ribosomes? . Free Ribosomes produce proteins that are Required inside the cell.

. Attached Ribosomes produce proteins that are Required to be transported outside the cell.

. Modification of Amino Acid Based Hormones is done inside Golgi apparatus, So for these Hormones they need to be synthysised on the Attached Ribosomes in the Rough ER.

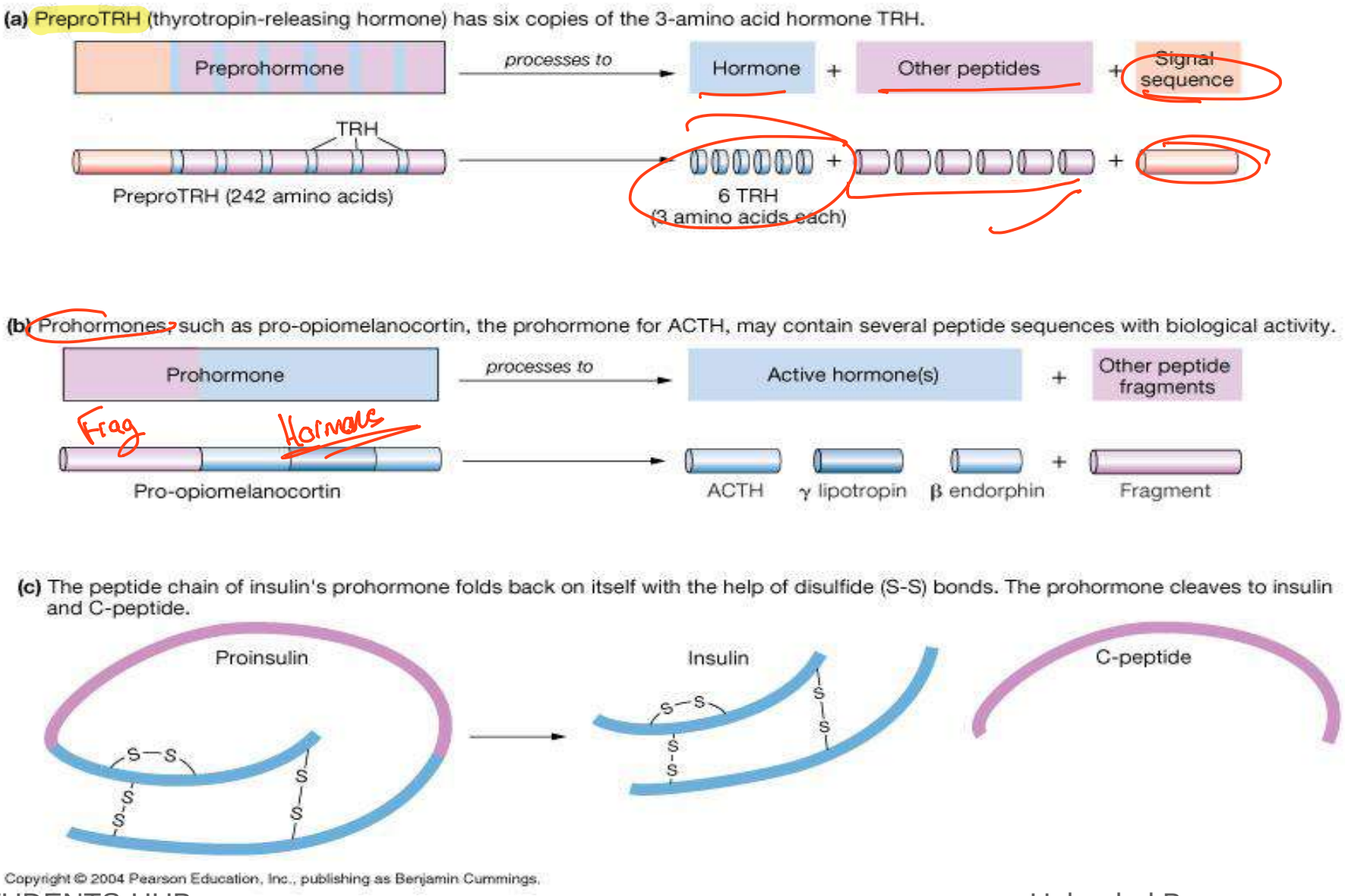
* Once we have a Hormone that is amino acid Based → to be synthysized → MRNA that comes From nucleose → Attached Ribosomes on the Rough ER → Build up the Hormones → untile it goes out in a Vicle → golgi App. for modif. → Exocytosis → goes out to the blood

. Pre pro Hormone → more than 1 part Attached toint → Once it's produced on the Rough ER

A Small peice will be cut of → Signal Sequence →

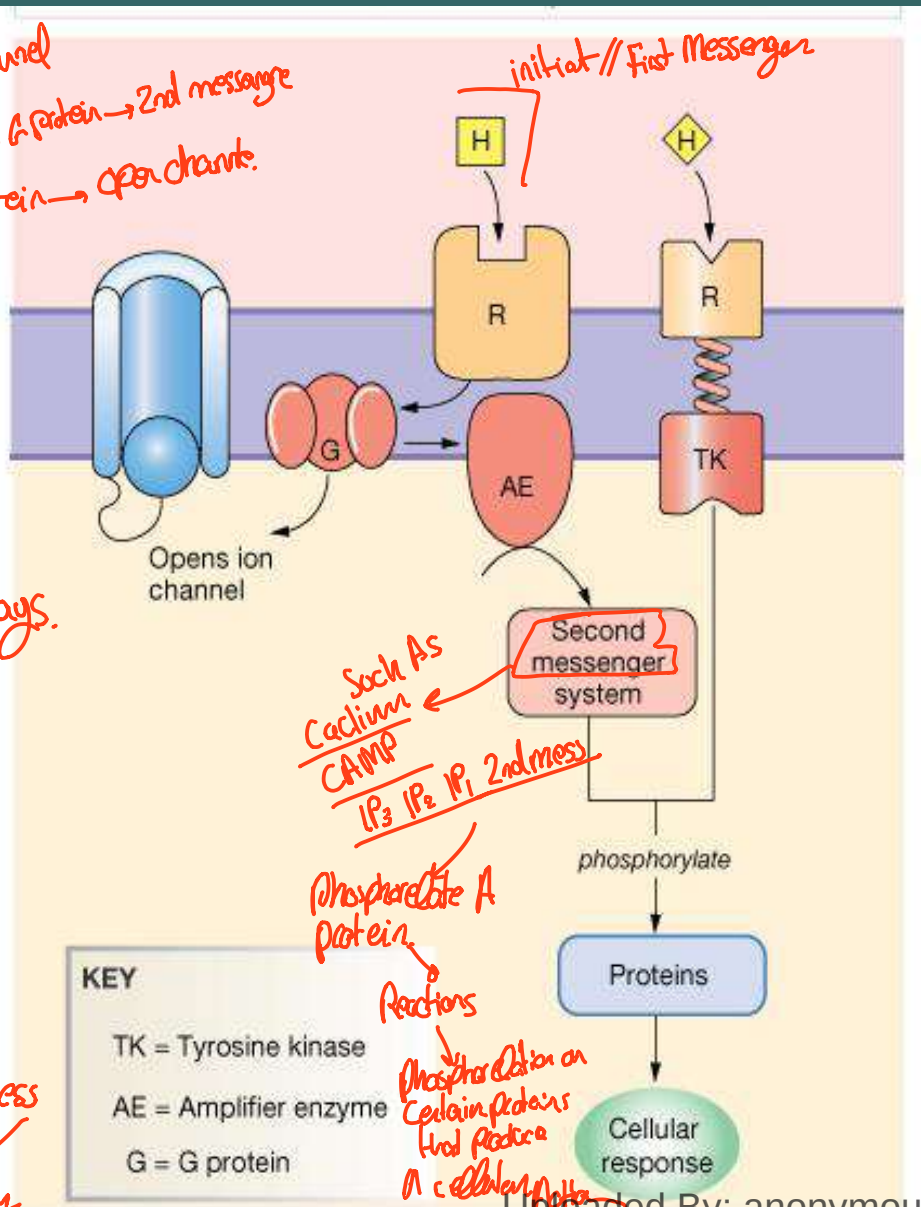
. Diabite → Insuline → Active / not-Active ⇒ So they check for C Fragments → gives indication For the Active insuline. // Pre Pro Hormone Helps in giving indications in many diseases

Peptide hormone processing



Protein and Polypeptide Hormone Receptors

- **Surface receptor**
- Hormone binds
- Transduction
- Enzyme activation
- Open channels
- Second messenger systems
- Synthesis



Steroid Hormones: Structure and Action

Has different Actions

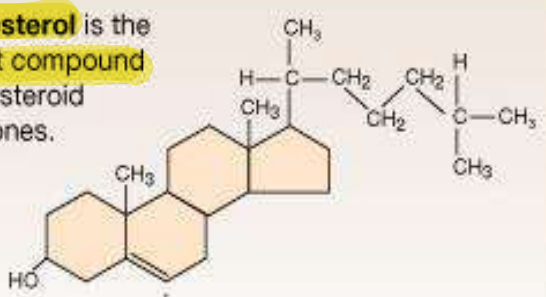
- From cholesterol, lipophilic, enter target cell, (Directly)
- Cytoplasmic or nuclear receptors (mostly)
  - Receptor in Cytoplasm / nucleus → Activate DNA to Produce Protein. (Have Slower Action)
- Activate DNA for protein synthesis
- Slower acting, longer half-life → Their action is slower than the action of Amino Acid Based Hormones. (Peptide Hormone) → Action / Cascade is longer.
- Examples: cortisol, estrogen & testosterone
  - Sex Hormone

Steroid hormones are derived from cholesterol

* Cholesterole is a main component of steroidal Hormones.

→ In Ovaries once Female Ovulates → what left From the cells → granulosa cells → Change their function and start to store cholestrol as much as they can → So it's Ready to Produce estrogen and pigestrone

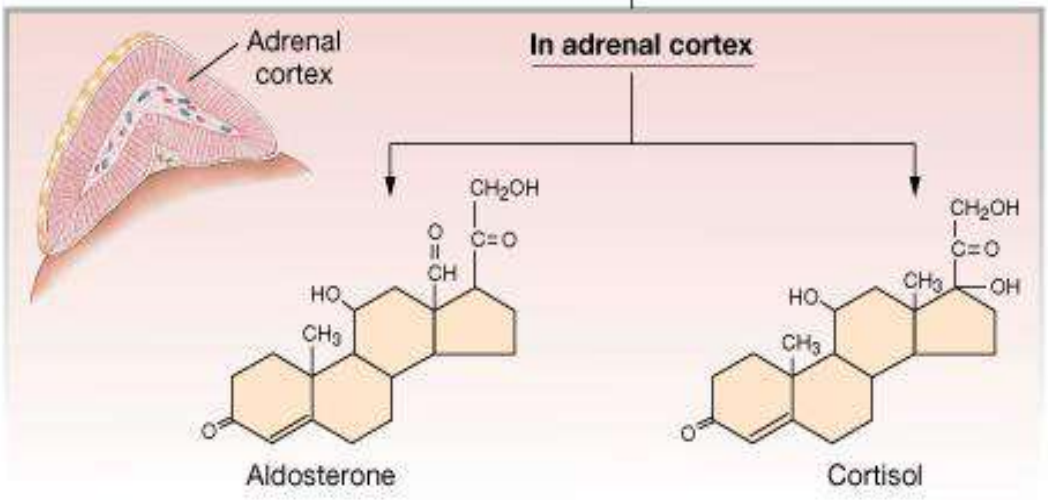
Cholesterol is the parent compound for all steroid hormones.

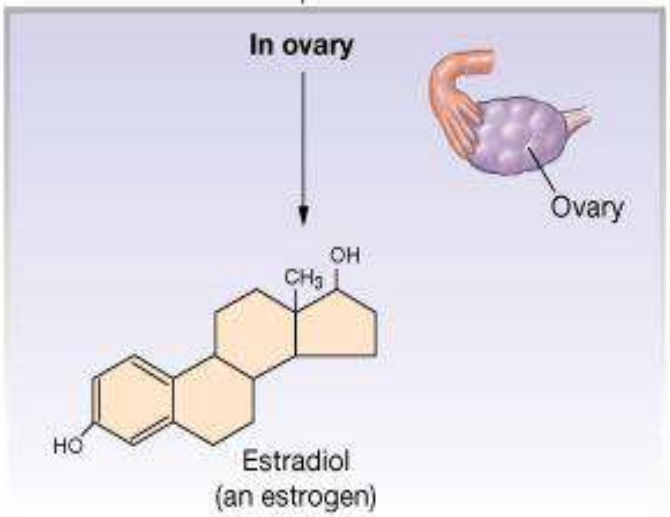


modified by enzymes to make steroid hormones such as

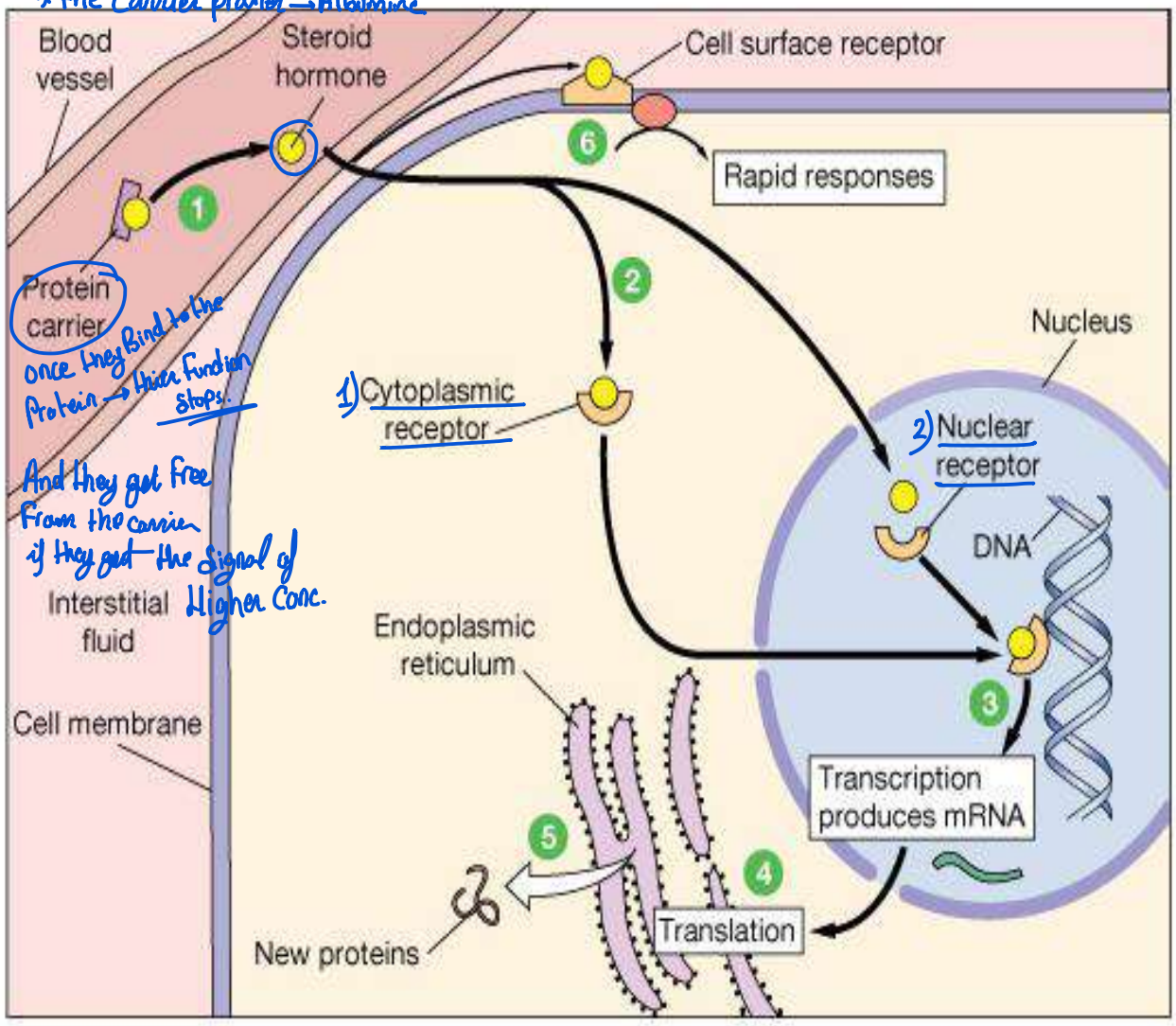
What kind of organelles you expect to find in those cells?

Smooth ER → which Produce lipids + Hydrophobic Compounds





Steroid hormone action



1. Most hydrophobic steroids are bound to plasma protein carriers. Only unbound hormones can diffuse into the target cell.
2. Steroid hormone receptors are in the cytoplasm or nucleus.
3. The receptor-hormone complex binds to DNA and activates or represses one or more genes.
4. Activated genes create new mRNA that moves back to the cytoplasm.
5. Translation produces new proteins for cell processes.
6. Some steroid hormones also bind to membrane receptors that use second messenger systems to create rapid cellular responses.

Amino Acid Based Hormone

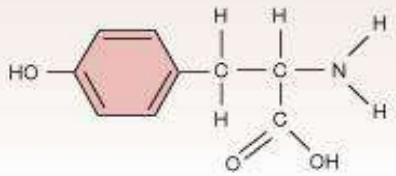
Amine Hormone Structures and Functions

- Made of 1-2 amino acids
- Receptors
  - Surface
  - Intracellular
- Small size, OH group
- Benzine ring
- Examples
  - Thyroxin
  - Epinephrine

* These types are connected together by Tyrosin

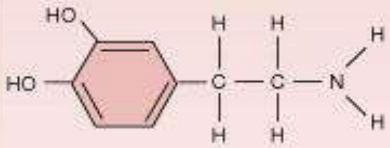
Amine Hormone Structures and Functions

Tyrosine
is the parent amino acid for
catecholamines and thyroid hormones.

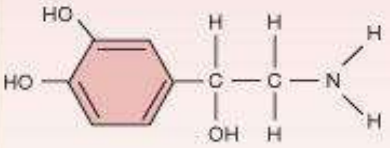


Catecholamines
are made by modifying the
side groups of tyrosine.

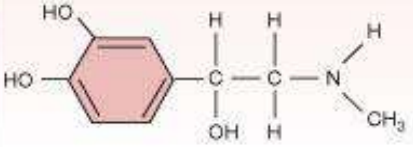
Dopamine, norepinephrine, Epinephrine.



Dopamine



Norepinephrine



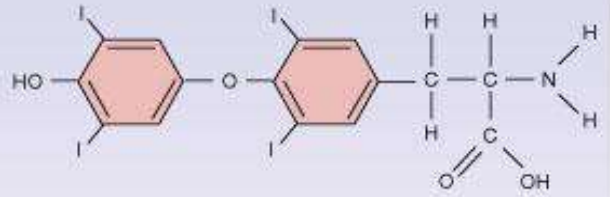
Epinephrine

(their main thing is Tyrosin)

→ Secreted from tyrosin

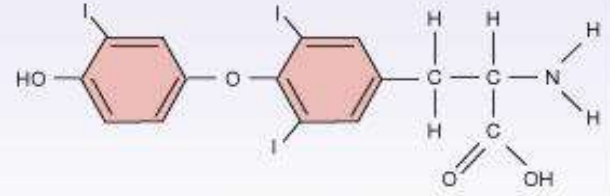
$T_3 + T_4$

Thyroid hormones
are synthesized from two tyrosines
and iodine (I) atoms.



Thyroxine (Tetraiodothyronine, T_4)

From thyroid Gland



Triiodothyronine (T_3)

Comparison of Peptide, Steroid, and Amine Hormones

			AMINES	
	PEPTIDE HORMONES	STEROID HORMONES	CATECHOLAMINES	THYROID HORMONES
Synthesis and storage	Made in advance; stored in secretory vesicles	Synthesized on demand from precursors	Made in advance; stored in secretory vesicles	Made in advance; precursor stored in secretory vesicles
Release from parent cell	Exocytosis	Simple diffusion	Exocytosis	Simple diffusion
Transport in blood	Dissolved in plasma	Bound to carrier proteins	Dissolved in plasma	Bound to carrier proteins
Half-life	Short	Long	Short	Long
Location of receptor	On cell membrane	Cytoplasm or nucleus; some have membrane receptors also	On cell membrane	Nucleus
Response to receptor-ligand binding	Activation of second messenger systems. May activate genes	Activate genes for transcription and translation. May have nongenomic actions	Activation of second messenger systems	Activate genes for transcription and translation
General target response	Modification of existing proteins and induction of new protein synthesis	Induction of new protein synthesis	Modification of existing proteins	Induction of new protein synthesis
Examples	Insulin, parathyroid hormone	Estrogen, androgens, cortisol	Epinephrine, norepinephrine	Thyroxine (T_4)

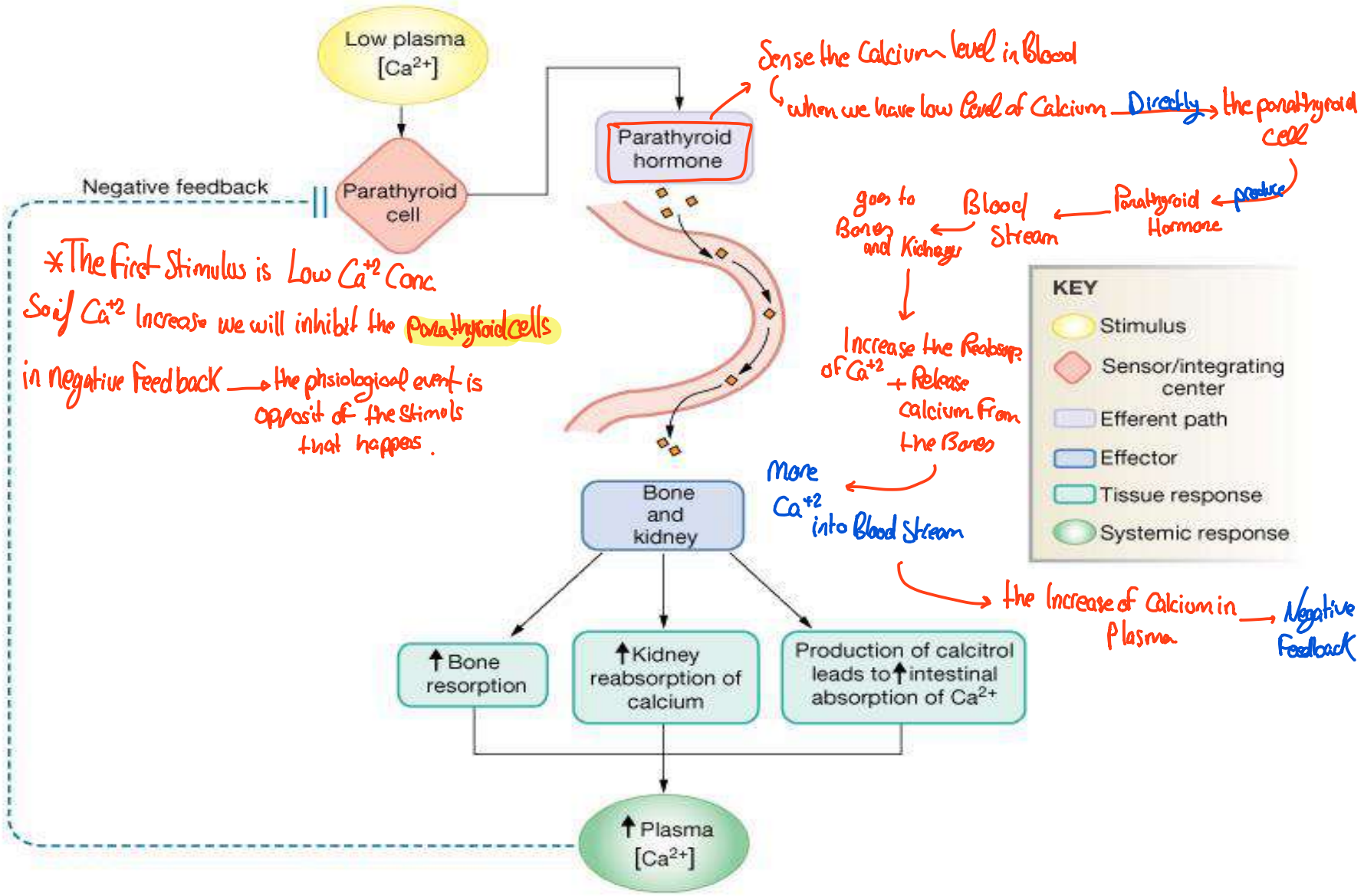
Endocrine Reflex Pathways: Overview

What's the pathway for the Hormone? Any Hormone to be Activated we have to have a stimulus. → For insulin to be Produced (Increase in Blood Sugar)
→ For Glucagon to be Produced (Decrease in Blood Sugar)

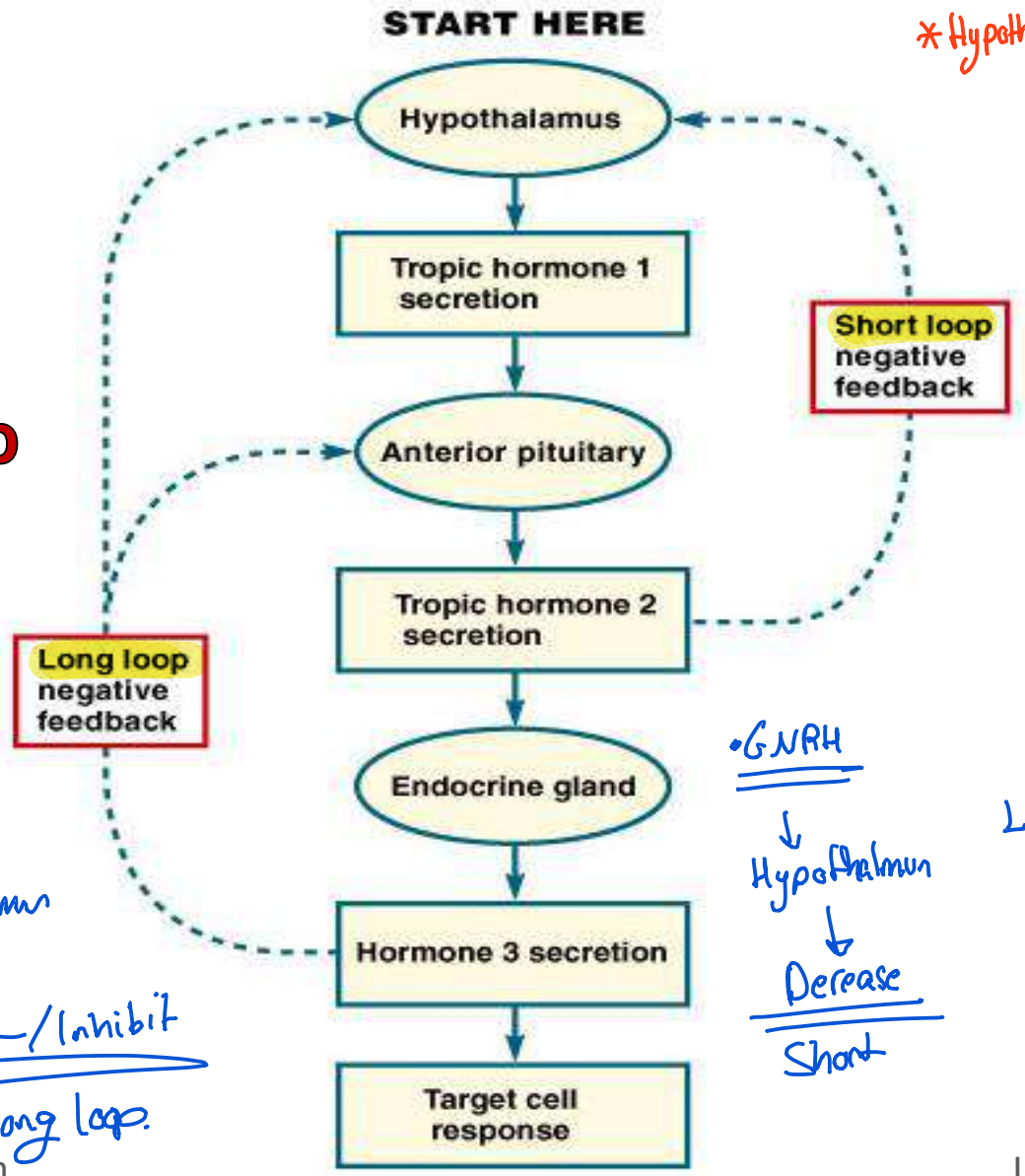
- **Stimulus** (Increase in Blood Sugar)
- **Afferent signal**
- **Integration** (Integration Center → Pancreas)
- **Efferent signal (the hormone)** β cells
- **Physiological action** → Exocytosis of vesicle containing insuline
- **Negative feedback** → The Action.

*Insulin is a good example for negative feedback discuse? When Blood Sugar Rises → Receptors in the Body Sense the Change → the Control center (Pancreas) Secrets insulin into the Blood Effectively lowering Blood Sugar level.

A simple endocrine reflex: Parathyroid hormone



Negative Feedback Loops



Long Loop Reflexes

Short Loop Reflexes

* Hypothalamus Produces a Hormone (Trophic Hormone)
Anterior Pituitary Gland
2nd Tropic Hormone
Produce
Endocrine Gland → Hormone
Target

Example:

- Test.
↓
Hypothalamus
↓
Decrease / Inhibit
Long loop

- GNRH
↓
Hypothalamus
↓
Decrease
Short

GNRH
↓
Pituitary
LH + FSH
↓
Gonads (ovaries)
↓
Progestron
Estrogen

* An Increase of insulin causes a decrease in Blood Sugar and the opposit.
↳ Short + Direct loop for Negative Feedback.

Tropic Hormone. Tropic Hormone

- Hypothalamus Secrete → A Hormone (GnRH) stimulate → Pituitary Gland (LH, FSH) → Gonads Release → Test, estrogen, progesterone

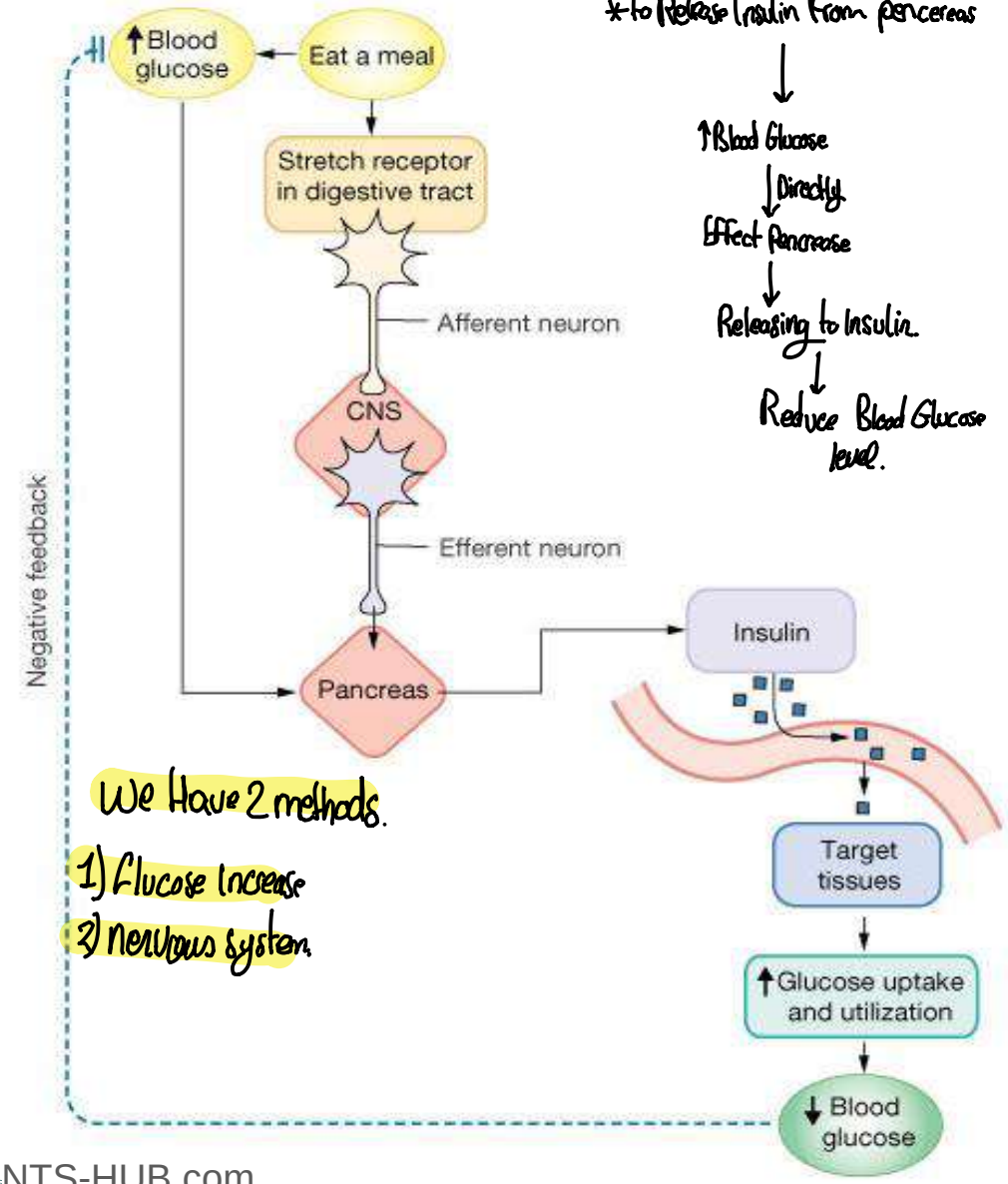
Increase in Test. → Anterior Pituitary to Reduce the Release of LH and FSH

× Effect the Release of GnRH From the Hypothalamus.

Long loop ←

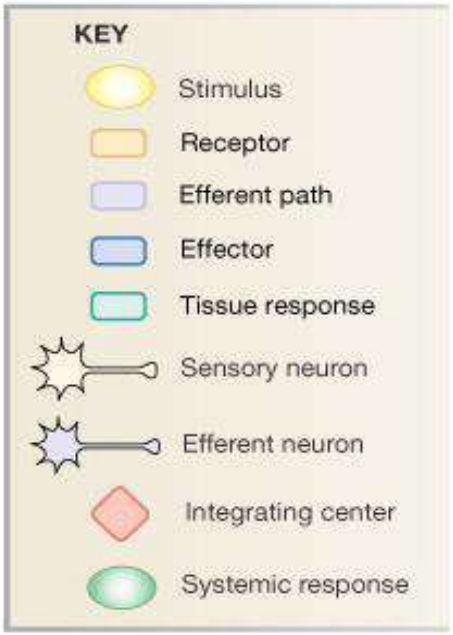
- FSH + LH → Can effect the Release of GnRH From the Hypothalamus
Short loop.

Endocrine Reflex Pathways: multiple stimuli

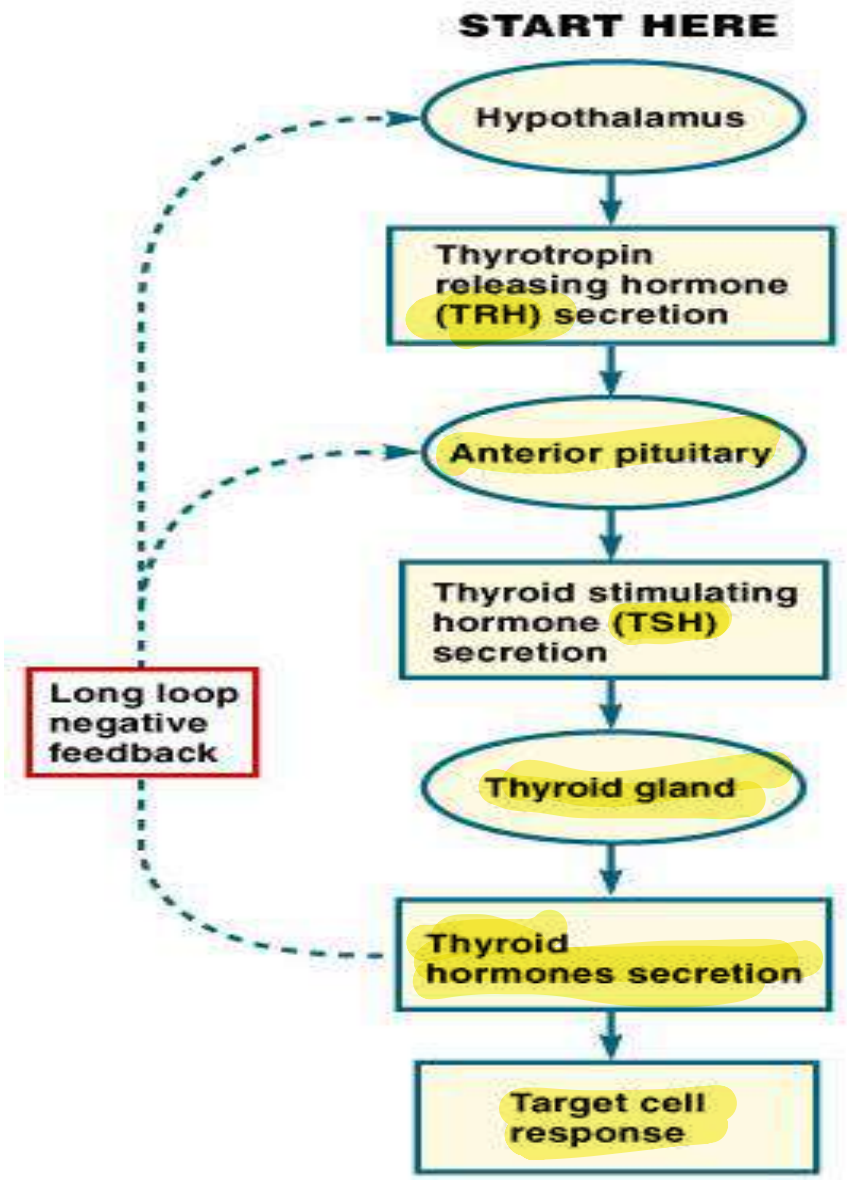


*to Release Insulin From pancreas
↓
↑Blood Glucose
↓Directly
Effect Pancreas
↓
Releasing to Insulin
↓
Reduce Blood Glucose level.

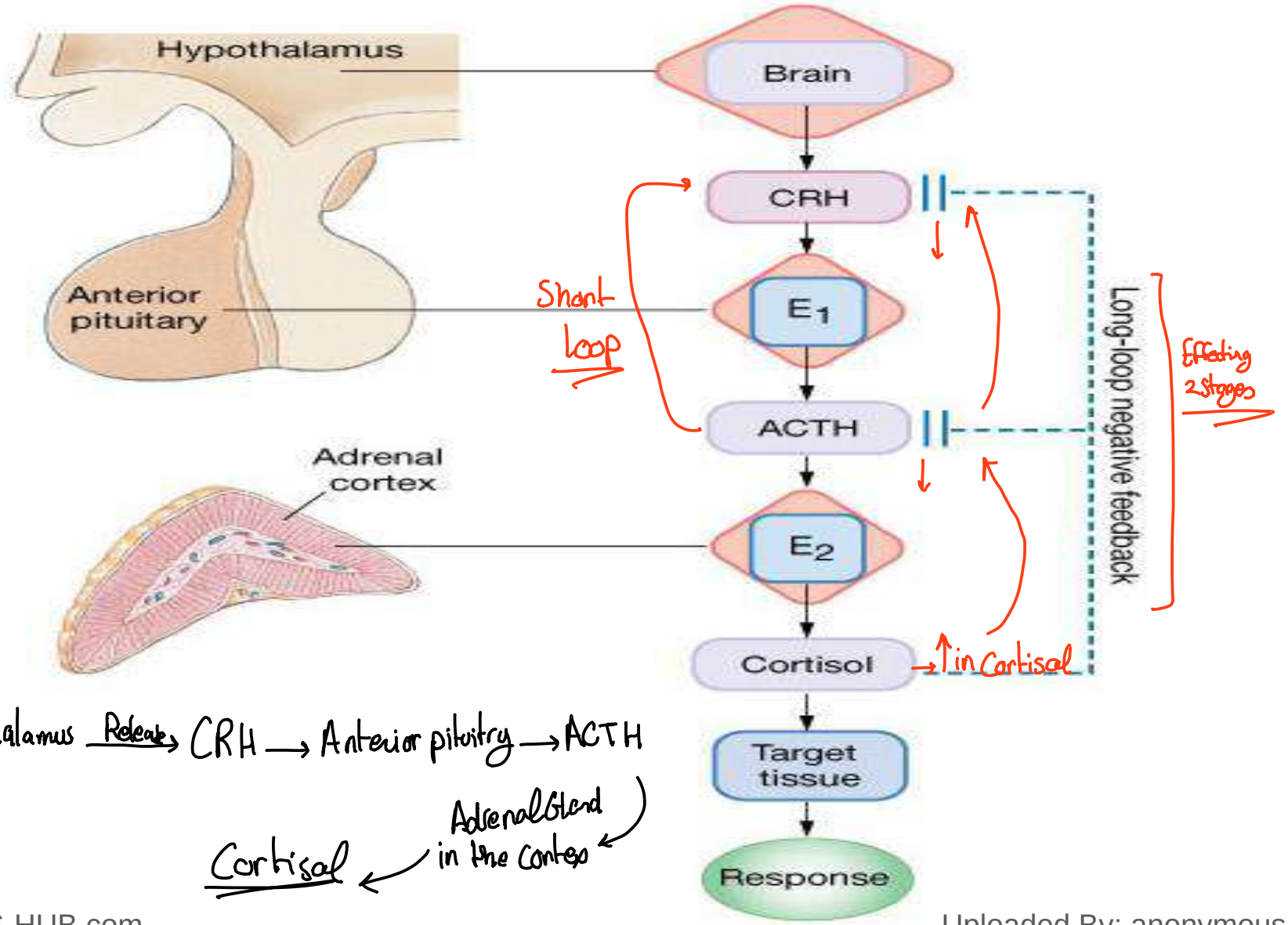
We Have 2 methods.
1) Glucose Increase
2) nervous system.



Example of Negative Feedback Control: Thyroid Hormones



Negative Feedback Controls
Long & Short Loop Reflexes



Tropic Hormones

Affect release of another hormone

- **Releasing hormones**
- **Inhibiting hormones**

Common Tropic Hormone Pathway

1. Hypothalamus secretes releasing or inhibiting hormone into capillary bed
2. Blood with tropic hormones enters portal vein
3. Hypothalamic tropic hormones access anterior pituitary secretory cells through capillary beds
4. Alter release of anterior pituitary tropic hormones
5. Anterior pituitary tropic hormones enter bloodstream in same capillary bed
6. Travel to distant endocrine gland to trigger release of hormone

Control of Hypothalamic Tropic Hormone Release

→ How to Control?

- **Neural input** → As for example the stretch in the stomach
- **Hormonal - negative feedback** → ↑Hormone → event → normal → negative feed back for the event.
- **Circadian rhythm** → sleep + wake up cycle
  - **Suprachiasmatic Nucleus of Hypothalamus**

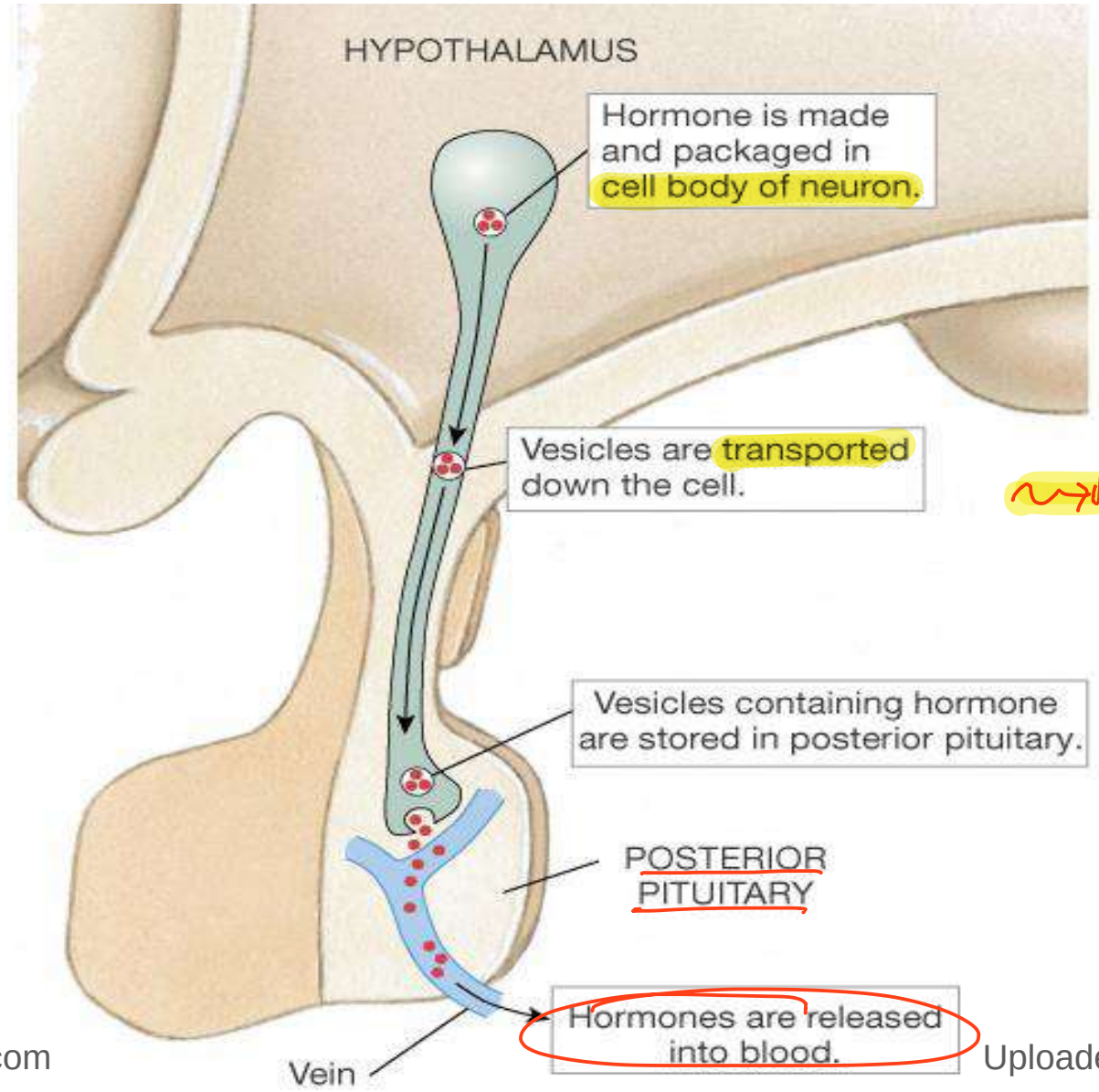
Neurohormones
secreted into the Blood by Neurons

Another type of Hormones → Released to the blood But they are Produced From neurons cell.

Oxytosin
Vasopressin (ADH)
From the hypothalamus

- **Adrenal Medulla–catecholamines**
- **Hypothalamus to:**
  - **Anterior pituitary**
    - **Trophic Hs** ✓
    - **Growth H.** ✓
    - **Prolactin** ✓
  - **Posterior pituitary**
    - **Vasopressin** ✓
    - **Oxytocin** ✓

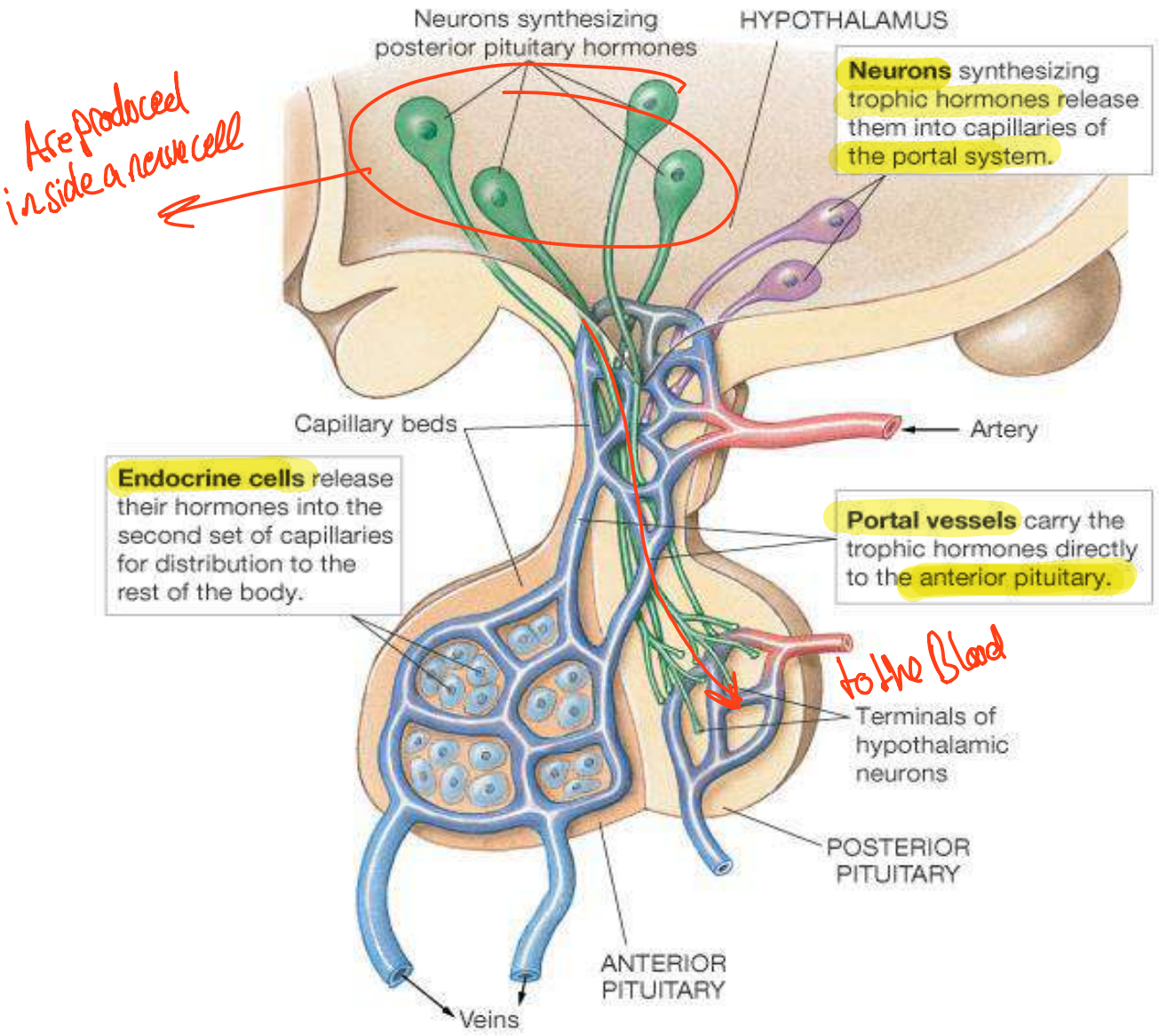
Neurohormones
secreted into the Blood by Neurons



Posterior Pituitary.

→ neurohormone

The hypothalamic-hypophyseal portal system



Endocrine Control

Stimulation that comes from higher area (Hypothalamus)

Pituitary level

Endocrine Gland Level.

- **Three Levels of IntegrationThree Levels of Integration**
- **Hypothalamic stimulation–from CNS**
- **Pituitary stimulation–from hypothalamic trophic Hs**
- **Endocrine gland stimulation–from pituitary trophic Hs**

.We have an endocrine gland Release → X Horman

↓

was Released Because of a Stimulus.

Ex: → Low level of calcium (Calcitonine + PTH) Release

↓

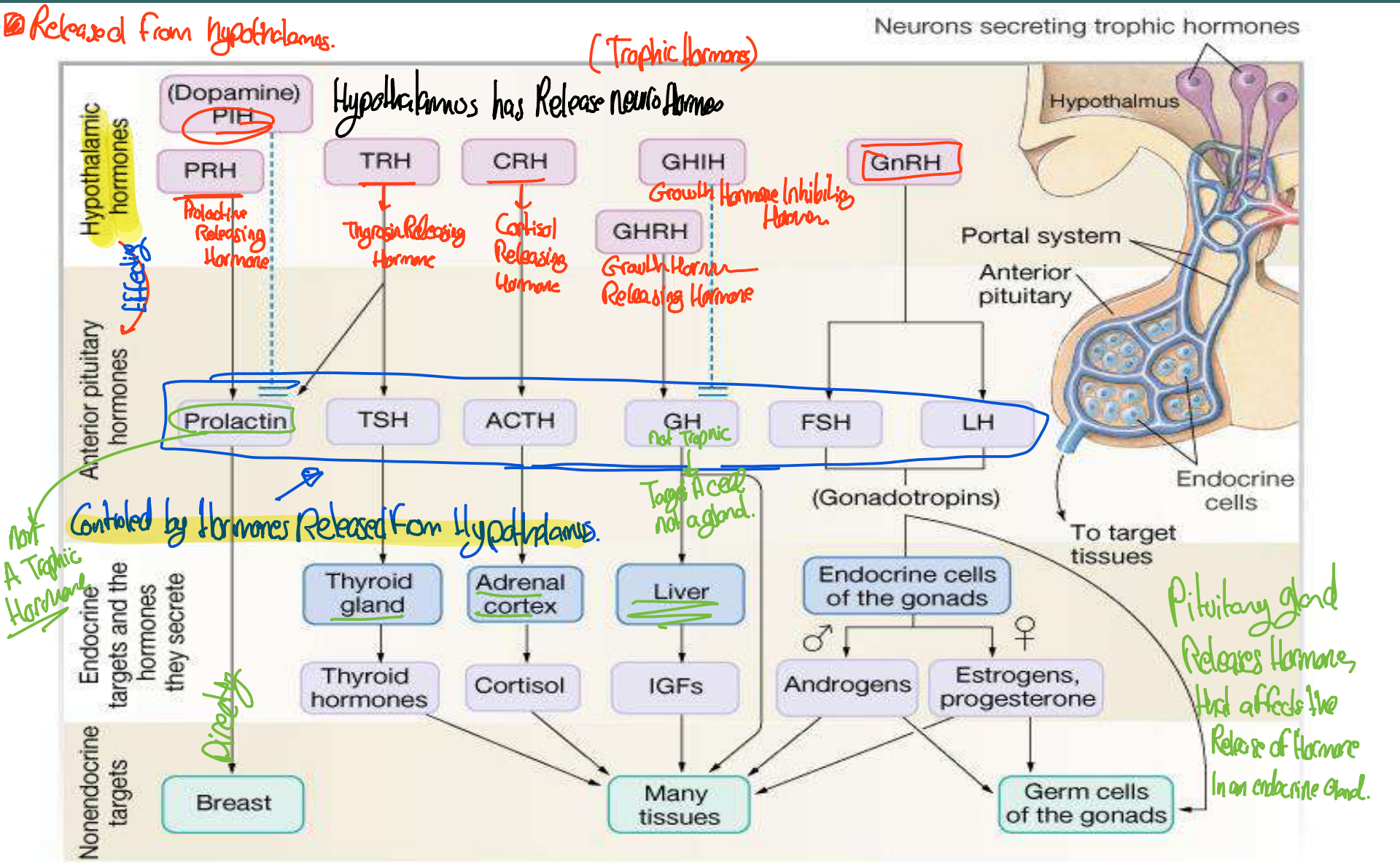
Humoral Stimulus / Electrolite level effect the Release of Horman

Ca^{+2} Release from bones → ↑Ca^{+2} → Negative FeedBack

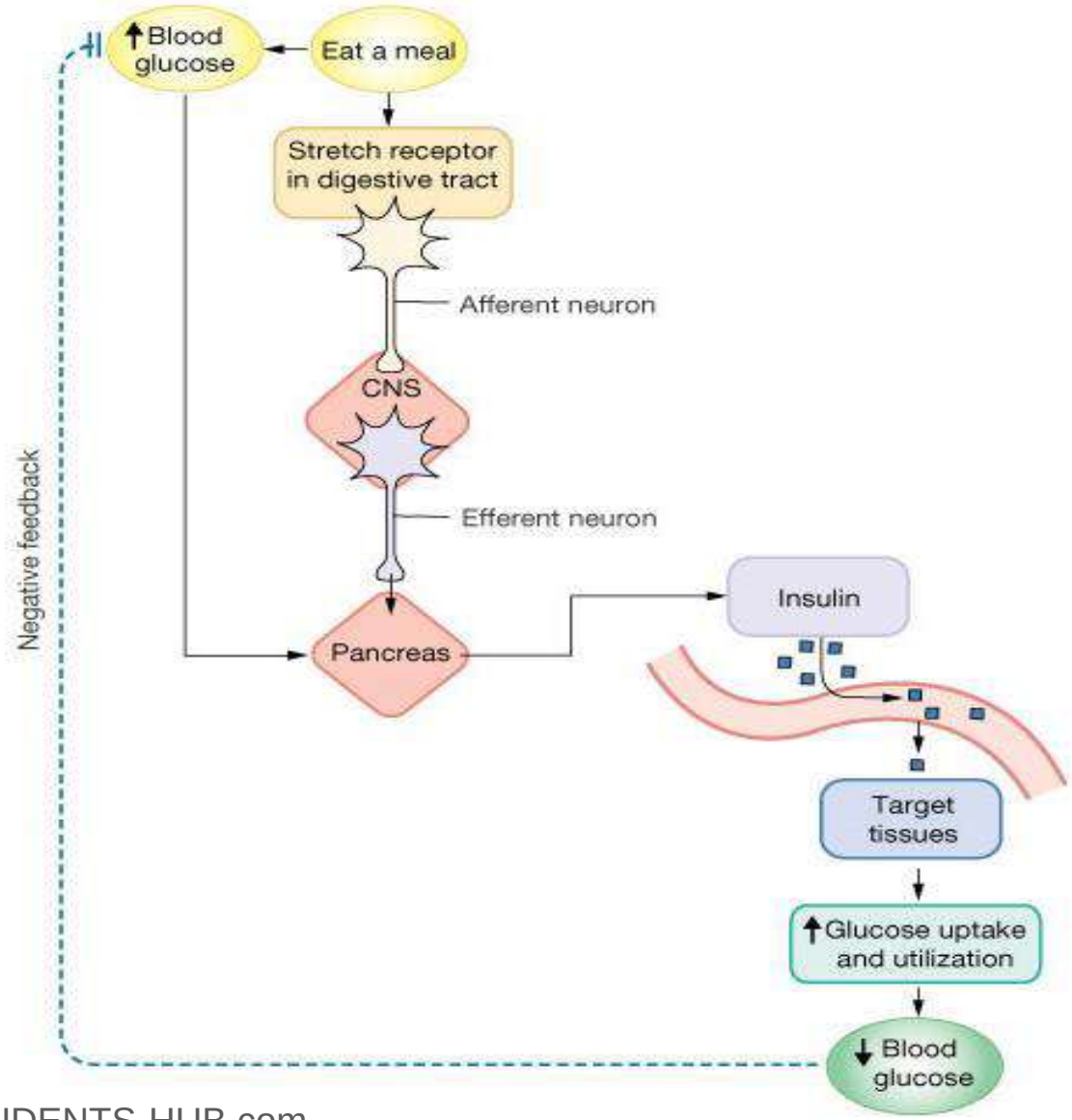
↓

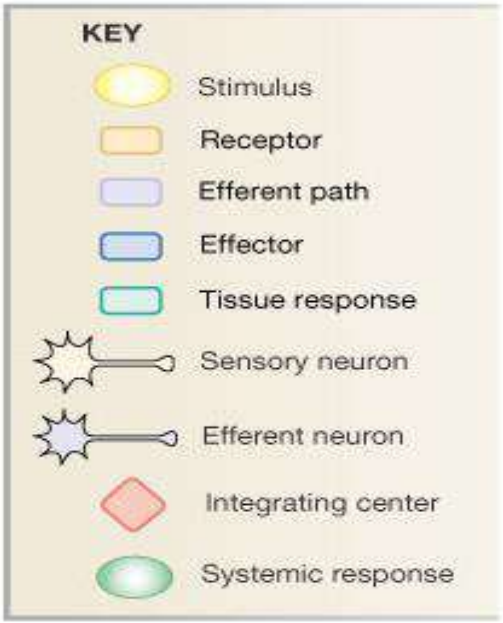
Stop the Release of the Hormone

Endocrine Control: Three Levels of Integration



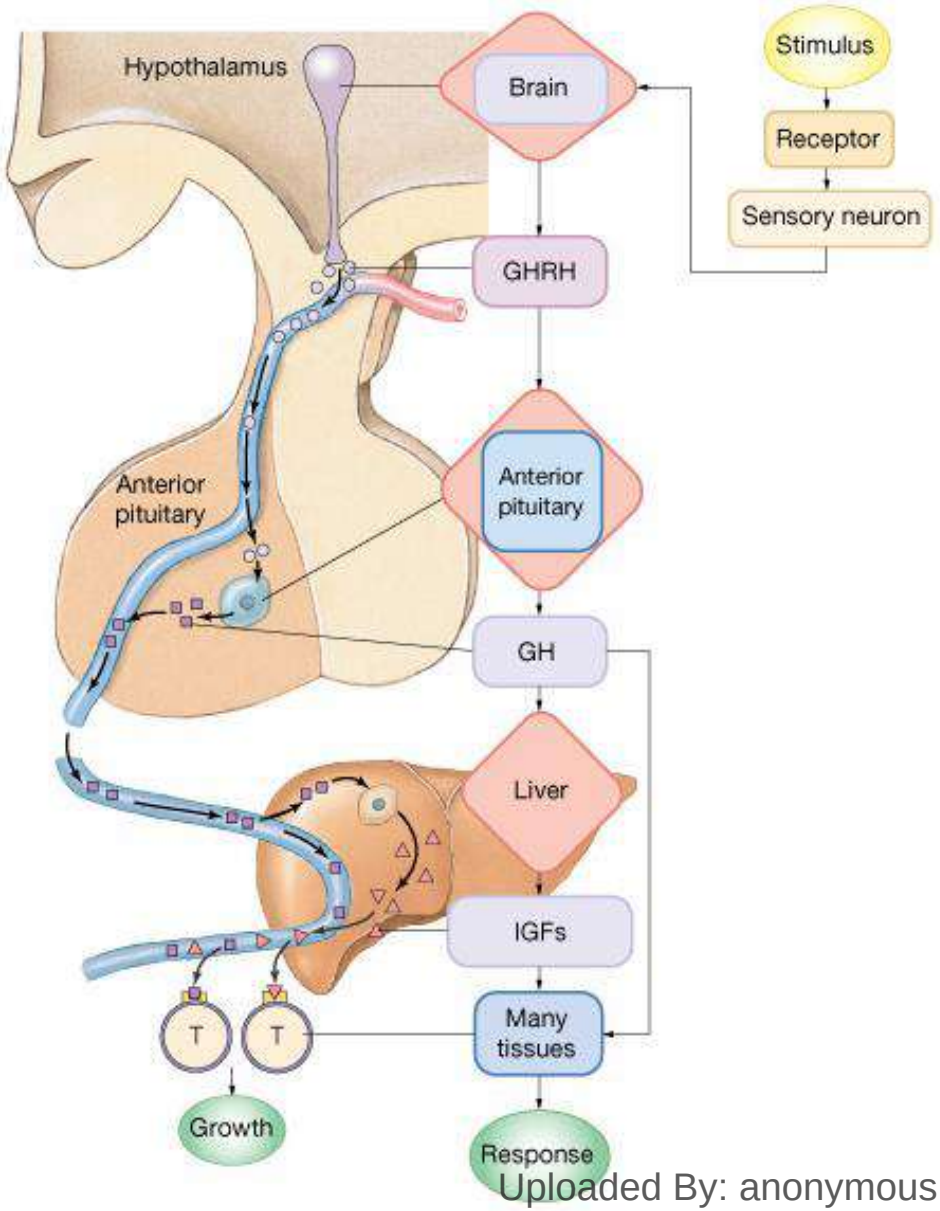
Multiple Stimuli for Hormone Release: Nervous & Endocrine





Multiple Hormones Can Target a Cell/Tissue

- **Growth H**
- **Somatomedins**
- **Thyroxin**
  - **All have receptors on many tissues**
  - **Stimulate pathways for growth**



Hormone Interactions

*Hormones do interact with each other → they do:

- **Antagonism**
- **Additive**
- **Synergism**
- **Permissiveness**

Antagonism

Effects of two hormones oppose each other

if one increase the other decrease

Higher Blood Sugar conc

Example: insulin and glucagon on blood glucose

lower Blood Sugar

3) Additive

We have more than one type of Growth Hormones → they add up together

Effects of two hormones favor each other and sum

Does the sumation of effect.

Synergism

One Hormone Increases the Level of

effects of two hormones favor each other but the net effect exceeds the sum of individual effects

Example: Glucagon, cortisol, and epinephrine on blood glucose

7 8

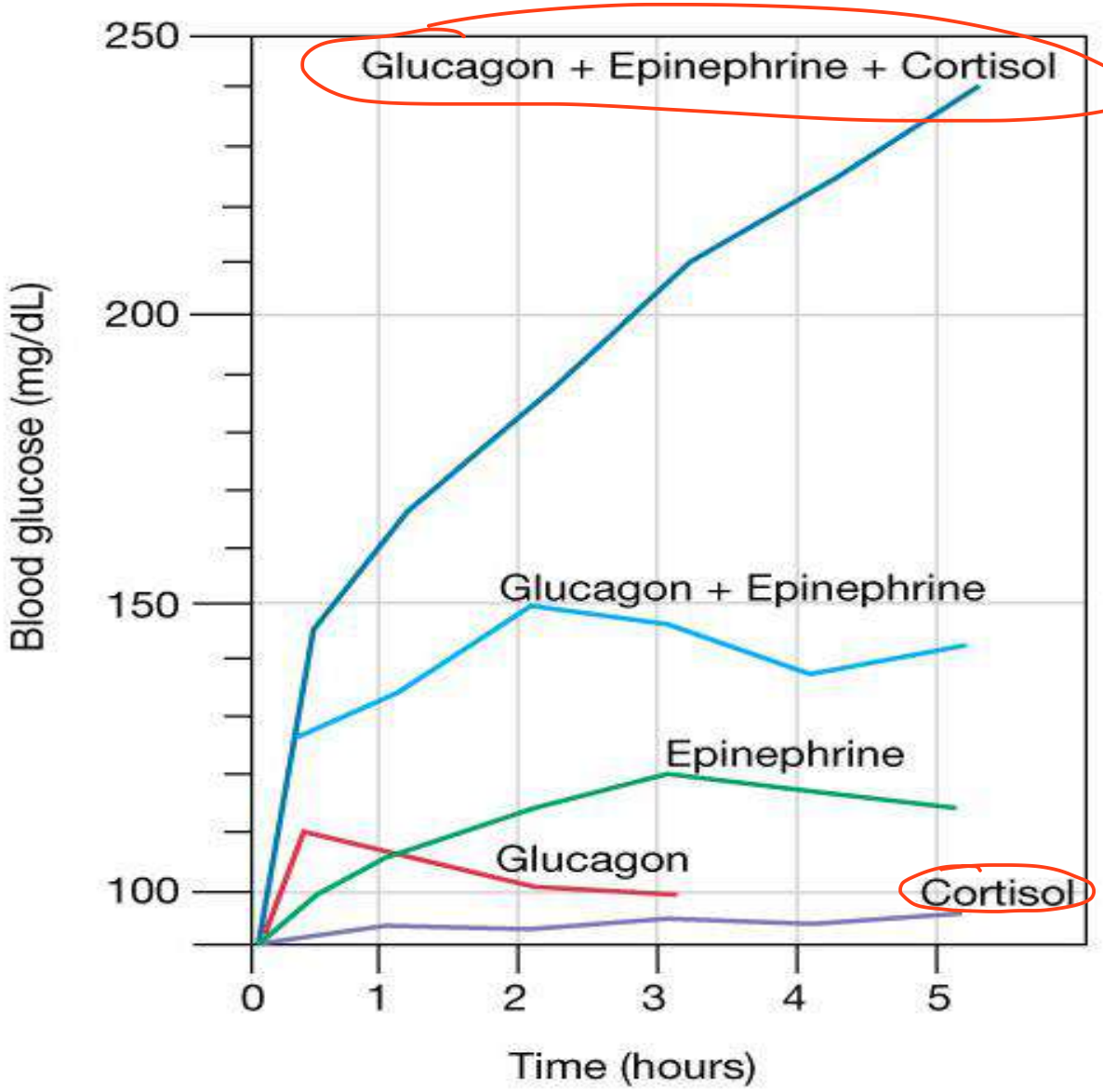
4 Increase

if I Release gl Cor Ep what will be the Blood Sugar?

↳ 19: Additive ∝

↳ One Inhance the Release of another one.

Synergism



All together

Massive increase

بكل حاجه بزيد من فاعلية التانى

Permissiveness

The Release of Hormon effect the Release of other Hormones.

One hormone needed for another to exert its effects

Cause the production of Receptors.
↗ where Adrenaline should Bind.

if Adrenaline was there without Receptors there will be no effects

Example 1: Thyroid hormones cause expression of adrenergic receptors in bronchiolar smooth muscle

Example 2: Estrogen causes expression of progesterone receptors in uterus

Pathologies

- "NO BAD HORMONES – JUST TOO MUCH OR TOO LITTLE"

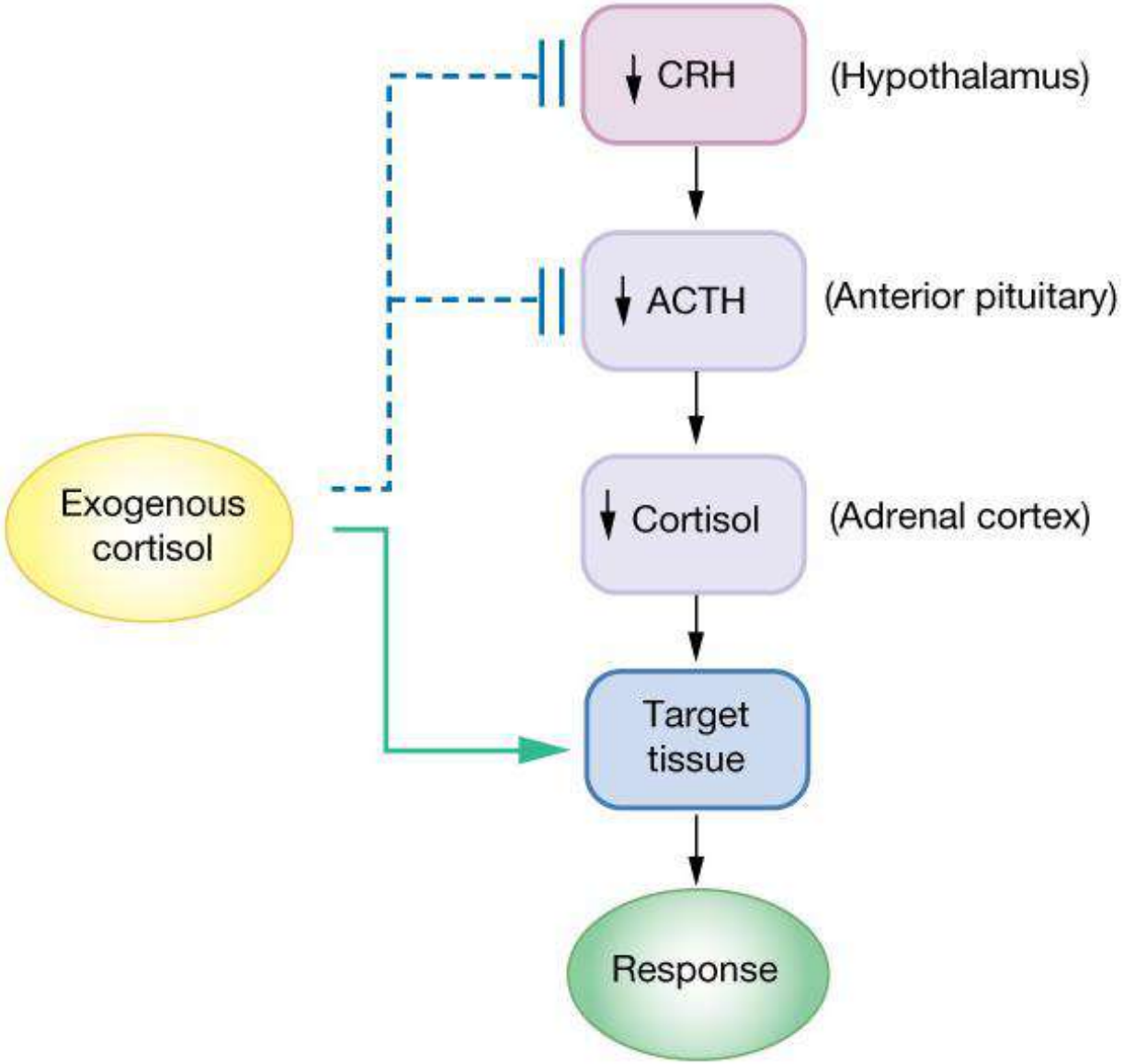
- Exogenous medication
  - Replaces & exceeds normal
  - Cause atrophy of gland
- Hypersecretion: too much
  - Tumors or cancer
  - Grave's disease- thyroxin (T4)
- Hyposecretion: too little
  - Goiter – thyroxin (T4)
  - Diabetes – insulin

↳ Abnormalities.

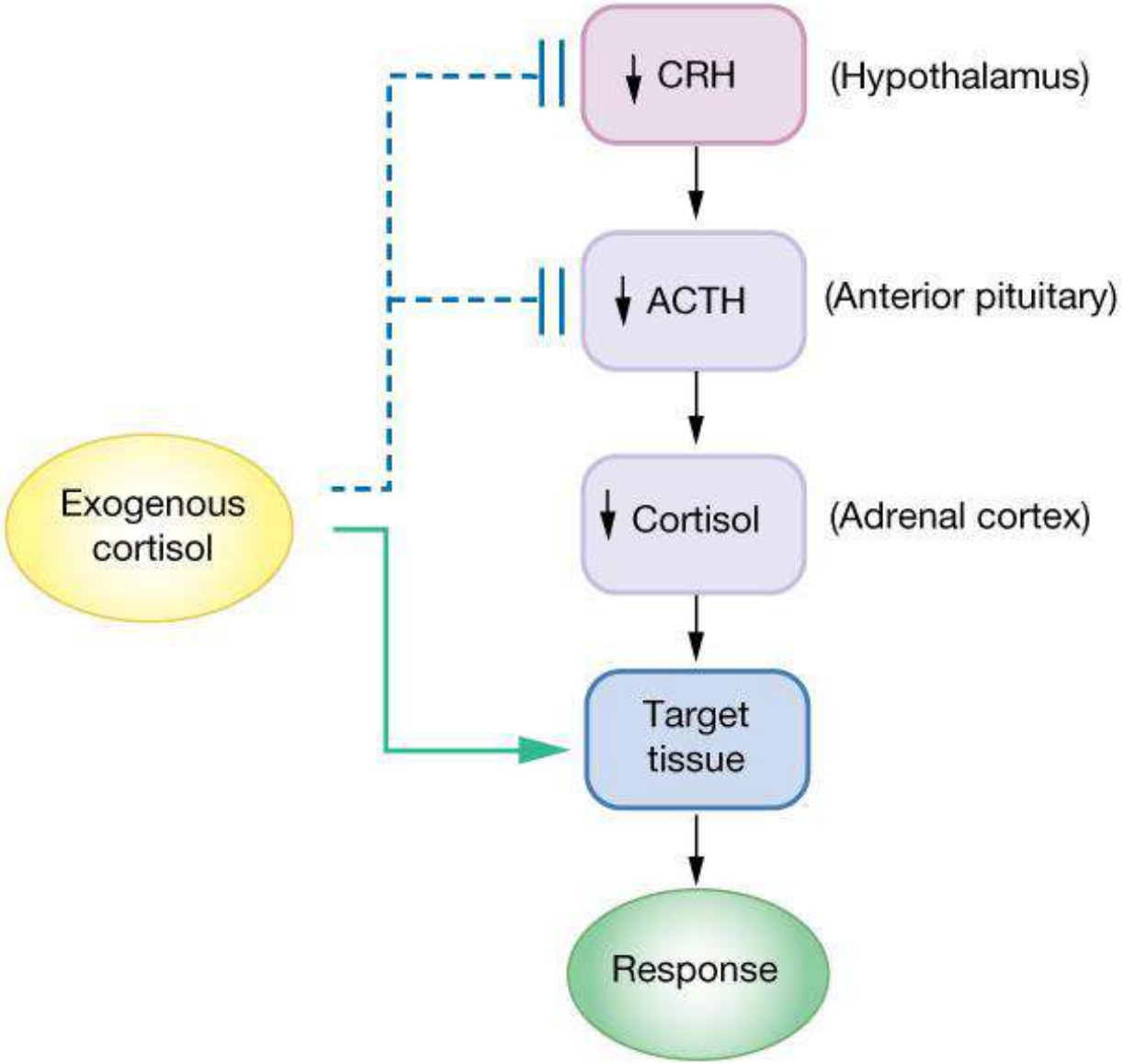
Hypersecretion OR Hyposecretion

↳ Dead cells → No insulin → Exogenously for insulin

Pathologies: Over or Under Production



Pathologies: Over or Under Production



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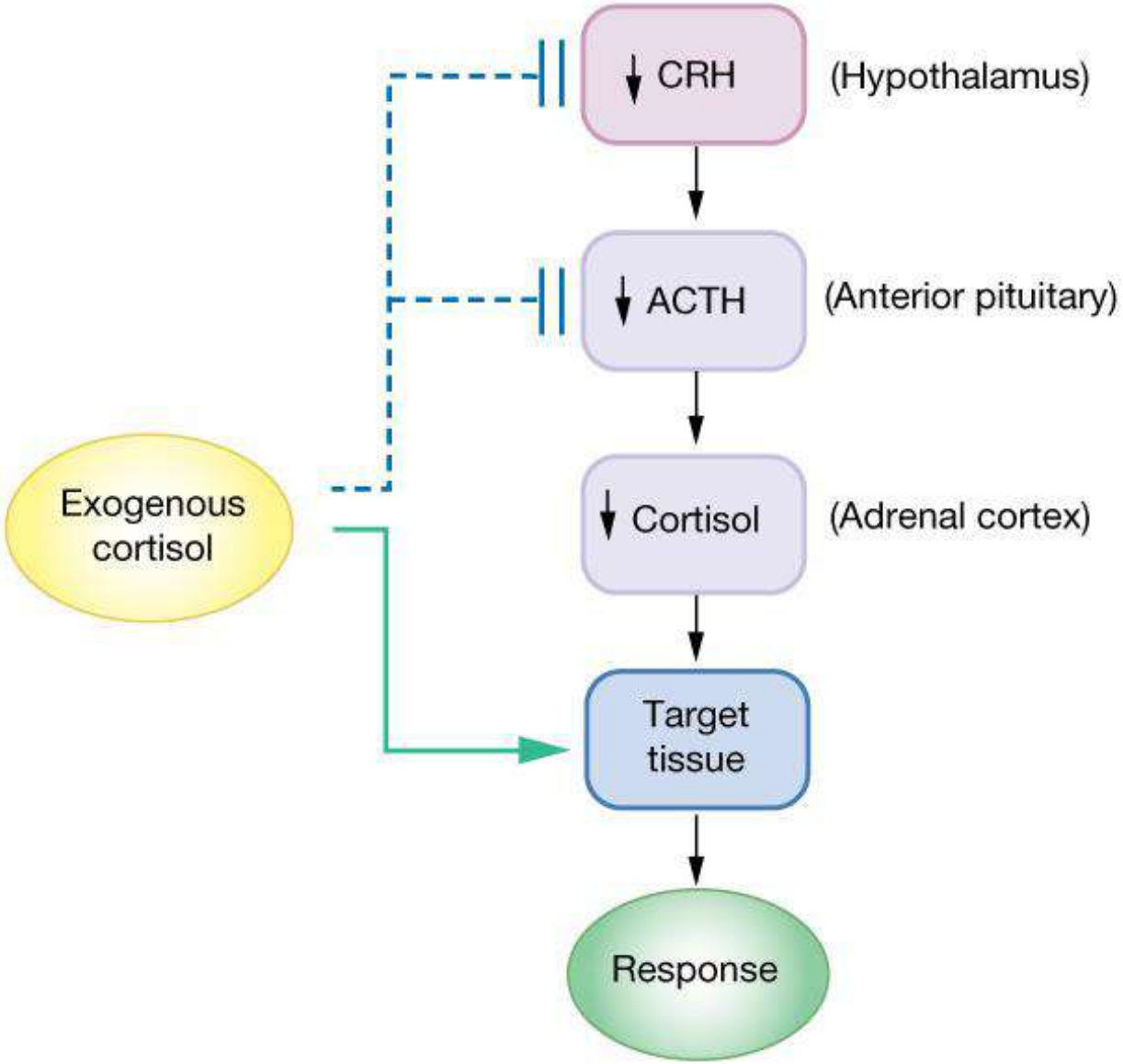

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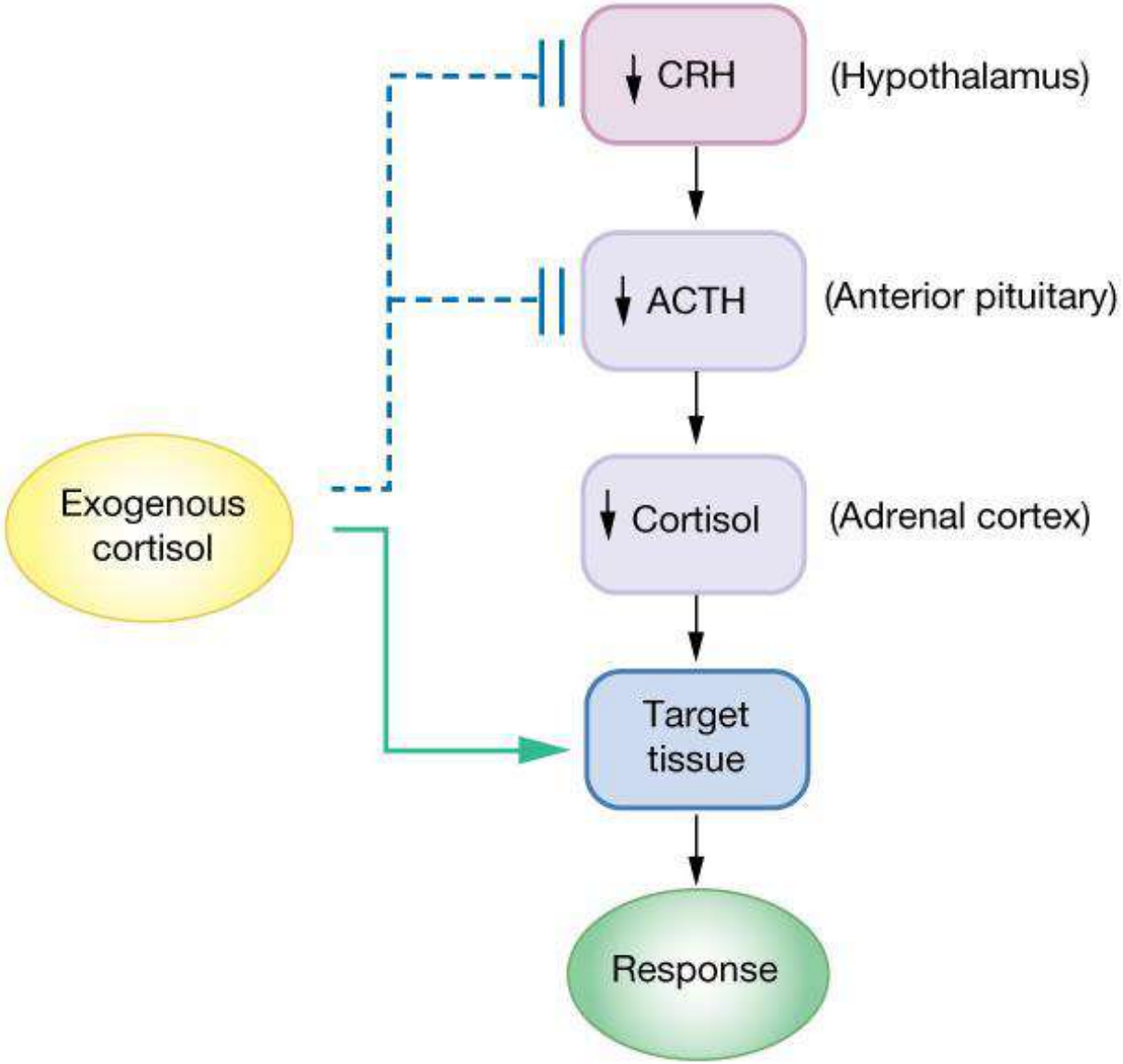

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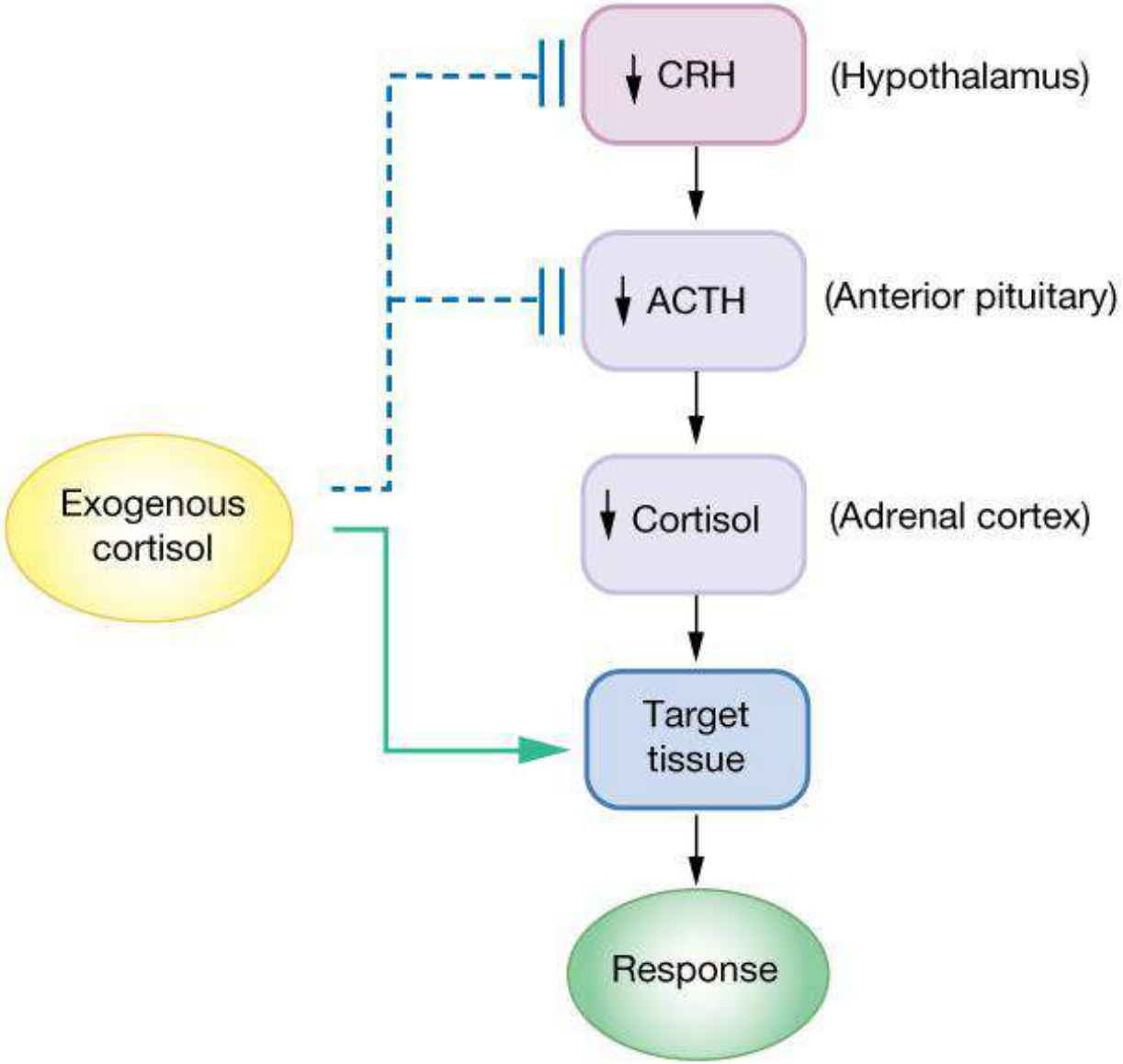

Pathologies: Over or Under Production