Department of Anatomy and Histology

School of Medicine

The University of Jordan

Endocrine system

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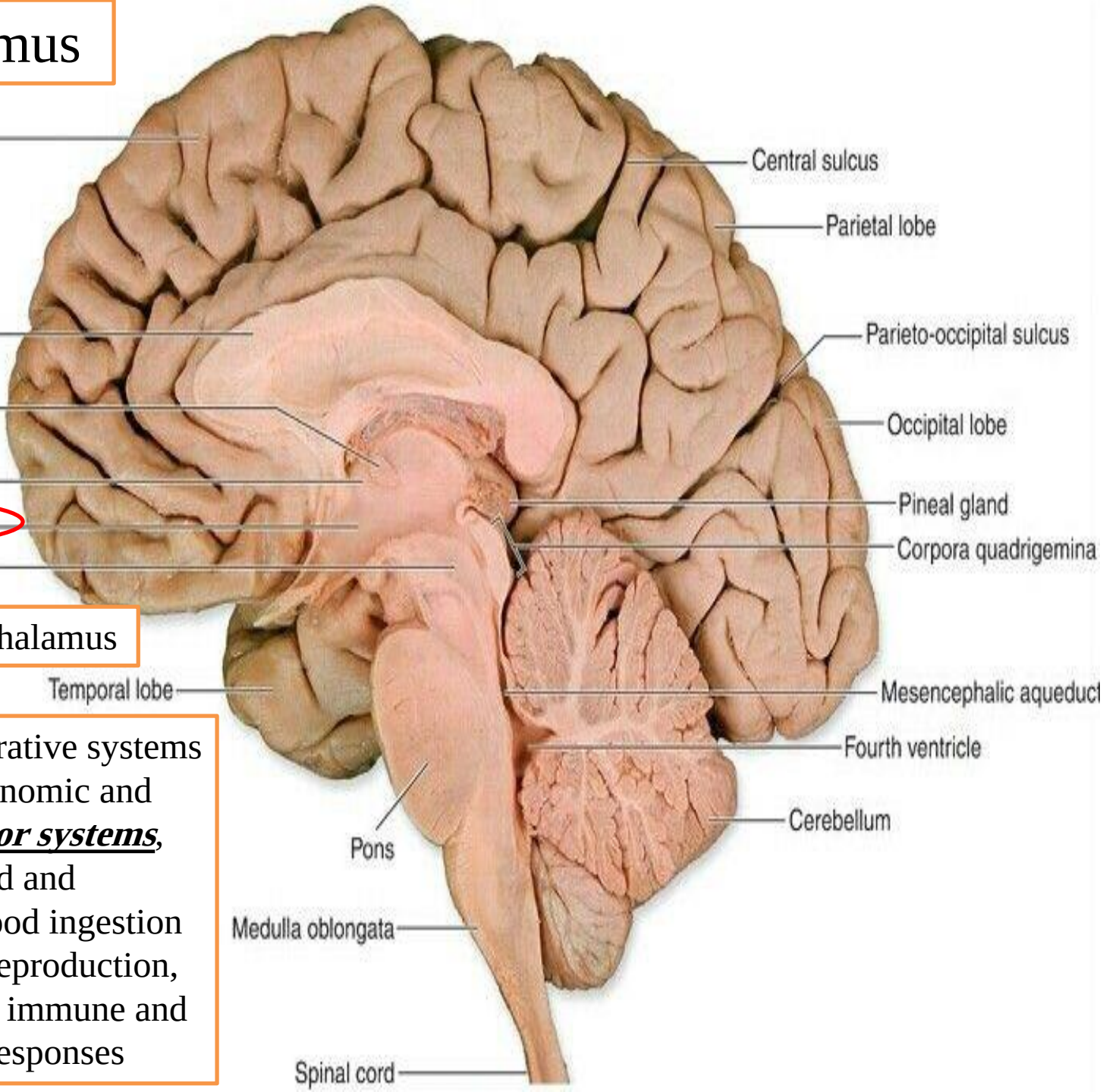
2022

Objectives

1. **Recognize and understand the main parts of the pituitary gland and their locations, relations and connections.**
2. **Comprehend the blood supply of the pituitary gland and its portal circulation.**
3. **Understand the embryological origins of the pituitary gland.**
4. **Grasp the clinical correlations of the pituitary gland on anatomical basis and its surgical approach.**
5. **Recognize and understand imaging of the pituitary gland.**
6. **Grasp the histological structure of the pituitary gland and its cells under light and electron microscopes.**
7. **Recognize and understand the location, simple structure of** the hypothalamus and its connections

The hypothalamus

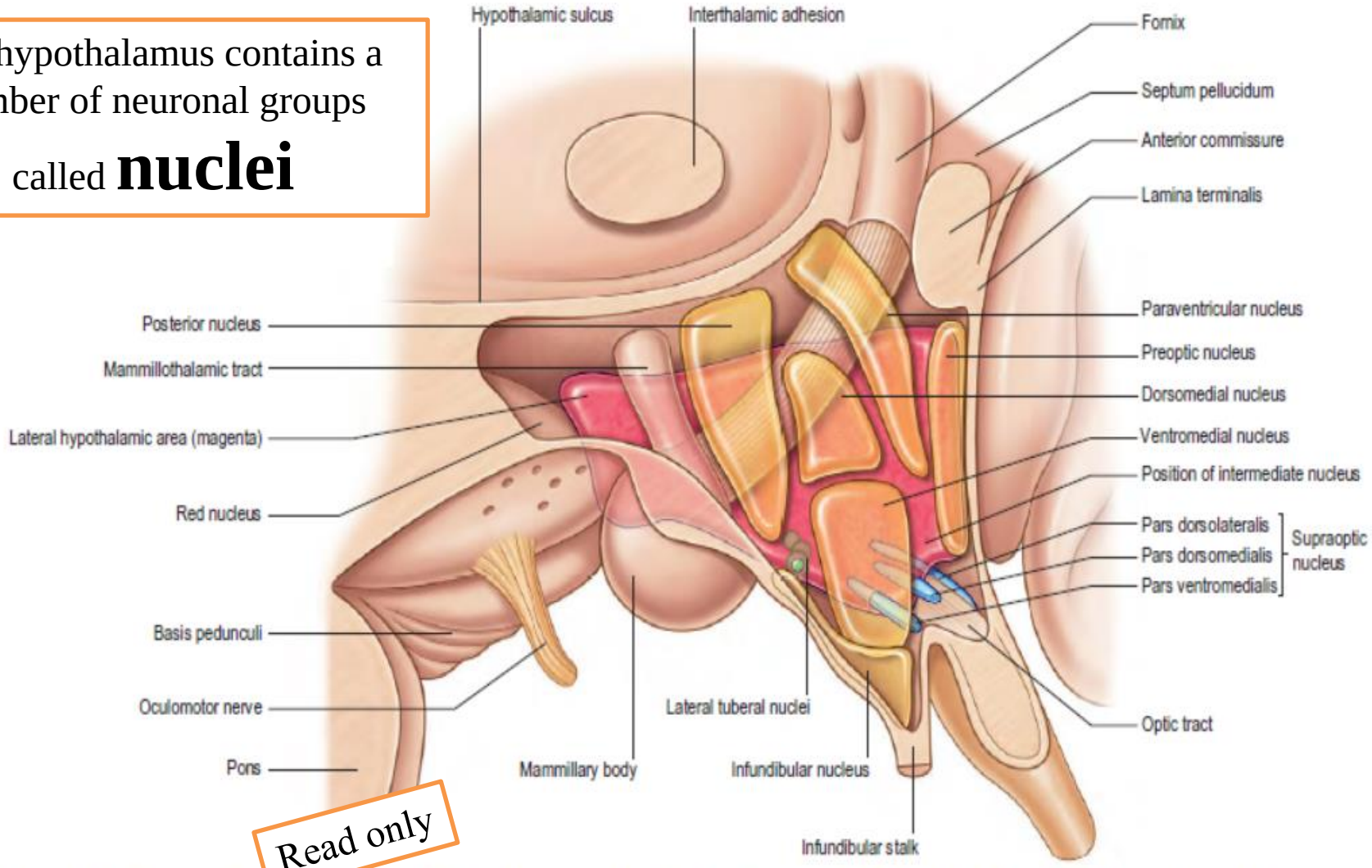
- consists of only 4 cm, 0.3% of the total brain



- It lies beneath the thalamus

- It contains the integrative systems that, via the autonomic and ***endocrine effector systems***, control fluid and electrolyte balance, food ingestion and energy balance, reproduction, thermoregulation, and immune and many emotional responses

The hypothalamus contains a number of neuronal groups called **nuclei**



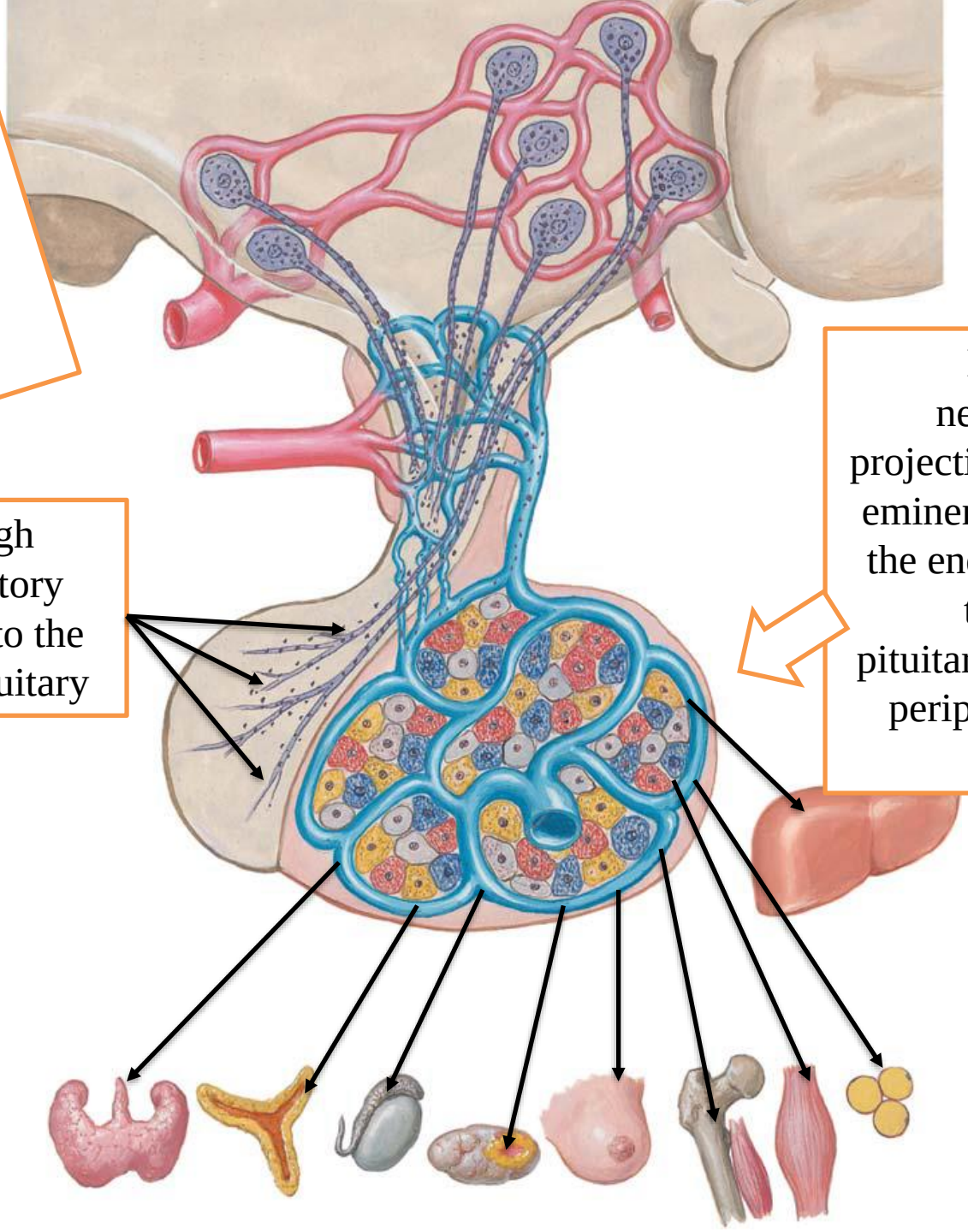
Read only

Fig. 21.8 The hypothalamic region of the left cerebral hemisphere viewed from the medial aspect and dissected to display the major hypothalamic nuclei. In the upper diagram the medially placed nuclear groups have been removed; in the lower diagram both lateral and medial groups are included. Lateral to the fornix and the mammillothalamic tract is the lateral hypothalamic region, in which the tuberomammillary nucleus is situated posteriorly, and the lateral preoptic nucleus rostrally. Surrounding the fornix is the perifornical nucleus, which joins the lateral hypothalamic area with the posterior hypothalamic nucleus. The medially placed nuclei (yellow) fill in much of the region between the mammillothalamic tract and the lamina terminalis, but also project caudal to the tract. The lateral tuberal nuclei are situated ventrally, largely in the lateral hypothalamic area. The supraoptic nucleus may form three rather separate parts. The intermediate nuclei form three groups between the supraoptic and paraventricular nuclei. (Modified from Nauta WJH, Haymaker W 1969 Hypothalamic nuclei and fibre connections. In: Haymaker W, Anderson E, Nauta WJH (eds) The Hypothalamus, by permission of Charles C Thomas Publisher, Ltd, Springfield, Illinois.)

The hypothalamus controls the endocrine system in a variety of ways:

A-Through neurosecretory projections to the posterior pituitary

B-Through neurosecretory projections to the median eminence (these control the endocrine output of the anterior pituitary and thereby the peripheral endocrine organs)



THE PITUITARY GLAND

Different names

also known as the HYPOPHYSIS

Master organ????

الغدة النخامية

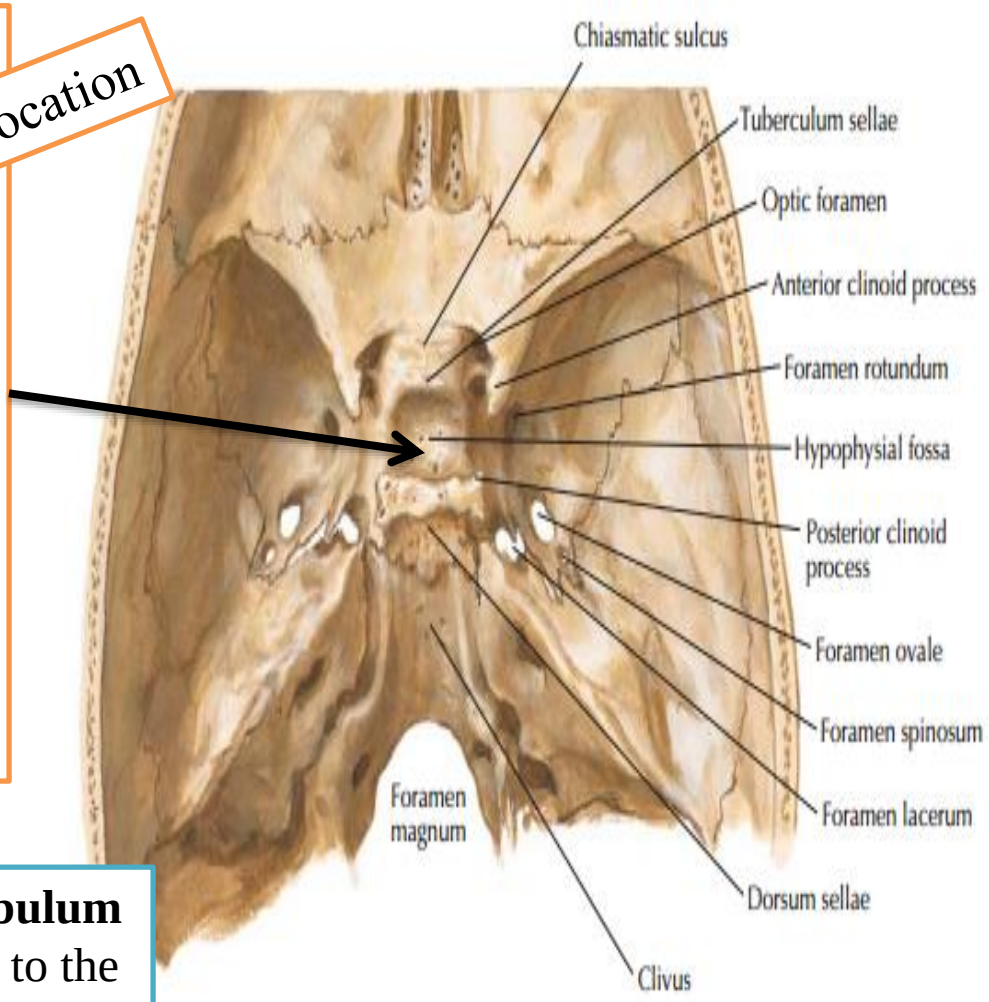
The pituitary

- It is a pea-sized
- Weighs 0.5 g in males and 1.5 g in multiparous women

location

- It is centrally located at the base of the brain, where it lies in a **saddle-shaped depression** of the sphenoid bone called

THE SELLA TURCICA



- A short stalk, the **infundibulum** connects the pituitary gland to the hypothalamus.

Gross Anatomy

Superiorly

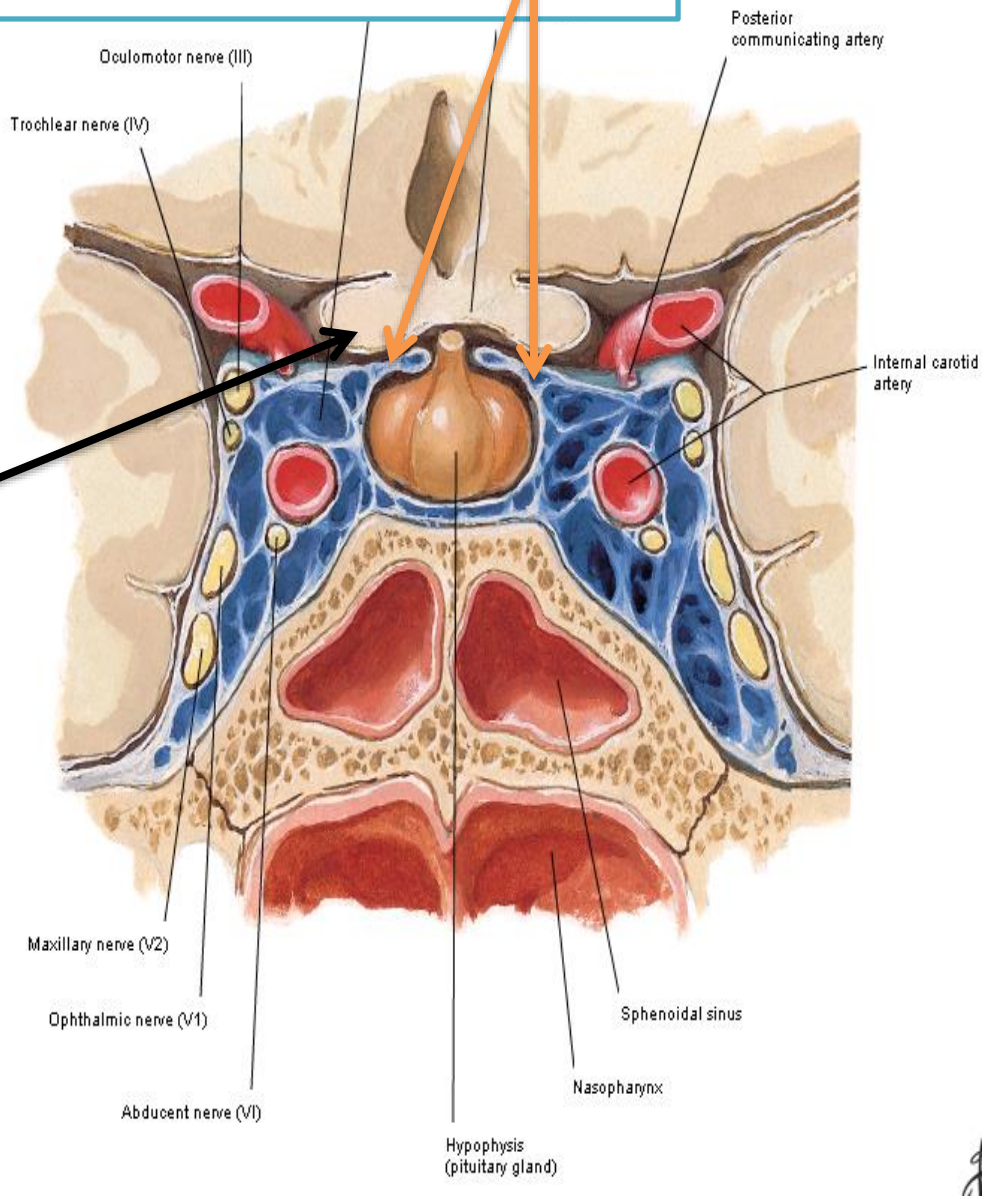
- A circular fold of dura mater, the

diaphragma sellae

forms the roof of this fossa

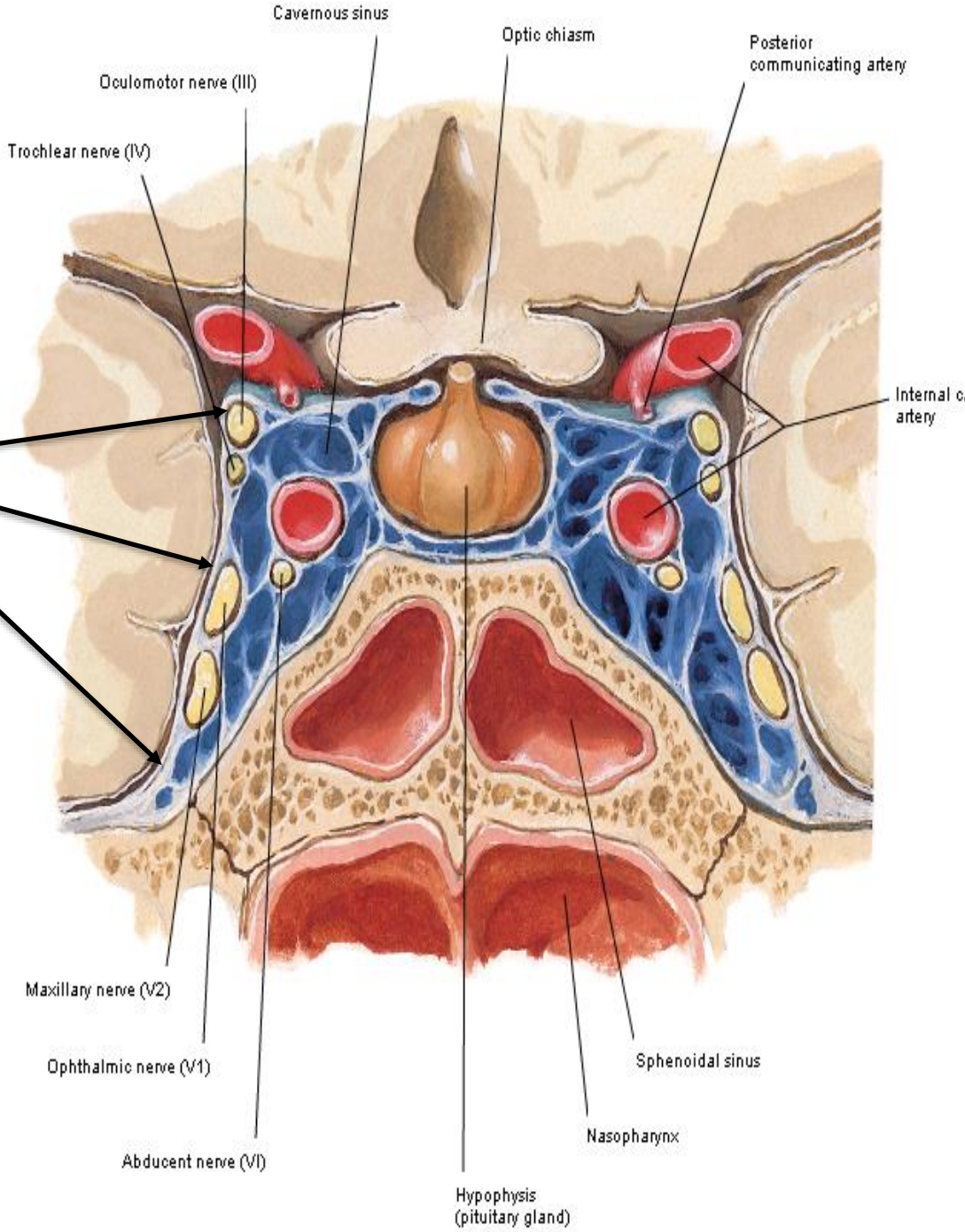
- The diaphragma sellae is pierced by a small central aperture through which the pituitary stalk passes, and it separates **the anterior part of the upper surface of the gland from**

The optic chiasma

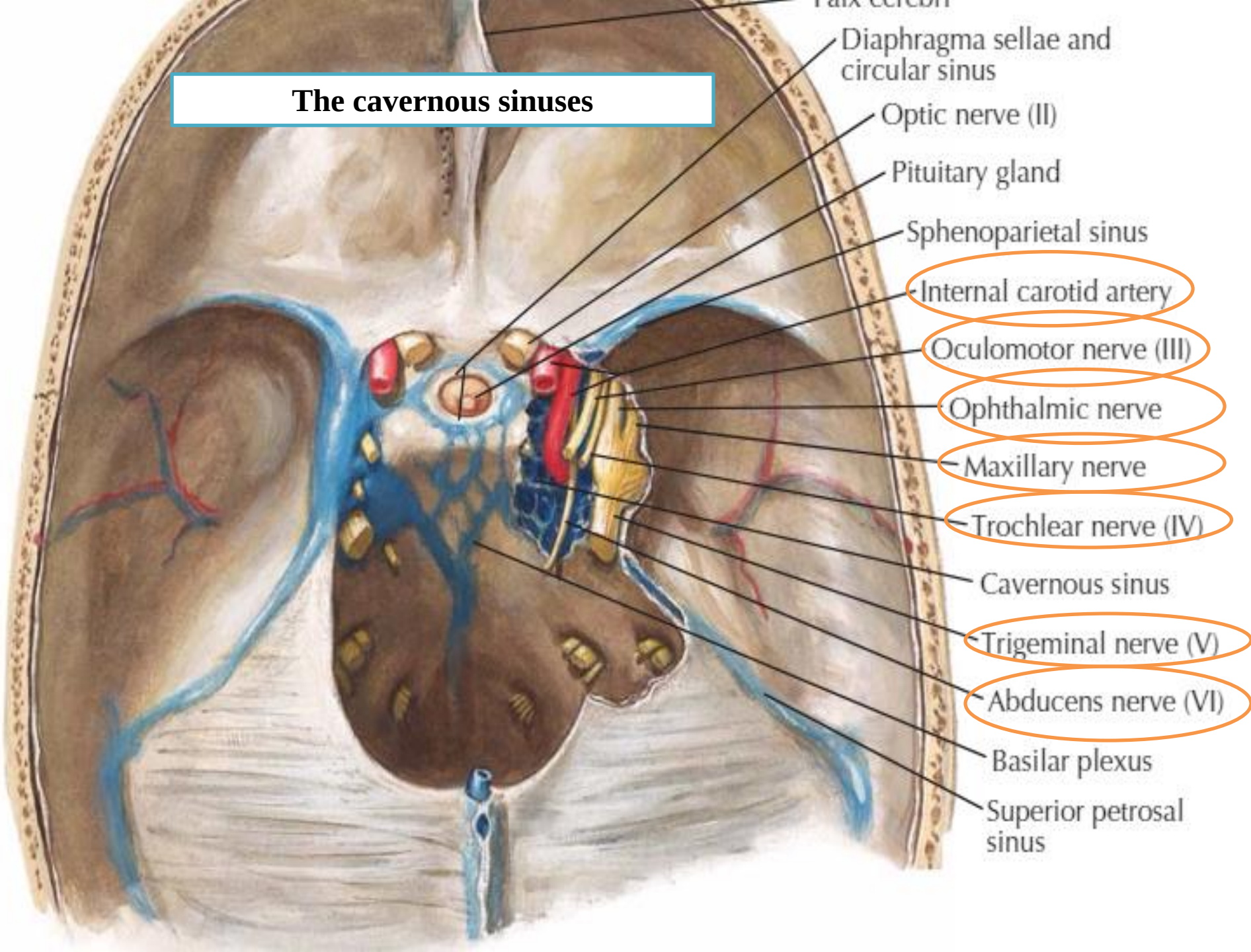


Laterally

- The hypophysis is bound on each side by **The cavernous sinuses** and the structures that they contain.



The cavernous sinuses



Structures Passing on lateral wall of the cavernous sinus

Cranial nerve number (3) oculomotor nerve

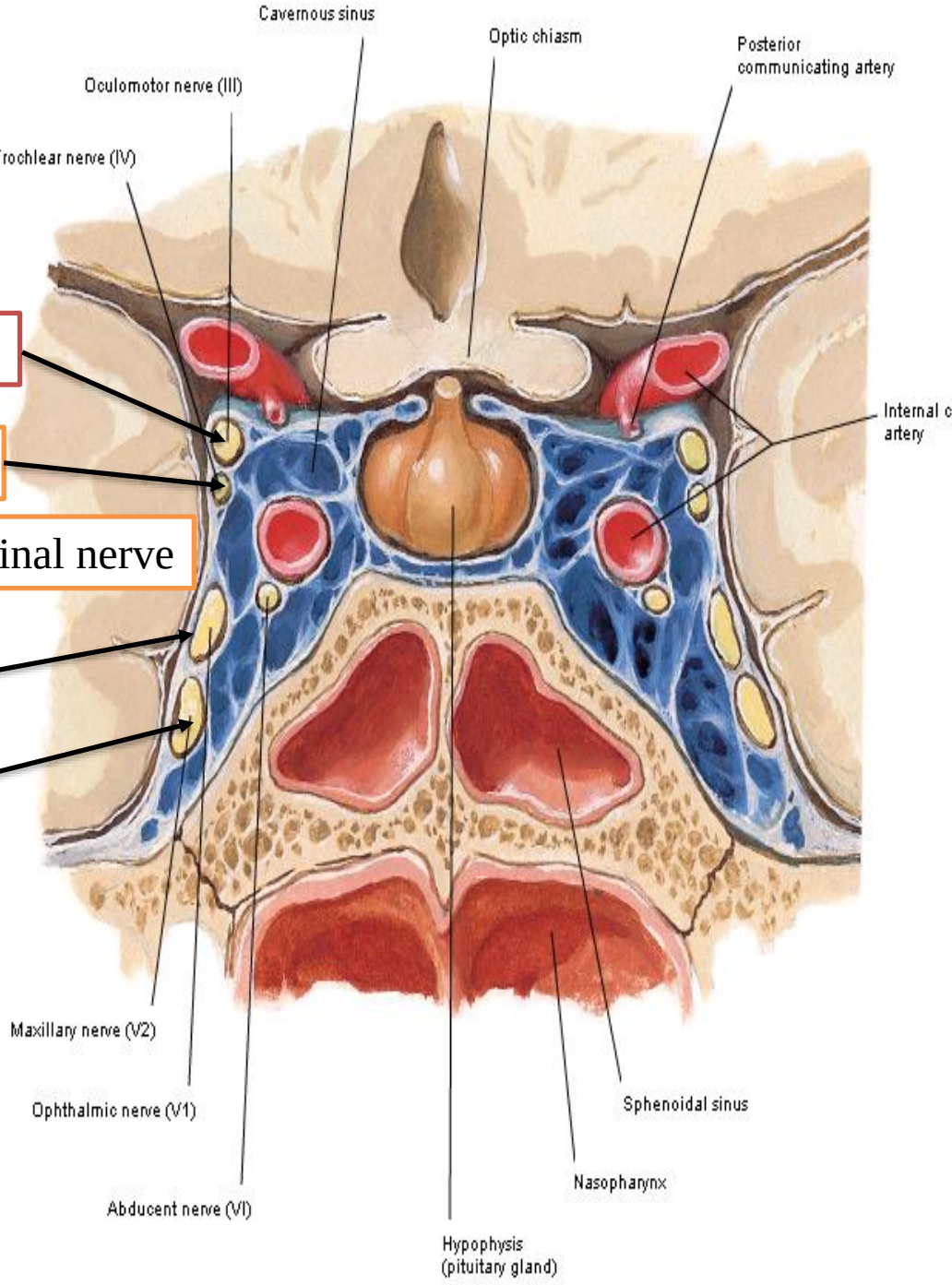
Cranial nerve number (4) Trochlear nerve

Divisions of Cranial nerve number (5) trigeminal nerve

Ophthalmic nerve

Maxillary nerve

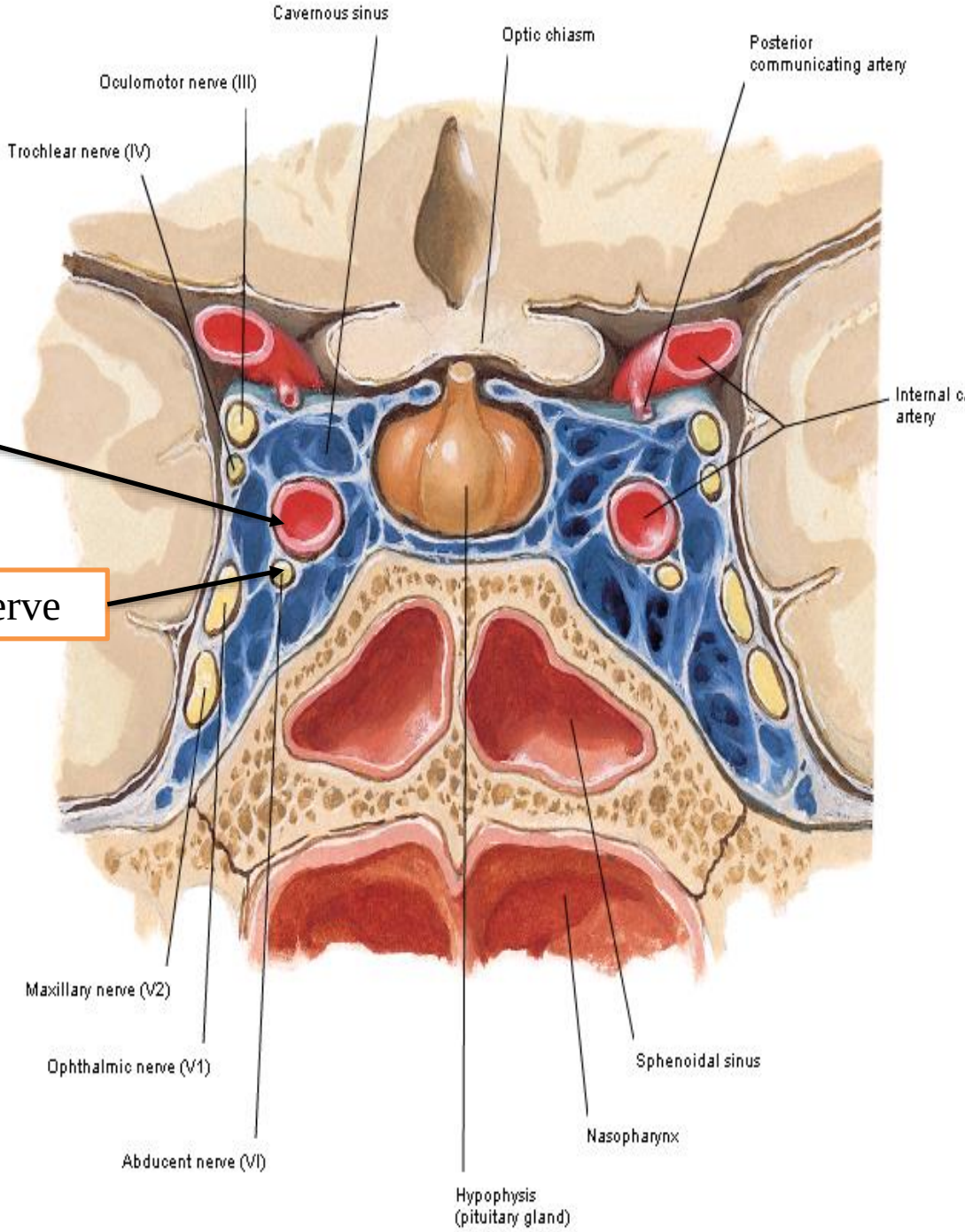
How about the mandibular nerve?



Structures inside the cavernous sinus

The internal carotid artery

The cranial nerve number (6) abducent nerve

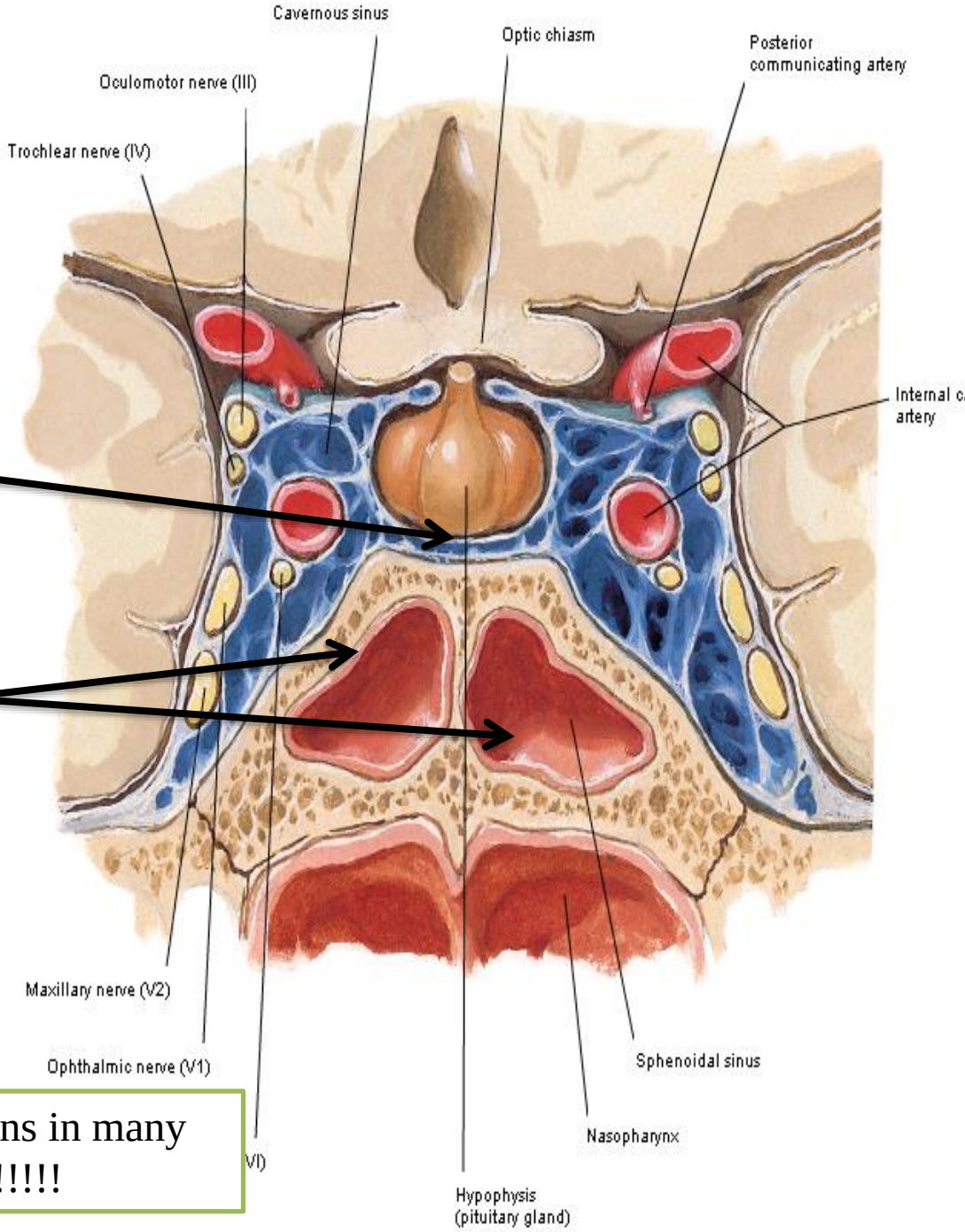


Inferiorly

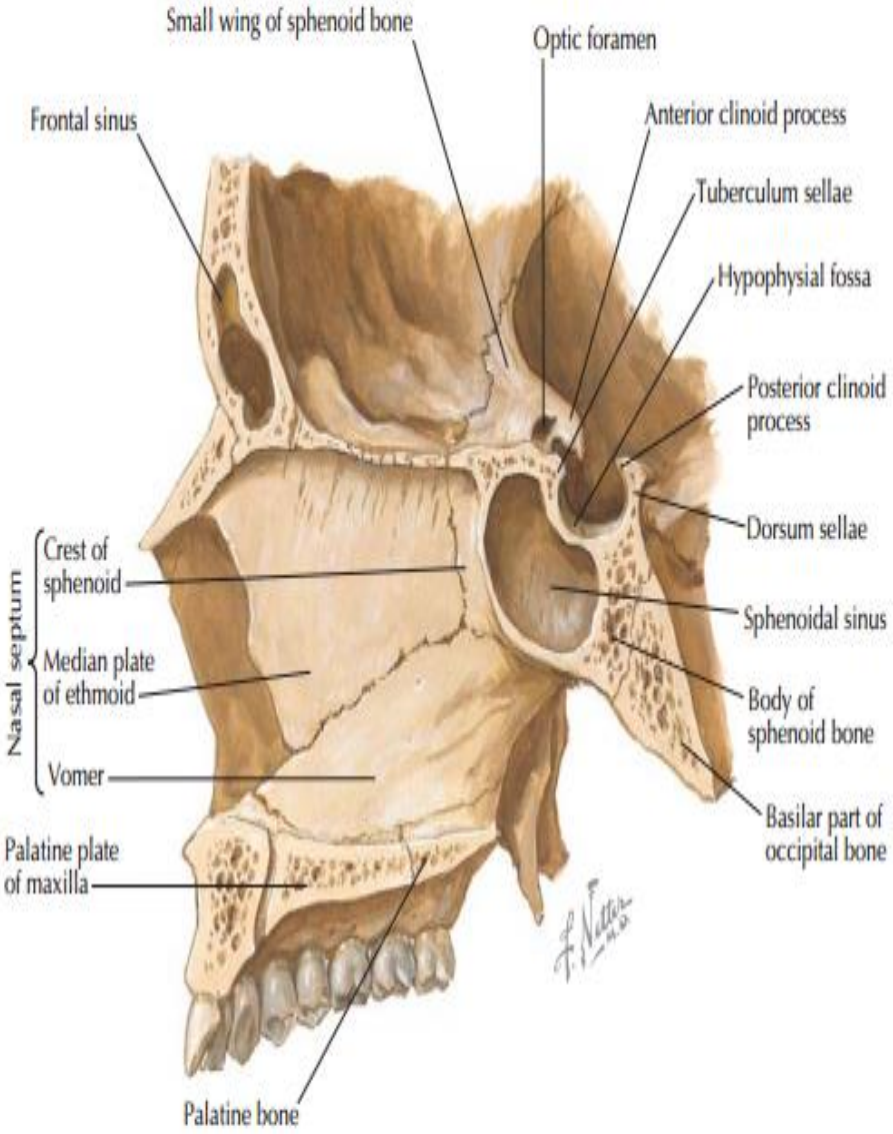
- it is separated from the floor of the fossa by a large, partially vacuolated **venous sinus**

The sphenoid air sinus

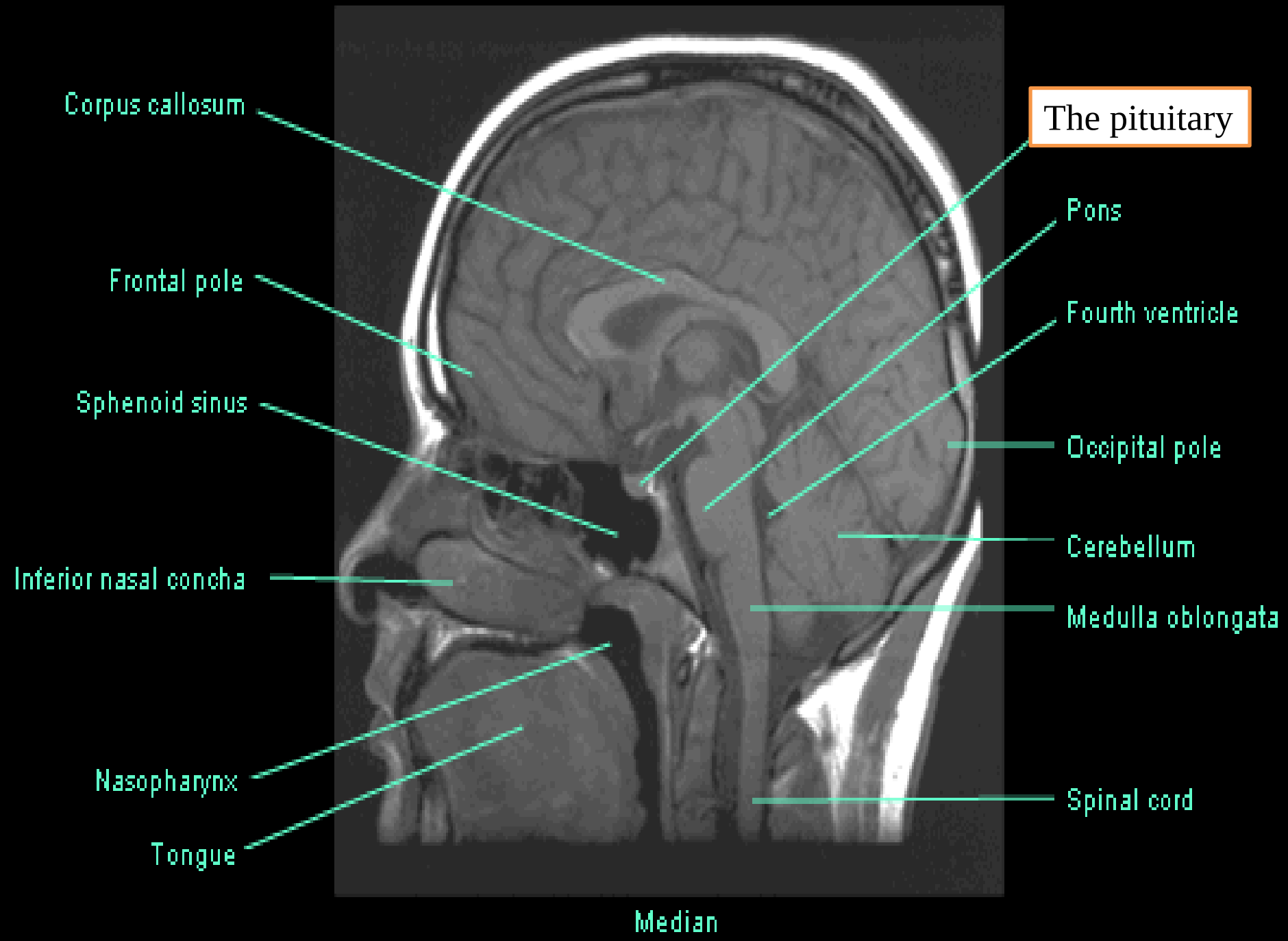
endoscopic transnasal applications in many pituitary surgical centers!!!!!



Radiology


Small wing of sphenoid bone
Optic foramen
Frontal sinus
Anterior clinoid process
Tuberculum sellae
Hypophysial fossa
Posterior clinoid process
Dorsum sellae
Sphenoidal sinus
Body of sphenoid bone
Basilar part of occipital bone
Nasal septum
Crest of sphenoid
Median plate of ethmoid
Vomer
Palatine plate of maxilla
Palatine bone


THE SELLA TURCICA
(hypophyseal fossa)

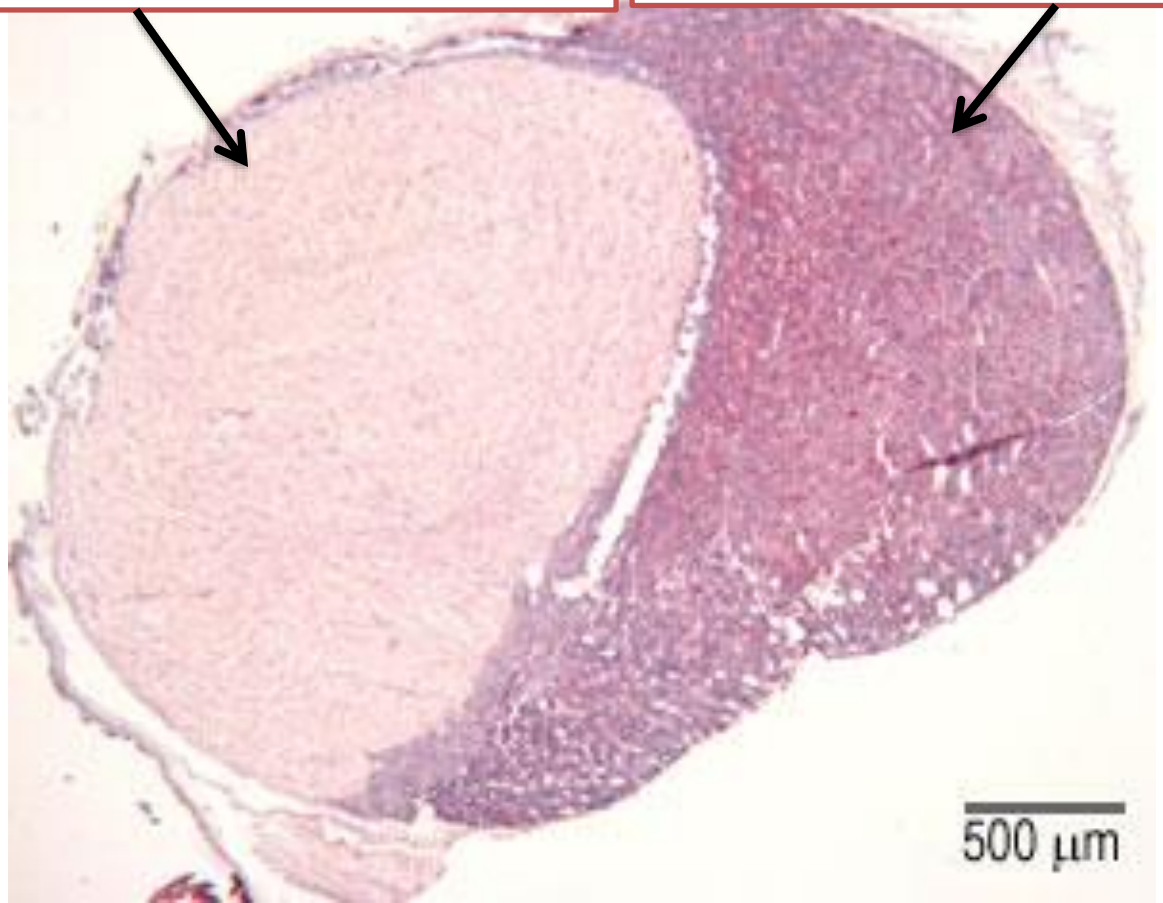

Corpus callosum
Frontal pole
Sphenoid sinus
Inferior nasal concha
Nasopharynx
Tongue
The pituitary
Pons
Fourth ventricle
Occipital pole
Cerebellum
Medulla oblongata
Spinal cord
Median

Surgical approach

The pituitary gland is composed of two functional tissues

Neural (secretory) tissue
Posterior lobe
(**Neurohypophysis**)

Glandular epithelial tissue
The Anterior lobe
(**Adenohypophysis**)



Embryology

Important

Each endocrine gland has
two different
Embryological origins

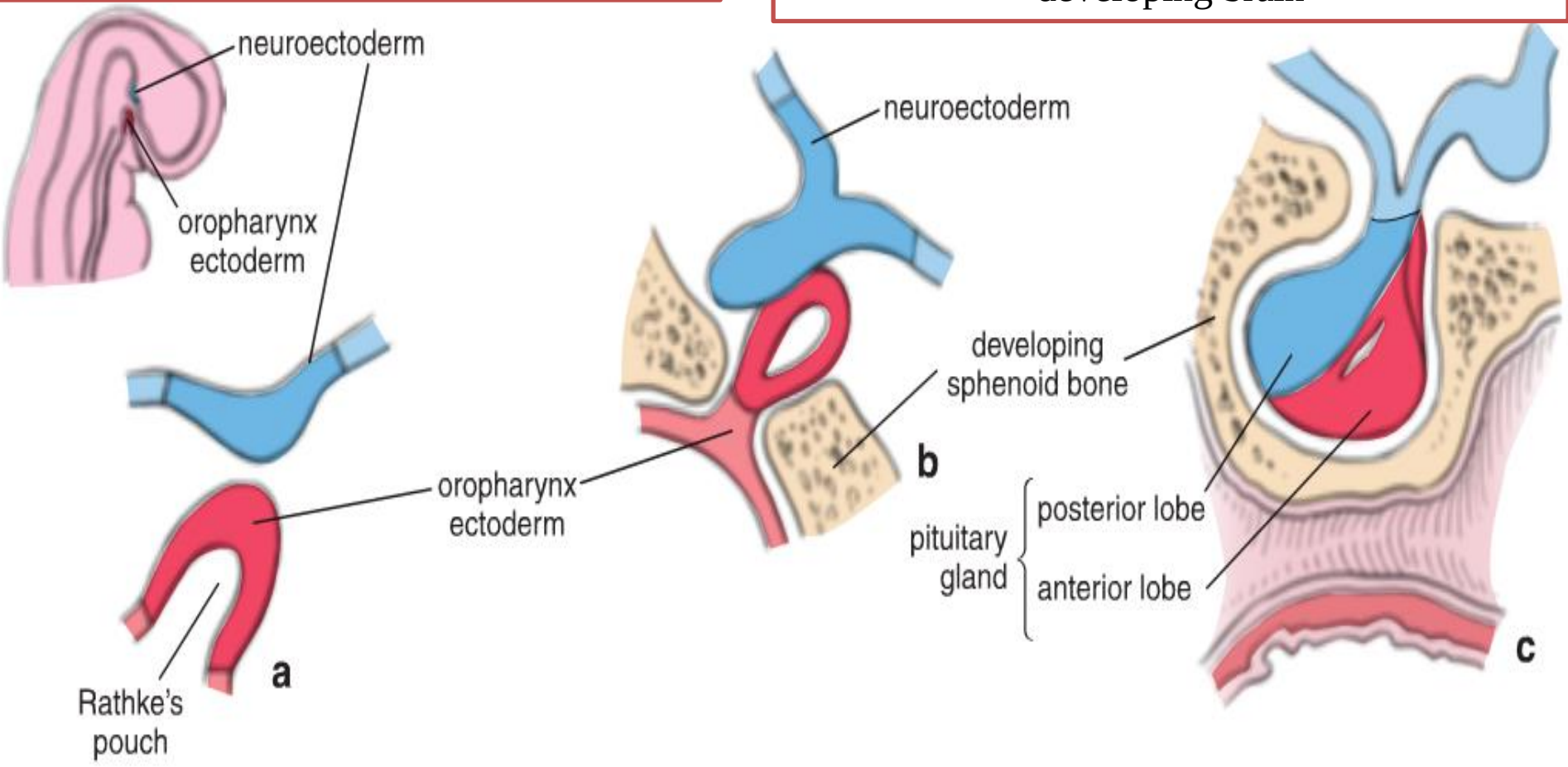
The two portions are of different embryologic origin

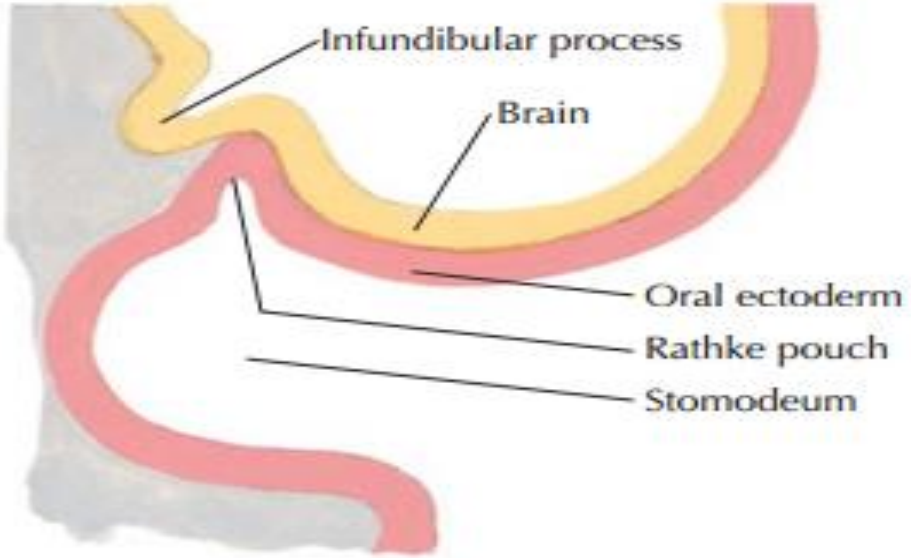
The anterior lobe of the pituitary gland is derived from an evagination of the **ectoderm** of the oropharynx toward the brain

Rathke's pouch

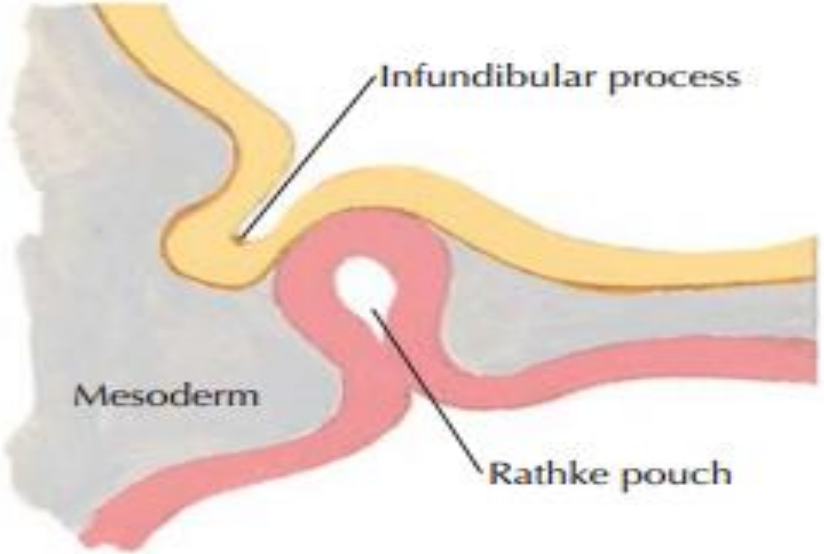
The posterior lobe of the pituitaryis derived from **a downgrowth (the future infundibulum)**

neuroectoderm of the floor of the third ventricle (the diencephalon) of the developing brain

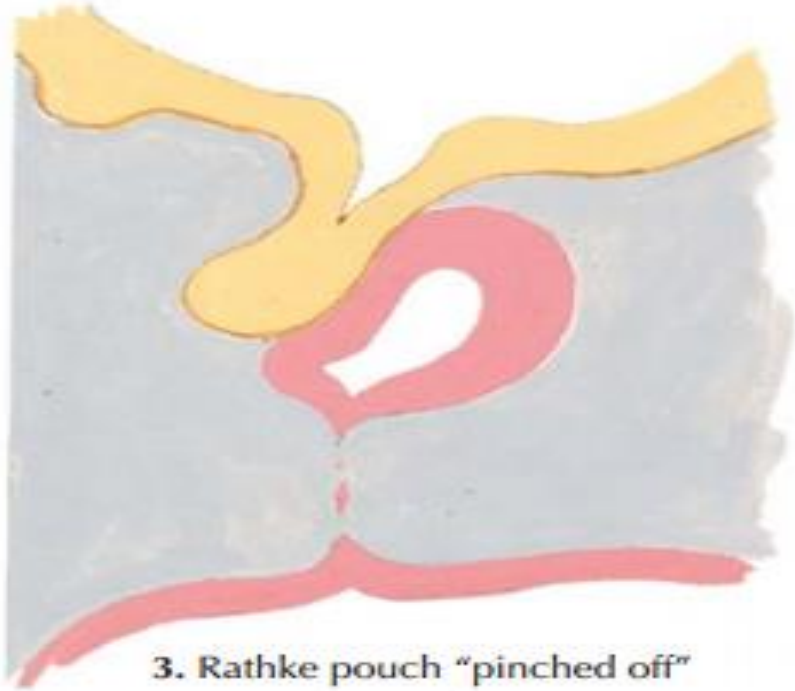




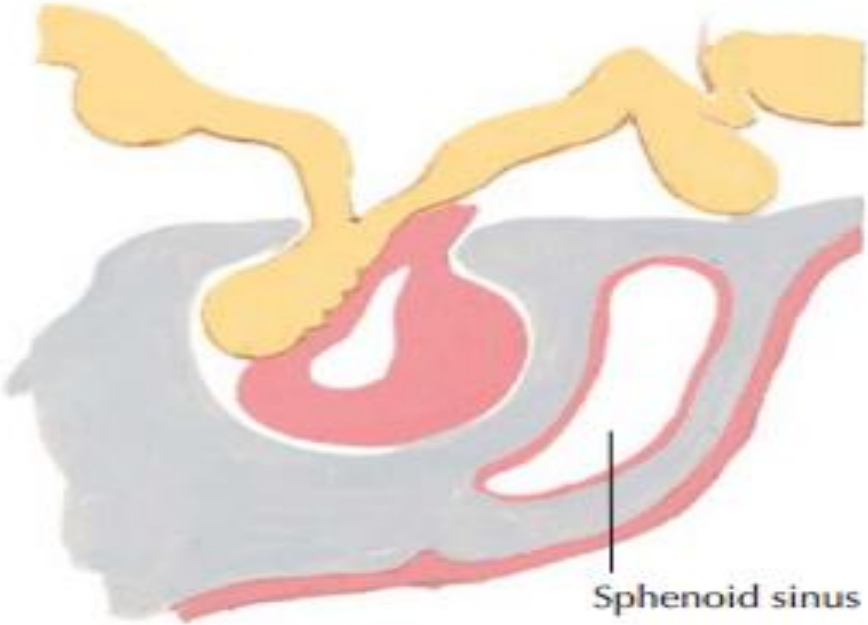
1. Beginning formation of Rathke pouch and infundibular process



2. Neck of Rathke pouch constricted by growth of mesoderm

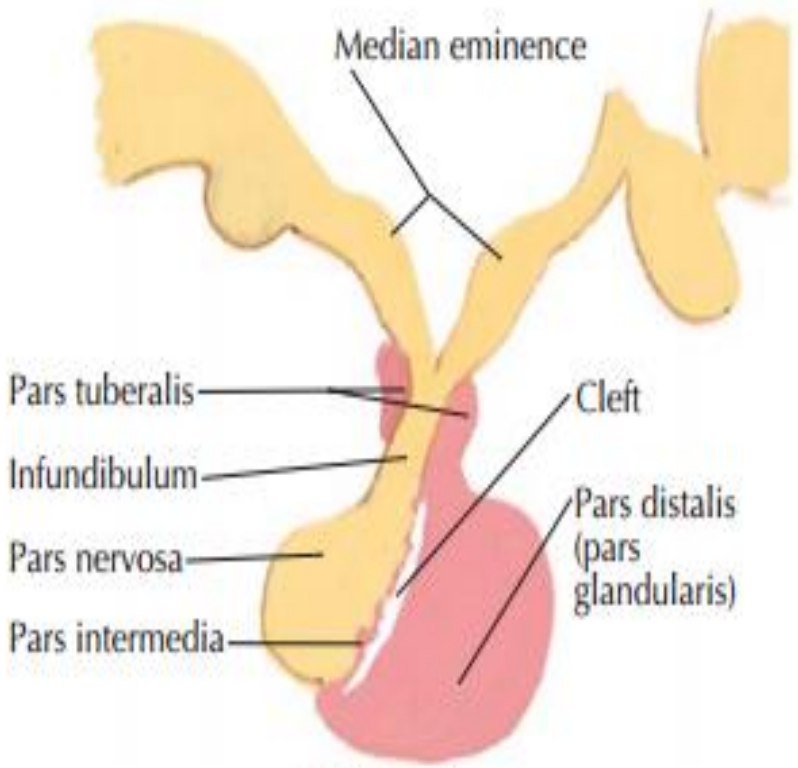


3. Rathke pouch "pinched off"

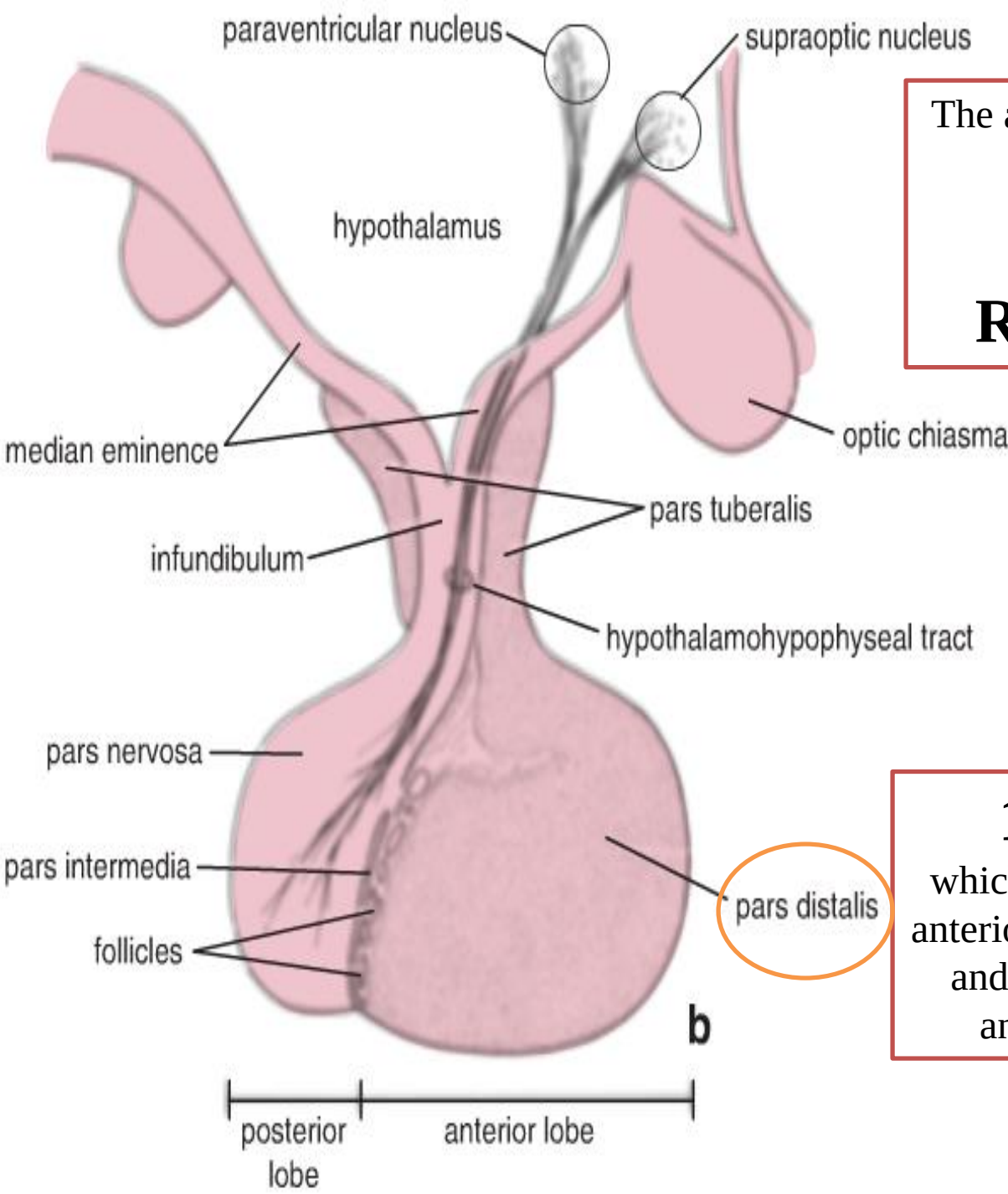


4. "Pinched off" segment conforms to neural process, forming pars distalis, pars intermedia, and pars tuberalis

5. Pars tuberalis encircles infundibular stalk (lateral surface view)



6. Mature form



The anterior lobe of the pituitary gland consists of three derivatives of

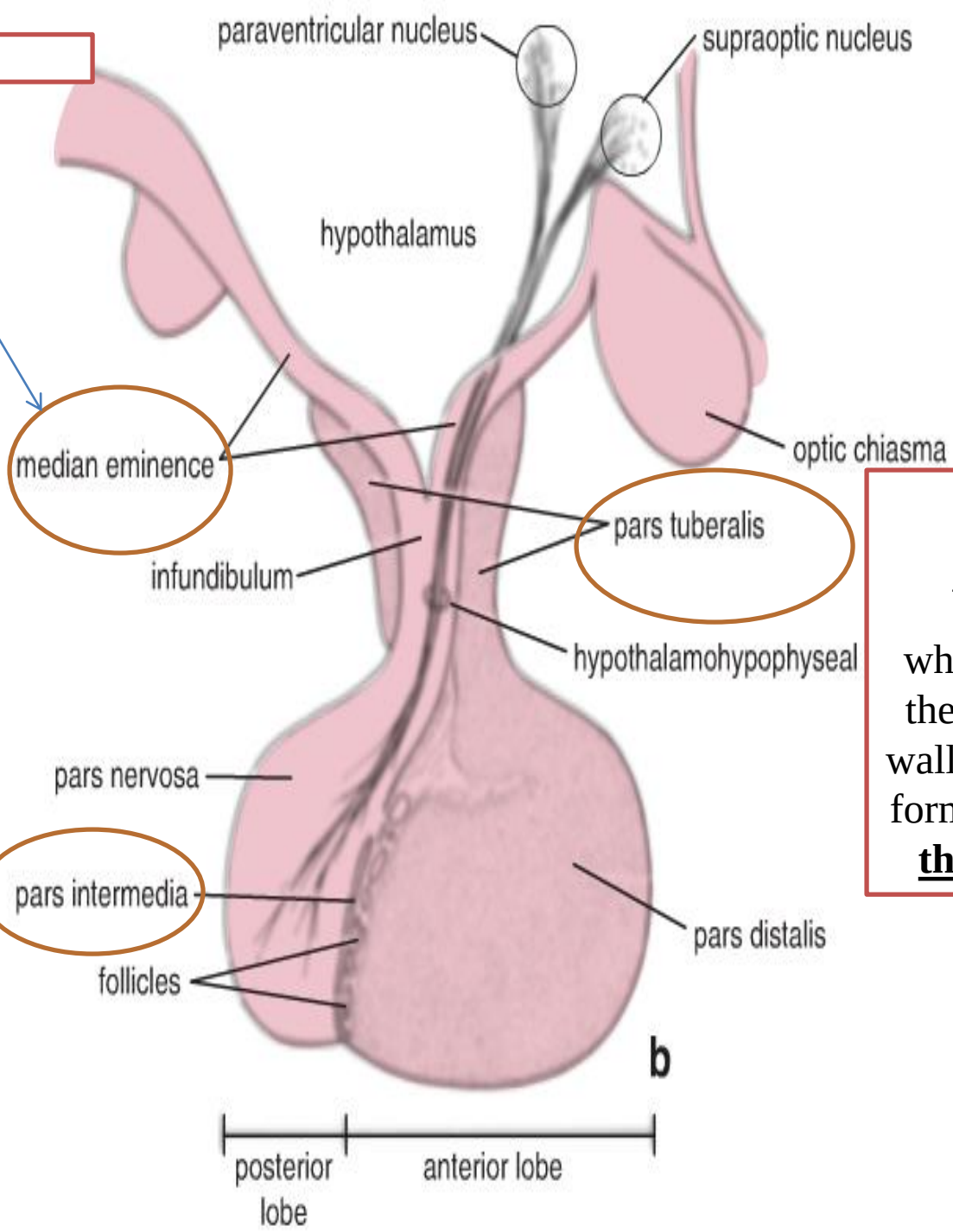
Rathke's pouch:

1-Pars distalis

which comprises the bulk of the anterior lobe of the pituitary gland and arises from the thickened anterior wall of the pouch

It **is not part** of the pituitary gland

The **median eminence** is part of the **hypothalamus** from which regulatory hormones are released



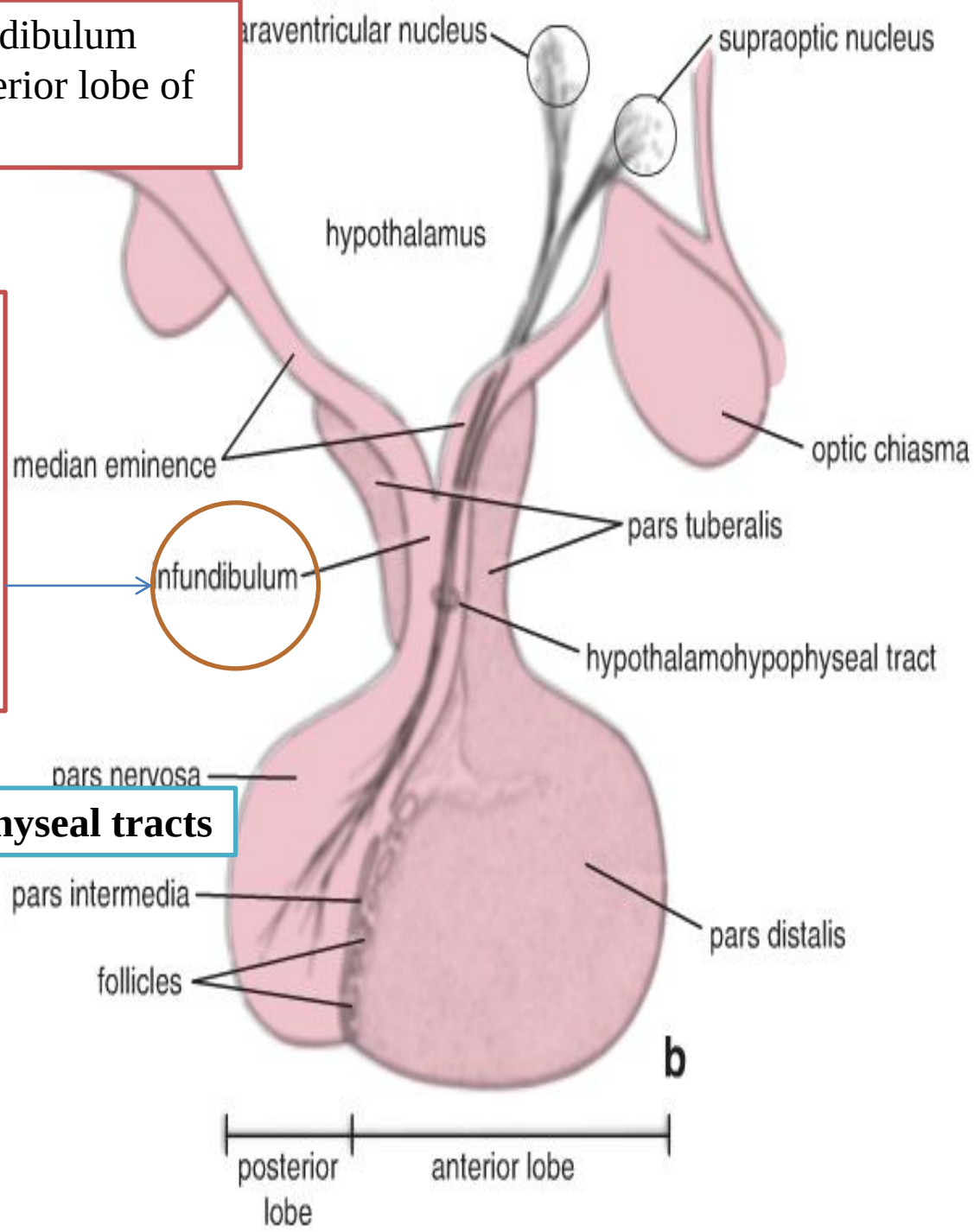
2-Pars intermedia
a thin remnant of the posterior wall of the pouch

3-Pars tuberalis
which develops from the thickened lateral walls of the pouch and forms a sheath around **the infundibulum**

The embryonic infundibulum gives rise to the posterior lobe of the pituitary gland

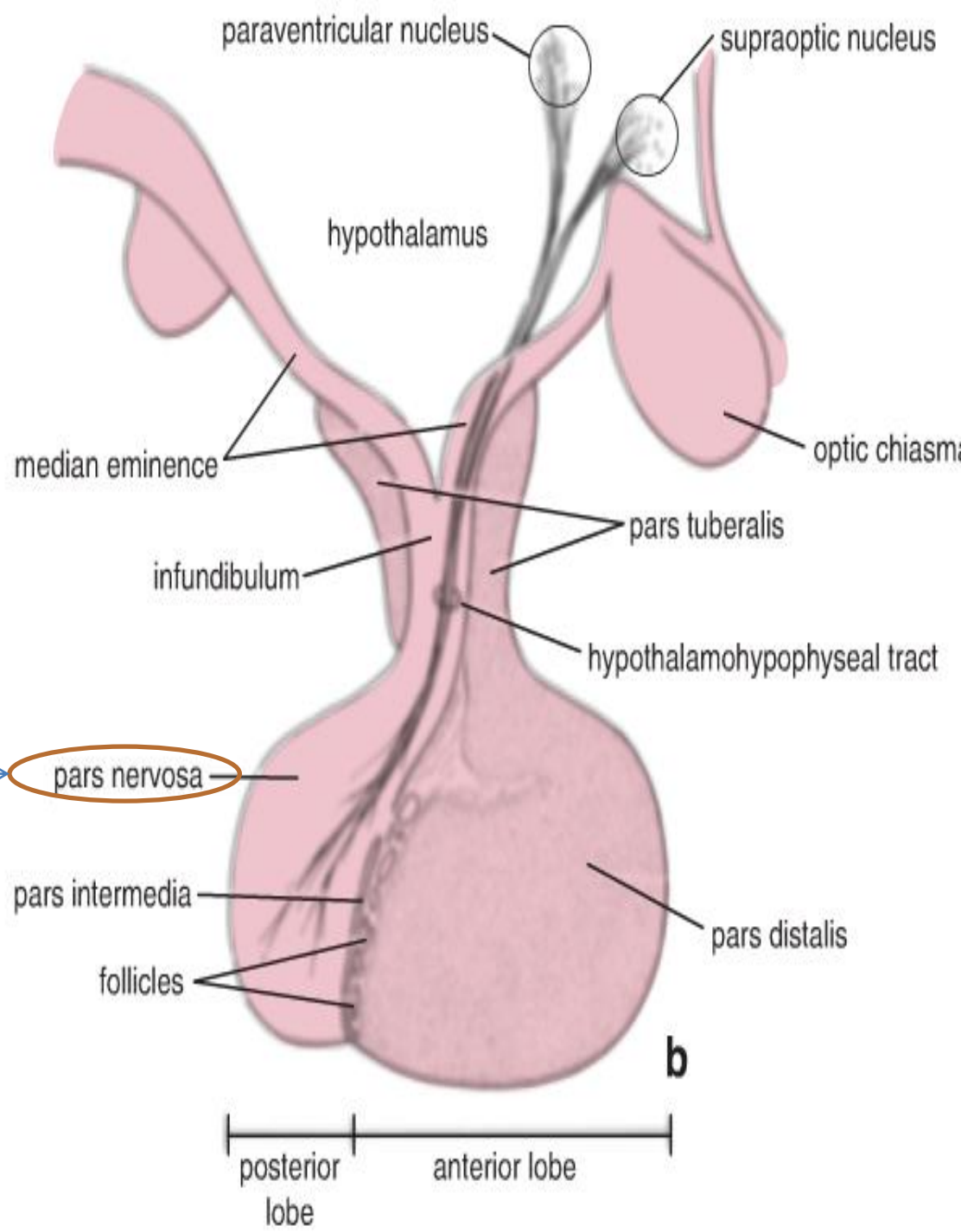
Infundibulum, which is continuous with the median eminence and contains the **neurosecretory axons forming the**

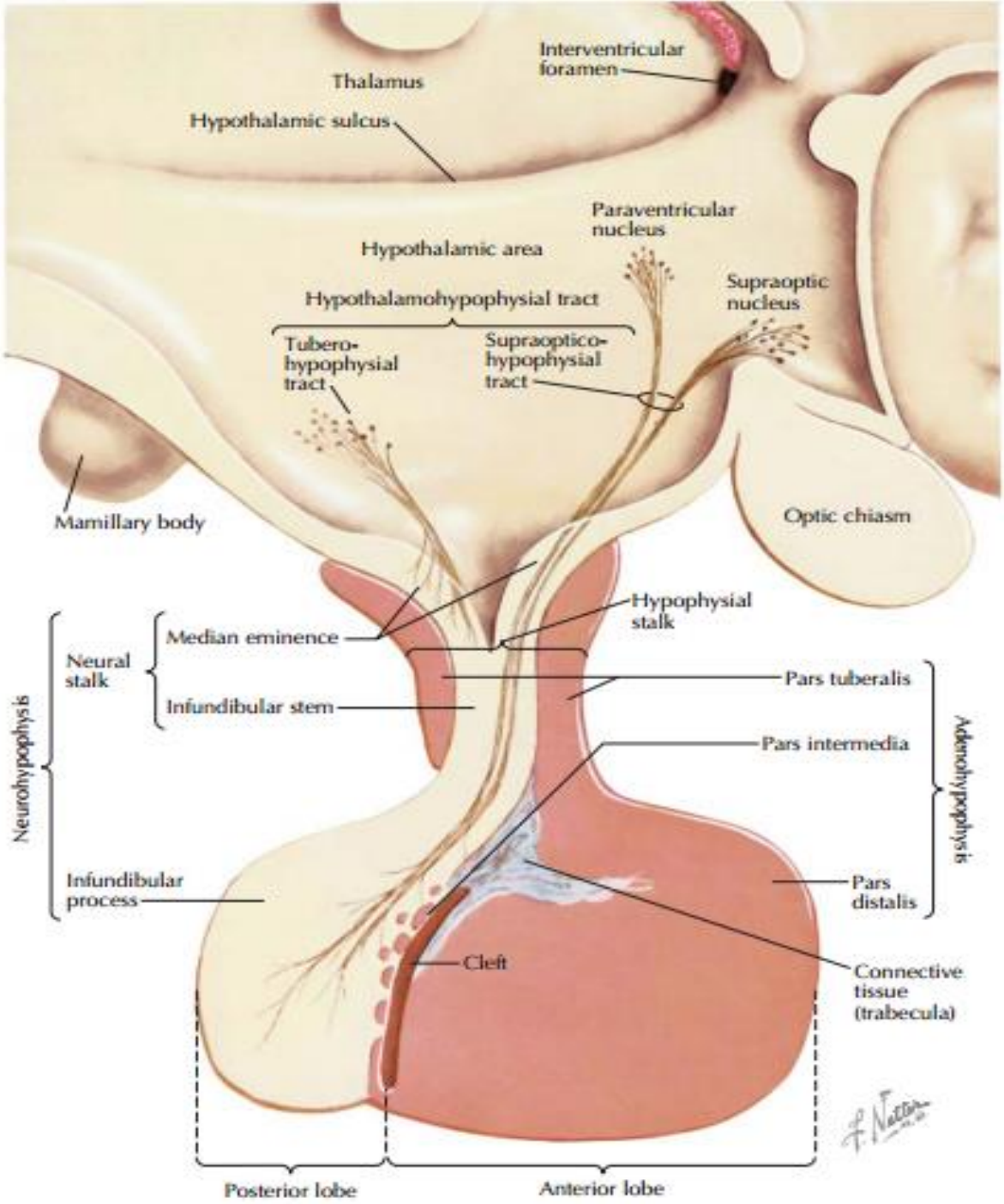
hypothalamohypophyseal tracts



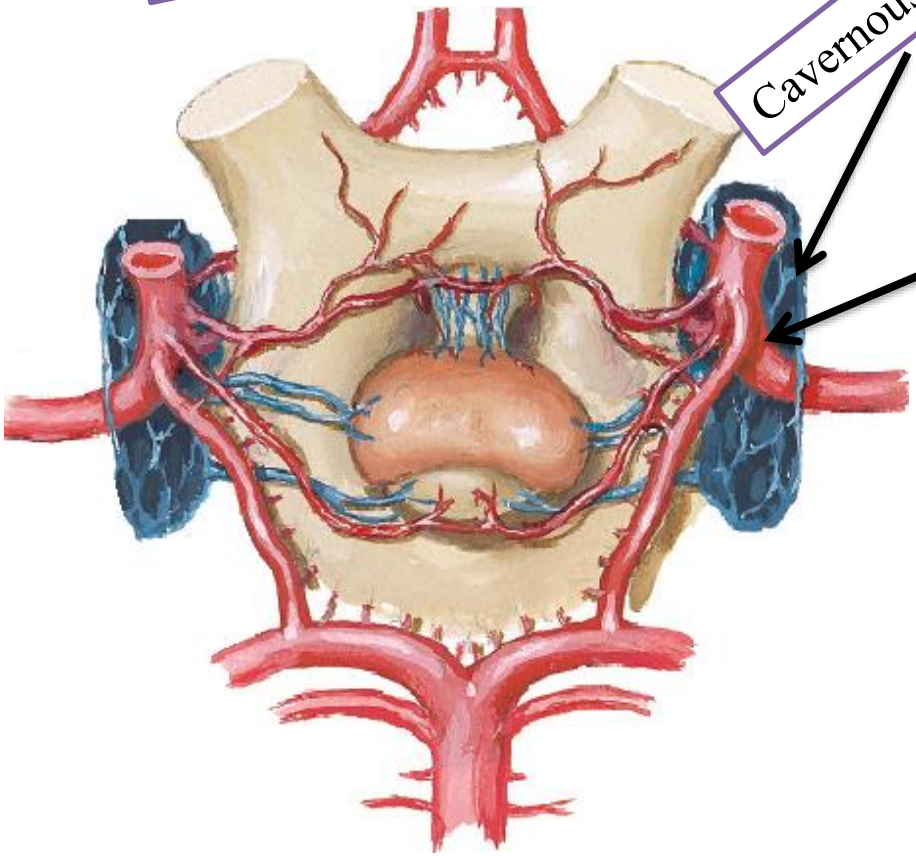
The posterior lobe consists of the following:

- **Pars nervosa,** which contains neurosecretory axons and their endings




Interventricular foramen
Thalamus
Hypothalamic sulcus
Paraventricular nucleus
Hypothalamic area
Supraoptic nucleus
Hypothalamohypophysial tract
Tubero-hypophysial tract
Supraoptico-hypophysial tract
Mamillary body
Optic chiasm
Hypophysial stalk
Neurohypophysis
Neural stalk
Median eminence
Infundibular stem
Infundibular process
Pars tuberalis
Pars intermedia
Adenohypophysis
Pars distalis
Cleft
Connective tissue (trabecula)
Posterior lobe
Anterior lobe

Blood supply

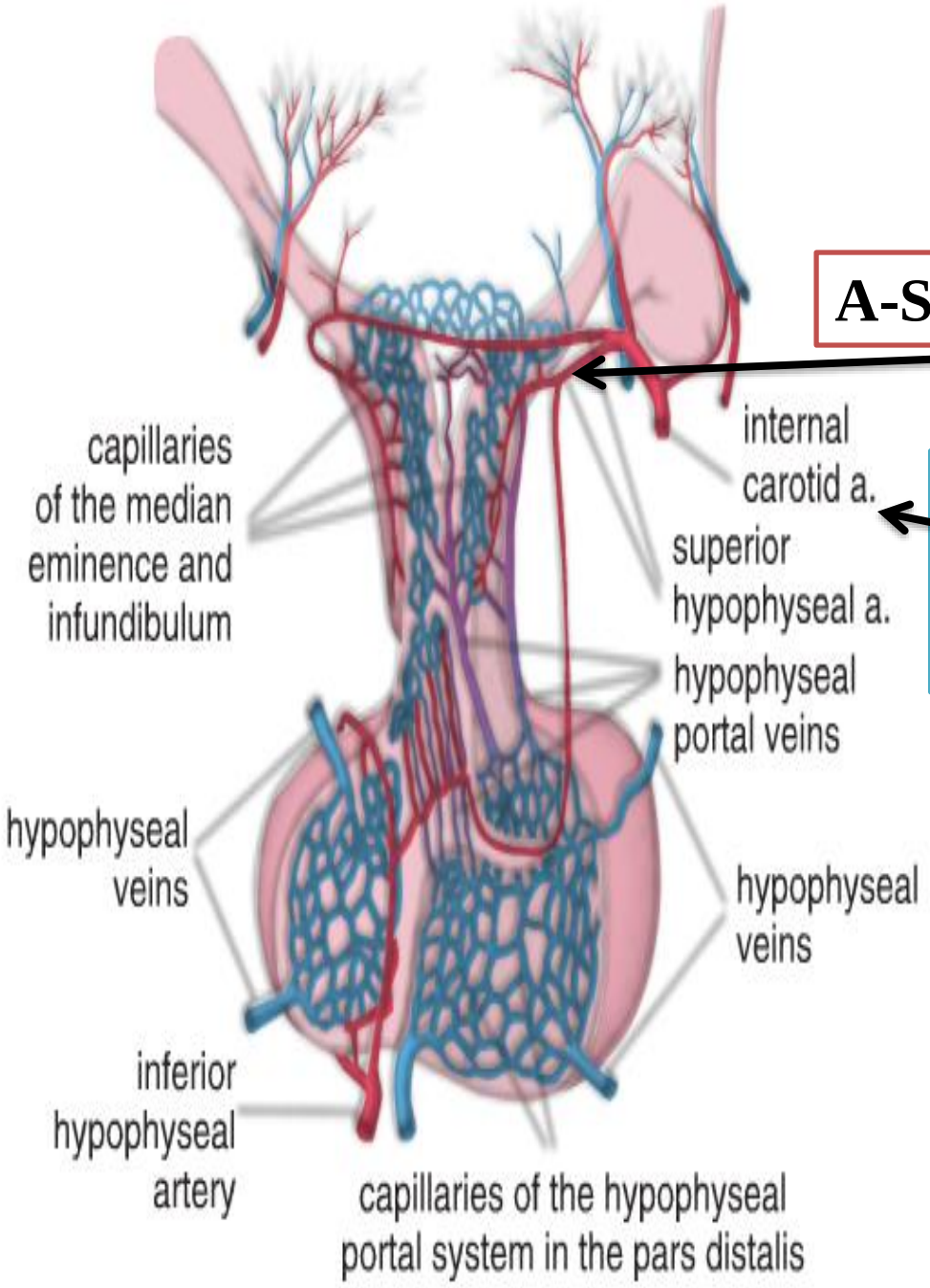


Hypophysial arteries are branches of the intercavernous segment of The internal carotid artery

<u>The inferior</u> branch supplies the posterior lobe of the pituitary gland

<u>The superior</u> branch leads into the median eminence to start the hypophysial portal system to the anterior lobe

Blood supply



A-Superior hypophyseal arteries

These vessels arise **from the internal carotid** arteries and posterior communicating artery of the circle of Willis

They supply

The pars tuberalis
Median eminence
Infundibulum

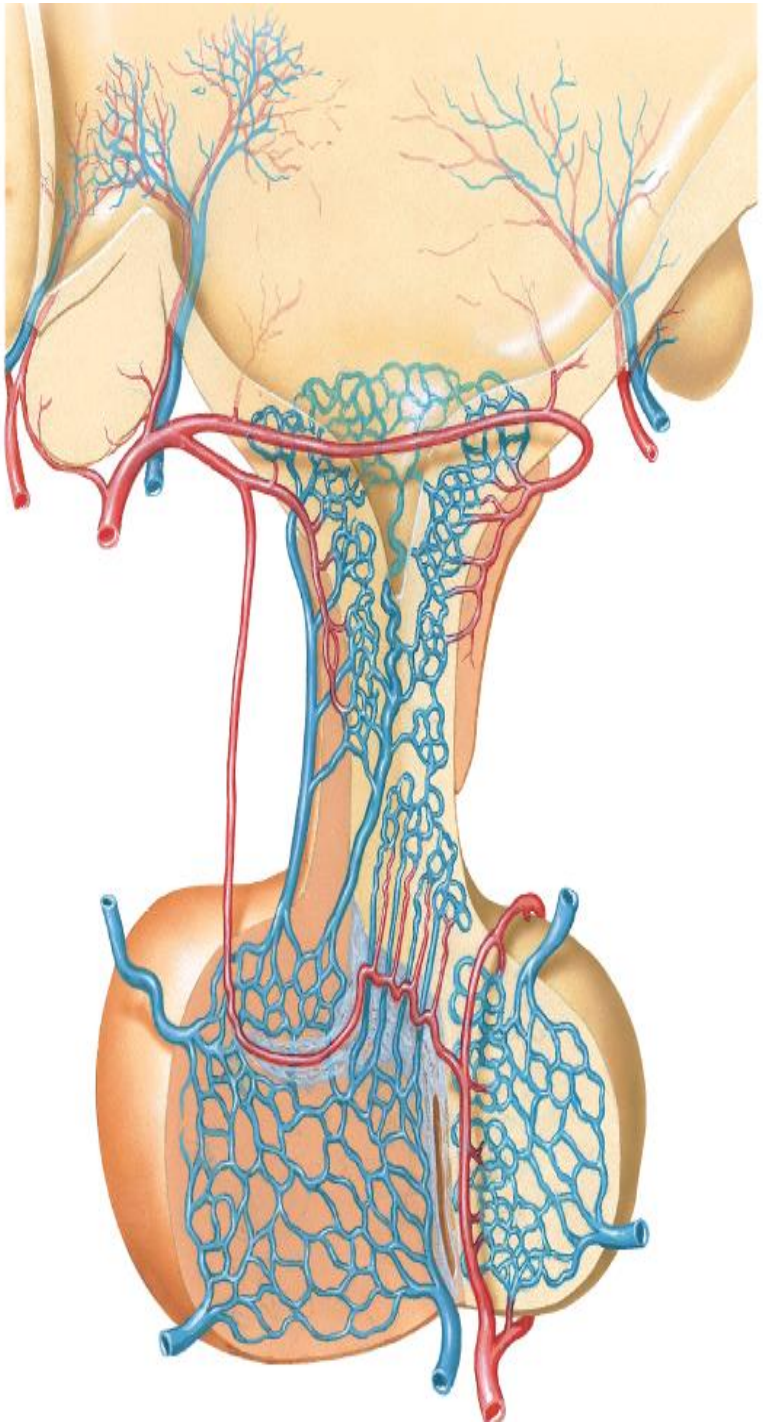
Divides into medial and lateral arteries

Form an arterial ring around the infundibulum

An important functional observation is that most of the anterior lobe of the pituitary gland has ***no direct arterial supply!!!!!***

What to do???

A Portal System

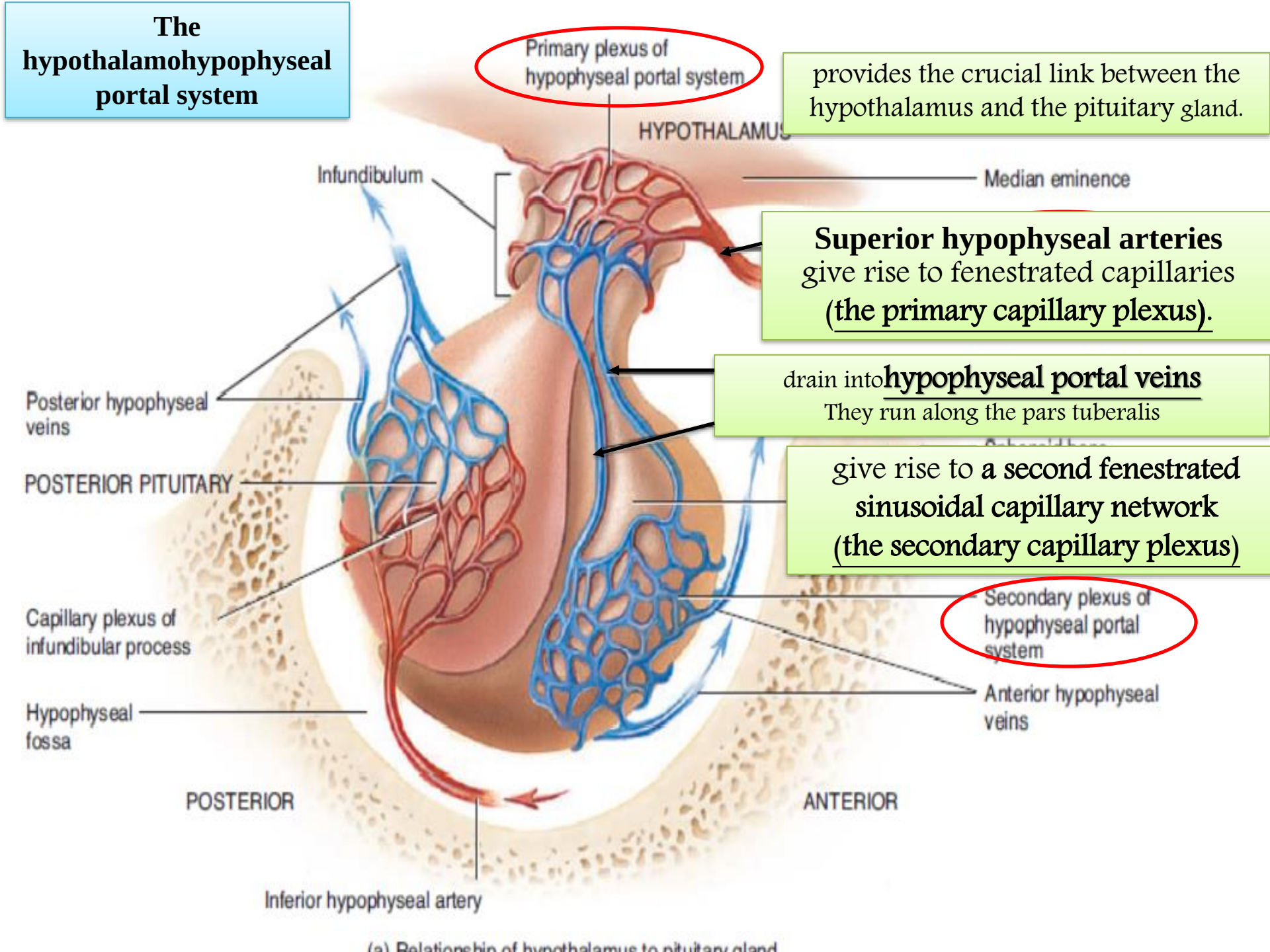


WHAT IS A Portal System?

Usually, blood passes from the heart through an artery to a capillary to a vein and back to the heart.

- In a *portal system,* blood flows from one capillary network into a portal vein, and then into a second capillary network before returning to the heart. The name of the portal system indicates the location of the second capillary network.

The hypothalamohypophyseal portal system

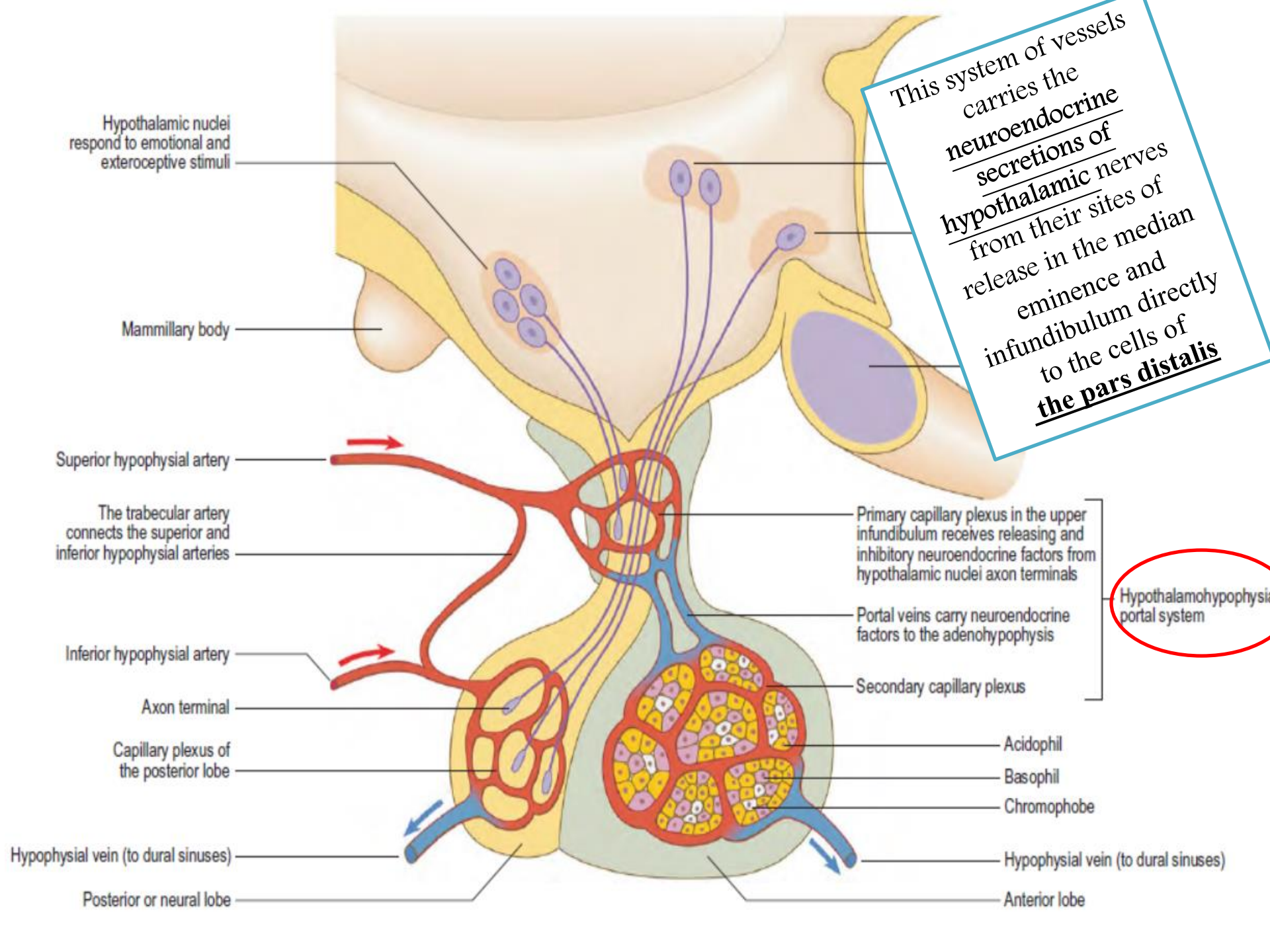


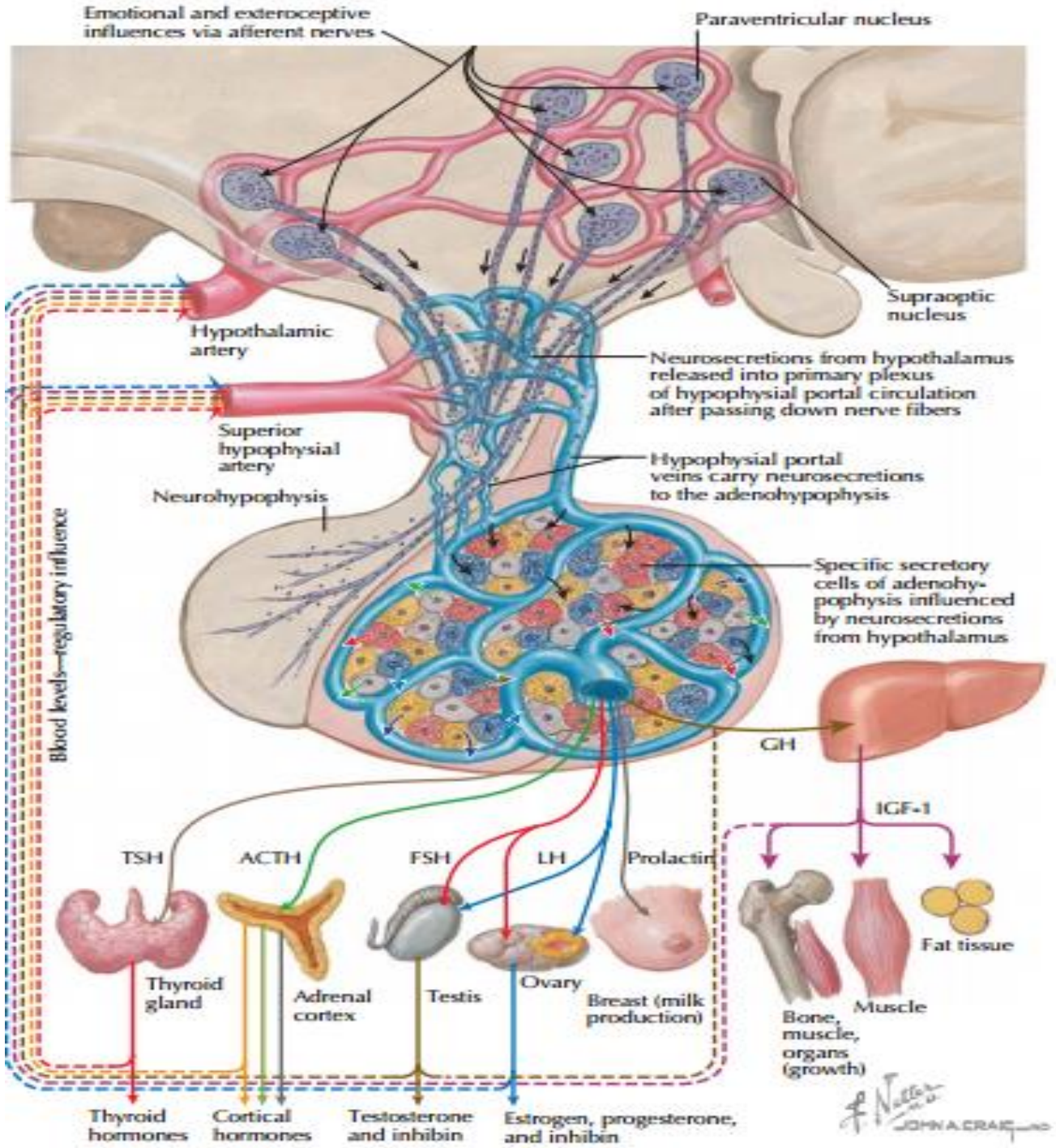
provides the crucial link between the hypothalamus and the pituitary gland.

Superior hypophyseal arteries give rise to fenestrated capillaries (**the primary capillary plexus**).

drain into **hypophyseal portal veins**
They run along the pars tuberalis

give rise to **a second fenestrated sinusoidal capillary network** (**the secondary capillary plexus**)

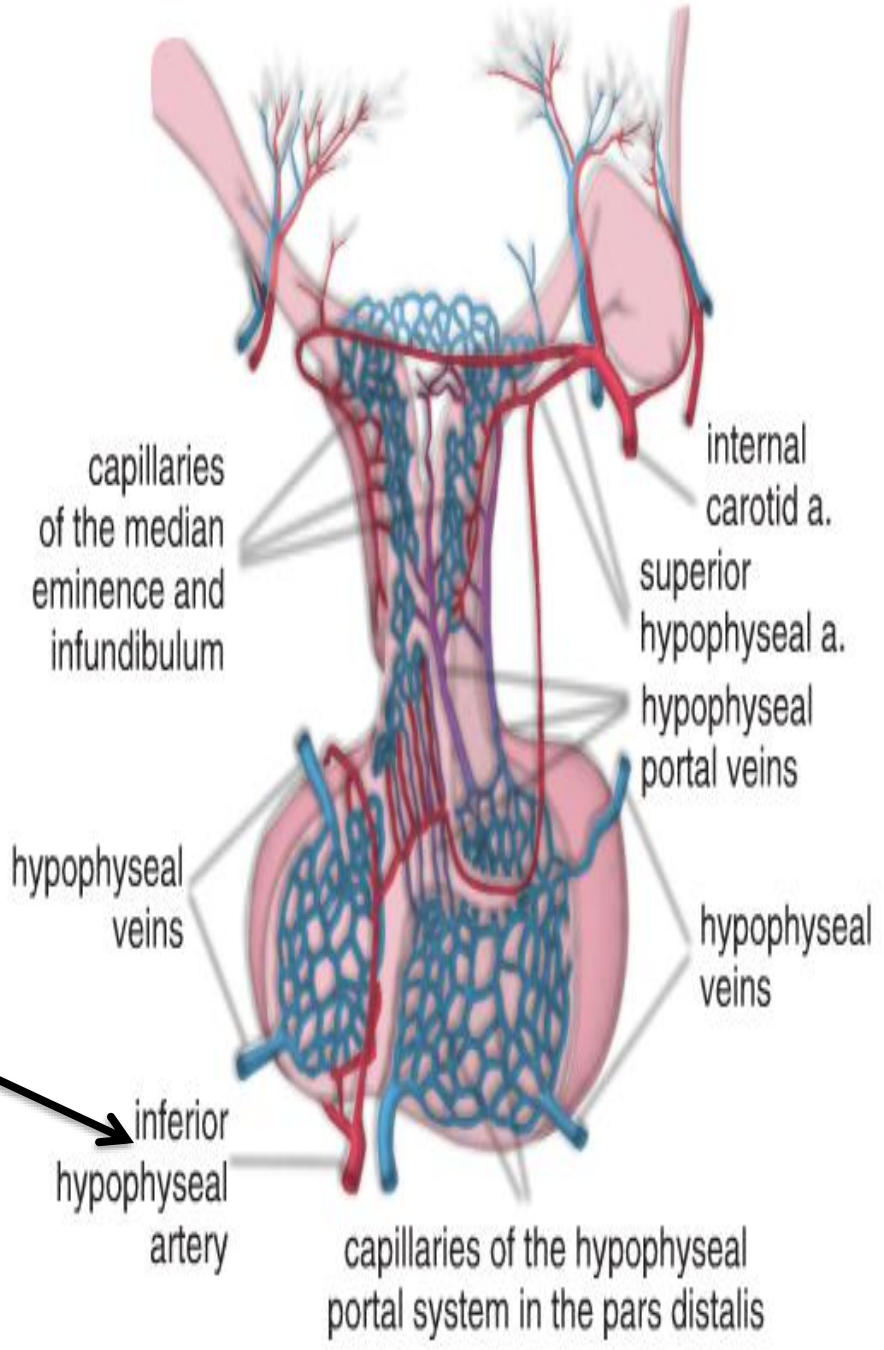

Hypothalamic nuclei respond to emotional and exteroceptive stimuli
Mammillary body
Superior hypophysial artery
The trabecular artery connects the superior and inferior hypophysial arteries
Inferior hypophysial artery
Axon terminal
Capillary plexus of the posterior lobe
Hypophysial vein (to dural sinuses)
Posterior or neural lobe
Primary capillary plexus in the upper infundibulum receives releasing and inhibitory neuroendocrine factors from hypothalamic nuclei axon terminals
Portal veins carry neuroendocrine factors to the adenohypophysis
Secondary capillary plexus
Hypothalamohypophysial portal system
Acidophil
Basophil
Chromophobe
Hypophysial vein (to dural sinuses)
Anterior lobe
This system of vessels carries the neuroendocrine secretions of hypothalamic nerves from their sites of release in the median eminence and infundibulum directly to the cells of the pars distalis


Emotional and exteroceptive influences via afferent nerves
Paraventricular nucleus
Supraoptic nucleus
Hypothalamic artery
Neurosecretions from hypothalamus released into primary plexus of hypophysial portal circulation after passing down nerve fibers
Superior hypophysial artery
Hypophysial portal veins carry neurosecretions to the adenohypophysis
Neurohypophysis
Blood levels—regulatory influence
Specific secretory cells of adenohypophysis influenced by neurosecretions from hypothalamus
GH
IGF-1
TSH
ACTH
FSH
LH
Prolactin
Thyroid gland
Adrenal cortex
Testis
Ovary
Breast (milk production)
Fat tissue
Muscle
Bone, muscle, organs (growth)
Thyroid hormones
Cortical hormones
Testosterone and inhibin
Estrogen, progesterone, and inhibin
JOHN A. CRAIG

B-Inferior hypophyseal arteries

The inferior hypophysial vessels arise solely from **the internal carotid arteries**

primarily supply the pars nervosa



Inferior hypophyseal arteries

Venous drainage

Most of the blood from the pituitary gland drains into the cavernous sinus and then into the systemic circulation.

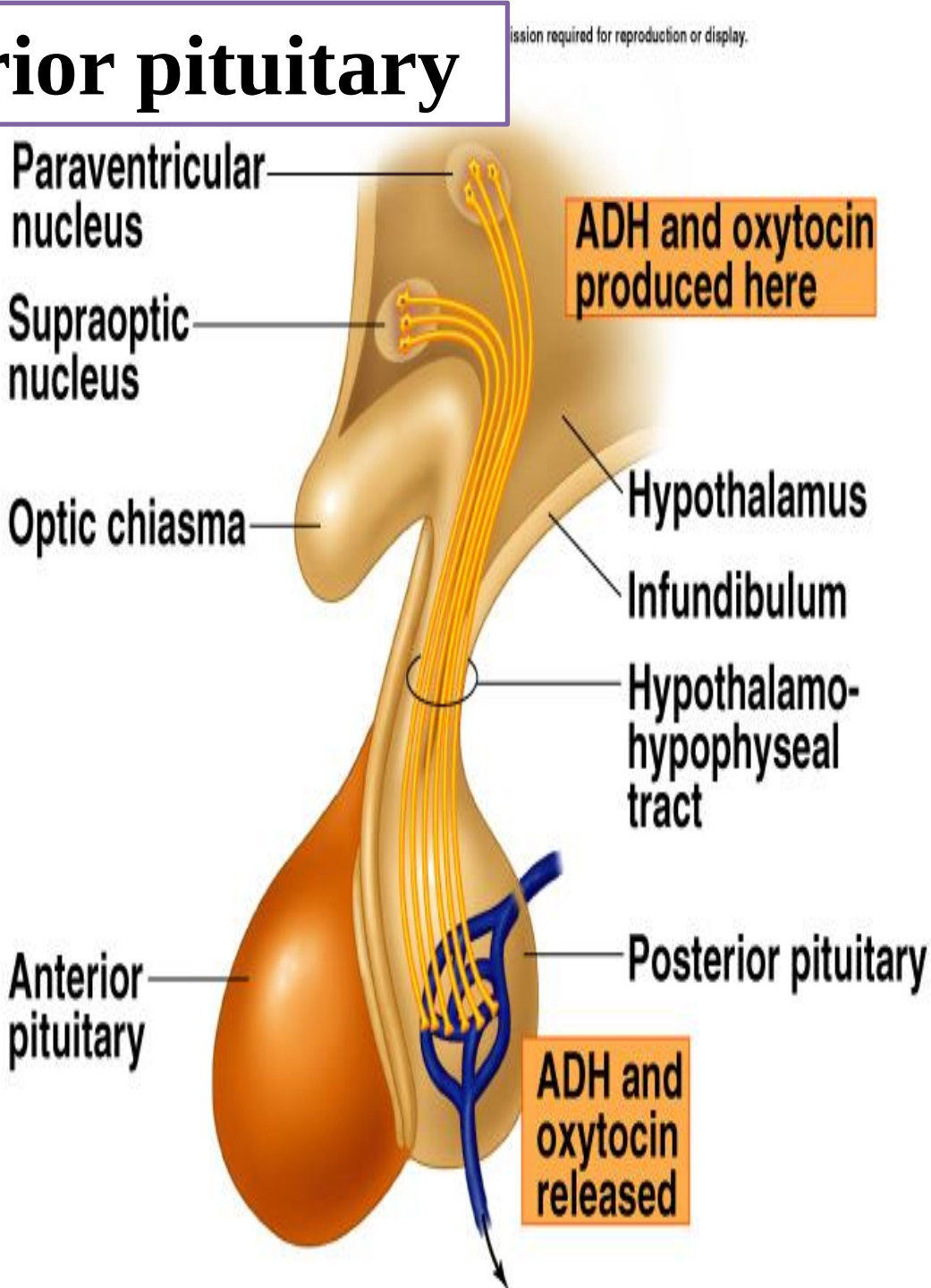
Some evidence suggests, however, that blood can flow **via short portal veins from the pars distalis to the pars nervosa and that blood from the pars nervosa may flow toward the hypothalamus**.

These short pathways provide a route by which the hormones of the anterior lobe of the pituitary gland could provide **feed back** directly to the brain without making the full circuit of the systemic circulation.

The posterior pituitary

Neurohypophysis

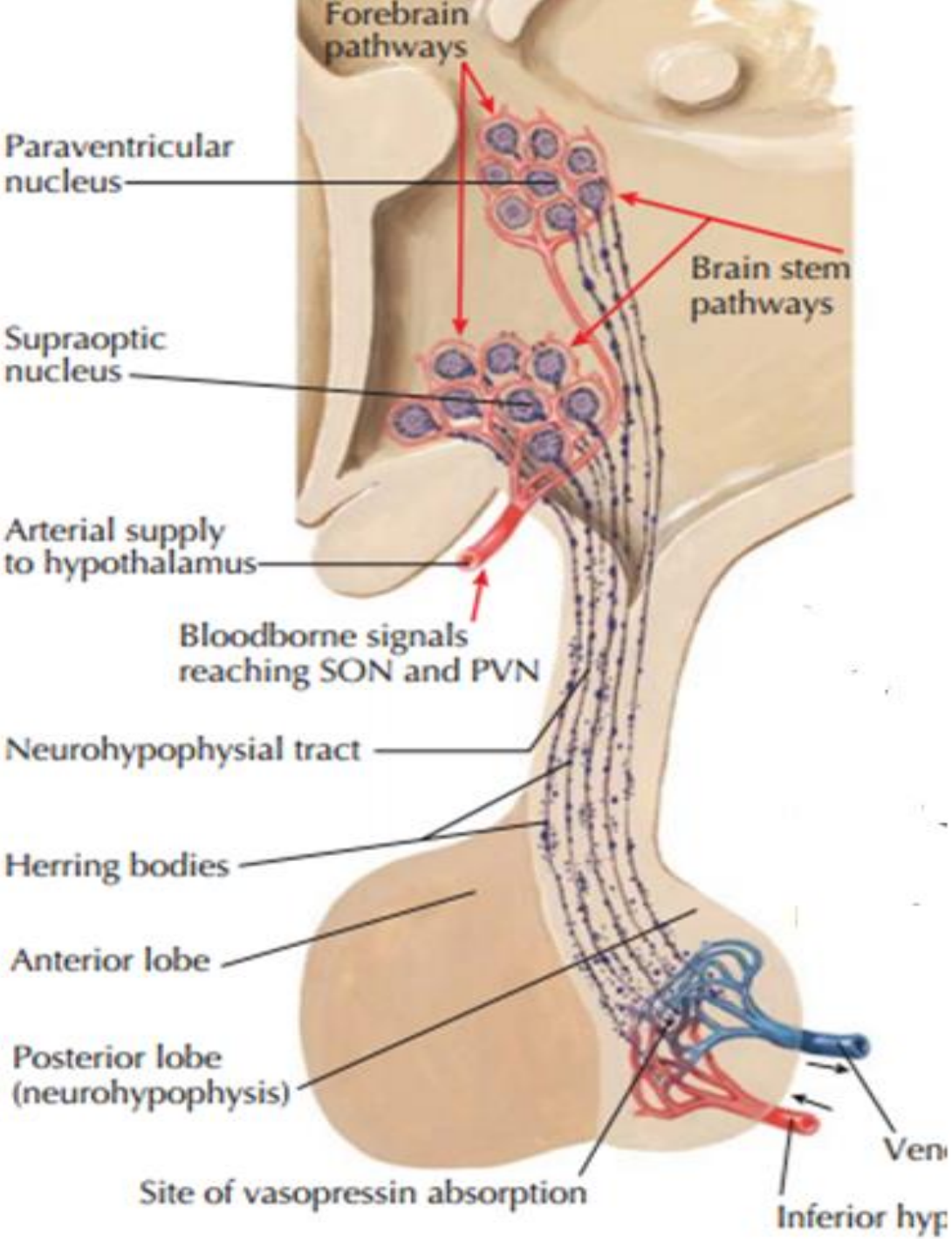
is neural tissue and is formed by the distal axons of
<u>The supraoptic nucleus (SON)</u>
and
<u>The paraventricular nucleus (PVN)</u>
of the hypothalamus.



The axon terminals store neurosecretory granules that contain vasopressin

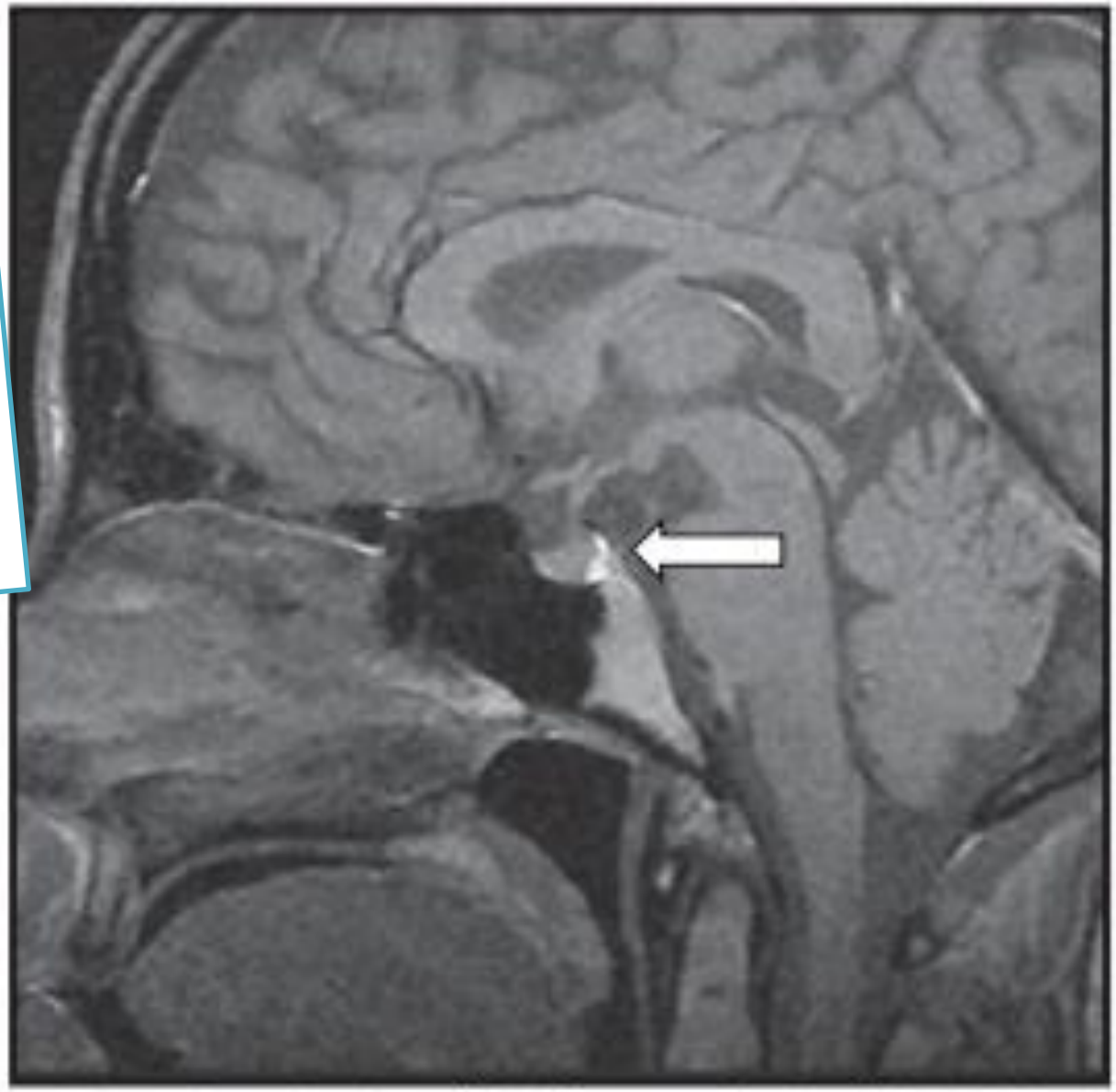
The blood supply for the posterior pituitary is from the inferior hypophysial arteries

The venous drainage is into the cavernous sinus and internal jugular vein



The stored vasopressin in neurosecretory granules in the posterior pituitary produces a bright signal on (MRI) **the "posterior pituitary bright** spot."

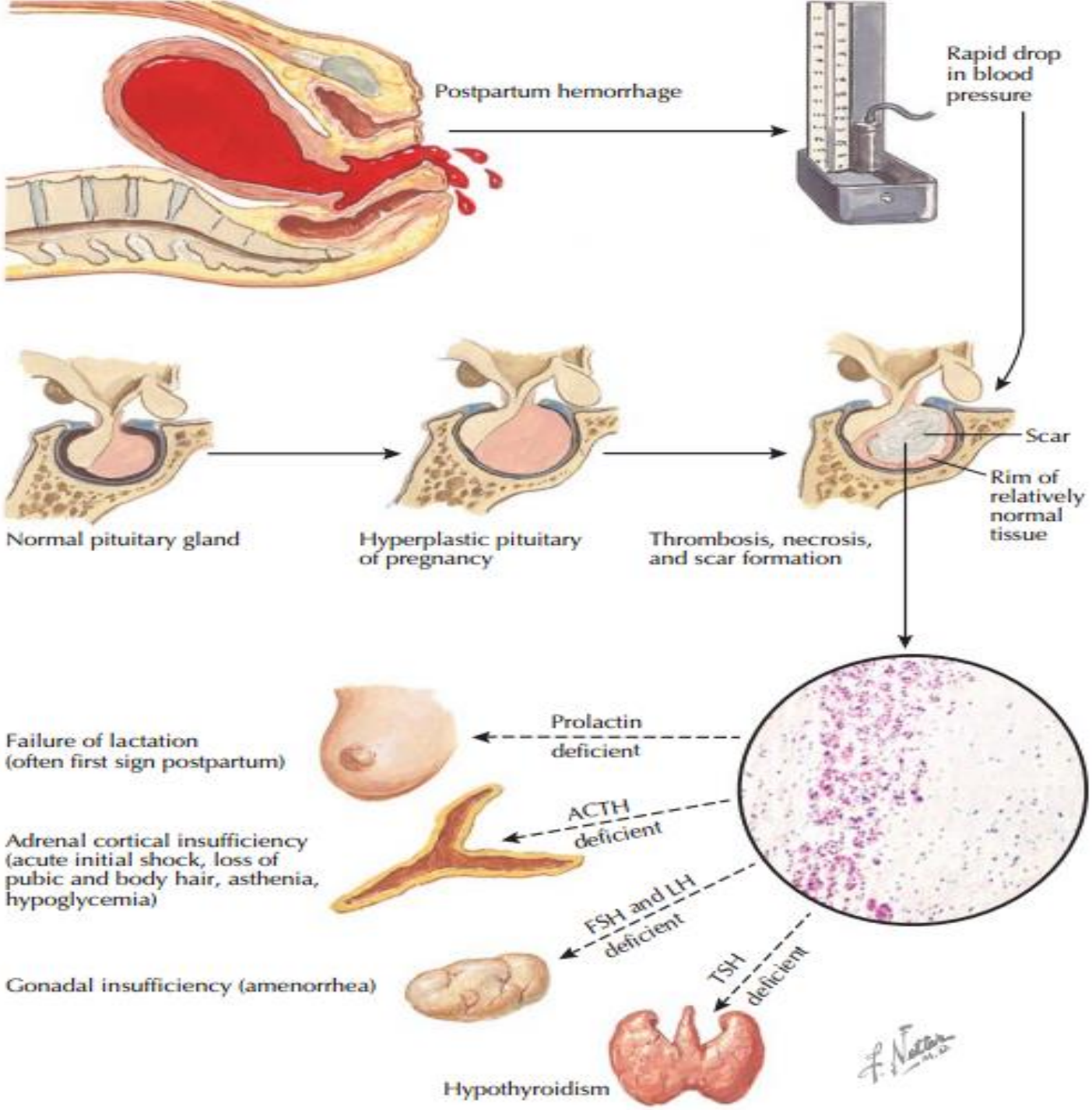
The posterior pituitary bright spot is present in most healthy individuals and is absent in individuals with central diabetes insipidus.



Posterior pituitary bright spot. Sagittal T1-MRI image showing hyperintensity (arrow) in the posterior aspect of the sella turcica.

Clinical applications

(SHEEHAN SYNDROME

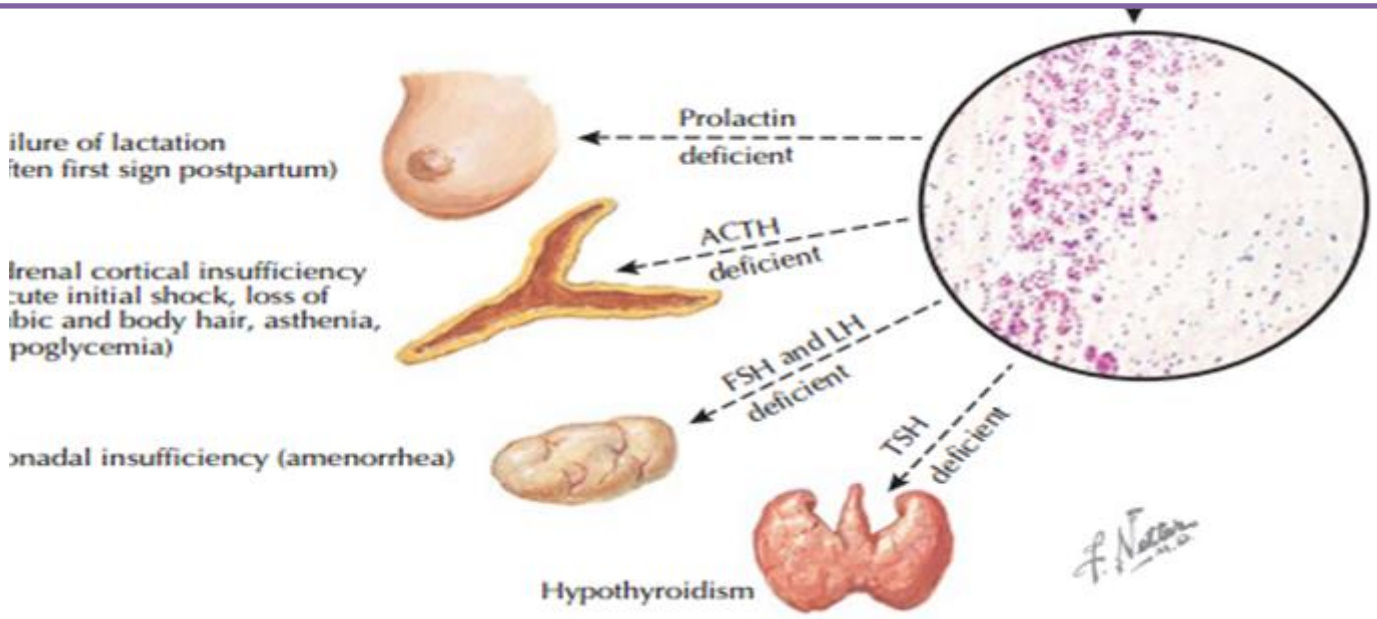


The pituitary gland enlarges during pregnancy (primarily because of lactotroph hyperplasia)

portal venous blood supply is uniquely vulnerable to changes in arterial blood pressure

severe postpartum uterine hemorrhage, spasm of the infundibular arteries, which are drained by the hypophysial portal vessels,.

could result in pituitary infarction.
If the lack of blood flow continued for several hours, most of the tissues of the anterior pituitary gland infarcted; when blood finally started to flow, stasis and thrombosis occurred in the stalk and the adenohypophysis



Pituitary Adenoma

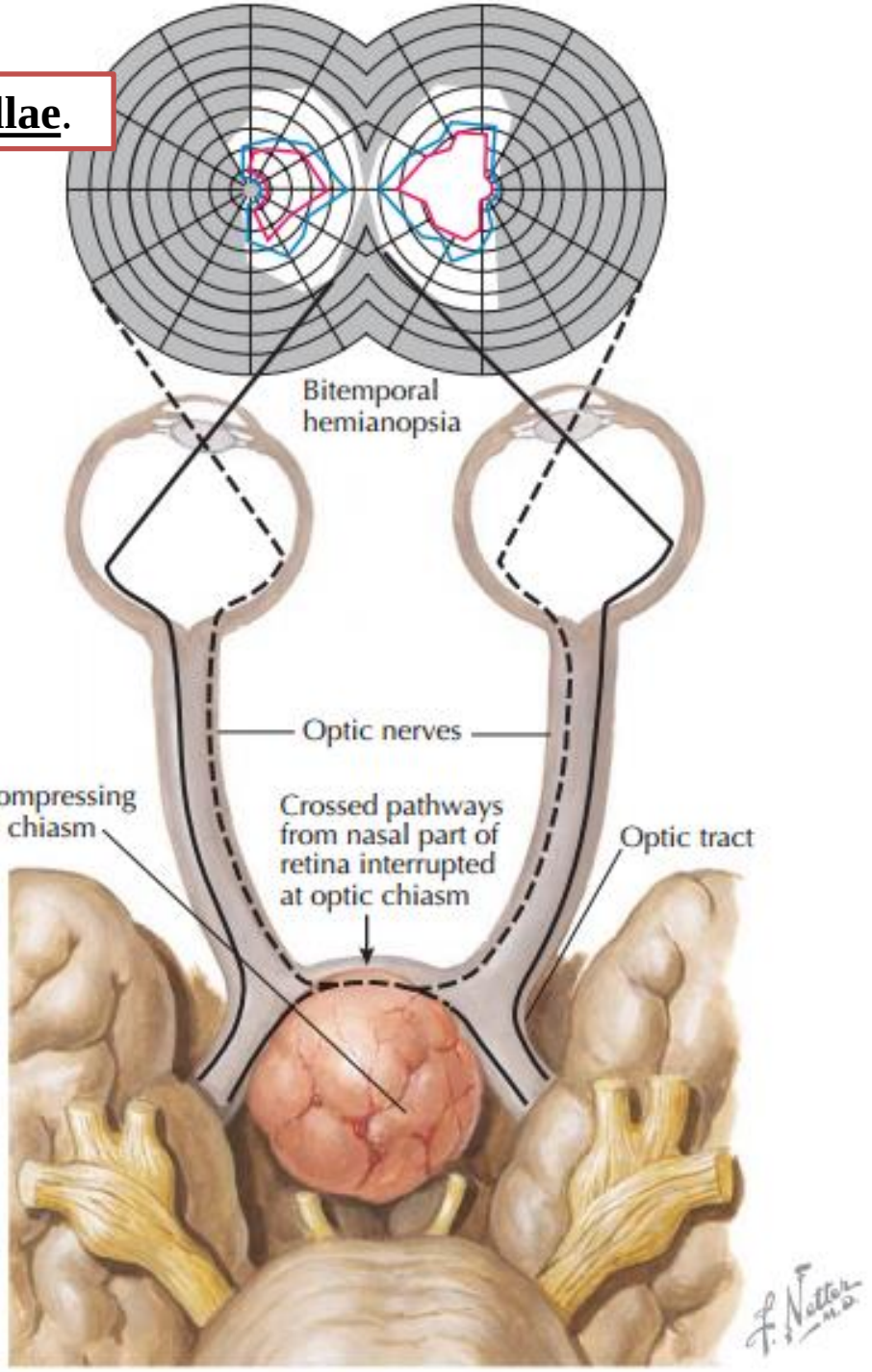
The optic chiasm lies above the diaphragma sellae.

The most common sign that a pituitary tumor has extended beyond the confines of the sella turcica

is a visual defect caused by the growth pressing on the optic chiasm..

The most frequent disturbance is a **Bitemporal hemianopsia**

which is produced by the tumor pressing on the crossing central fibers of the chiasm and sparing the uncrossed lateral fibers.

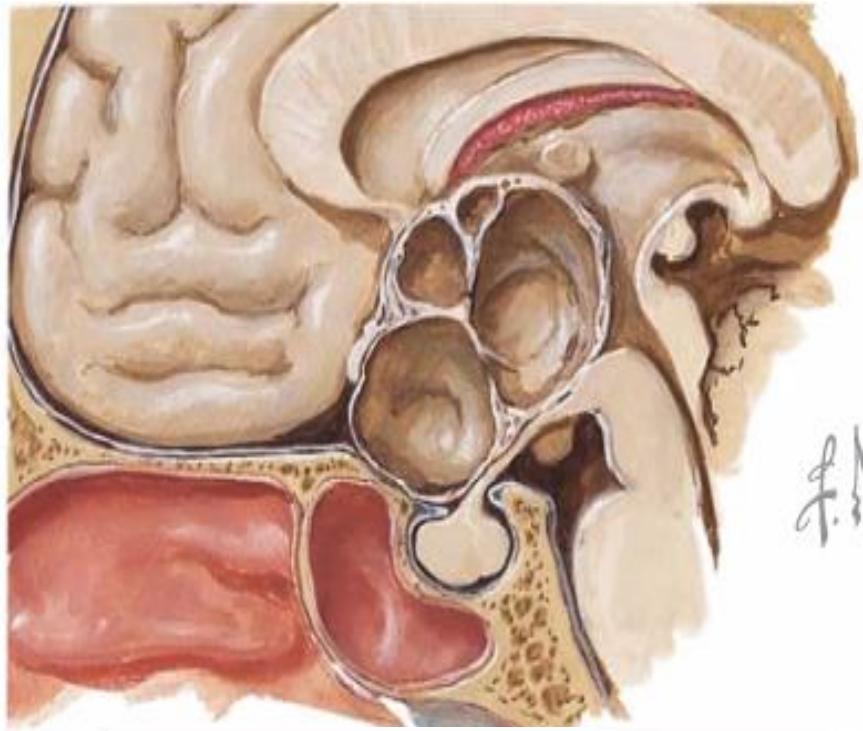


Bitemporal hemianopsia

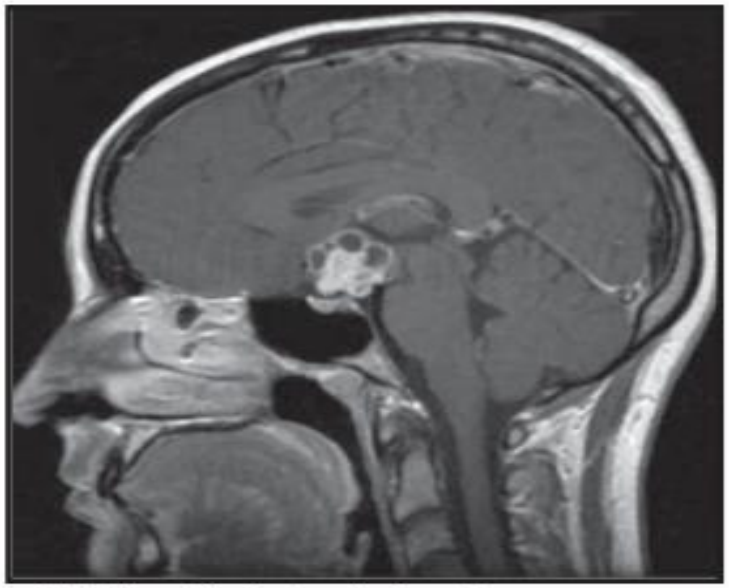
A city as seen with bitemporal hemianopsia.

Craniopharyngioma

is the most common tumor found in the region of the pituitary gland in children and adolescents and constitutes about 3% of all intracranial tumors and up to 10% of all childhood brain tumors.



Craniopharyngiomas histologically benign epithelioid tumors arising from embryonic **squamous remnants of Rathke pouch—may** be large (e.g., > 6 cm in diameter) and invade the third ventricle and associated brain structures.



MRI (sagittal view) showing cystic suprasellar craniopharngioma

Suprasellar

↓

Hypothalamic manifestations (obesity, somnolence) with or without hypopituitarism and/or diabetes insipidus

Intrasellar anterior lobe

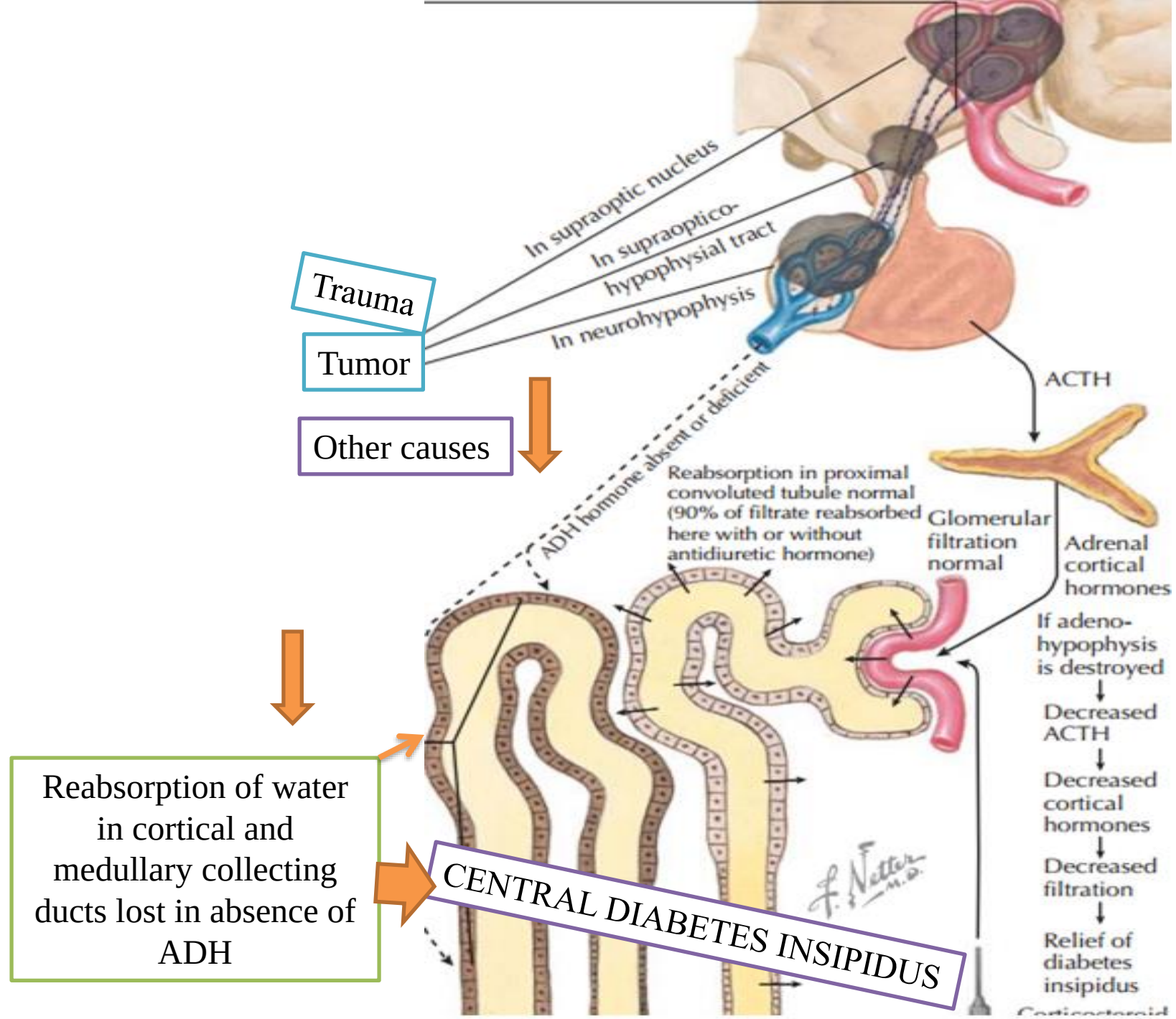
↓

Anterior lobe hypofunction of variable degree

Intrasellar posterior lobe

↓

Diabetes insipidus


Trauma
Tumor
Other causes
In supraoptic nucleus
In supraoptico-hypophysial tract
In neurohypophysis
ADH hormone absent or deficient
ACTH
Reabsorption in proximal convoluted tubule normal (90% of filtrate reabsorbed here with or without antidiuretic hormone)
Glomerular filtration normal
Adrenal cortical hormones
If adeno-hypophysis is destroyed
Decreased ACTH
Decreased cortical hormones
Decreased filtration
Relief of diabetes insipidus
Reabsorption of water in cortical and medullary collecting ducts lost in absence of ADH
CENTRAL DIABETES INSIPIDUS

PITUITARY APOPLEXY

acute hemorrhage of the pituitary gland

The typical presentation is acute onset of severe headache (frequently described as "the worst headache of my life")
vision loss
(the hemorrhagic
expansion takes the path **of least resistance and extends**
superiorly and compresses the optic chiasm);
ocular nerve palsies (e.g.,
ptosis, diplopia) caused by **impingement of the third,**
fourth, and sixth cranial nerves in the cavernous sinuses