ENDOCRINE SYSTEM

Anatomy & Histology
Lec. 1

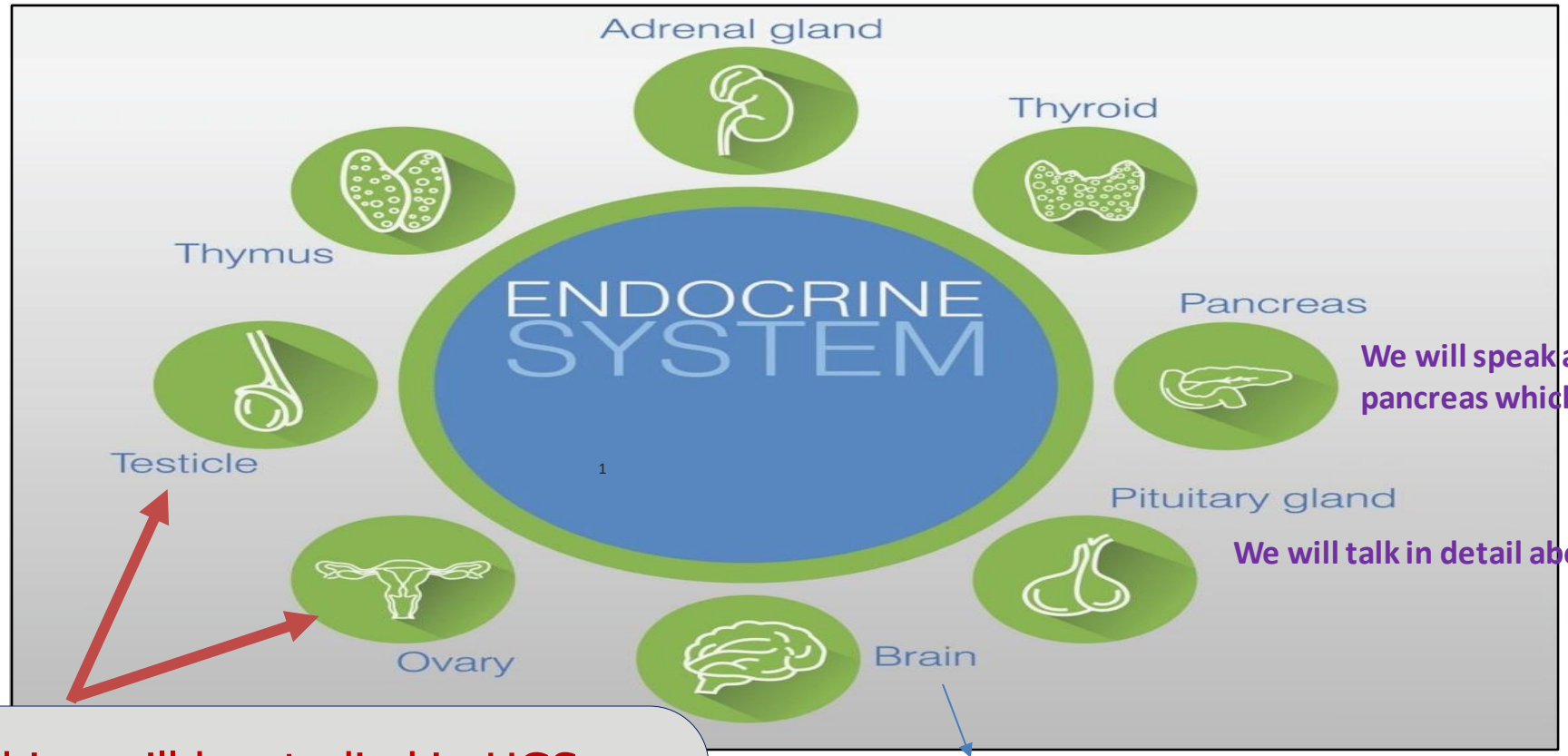
WRITER: Omar anazeh, Abdallah Aburoman

CORRECTOR: Shahd Alahmad

DOCTOR: GHADA ABU ALGHANAM

ما ينطق به الدكتور من شرح سيكون باللون الاحمر
وما يكون مهم في شرح الدكتور يكون باللون البنفسجي
ما يكون مهم في السلايدات يكون بخطين أو بخط

This diagram shows you all tissue that do perform hormone secretion



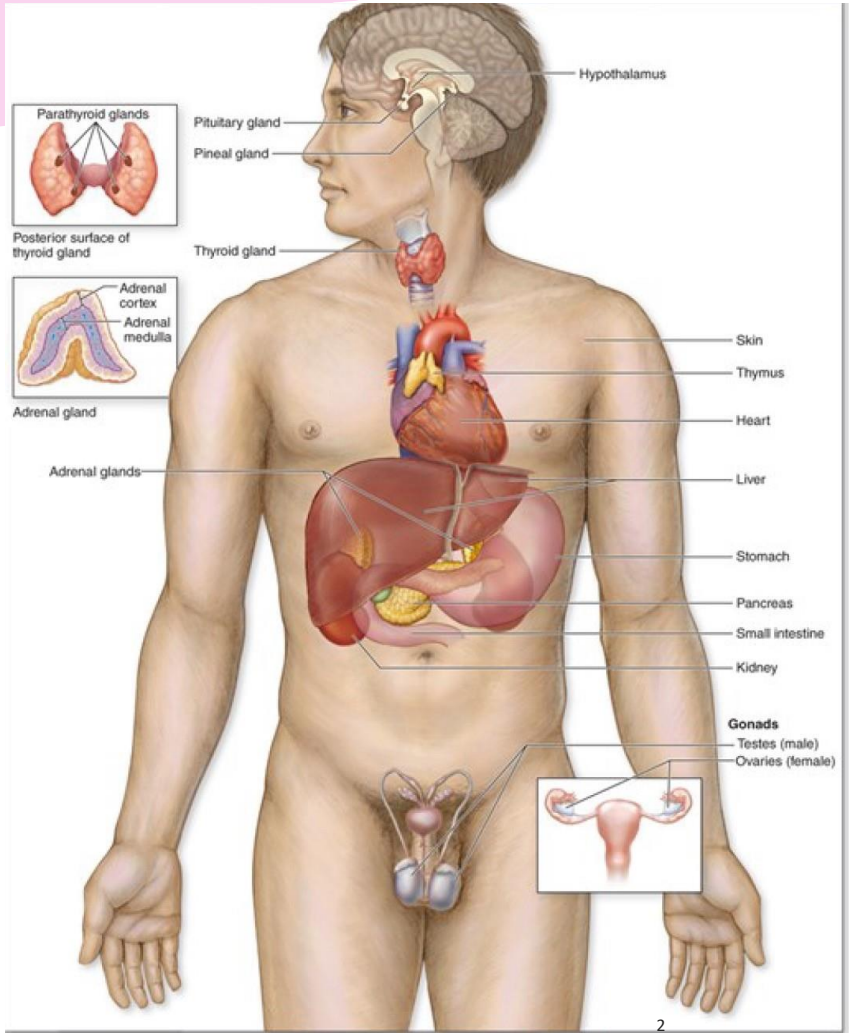
We will speak about "endocrine part" of pancreas which is an extremely small part of it.

We will talk in detail about pitutary

We will talk about the part of the brain that is involve in endocrine which is the **hypothalamus**.

These thing will be studied in UGS However, we just gonna mention tow hormones they are secreted from pituitary gland which will act at one of these two gonads.

Endocrine Glands



- Pituitary
- Pineal
- Thyroid
- Parathyroid
- Adrenal (suprarenal)

→ These ones are Solely endocrine glands or tissue

BUT the following glands; only part of their function is endocrine secretions:

Hypothalamus: they are nervous tissue, just small part of them work as endocrine tissue, in fact it is the master of endocrine system, that is the one oversees the function of the endocrine system.

Thymus: cell lymphoid organ

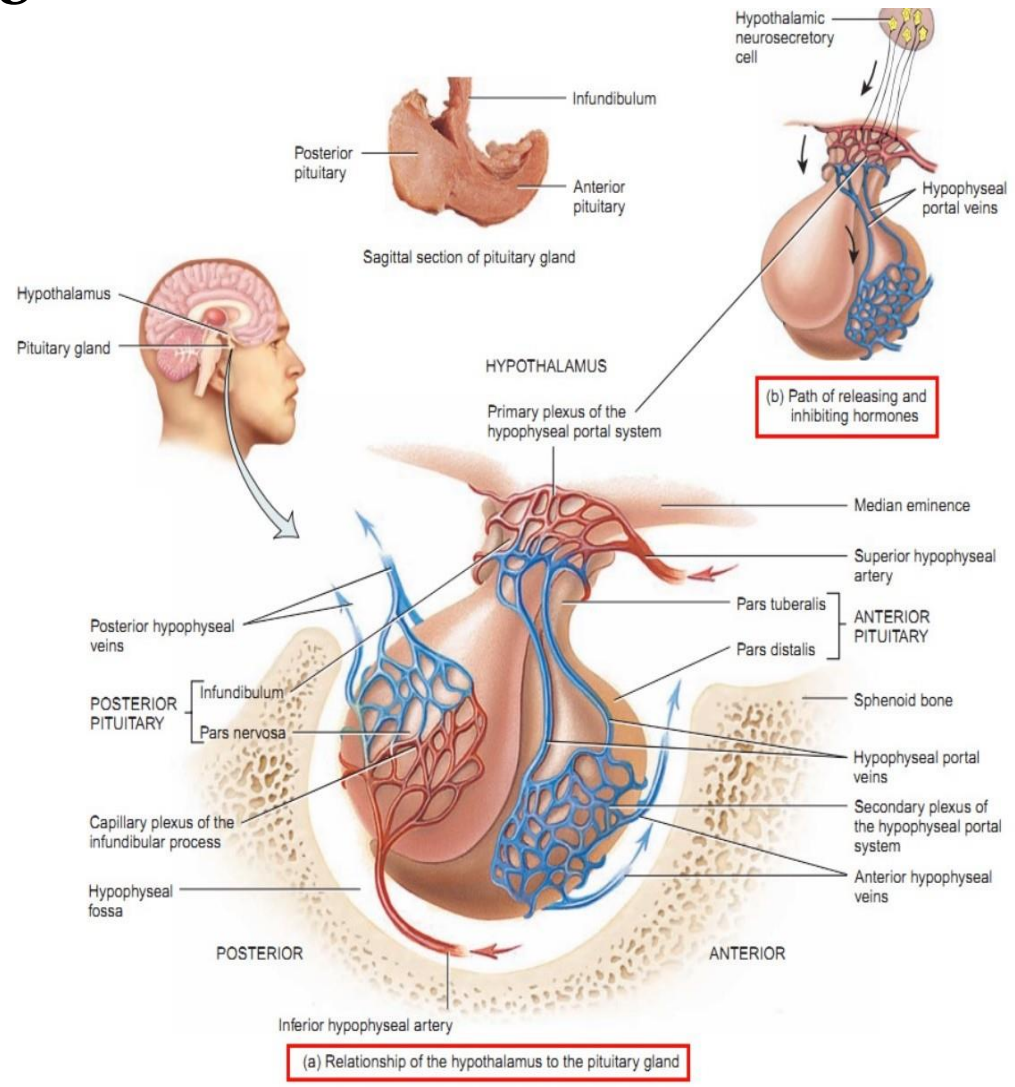
Pancreas: mainly exocrine

Gonads: Part of their function is the secretion and response to hormones, but their ultimate end products are gametes (sperm and ova). Their primary function is the production of these cells, which is regulated by hormones.

The endocrine system -Hypothalamus

- Participates in the endocrine system by two mechanisms:

1. Secretions of two hormones.
2. Controlling the secretion of the pituitary hormones by: **Inhibitory and releasing** hormones



When we speak about endocrine in general, there is hierarchical arrangement for how their function, the same arrangement in the company

Same thing here in the endocrine
The COs=hypothalamus
رئيس القسم=pituitary,

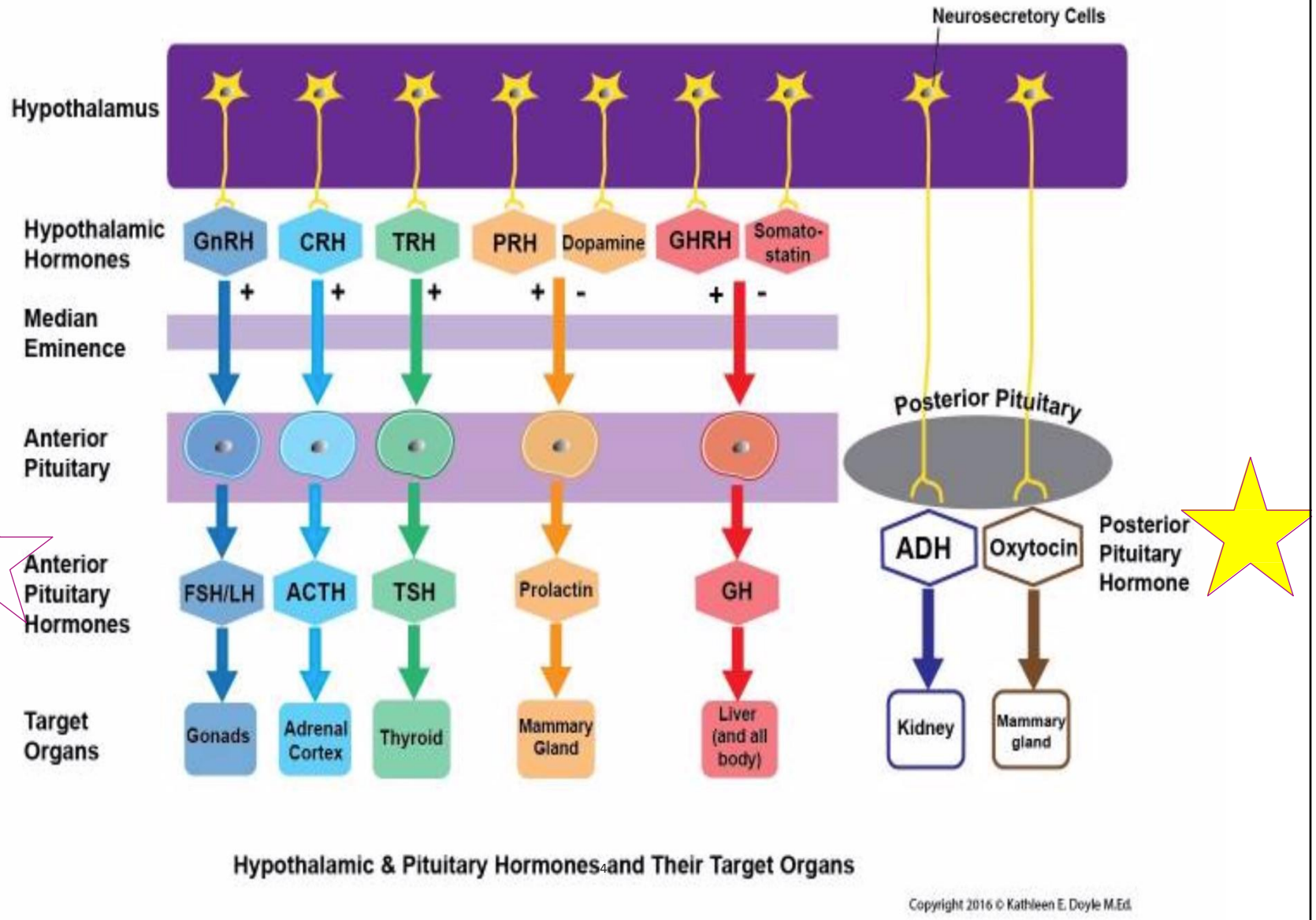
because their function derived from the hypothalamus (the releasing and the inhibitory secretion from the hypothalamus affect certain cells in the pituitary to secrete certain hormone so the secretion depend on the releasing and inhibitory secretion from the hypothalamus.this aspect how the hypothalamus is associated with the pituitary,

Another aspect:
In the anterior pituitary (because we have posterior and anterior pituitary), there is secretory cells receiving hormones from the hypothalamus and these hormones either stimulate or inhibit them to secrete certain hormone to the body.

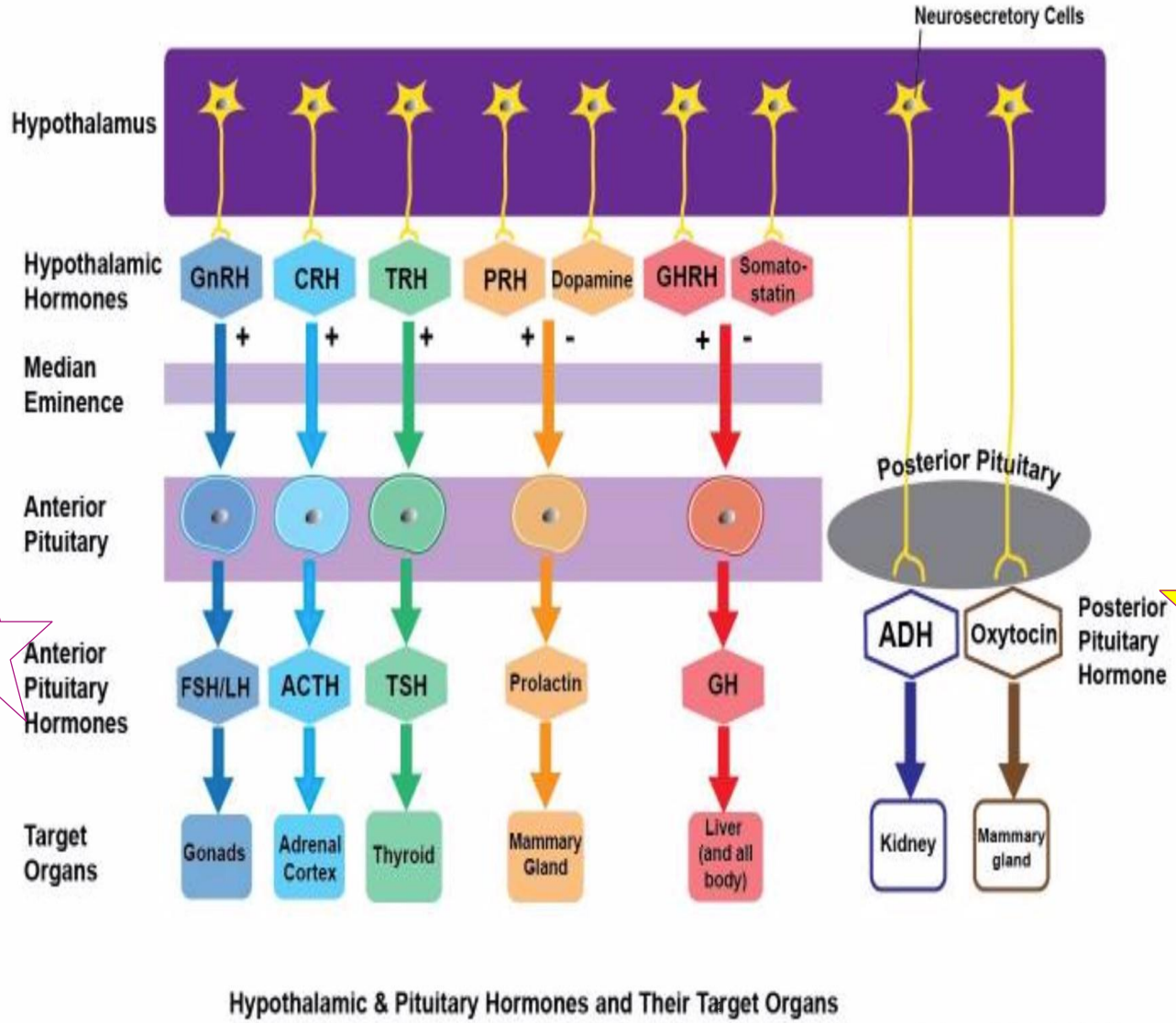
We have a different scenario: in fact, the posterior pituitary is embryologically an extension of the hypothalamus. The hypothalamus is nervous tissue, and the posterior pituitary stores its secretions (two hormones). Thus, **no hormones are synthesized in the posterior pituitary**; it is just a storage site.
The anterior pituitary, on the other hand, is different. It functions as a factory with many different "factories" within it, as many hormones are synthesized there.

So there is two type of connection between the hypothalamus and the pituitary

So these hormones which we have already talked about



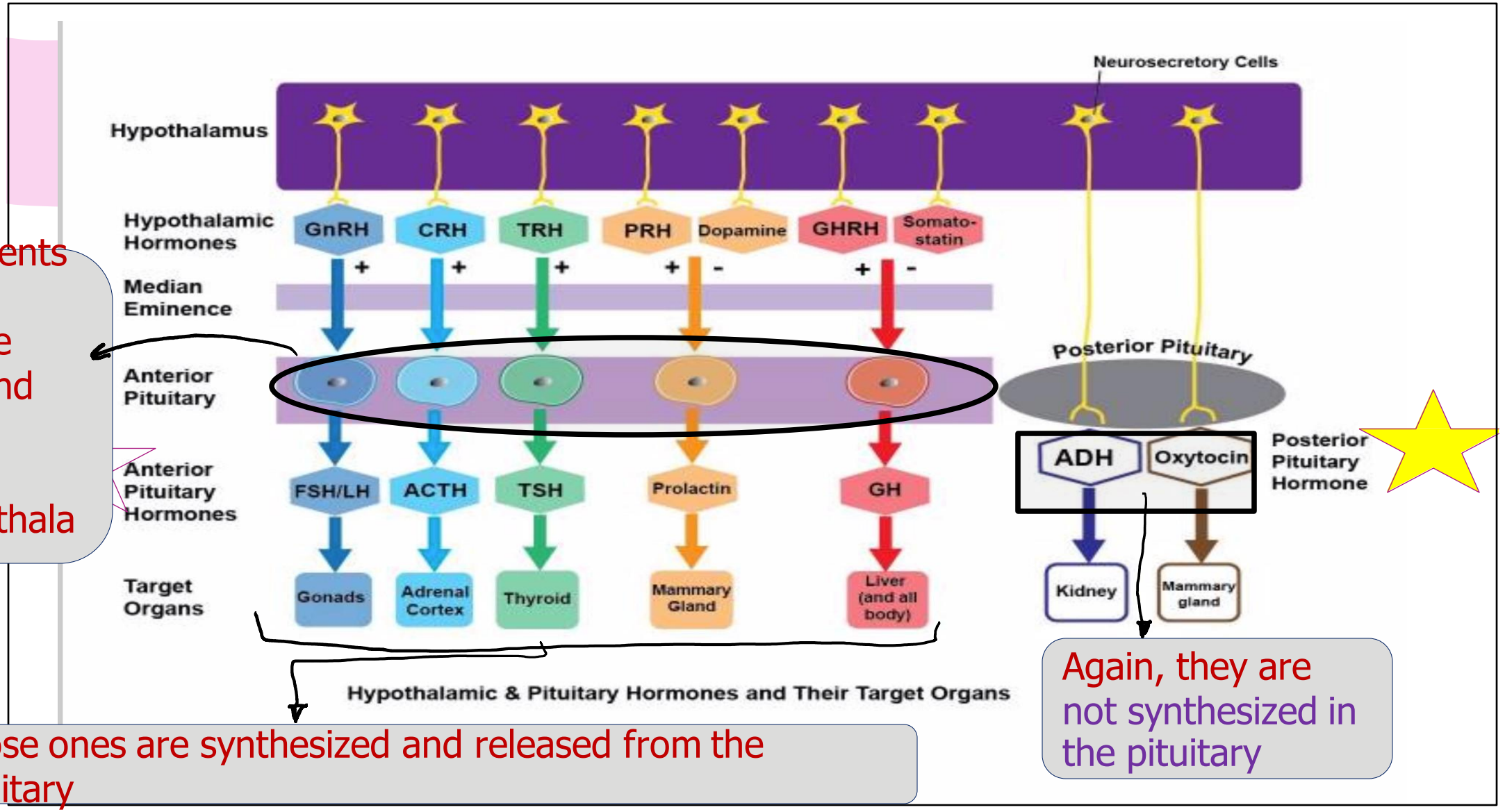
the hypothalamus synthesizes two hormones and store them in the posterior pituitary, and produces the releasing and inhibitory which bind to different cells in the anterior pituitary, according to this binding, these cells secrete or don't secrete the hormones.
the hormones that are secreted by the anterior, go to the blood and then they circulate at the various tissue and organs or gland in the body.



For example: (look at the picture)
-FSH & LH go to the gonads in male and female
-ATCH goes to the adrenal gland
-TSH goes to the thyroid gland
-Prolactin goes to the mammary gland
-GH goes to many tissue

Which one is being release, which one is being inhabit, this will be covered in the physiology.
What is happen in fine details? This in biochemestry.
Something going wrong in tissue, this in pathology
If we need to correct something, this in the pharmacology

This represents cells which receives the releasing and inhibitory secretion from hypothalamus



Those ones are synthesized and released from the pituitary

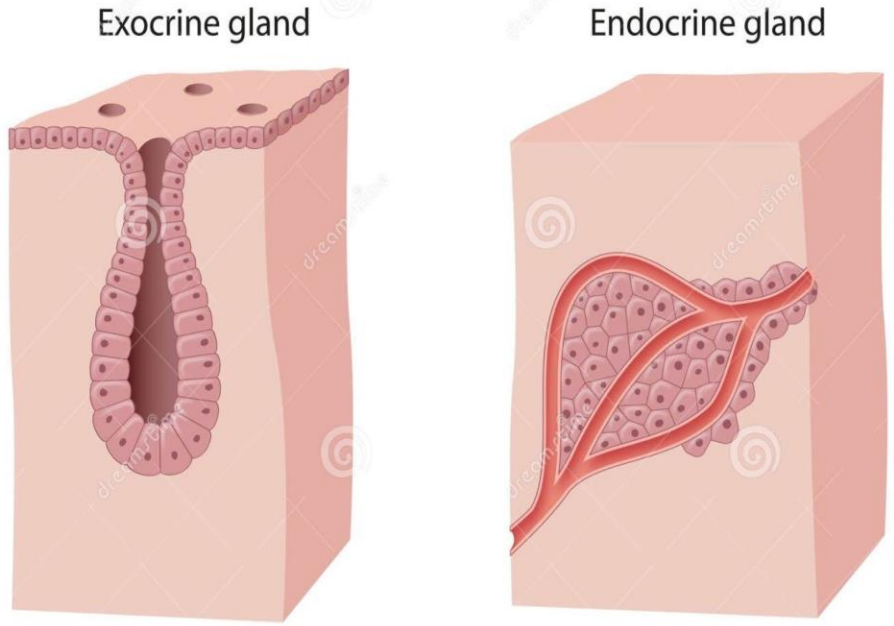
Again, they are not synthesized in the pituitary

this is a simple picture of the endocrine system, in general

Now we will start with pituitary gland. And before that let's go in a quick recap of how endocrine tissue are actually arises.

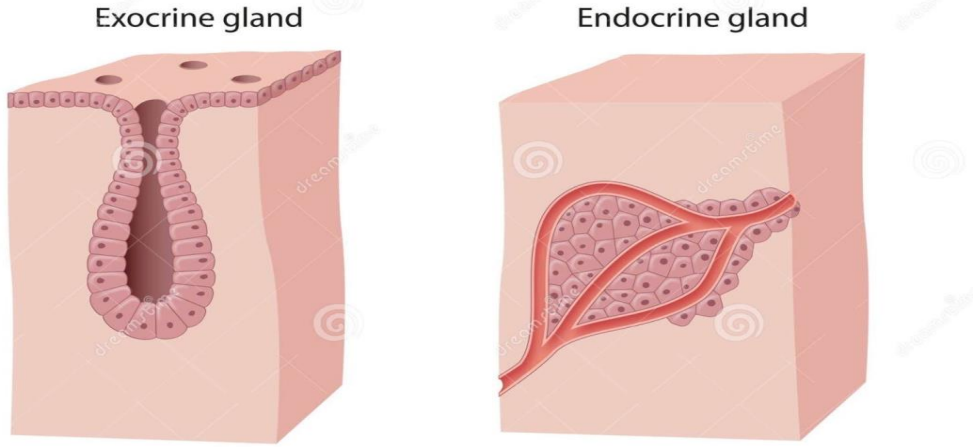
If you recall, when we said that the glandular tissue usually grows in the surface, then depending on specific signaling pathway, they has been upregulated, those cells will grow to the connective tissue and then they proliferate and differentiate and they give rise to the glandular tissue.

Now If these proliferated cells form a connection with the surface then it is an exocrine cells that we won't talk about , we talked about before and we will go in the details of them according to the system we study.



- Is made up of ductless glands that secrete chemical messengers called hormones into the bloodstream or in the extracellular fluid.

So, proliferation and differentiation of the cells and neo-vascularisation (which means the growth of the cells combined by the formation of new blood vessels surrounding these cells), so these cells considered high vascularized and you will see in the histological images that almost each cell surrounded by sinusoid capillary. So their blood supply consider high. However, then they lose the connection with the surface, and the blood vessels will compensate with that loss of connection.



Blood is the vehicle, or the rout that these cells will deliver their secretion to the rest of the body (by the blood). So the blood which is draining these cells will go to the circulation and go to the body cells, where each cell takes the hormone that it has its receptor.

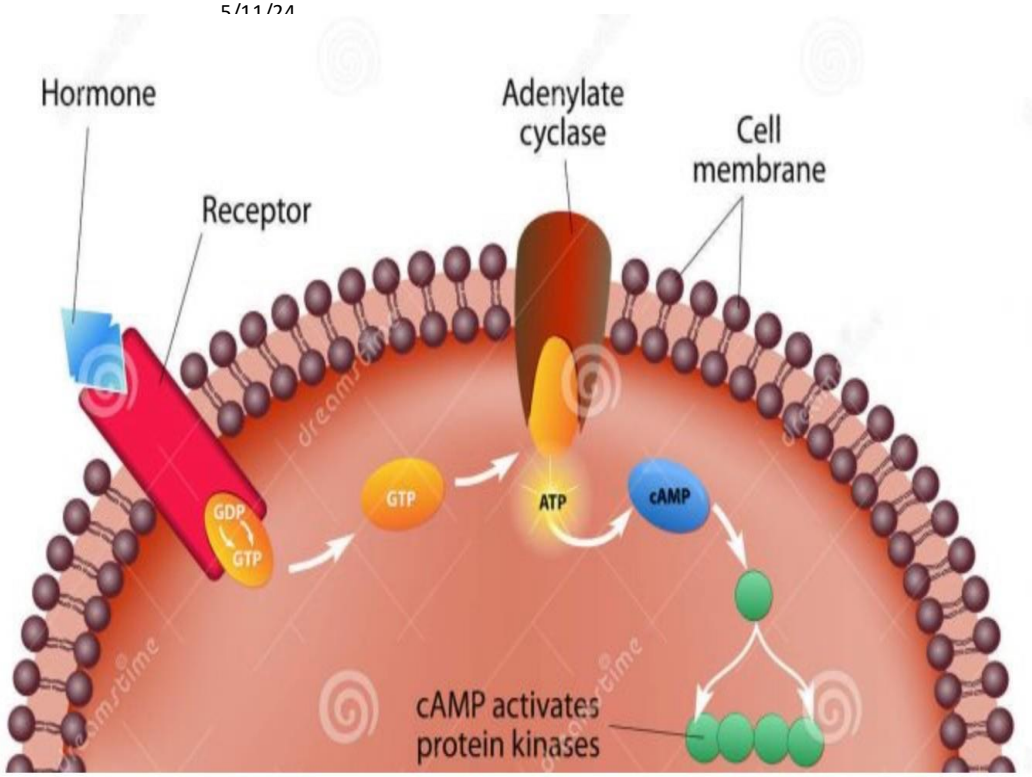
So, hormone will bind to specific cell depending on its type. For example, prolactin will circulate in the blood, but it only will go to the cells they have its receptor (the mammary gland)

While the GH (growth hormone) has a huge audience, it is gonna bind to many cells, there are many cells have its receptor (depend on the age and gender)

Endocrine system

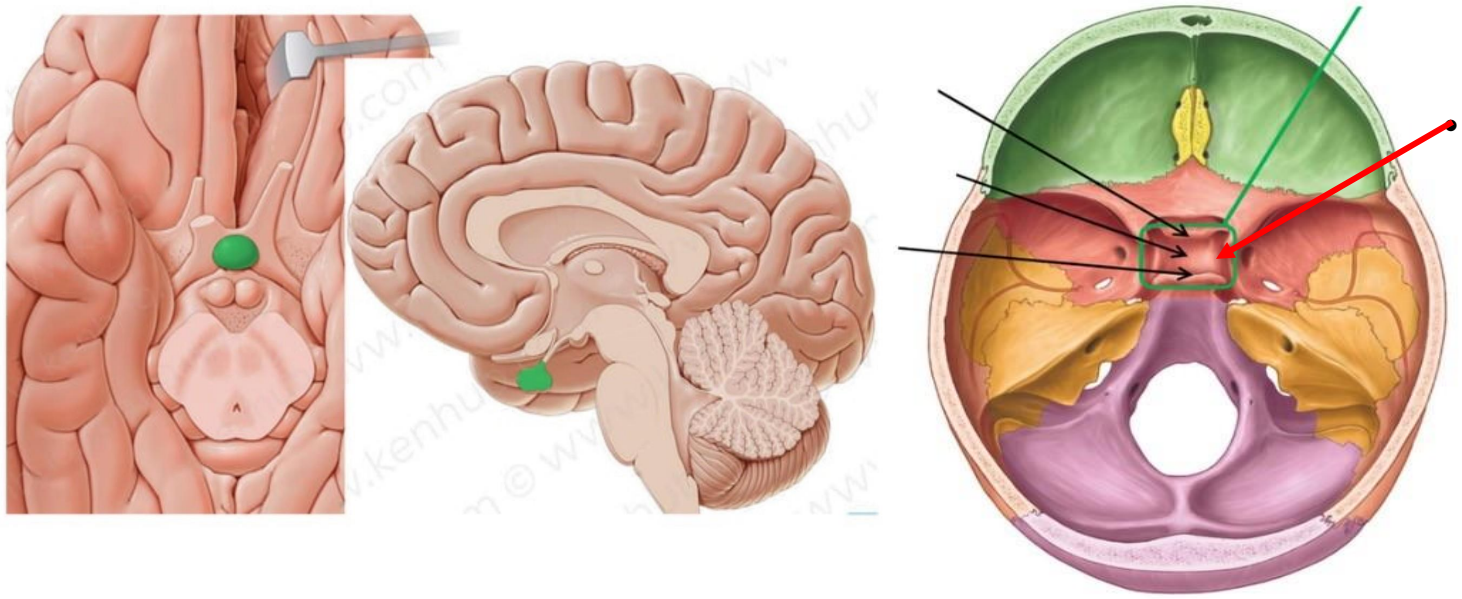
The binding of the hormone to its receptor will lead to a new cascade or new intracellular cascade events which will lead to specific effects that this hormone needs to do in this cell.

For example: growth hormone will lead to proliferation of specific cells. if you remember in the bone. we said that bone becomes longer because there is epiphyseal plate, growth plate, part of this process happens because I have high levels of growth hormone. in the fact the correction of short people could be by exogenous growth hormone which can accelerate the progression of the resident cartilage.
بعدين الشخص بيطول,,, this if they still have their growth plate and it had not been closed yet.



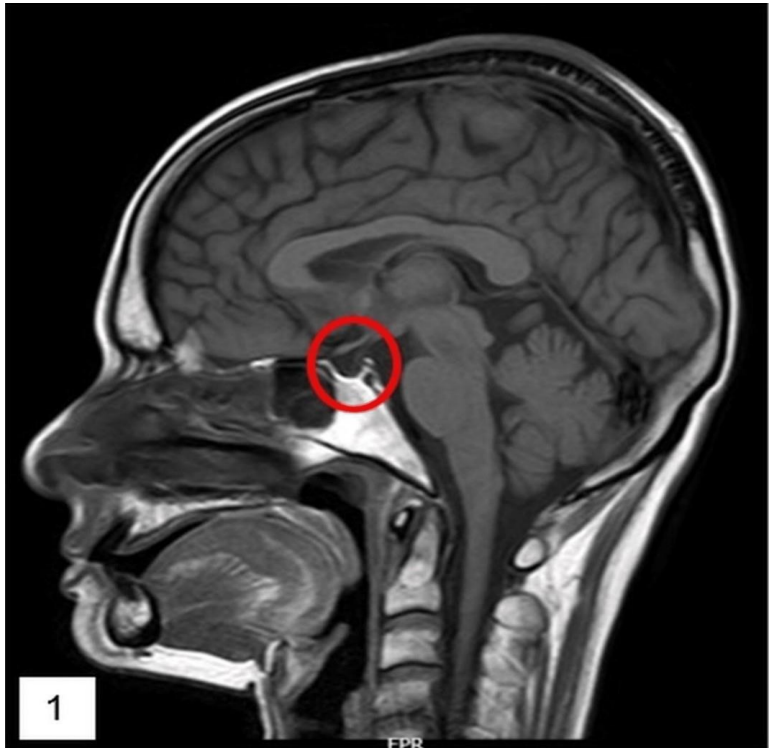
A hormone is a chemical substance made and secreted by one cell that travels through the circulatory system or the extracellular fluid to affect the activities of cells in another part of the body or another nearby cell.

Pituitary Gland (master endocrine gland)



- Also called hypophysis cerebri. Relatively small- 0.5 gm.extremely tiny, has 1 cm long, but very impotrant. Centrally located at the base of the brain.

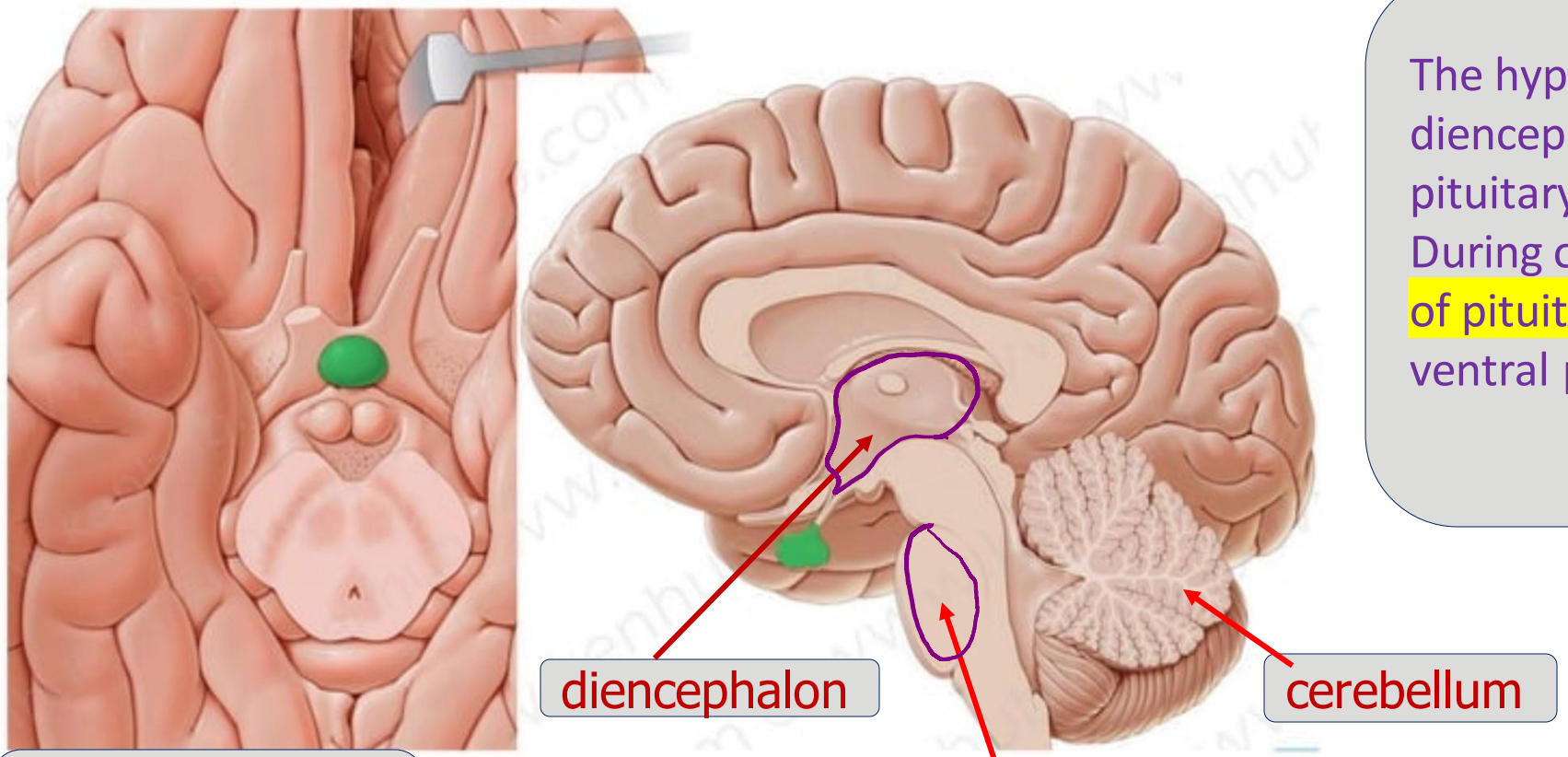
- Rests in a saddle-like bony depression (sphenoid) called hypophyseal fossa of the Sella turcica.



- Connected to the brain (hypothalamus) by a stalk called the infundibulum.

- Has two lobes: the anterior part which called adenohypophysis (, and the posterior part called neurohypophysis (or posterior pituitary). And simply from the name, the posterior pituitary is a nervous tissue (an extention from the hypothalamus)

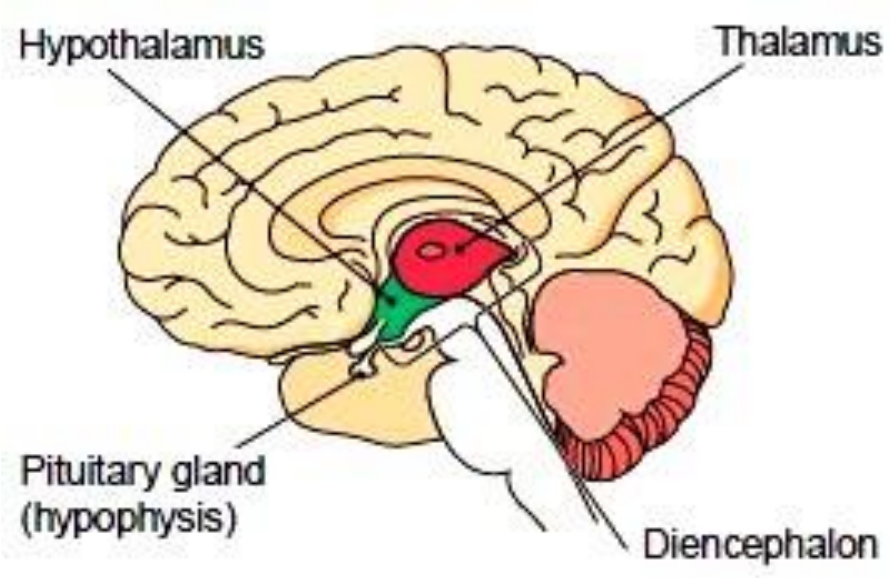
Pituitary Gland (master endocrine gland)



This pic shows Pituitary from inferior view

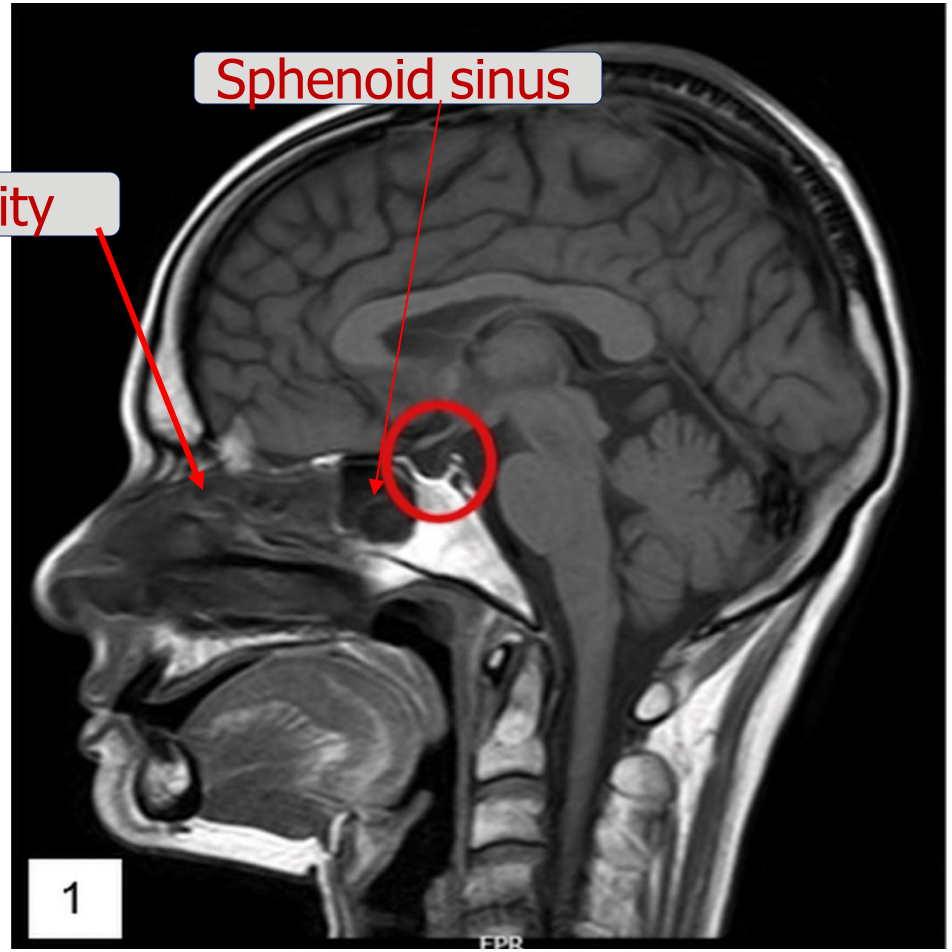
The hypothalamus is part of the diencephalon and is connected to the pituitary gland by the infundibulum. During organogenesis, posterior part of pituitary gland develops from the ventral part of the diencephalon.

Additional : The diencephalon is a region of the brain that plays a crucial role in the endocrine system. It includes structures such as the thalamus, hypothalamus, epithalamus, and subthalamus. The diencephalon, especially the hypothalamus, is vital for the regulation and coordination of the endocrine system. The hypothalamus directly influences the pituitary gland, which in turn regulates other endocrine glands throughout the body, making it a key player in maintaining hormonal balance and homeostasis.



Now, this gland which is located at its home, it is further protected on its superior aspect by the diaphragma sellae, which is fold of dura matter.

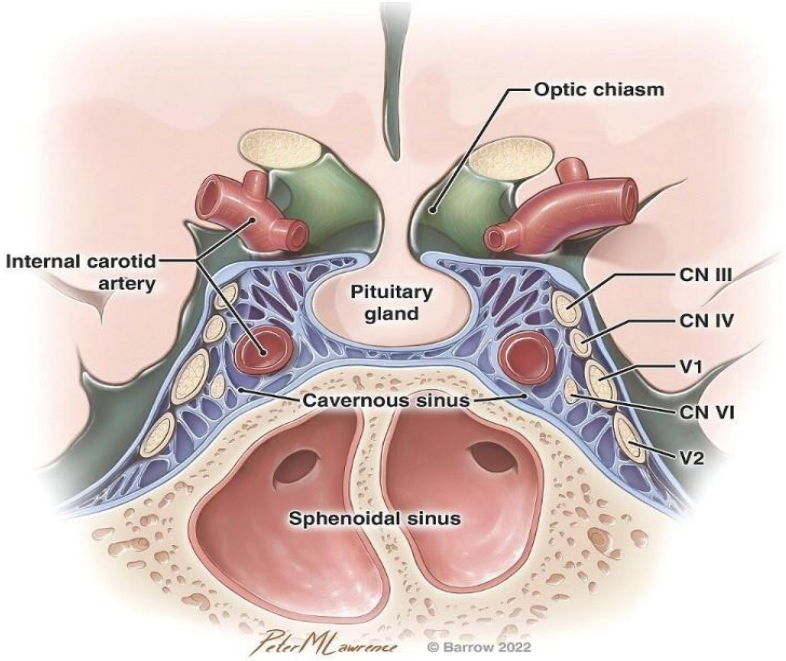
Start with the nasal cavity, it is surrounded by air sinuses, and one of them is the sphenoid sinus, and it is considered anterior relation to the pituitary, look at the proximity of the pituitary with its sellae turica to this whole region and compare it with its relation to the delecate tissue of the brain, actually hidden in the brain.



So if we need to operate to the pituitary, Do we have to dig deep and move the two hemisphere in order to reach? Actually I don't need to separate the two hemisphere and break the white matter and approach, it is senseless procedure. Due to the knowledge of the anatomy of the pituitary it easier to approach through the nose, and what you doing is entering the cavity and then you reaching a bone then sinus then again bone. And that is fine, if break a bone it has high healing capacity, so it can heal again.but if you go nervoustissue you will damage a lot in order to fix the pituitary

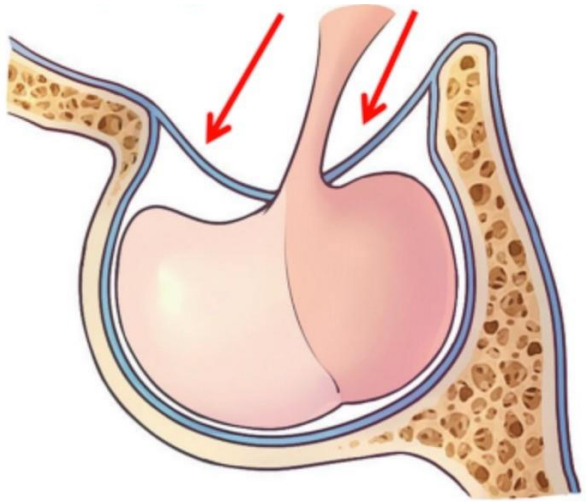
Pituitary/relations

- **Anterior**: Sphenoid sinus.
- **Posterior**: dorsum sellae, basilar artery, pons.
- **Inferior**: body of the sphenoid (sinus).
- **Superior**: Diaphragma sellae.
optic chiasm!!!!! it is important because anything can go wrong in pituitary (and is possible, the adenoma percentage is high in pituitary) will give rise to extra tissue that could apply a pressure on the optic chiasm, that is will experience by the patient with visual disturbance, and then upon examinations you know that this pituitary has to be examined and then a number of test have to perform in order to assess the situation
- **Lateral:** cavernous sinus (contents)

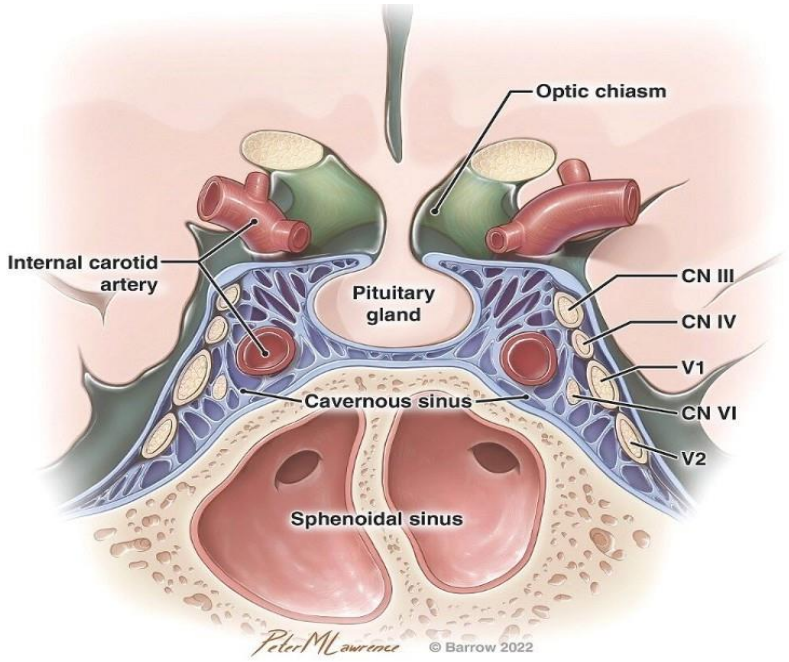


Diaphragma sellae: a fold of dura that acts as a roof with a central aperture that allows the passage of the infundibulum (stalk), and seprate the PG from overlying optic chiasma.

Cavernous sinus: dural venous sinuses (sphenoid bone, PG).



Cavernous sinus: it is the veinous drainage (contain blood supply within the dura, and it has a number of extremely important structure running in it, so all of this simply to show you that if anything goes wrong with the pituitary it will make a pressure on the neighbouring structure, like cranial nerves(as show in the photo) and the blood vessels surround it, and a hemorrhage in the blood vessels in the cavernous sinus affect the pituitary gland as well.



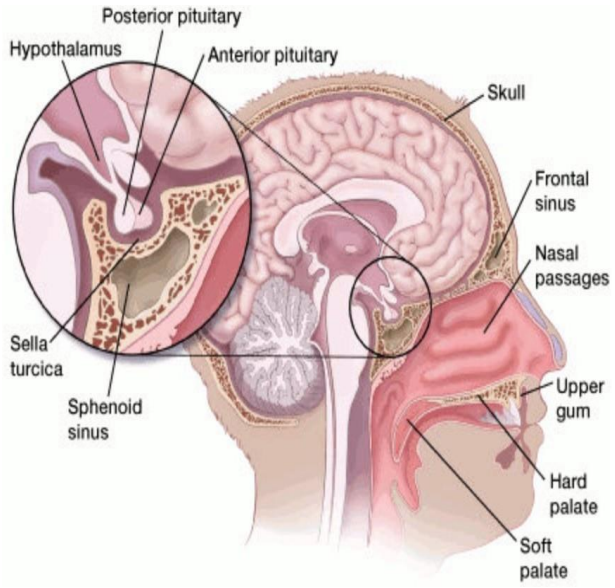
So knowing what surround the pituitary is very important to understand if something going wrong or when you make surgically operation to the pituitary, so if deviate right and left you need to expect what you fixing and avoid the delicate structure

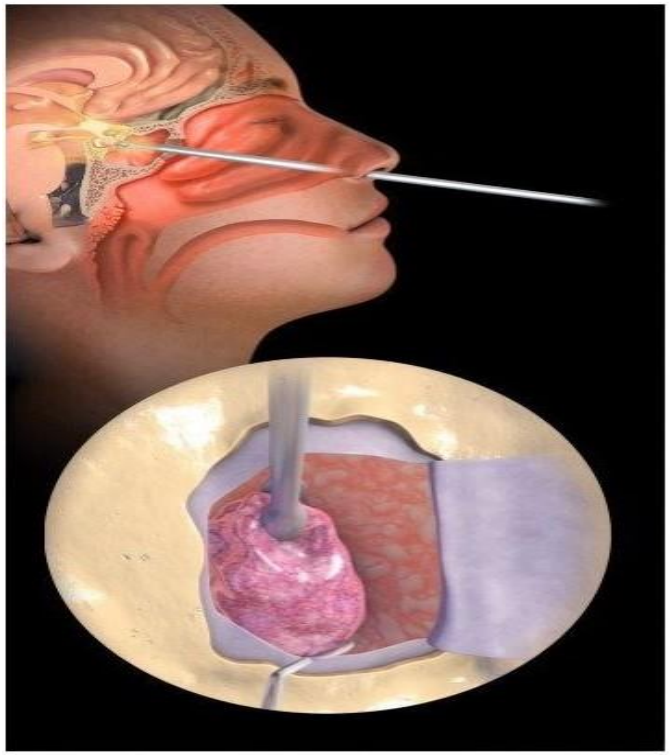
Endoscopic Transnasal/Transsphenoidal

5/11/24

Craniotomy!!!!

- Is the most common procedure for removing pituitary tumors.
- The neurosurgeon reaches the tumor through the nasal passages and the sphenoid sinus.
- Less-invasive approach--avoid important brain structures by accessing the pituitary gland from underneath the brain.
- Transsphenoidal surgery leaves no visible scar, minimizes the risk of complications, and enables faster recovery.

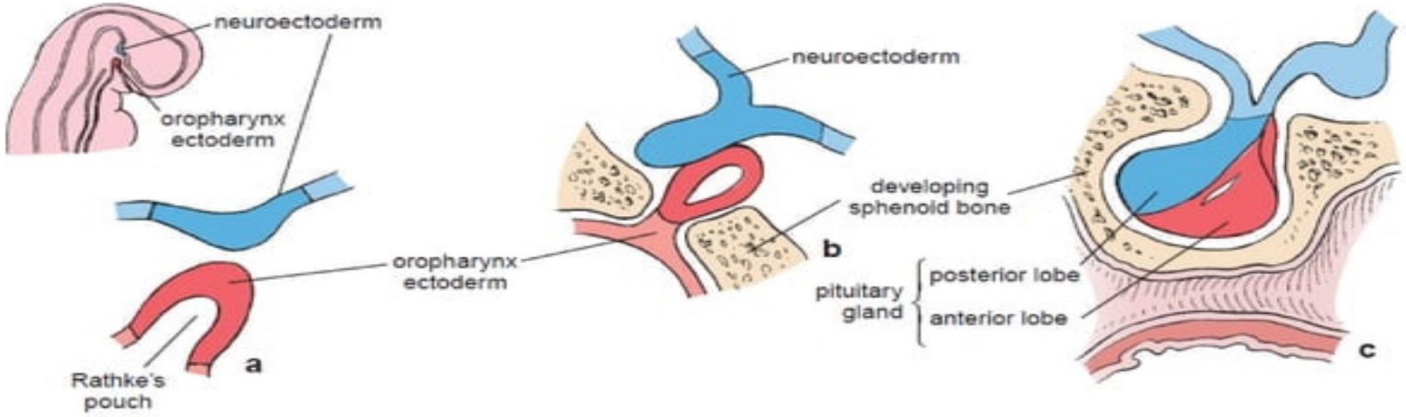




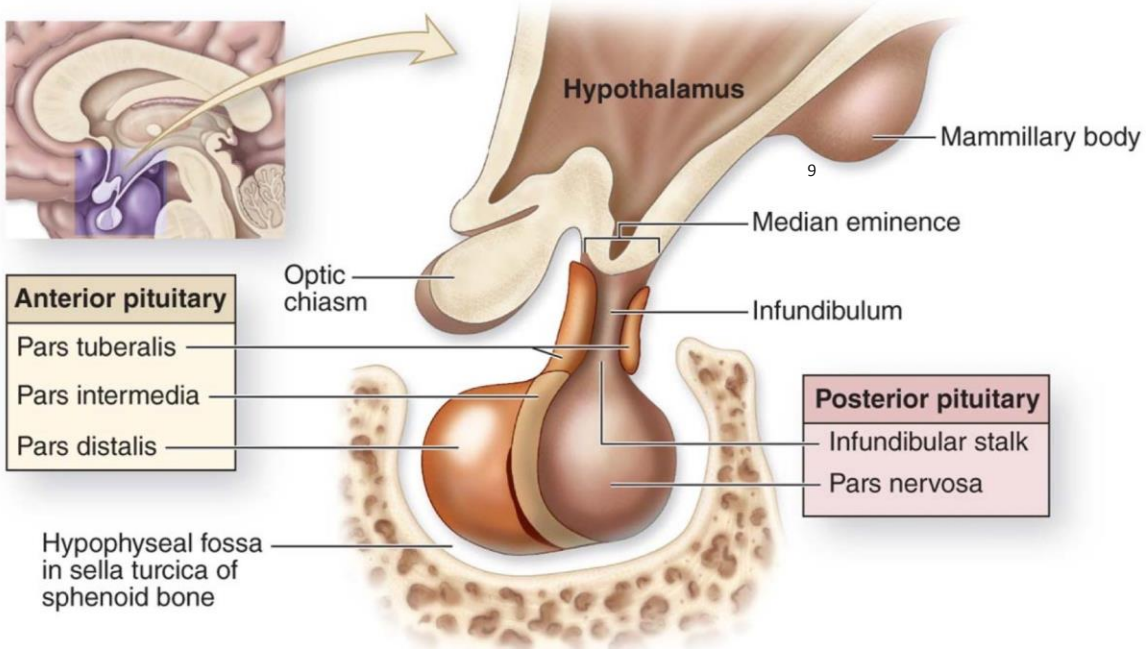
How do we operate on the pituitary in case that surgery is our last solution? Note that we don't go to this choice in all cases, there are a lot of new technology , hormonal therapy and immunotherapy that we can use to avoid surgery. So surgery is the last way to solve the problem.
Unless we have to go to surgery, this is the most suitable way (Transnasal / Transsphenoidal).
So we will insert the tools through the nose… nasal cavity…. Then we reach sphenoidal air sinuses…. Then we drill the bone and operate on the pituitary.

Structure and Origin

- Two tissue types----two origins.
- Adenohypophysis (anterior lobe).
- Neurohypophysis (posterior lobe).



Development of pituitary gland



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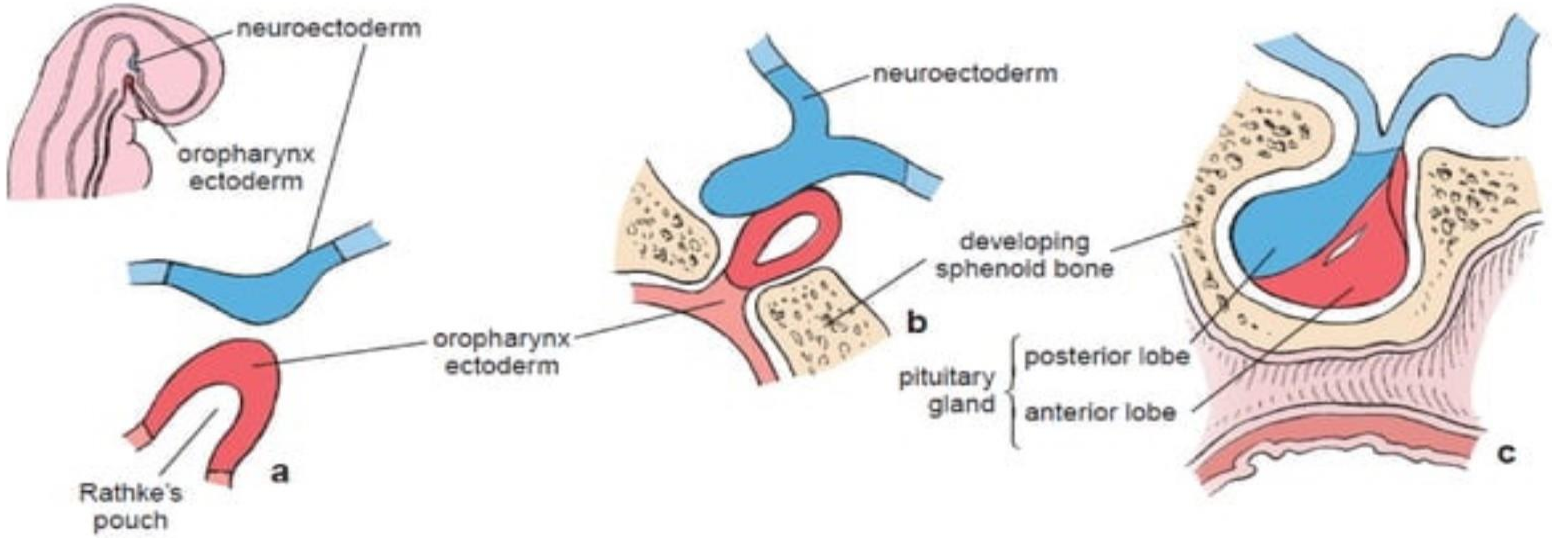
Adenohypophysis (anterior lobe): look at the red part in pic

- Pars tuberalis (surrounding the infundibulum).
- Pars intermedia (between anterior and posterior lobes).
- Pars distalis (the largest part) 75% of anterior lobe.

Neurohypophysis (posterior lobe): look at the blue part in pic

- Pars infundibularis.
- Pars nervosa.

As we said, pituitary gland is divided into anterior pituitary (Adenohypophysis), and posterior pituitary (Neurohypophysis), each one of them has different origin. The blue color in the figure below represents the origin of neurohypophysis (posterior pituitary) and the red color represents the origin of adenohypophysis (anterior pituitary).



Development of pituitary gland

Pituitary organogenesis

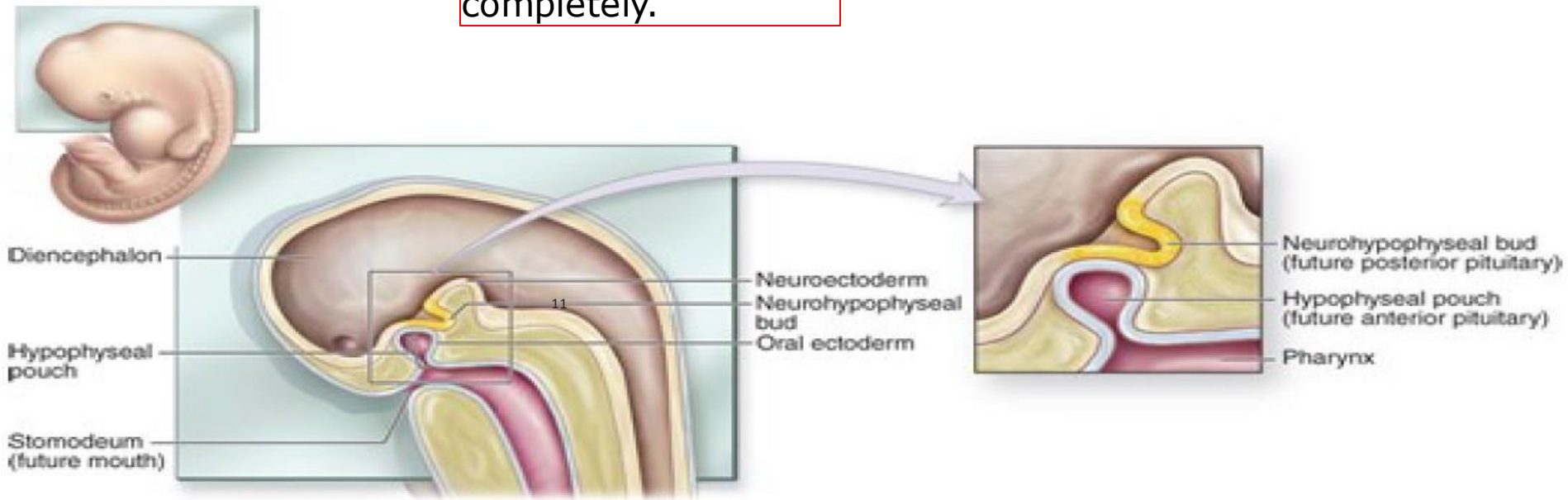
- Begins during week 4 of fetal development.
- A thickening of cells in the oral ectoderm form the hypophyseal placode, which gives rise to Rathke's pouch, an upward evagination that extends towards the neural ectoderm.

- A downward extension of the ventral diencephalon forms the posterior lobe (at the same time).
- The two nascent lobes connect to form the composite structure of the adult pituitary.
- Rathke's pouch constricts at its base and eventually separates altogether from the oral epithelium during week 6-8

At the fourth week of development, down growth of the diencephalon (neuro ectoderm) accompanied by upward growth of the oral ectoderm, and they meet in the middle.
If you follow the progress of this formation, you do realize that the oro-ectoderm will eventually separate, while the neuroectoderm doesn't.
The oroectoderm will form the anterior pituitary, while the neuroectoderm will form the posterior pituitary, the most distal end of neuroectoderm will form the pars nervosa, and the attachment will form the infundibulum.
The surrounding mesenchyme make adaptation and forming the sella turcica in the sphenoid bone.
The distal end of the neuroectoderm will expand and become more bulbous whereas the oroectoderm will also adapt to new position and send some of its tissue to surround the infundibulum to form the pars tuberalis.
The bulge of the oroectoderm called Rathke's pouch (ectoderm from outside and an empty space inside, this empty space will decrease in size and form a small cysts in middle part of anterior pituitary which we call it pars intermedia, this actually represents the remnants of Rathke's pouch in embryo).

The cavity of the vesicle is reduced to a narrow cleft, which may disappear completely.

Cells of the pouch later differentiate to form different pars of the adenohypophysis.



The infundibulum differentiates into the stalk and pars nervosa of the pituitary gland.

Blood supply

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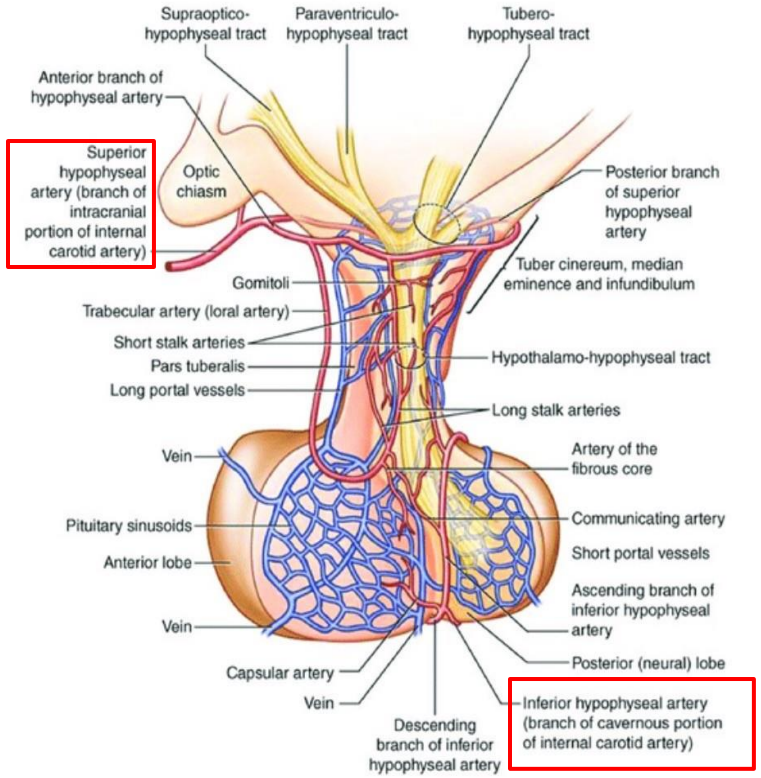
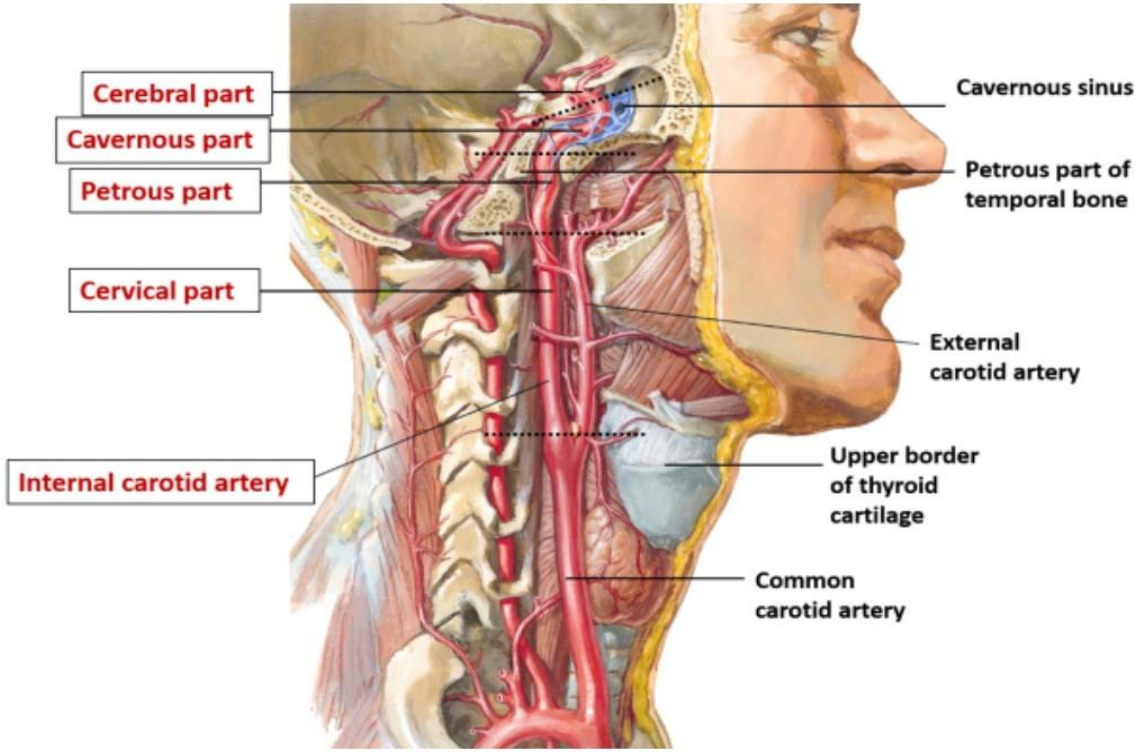




Blood supply of pituitary gland:

As you know, internal carotid artery will enter intracranially and gives rise to many blood vessels which will supply different tissues, one of these tissues is the pituitary gland.

The blood supply of the pituitary gland comes from superior and inferior hypophyseal arteries, the superior hypophyseal artery will supply the anterior pituitary, while inferior hypophyseal artery will supply the posterior pituitary, but there is anastomosis between them.

The hypothalamic-hypophyseal portal system

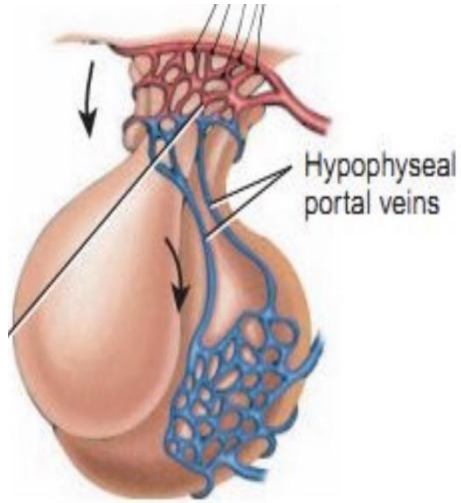
Instead of having (artery – capillaries – vein) one set of capillaries, we have in the anterior pituitary a portal vein, so (artery- capillaries- portal vein- capillaries- vein) two sets of capillaries, why?

This portal vein acts as Shortcut for the hypothalamic hormones that will regulate the release of anterior pituitary hormones.

Why not the hypothalamus secretes this hormones into systemic circulation?

This way is more rapid, prevents dilution of hormones in the blood and prevents peripheral damage of the hormones.

Anterior pituitary also supplied by inferior hypophyseal artery because we have anastomosis between them.



The hypothalamic-hypophyseal portal system

Superior hypophyseal artery

↓

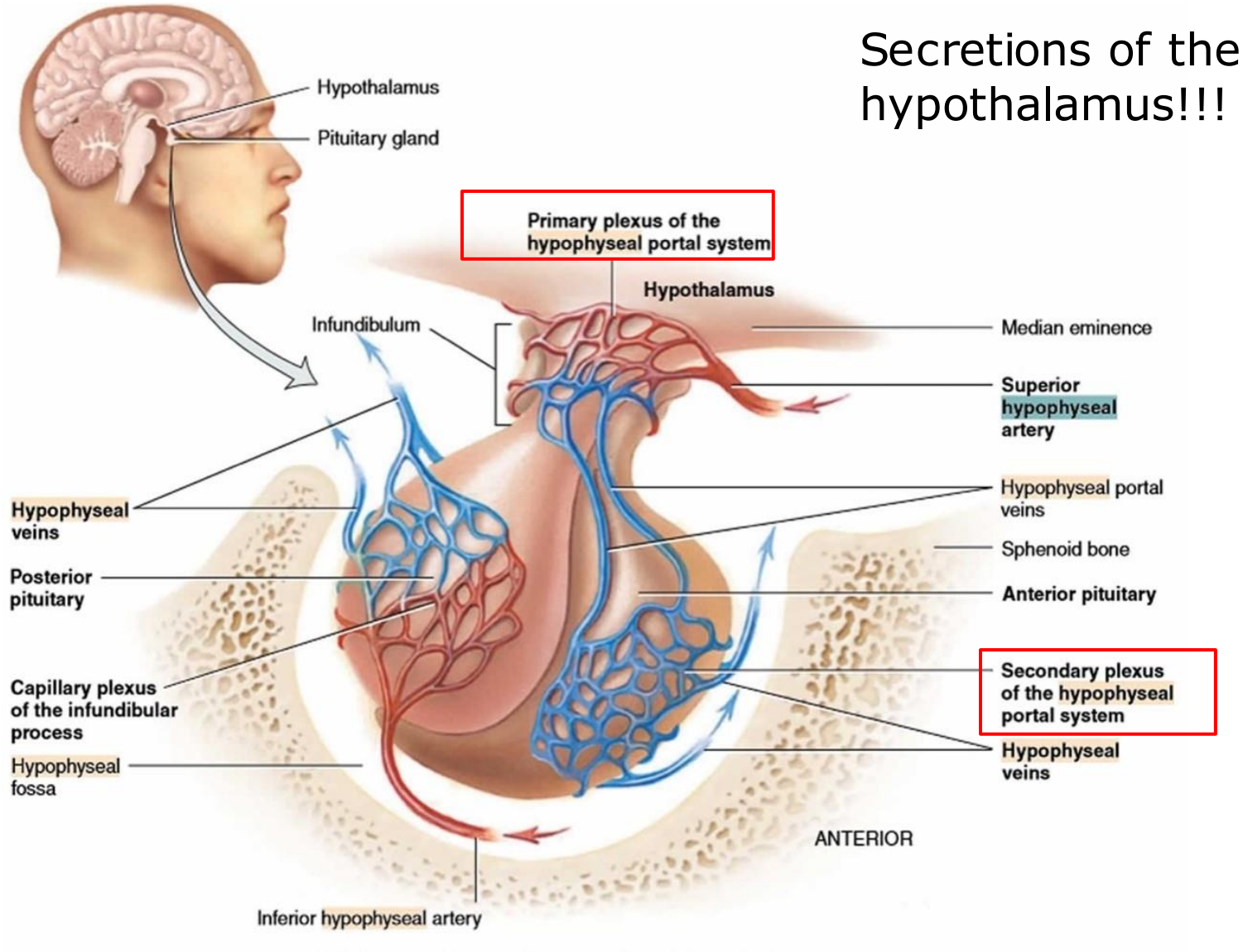
Primary plexus (capillaries)

↓

Hypophyseal portal veins

↓

Secondary plexus (capillaries)



Secretions of the hypothalamus!!!

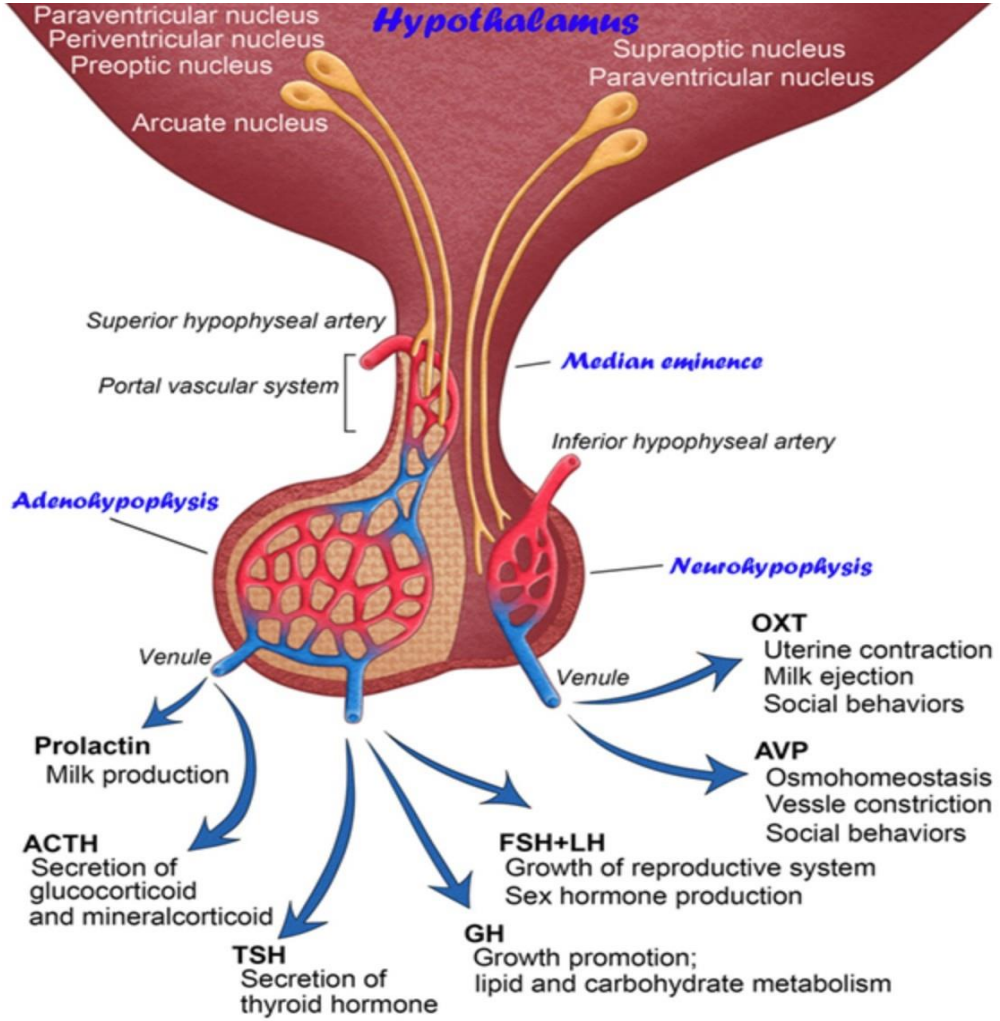
Secretions of the hypothalamus

- **To Neurohypophysis.**
  1. Hypothalamic-hypophyseal tract
  2. Supraoptic and the paraventricular Ns.
  3. Axonal transport-–pars nervousa.
  4. ADH, Oxytocin.

- **To Adenohypophysis**

Rreleasing and inhibitory hormones:

TRH, GnRH, GHRH, PIH, GHIH, and CRH).

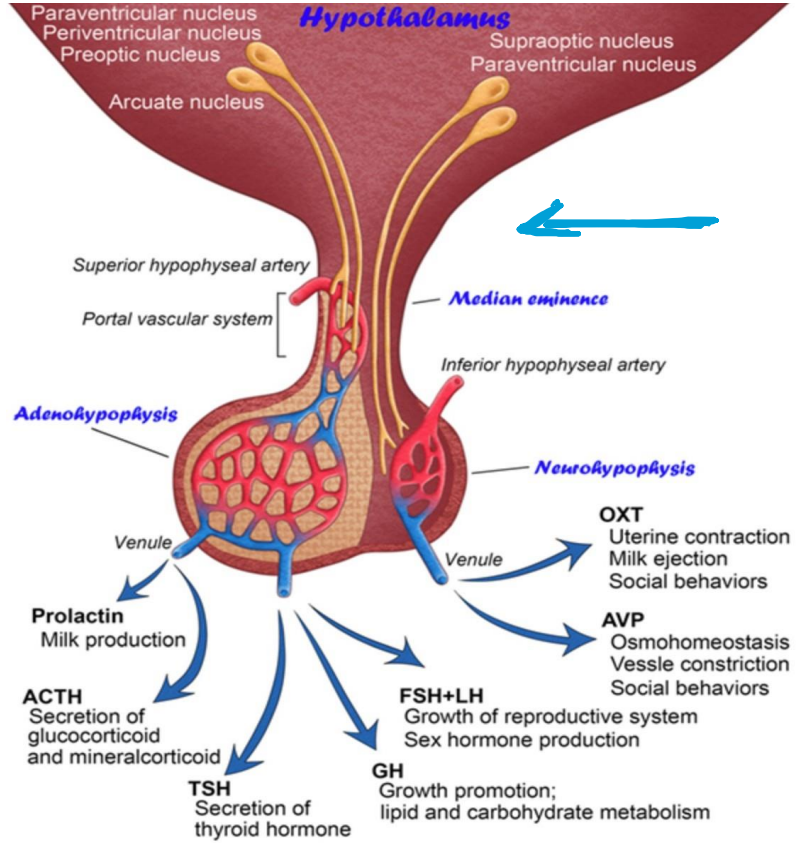


The hypothalamic-hypophyseal tract----axons extending from the hypothalamic supraoptic and paraventricular nuclei, through the infundibulum and into the pars nervosa.

This figure shows the relation between the hypothalamus and the pituitary. Hypothalamus is a nervous tissue, meaning that it contains neurons, the neurons do function in an endocrine manner.

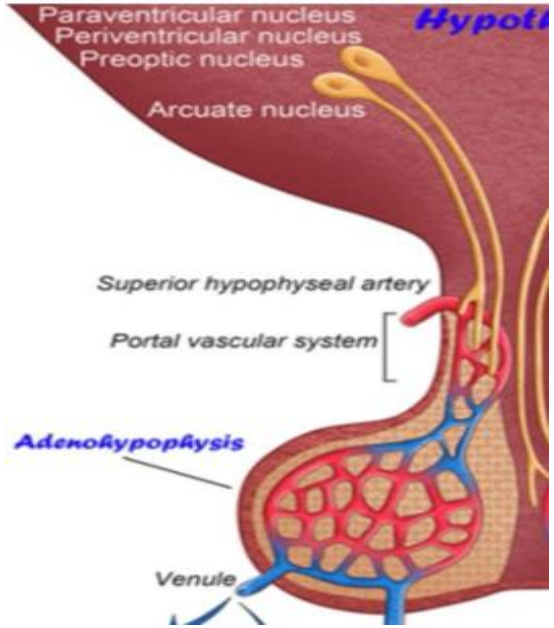
The hypothalamus has a number of nuclei (collection of cell bodies within CNS) only two of these nuclei are associated with posterior pituitary (Supraoptic nucleus + Paraventricular nucleus) these neurons because they function in an endocrine fashion, they are relatively larger than the surrounding, and there axons also larger. So they synthesize and release hormones (ADH And Oxytocin).

So these neurons synthesize and deliver the hormones via their axons to reach the posterior pituitary, which is composed of unmyelinated axons with the supportive glial cells (pituicytes), within the axons we have small bulges called herring bodies (neurosecretory bodies) which act as a storage of hormones, Neural impulse is required to release these two hormones.



ADH acts on the kidney to increase reabsorption of water to correct the hypertonicity. The increase in the Tonicity of the blood, this will be sensed by the hypothalamus , this will lead to generation of action potential in the neurons that will travel along the axons that will lead to release of hormones through the blood from the posterior pituitary then reaching the kidney through the circulation to do their functions.
This is called hypothalamic – hypophyseal tract, because the axons carry similar massages that are delivered down to reach the posterior pituitary.

A section in the anterior pituitary shows a glandular tissue, they are designed to synthesize and release hormones in response to a higher massage from the hypothalamus (releasing and inhibiting hormones).



Neurohypophysis

NB: neurosecretory (Herring) bodies

- Contains around 100,000 unmyelinated axons of large secretory neurons with cell bodies in the supraoptic and paraventricular nuclei.

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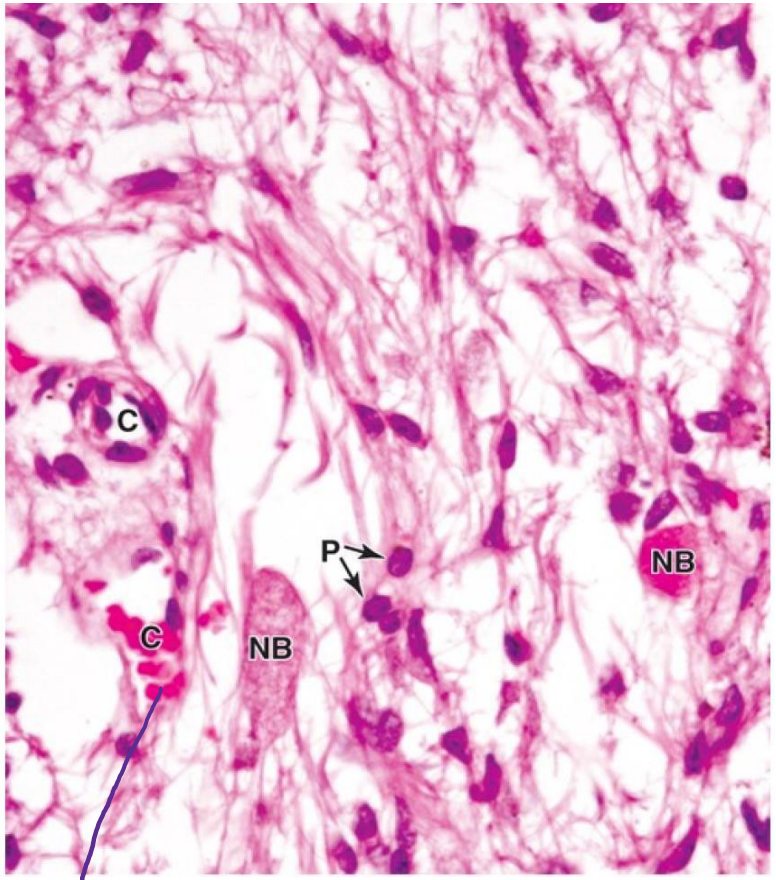
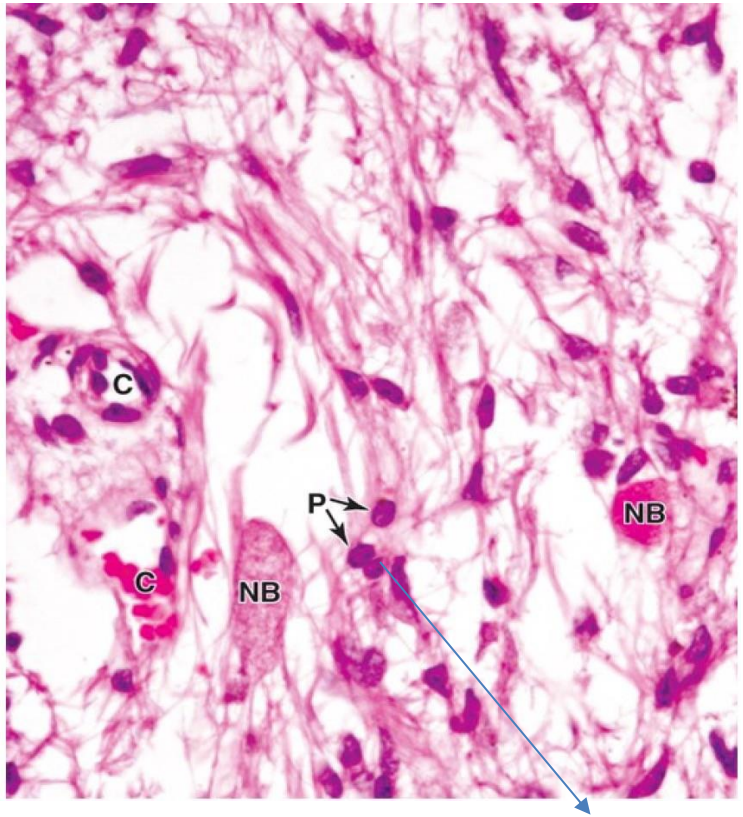
- Highly branched glial cells called pituicytes (most abundant).
- Neurosecretory (Herring) bodies contain either: antidiuretic hormone (ADH, arginine vasopressin) or oxytocin.
- Carrier proteins: neurophysin I and II.
- Nerve impulse is required to release these two hormones



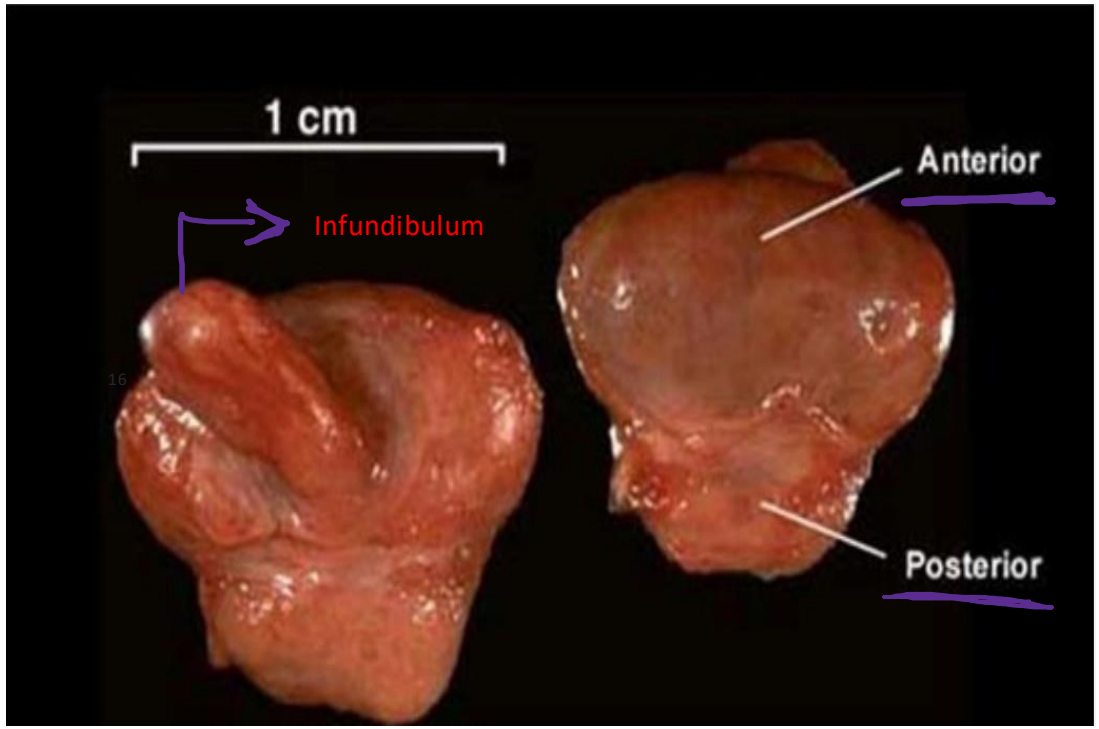
- Neurosecretory (Herring) bodies is where the hormones are being stored in the distal end of the axon
- <u>These herring bodies contain 1 hormone or 2 ???</u> ONLY 1 hormone because the 2 hormones have separate functions and they go to different target tissues, for example: ADH is needed when the tonicity of the blood is high so the hypothalamus will sense this and that will lead to the release of ADH after an action potential reaches the neuron , so I need ADH alone not oxytocin in this situation.

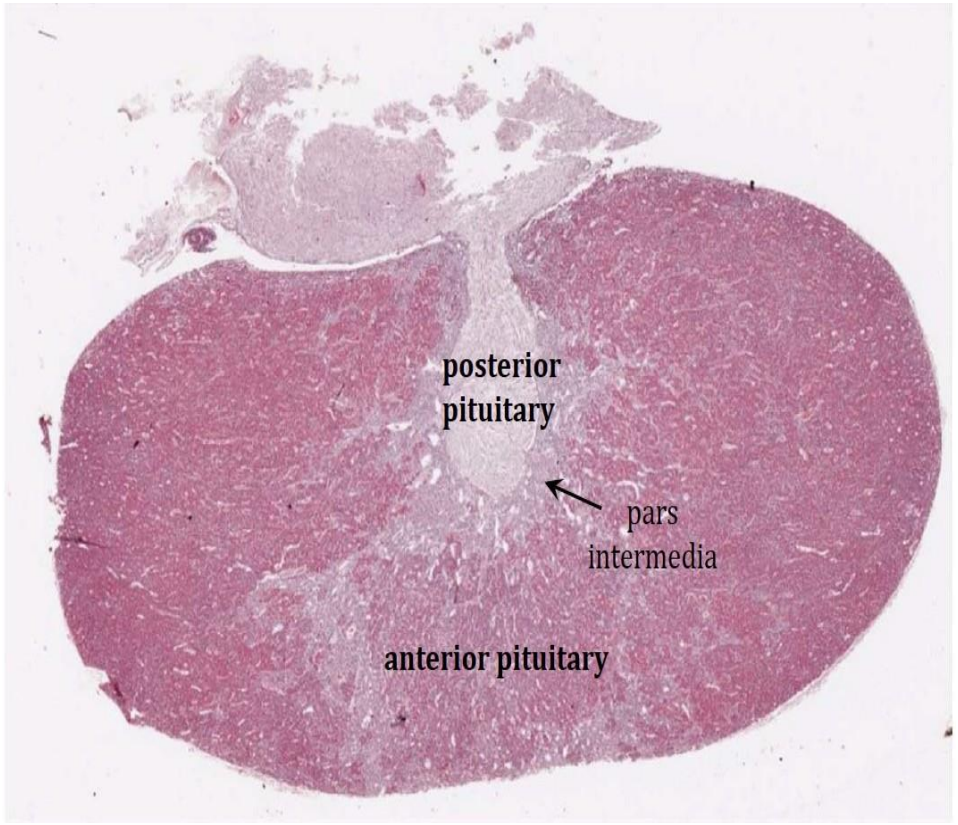
NB: neurosecretory (Herring) bodies



supportive glial cells (pituicytes)

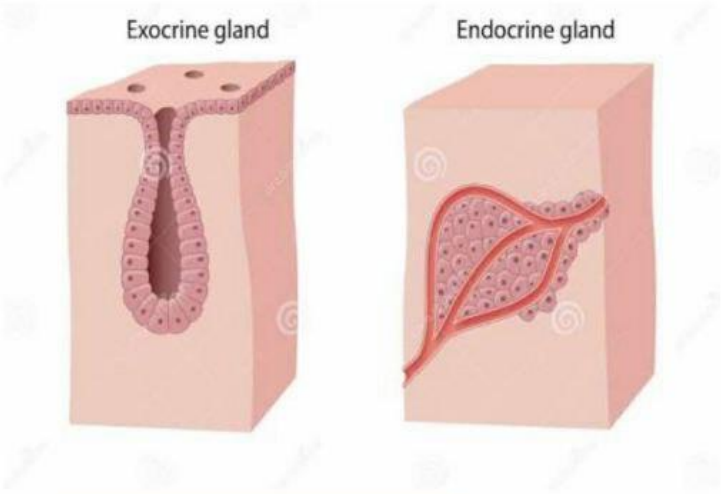
Adenohypophysis





This figure shows the macroscopic appearance of the pituitary gland, the light color represents the posterior pituitary, while the dark color represents the anterior pituitary.

V2: An amendment was made in slide No. 10



- Is made up of ductless glands that secrete chemical messengers called hormones into the bloodstream or in the extracellular fluid.

V3:
Slide 14
highlighted sentence was added: posterior part of pituitary gland instead of pituitary gland.