GROSS ANATOMY OF THE SUPRARENAL GLANDS

1. **Recognize and understand the suprarenal glands and their locations, relations and connections.**
2. **Comprehend the blood supply of suprarenal glands.**
3. **Understand the embryological origins of the suprarenal glands .**
4. **Grasp the clinical correlations of the suprarenal glands development.**
5. **Recognize and understand imaging of suprarenal glands .**
6. **Grasp the histological structure of the suprarenal glands and its cells under light and electron microscopes.**

The adrenal glands are two small triangular structures located

Retroperitoneally

at the upper poles of the kidneys.

Retroperitoneal Space

The retroperitoneal space lies on the posterior abdominal wall behind the parietal peritoneum.

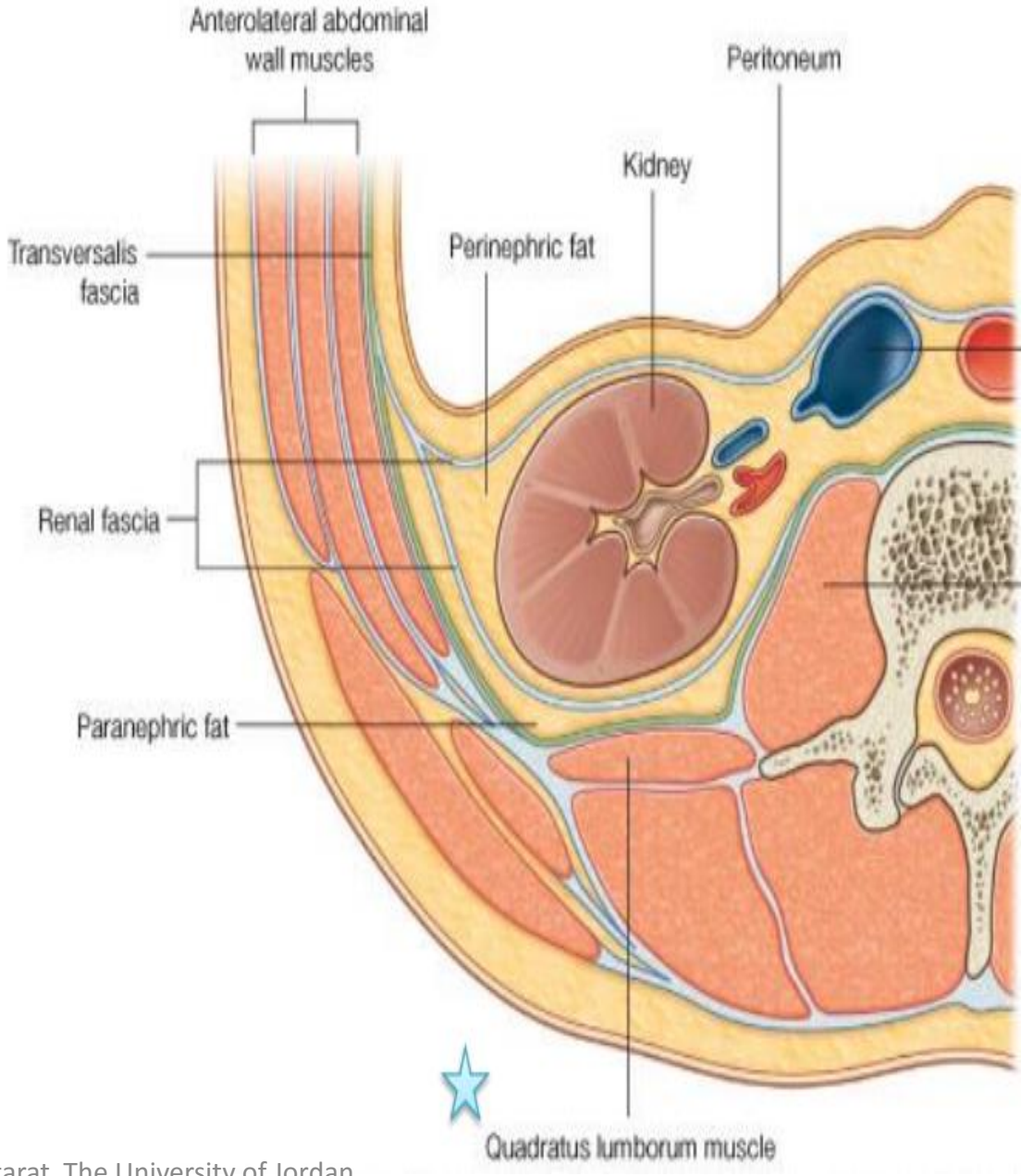
Spleen

Splenic artery and vein and pancreas

Left kidney

Psoas major muscle

The adrenal glands are covered with a thick connective tissue capsule from which trabeculae extend into the parenchyma carrying blood vessels and nerves.

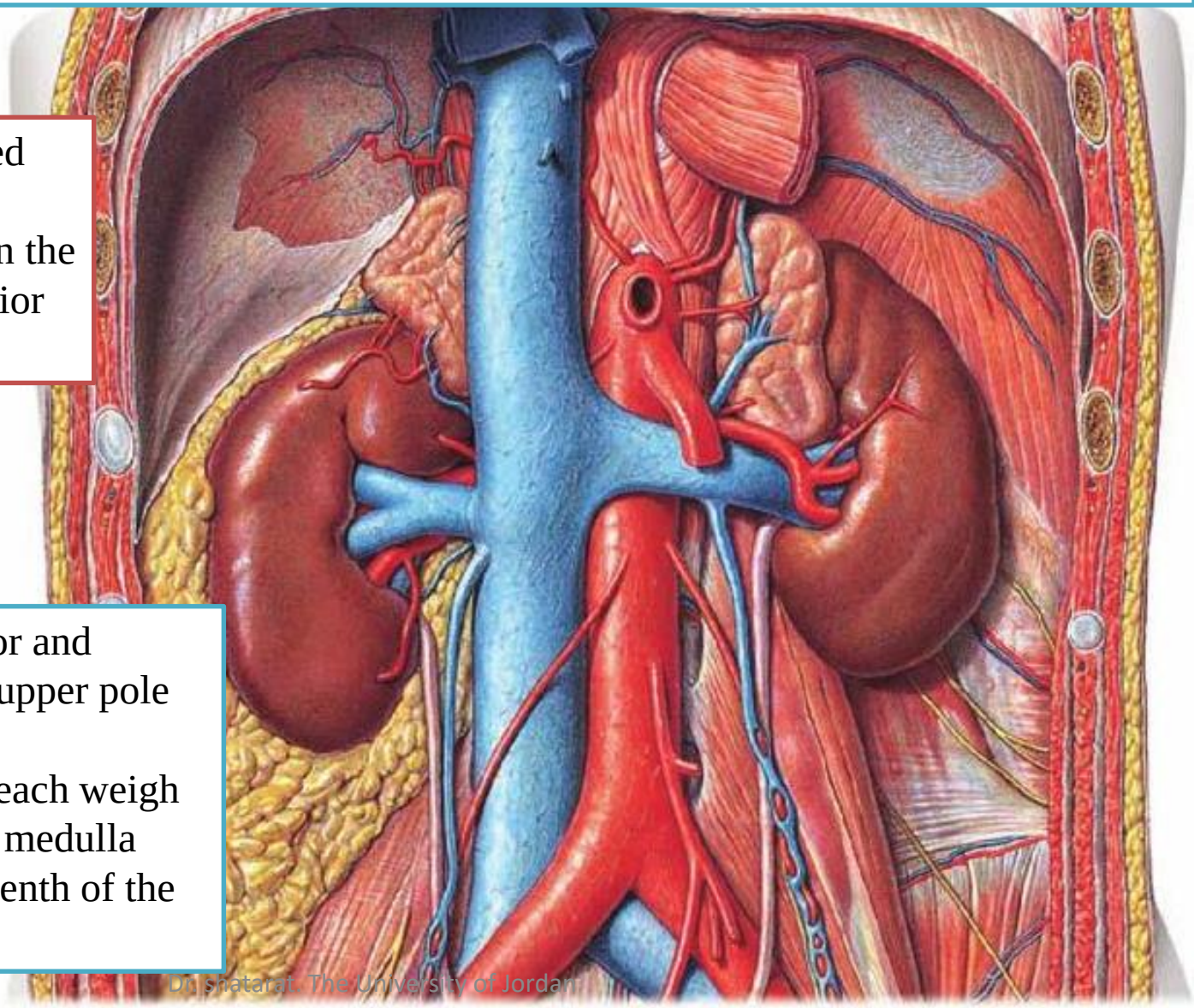


They are found ***on the posterior parietal wall***, on each side of the vertebral column, at the level of the **11th thoracic rib**

And

lateral to the first lumbar vertebra

- They have a flattened triangular shape and are embedded in the perirenal fat at the superior poles of the kidneys.

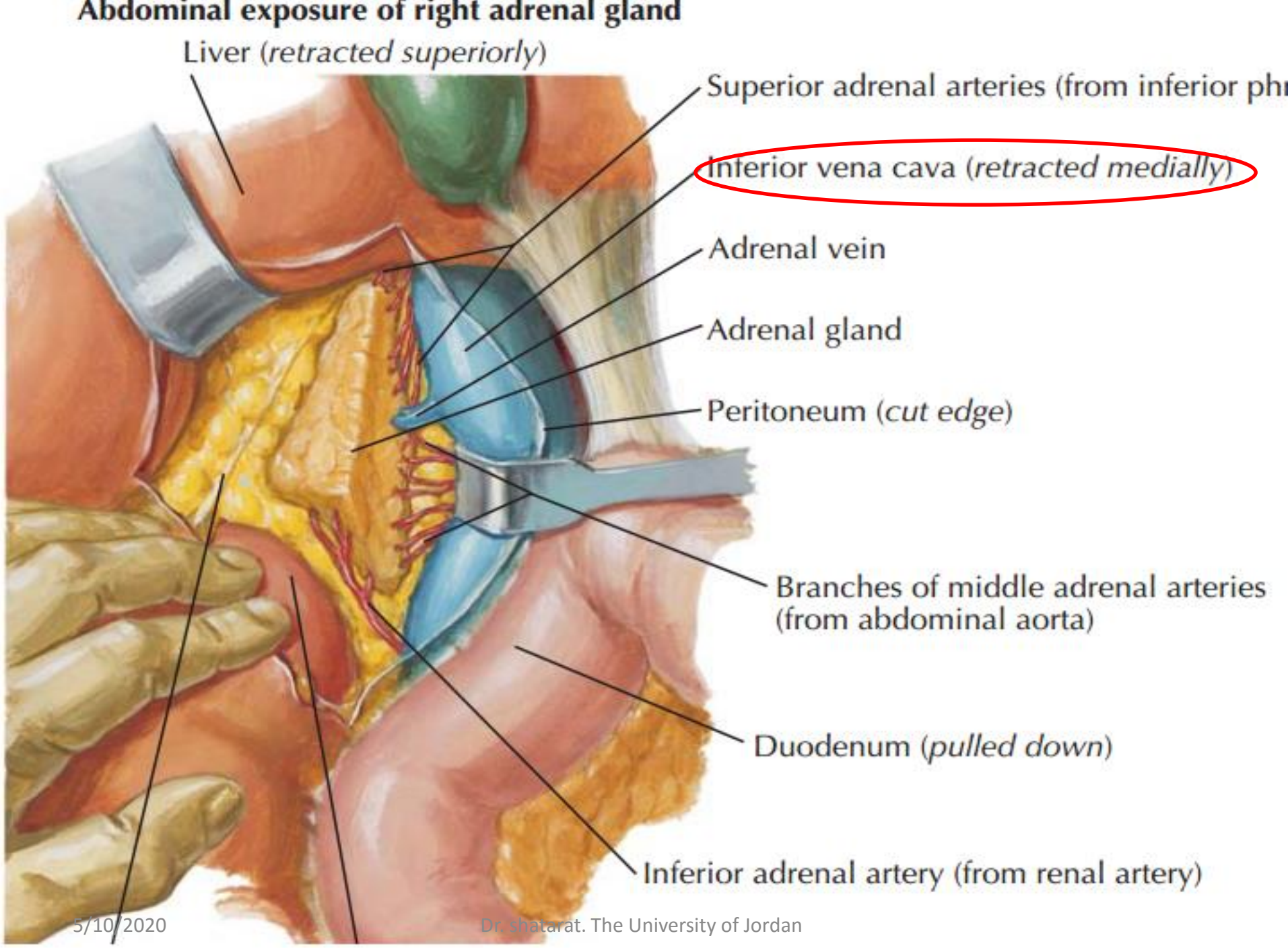


- lie immediately superior and slightly anterior to the upper pole of the kidneys
- The suprarenal glands each weigh approximately 5 g (the medulla contributes about one-tenth of the total weight).

The secretory parenchymal tissue is organized into two distinct regions

The cortex is the steroid-secreting portion. It lies beneath the capsule and constitutes nearly 90% of the gland by weight

The medulla is the catecholamine-secreting portion. It lies deep to the cortex and forms the center of the gland.


Abdominal exposure of right adrenal gland
Liver (retracted superiorly)
Superior adrenal arteries (from inferior phr
Inferior vena cava (retracted medially)
Adrenal vein
Adrenal gland
Peritoneum (cut edge)
Branches of middle adrenal arteries (from abdominal aorta)
Duodenum (pulled down)
Inferior adrenal artery (from renal artery)

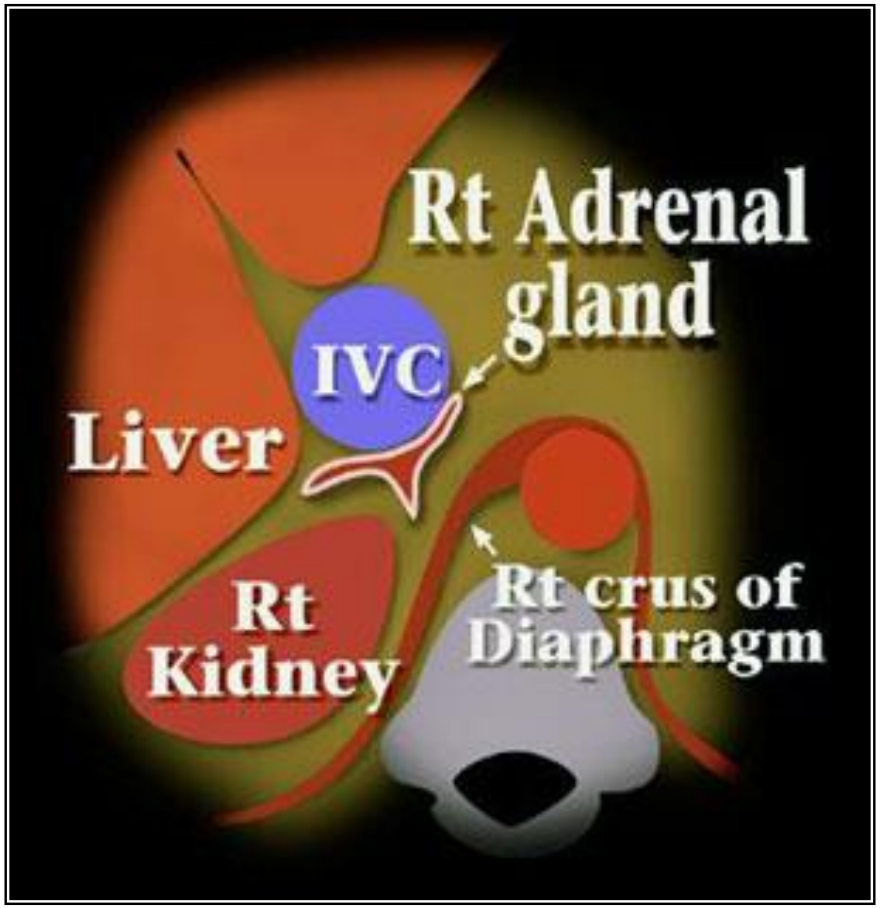
Relations of the right suprarenal glnad

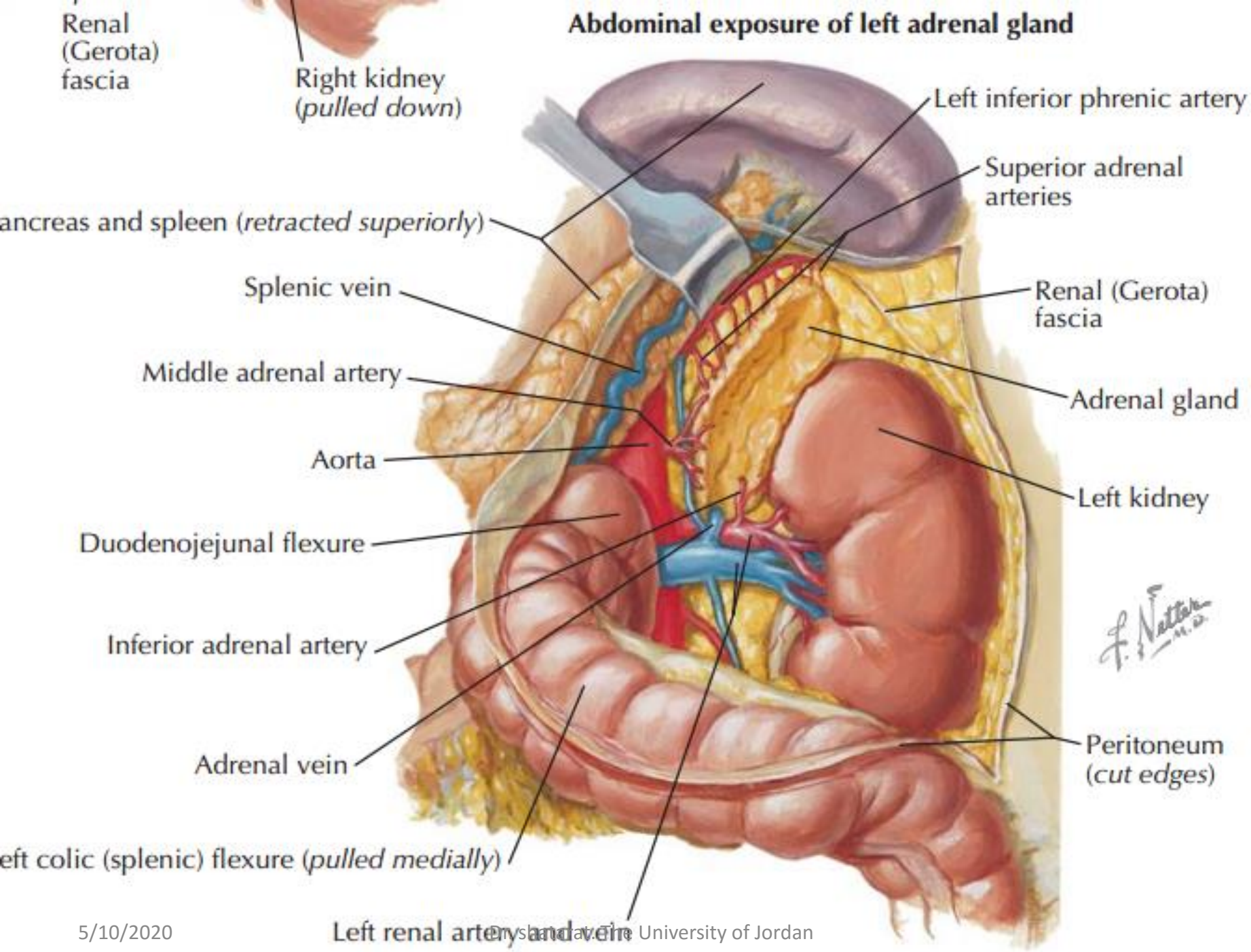
Anteriorly:

- Inferior vena cava (medially)
- Right hepatic lobe (laterally)

Posteriorly:

- Diaphragm (right crus)
- Superior pole of the right kidney




Abdominal exposure of left adrenal gland
Renal (Gerota) fascia
Right kidney (pulled down)
Left inferior phrenic artery
Superior adrenal arteries
ancreas and spleen (retracted superiorly)
Splenic vein
Renal (Gerota) fascia
Middle adrenal artery
Adrenal gland
Aorta
Left kidney
Duodenojejunal flexure
Inferior adrenal artery
Peritoneum (cut edges)
Adrenal vein
eft colic (splenic) flexure (pulled medially)
Left renal artery and vein

Relations of the left suprarenal gland

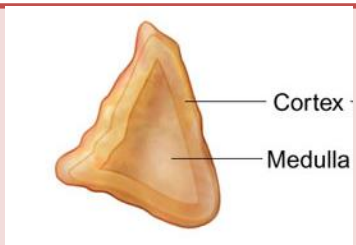
Anteriorly:

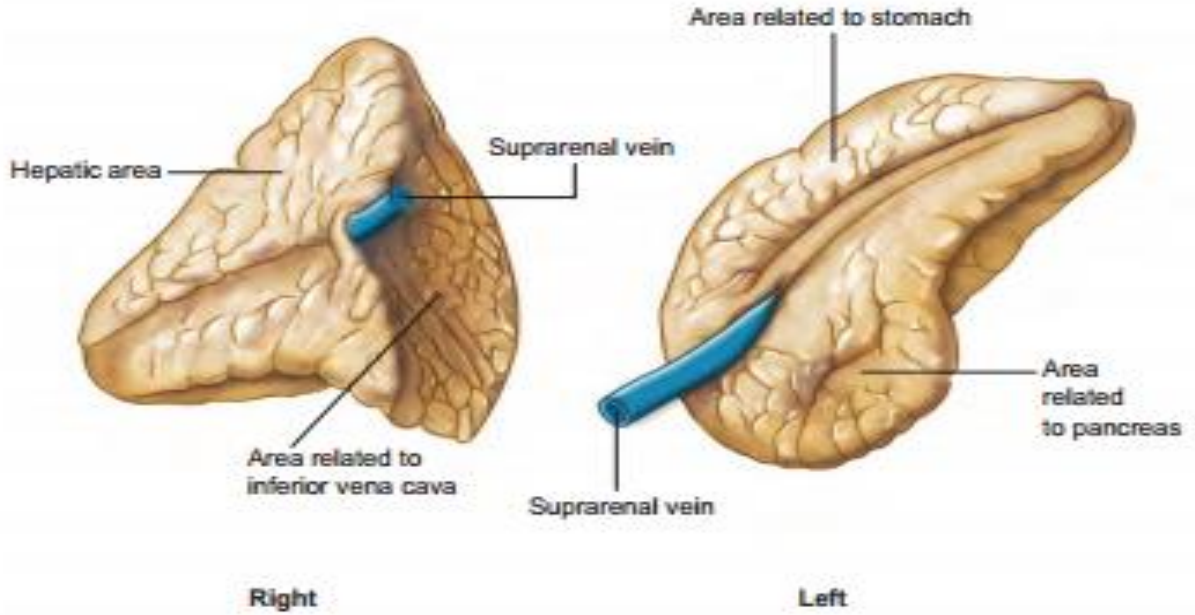
- Stomach
- Lesser sac of peritoneum
- The inferior area is in touch with the pancreas and splenic vein.

Posteriorly:

- Diaphragm (left crus)
- Superior pole of the left kidney

Comparison between Rt. & Lt. Suprarenals

Right Suprarenal	Left Suprarenal
	
Triangular (pyramidal)	Crescentic (semilunar)
Does NOT reach the hilum of the right kidney	Reaches the hilum of the left kidney
The hilum is directed upwards	The hilum is directed downwards
Its vein is short and drains to the IVC	Its vein is long and drains to the left renal vein.



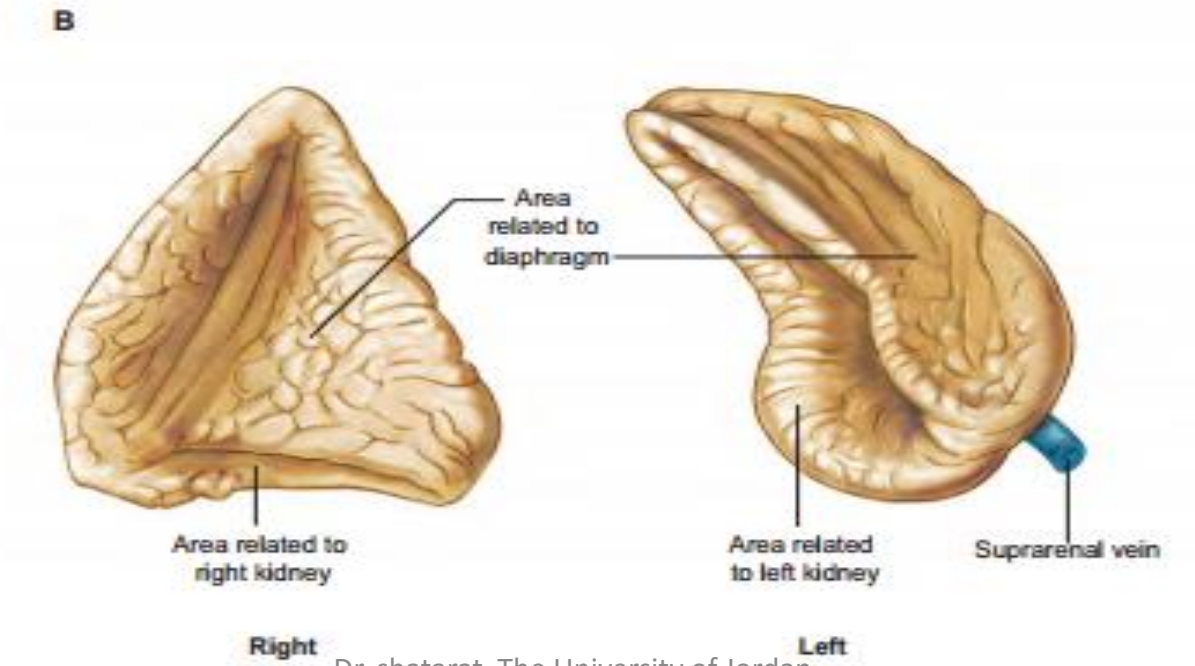


Fig. 72.1 Suprarenal glands: anterior (A) and posterior (B) aspects.

BLOOD SUPPLY

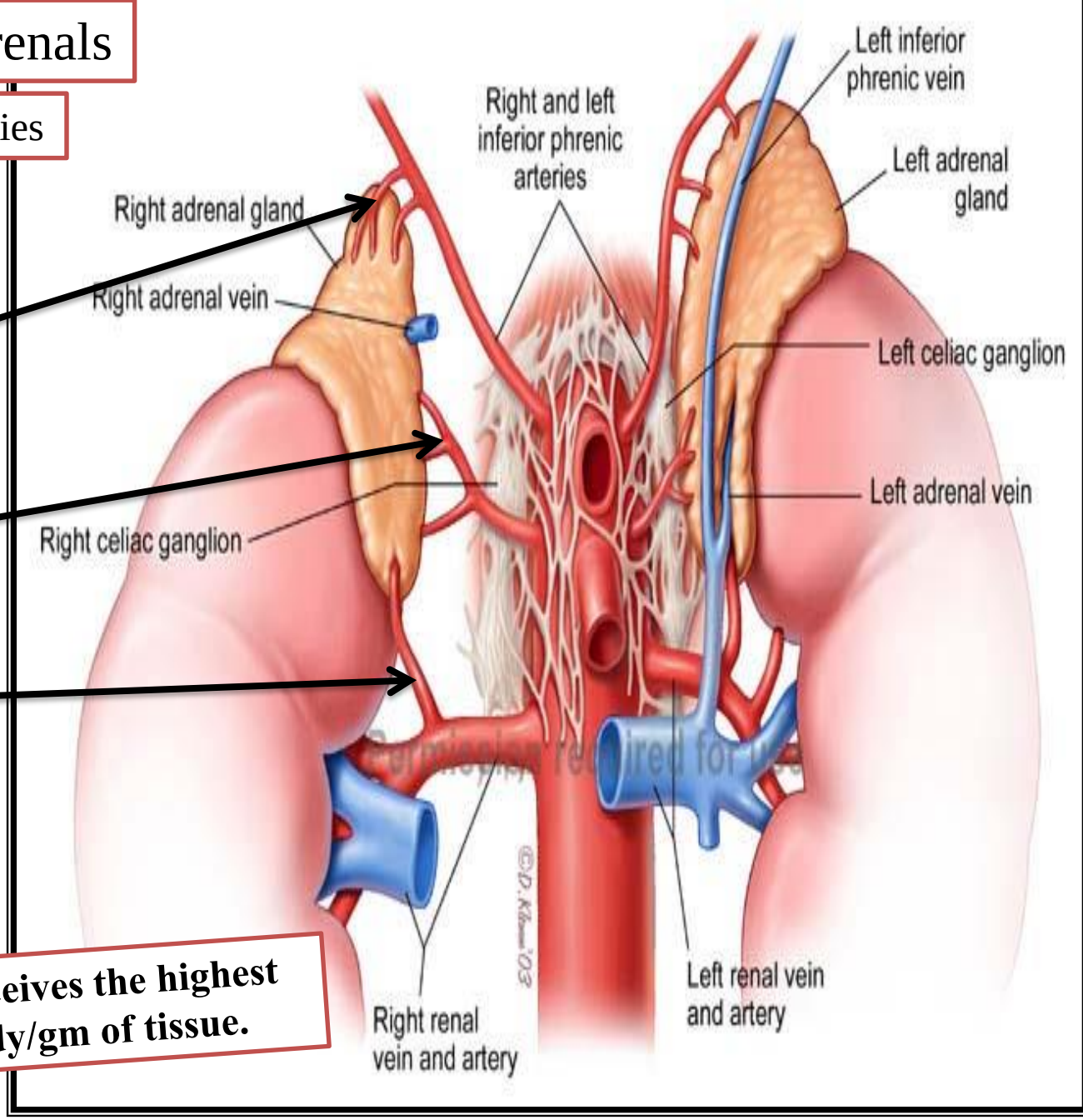
Blood supply of the adrenals

Each gland receives 3 arteries

Superior suprarenal a. from the inferior phrenic artery

Middle suprarenal a. from the abdominal aorta.

Inferior suprarenal a. from the renal artery.



The suprarenal gland receives the highest blood supply in the body/gm of tissue.

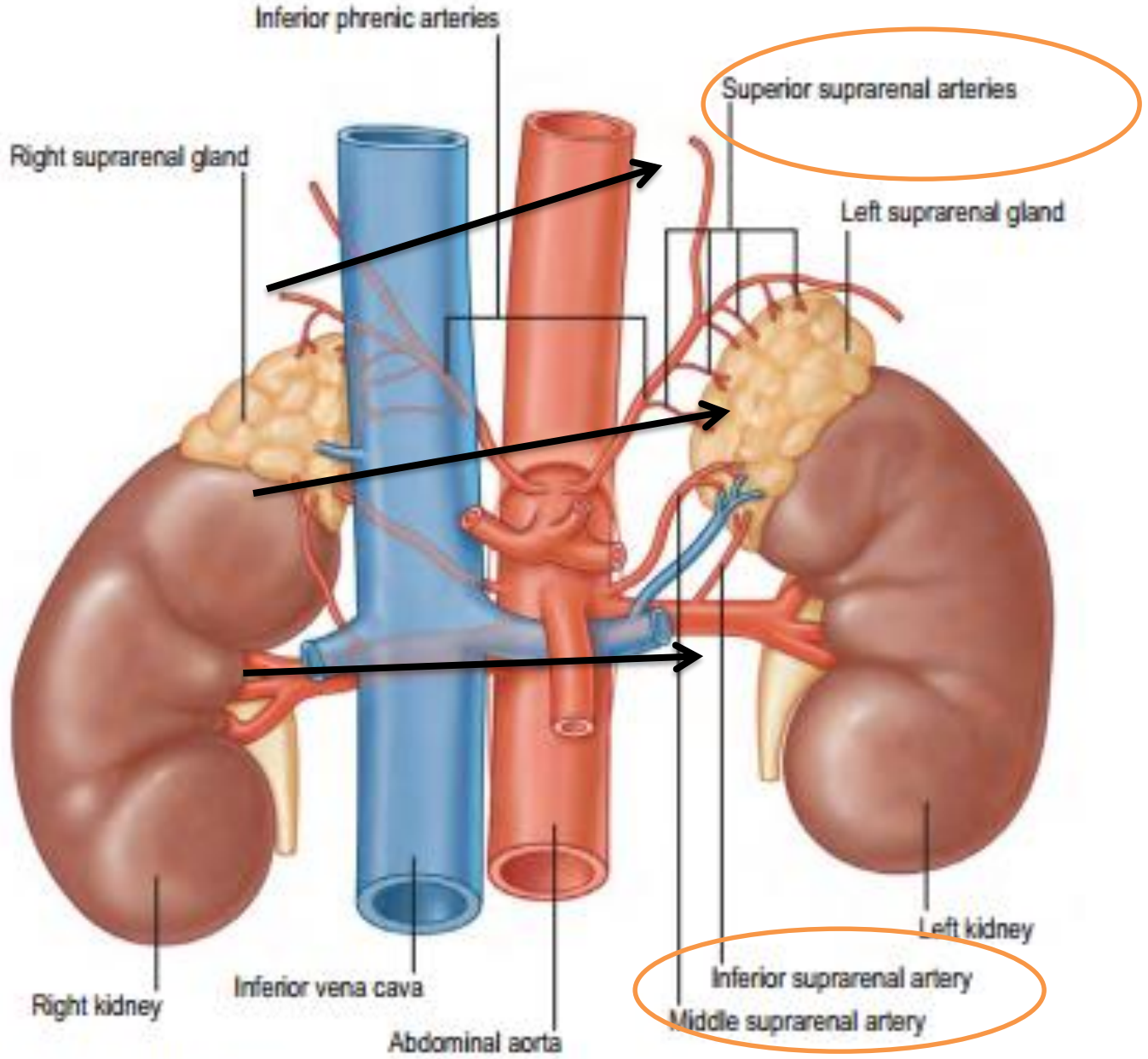


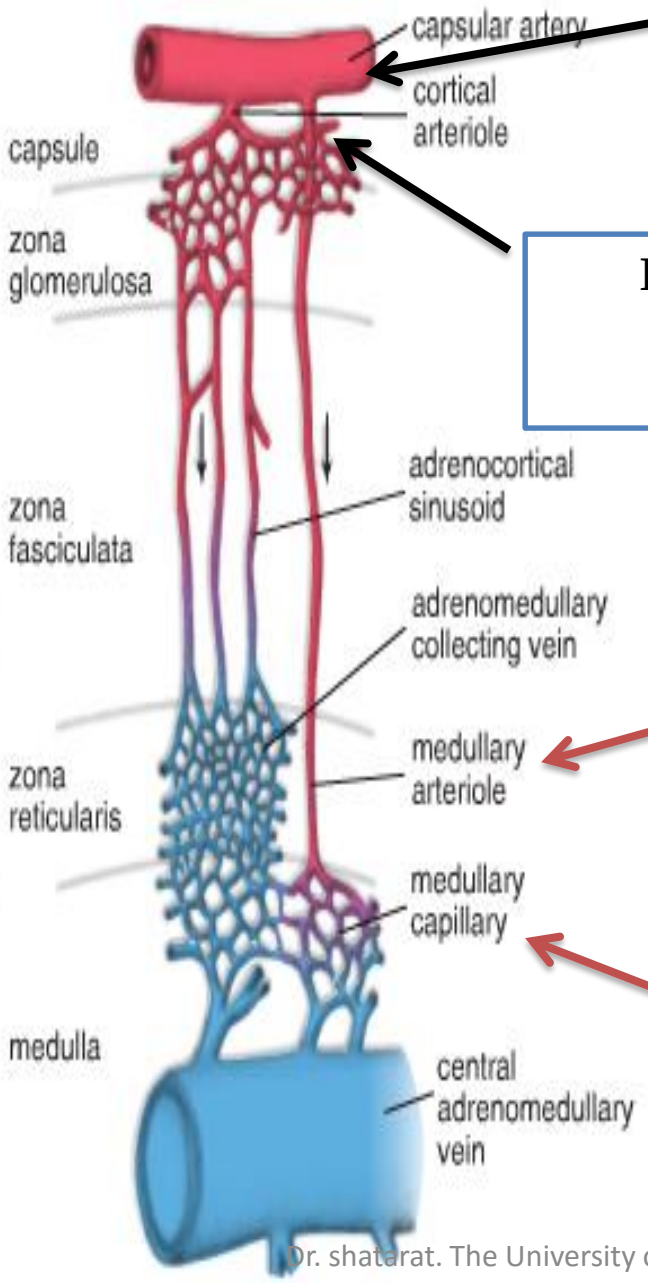
Fig. 72.3 Arterial supply and venous drainage of the suprarenal glands. (From Drake, Vogl and Mitchell, 2005.)

The capsule is penetrated by ~ 60 arterioles.

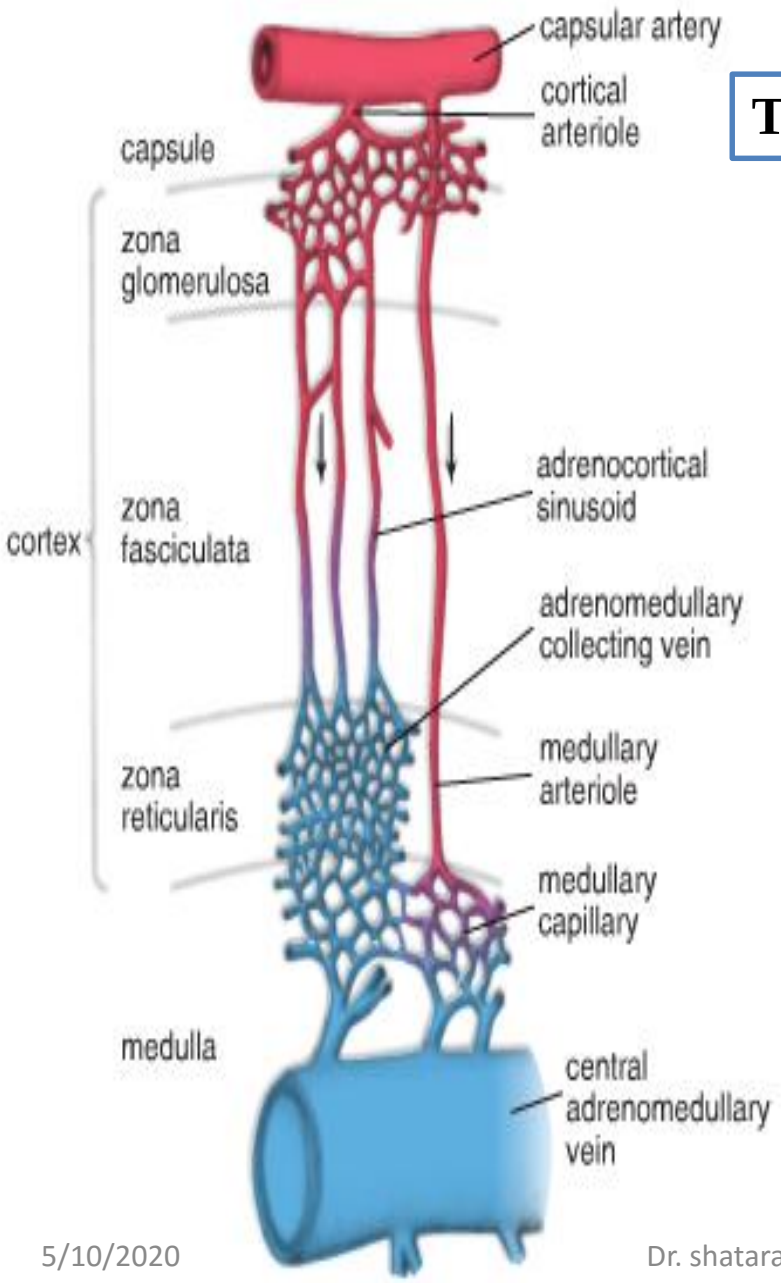
The superior, middle, and inferior suprarenal arteries In the capsule they branch forming a system that consists of

A) short <u>capsular capillaries</u> that supply the capsule.

B) intermediate fenestrated cortical sinusoidal capillaries that supply the cortex



C) long medullary arterioles that traverse the cortex traveling within the trabeculae, and bring arterial blood to the **medullary capillary sinusoids**.



The medulla thus has a dual blood supply

arterial blood from
the medullary arterioles
and
"venous" blood from
the cortical sinusoidal capillaries
that have already supplied the cortex.

Arterial and venous capillaries within the adrenal gland **help to integrate the function of the cortex and medulla**.
For example, ***cortisol-enriched blood flows from the cortex to the medulla,*** where cortisol enhances the activity of *phenylethanolamine-Nmethyltransferase* that **converts norepinephrine to epinephrine**.

An example of extra-adrenal chromaffin tissues

Extra-adrenal chromaffin tissues lack these high levels of cortisol and produce **norepinephrine** almost exclusively

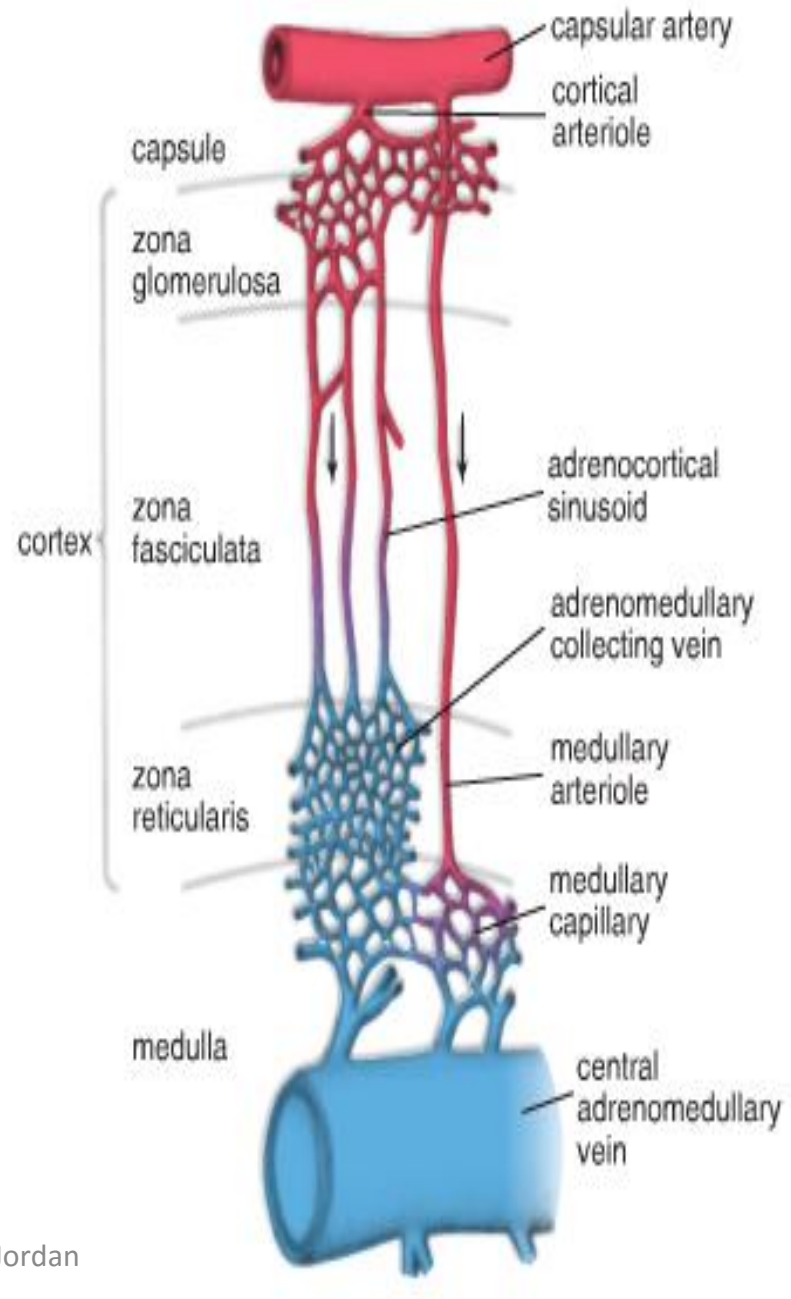
The largest cluster of chromaffin cells outside the adrenal medulla is near the level of the inferior mesenteric artery and is referred to as the organ of **Zuckerkandl**, which is quite prominent in fetuses and is a major source of catecholamines in the first year of life

Venous drainage of the adrenal glands is achieved via the suprarenal veins:

The venules that arise from the cortical and medullary sinusoids drain into the small adrenomedullary collecting veins that join to form

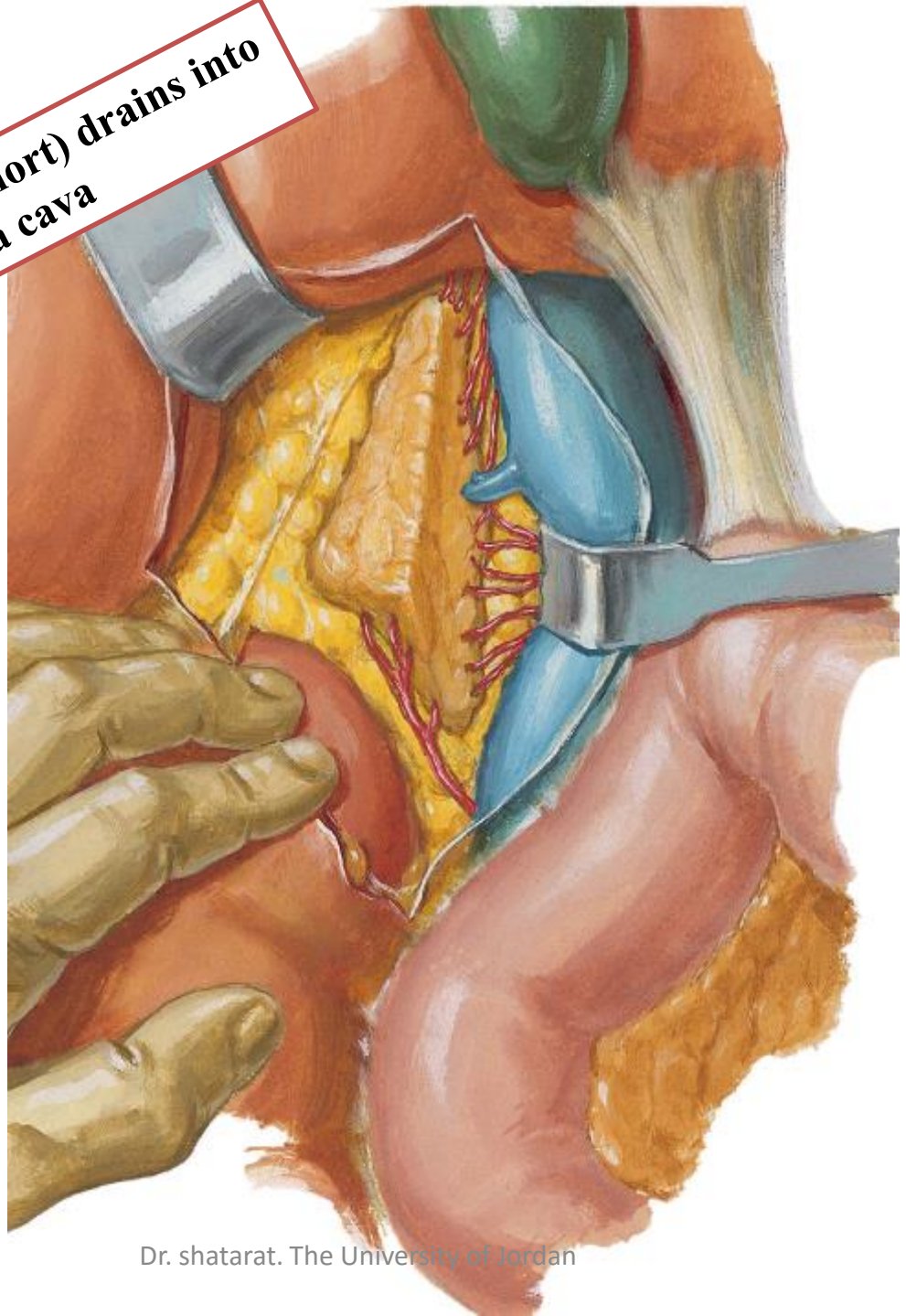
The Large Central Adrenomedullary Vein

which then drains directly into :



The right suprarenal vein (short) drains into the inferior vena cava

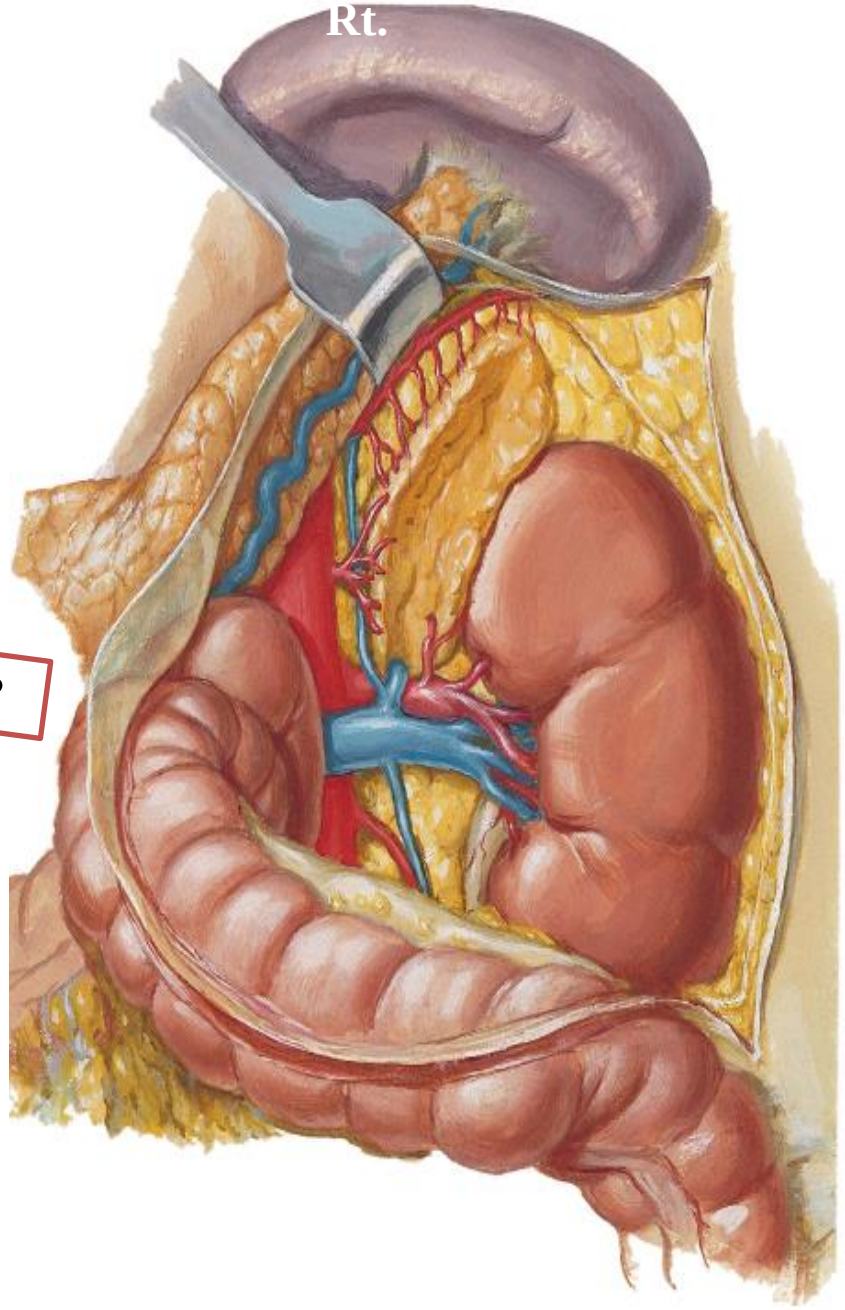
Why?



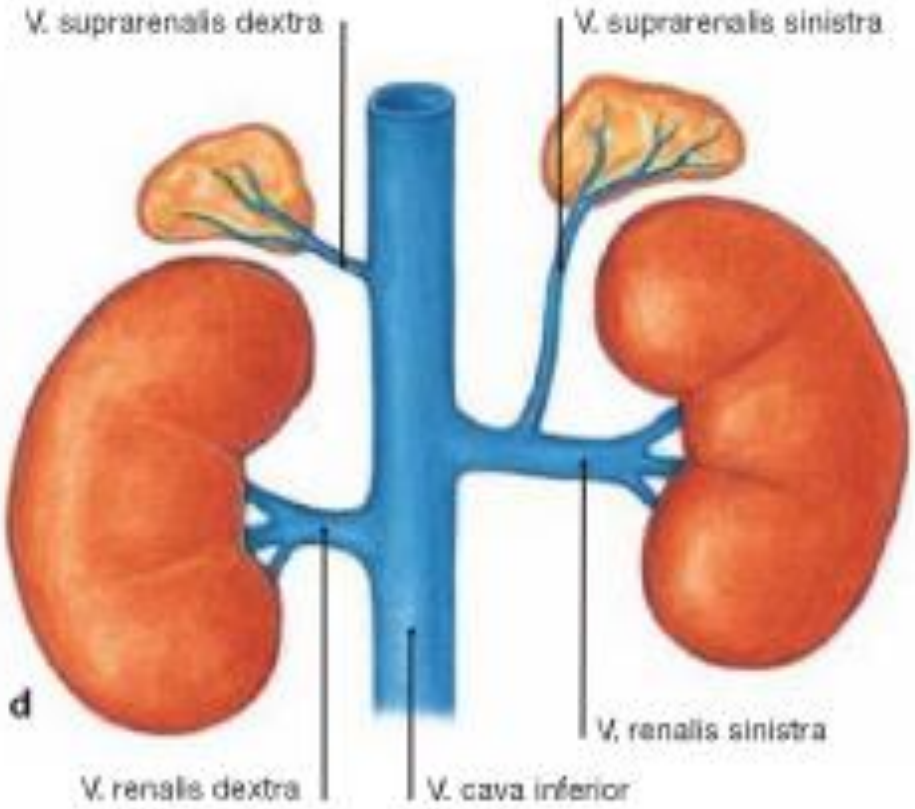
Rt.

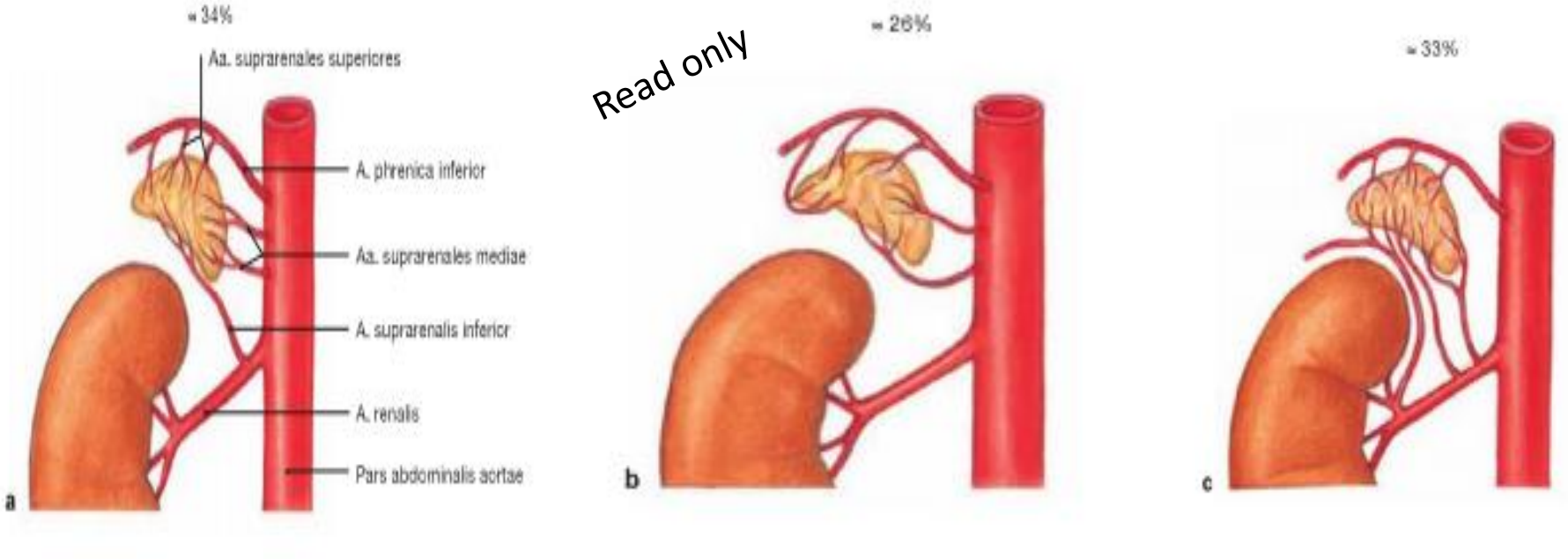
The left suprarenal vein (longer) drains into the left renal vein or the left inferior phrenic vein.

Why?



only one suprarenal vein exists for each adrenal gland

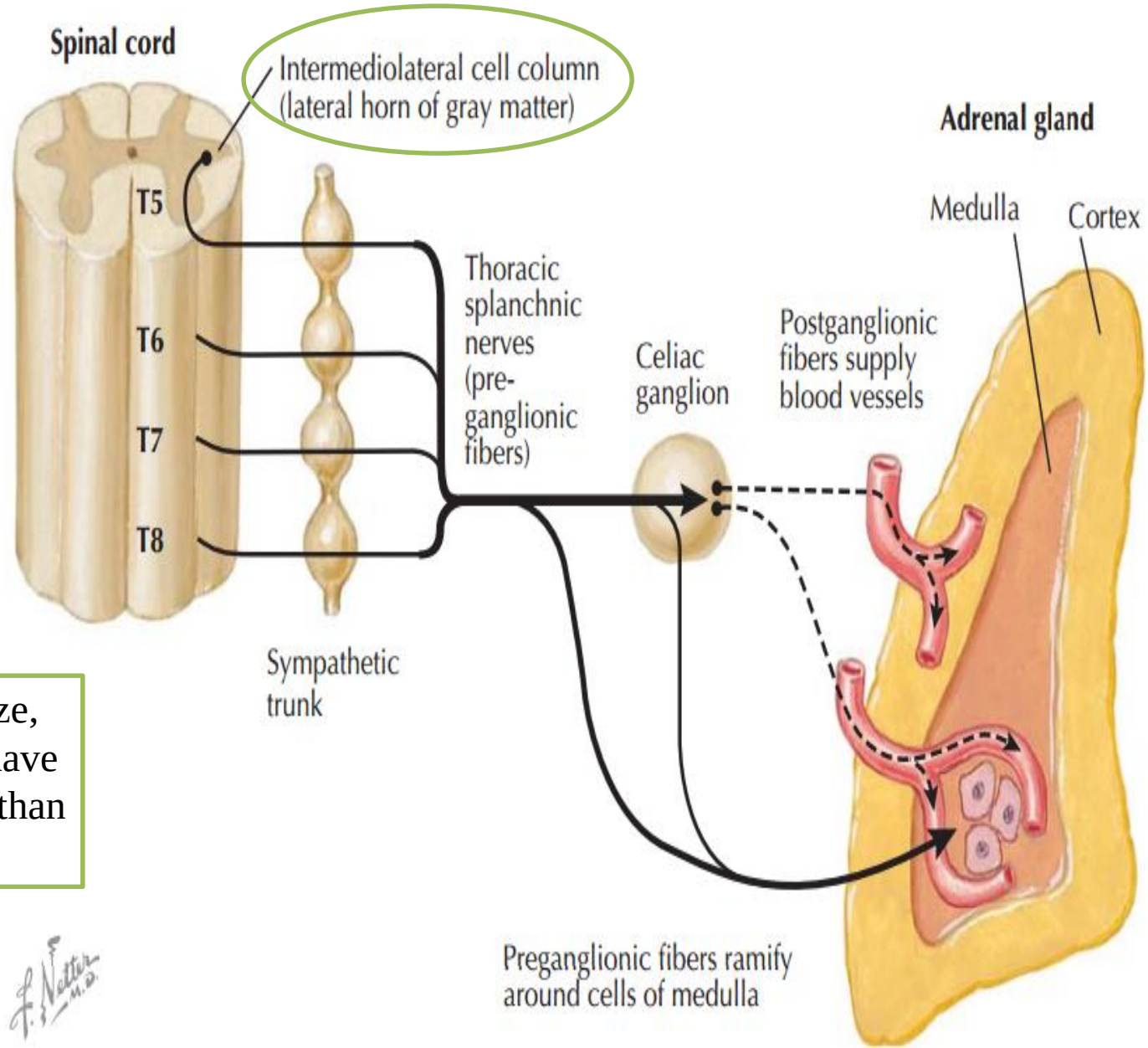




Read only

Normal variations in the adrenal gland
A) arterial supply via three arteries
b) arterial supply without tributary from the A. ranalis c) arterial supply without a direct branch of the Aorta

NERVE SUPPLY



Relative to their size, the adrenal glands have a richer innervation than other viscera

Catecholamines are released from the adrenal medullary and sympathoneuronal systems—both are key components of the fight-or-flight reaction

This reaction is triggered by ***neural signals from several sites in the brain*** (e.g., the *hypothalamus, pons, and medulla*), leading to synapses on ***cell bodies in the intermediolateral cell columns*** of ***the thoracolumbar spinal cord***

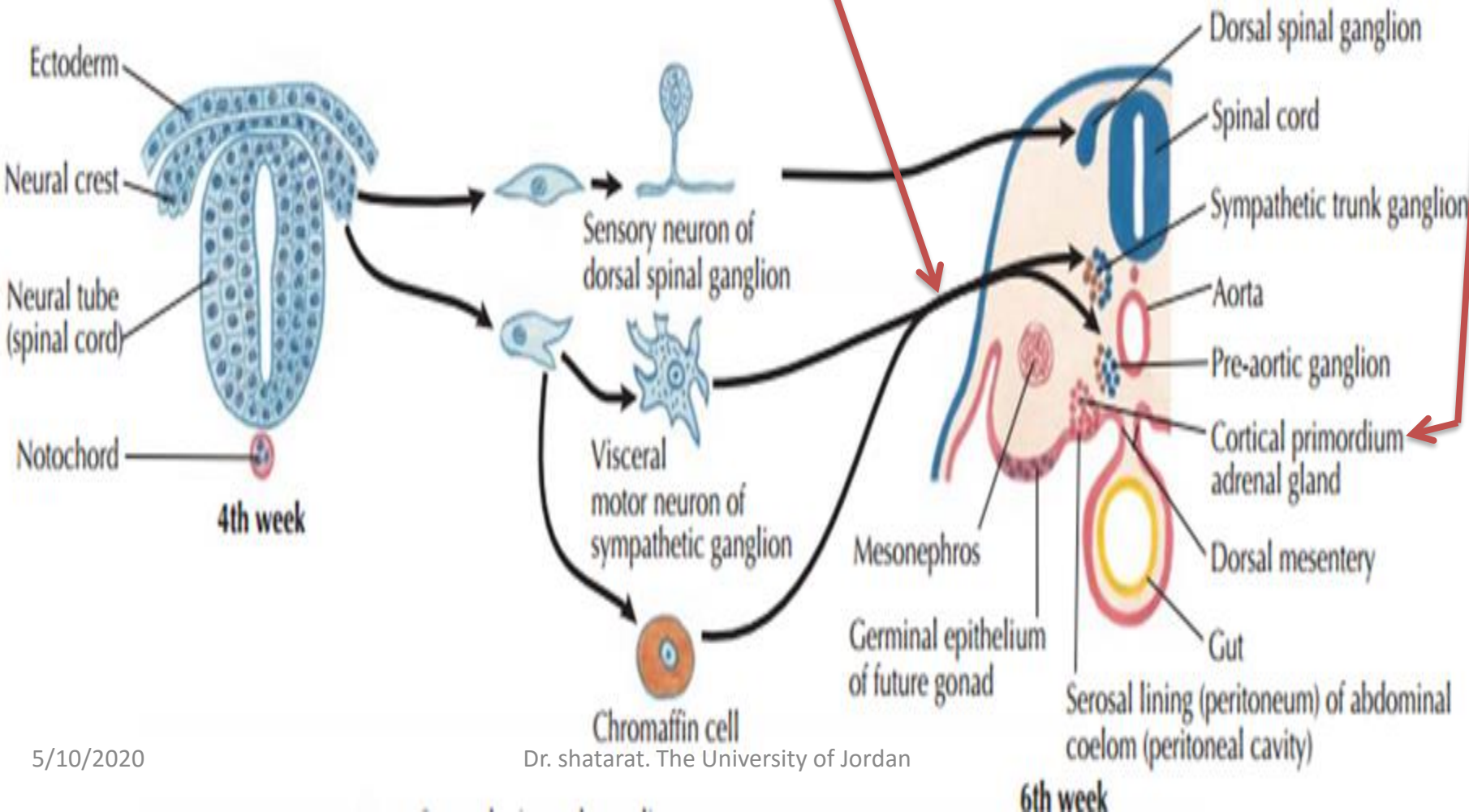
The preganglionic sympathetic nerves leave the spinal cord and synapse in ***paravertebral and preaortic ganglia*** of the ***sympathetic chain***.
Preganglionic axons from the lower thoracic and lumbar ganglia innervate the adrenal medulla ***via the splanchnic nerve***

ACETYLCHOLINE is the neurotransmitter in **the ganglia**, and the postganglionic fiber releases **NOREPINEPHRINE.**
The **chromaffin** cell of the adrenal medulla is a "**postganglionic fiber** equivalent," and its chemical transmitters are epinephrine and norepinephrine.

Embryology

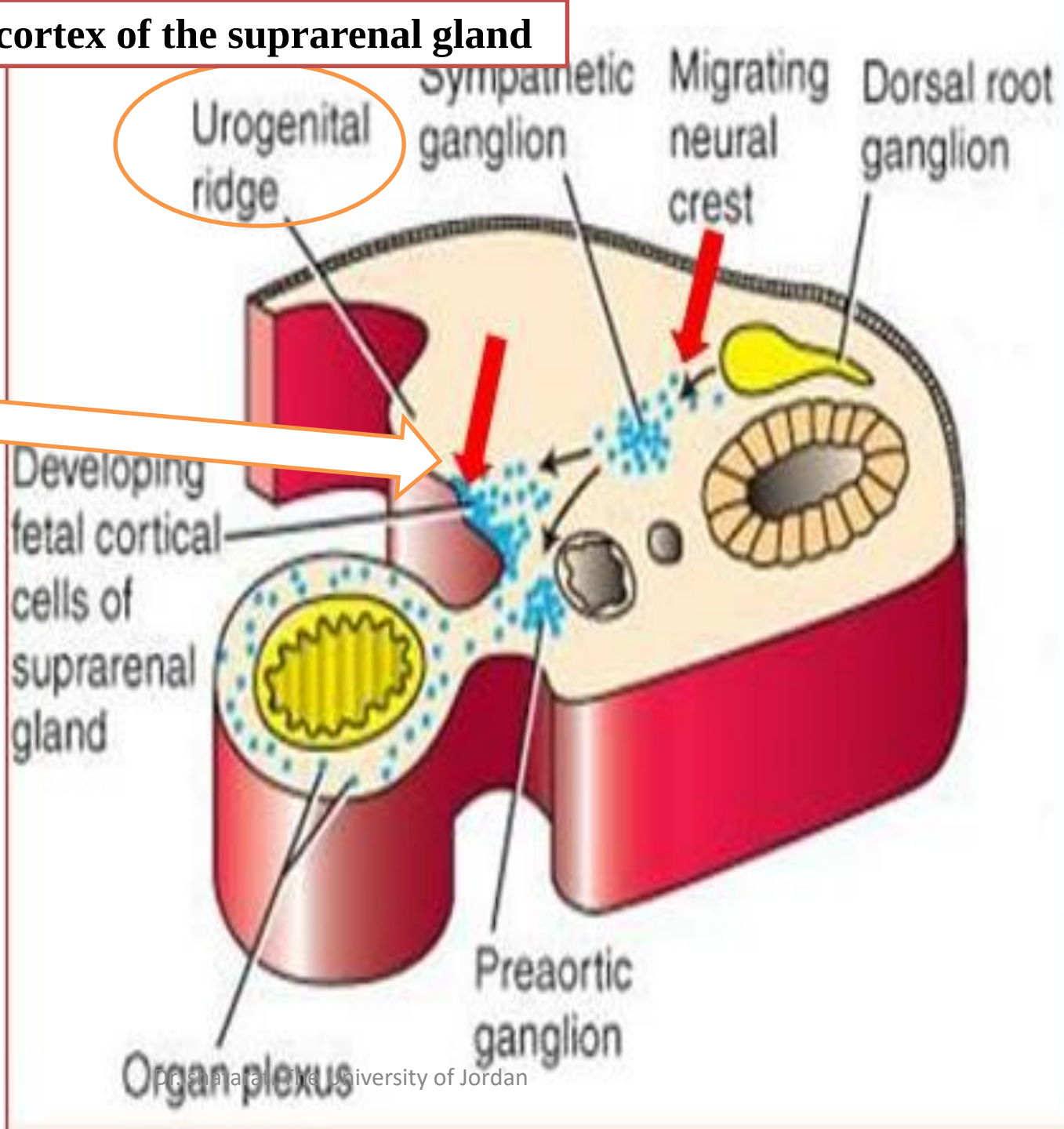
Two origins

Embryologically, the **cortical** cells originate from **mesodermal mesenchyme**, whereas
the medulla originates from ectodermal origin (**neural crest cells)** that migrate into the developing gland

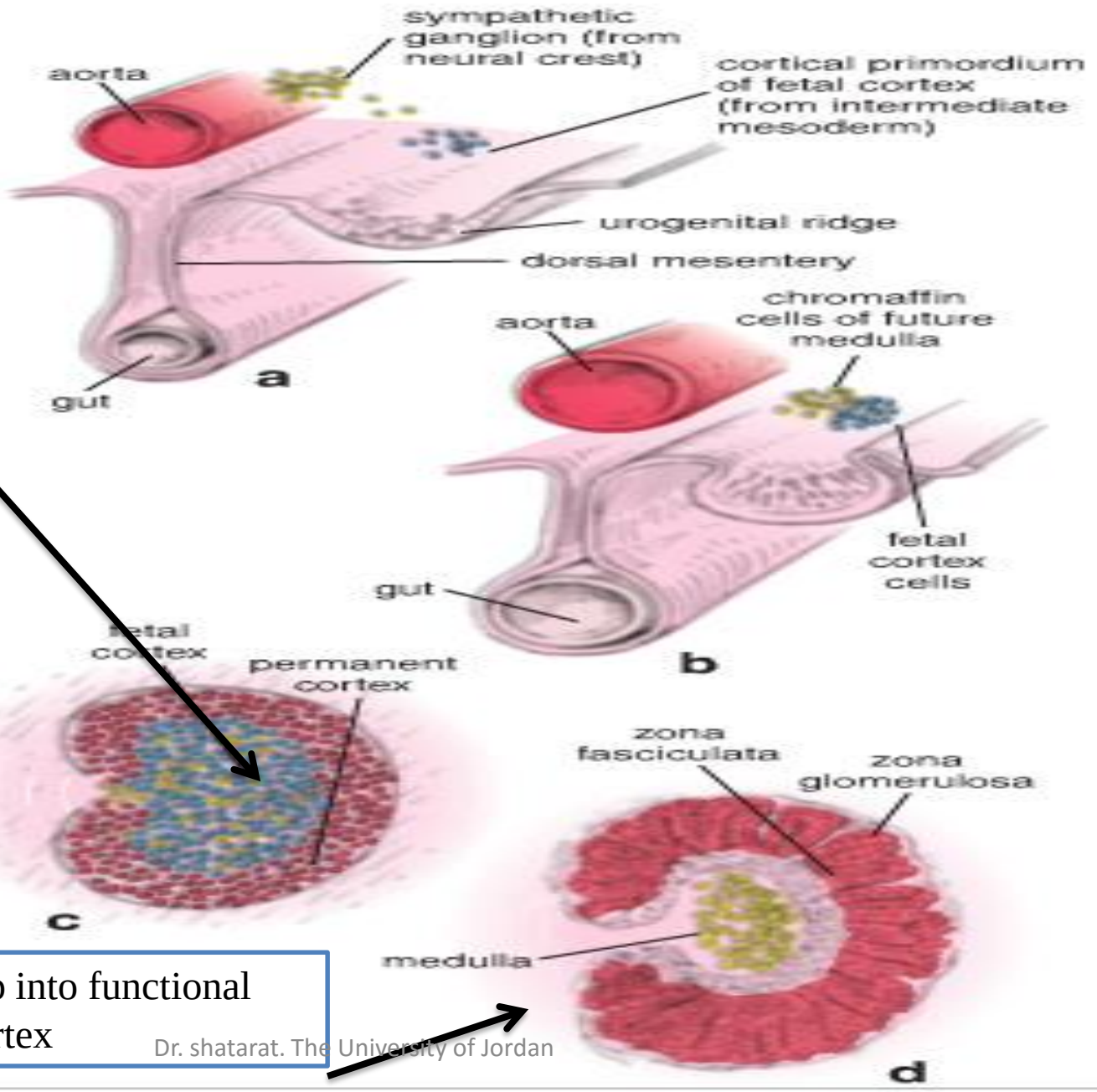


1-Development of the cortex of the suprarenal gland

It develops during the week 4 – 6 from mesoderm adjacent to urogenital ridge



At the beginning of 8th week of development **mesothelial cells** proliferate and differentiate into large **acidophilic cells** which surround the **medullary primordium** and form the fetal or primitive suprarenal cortex

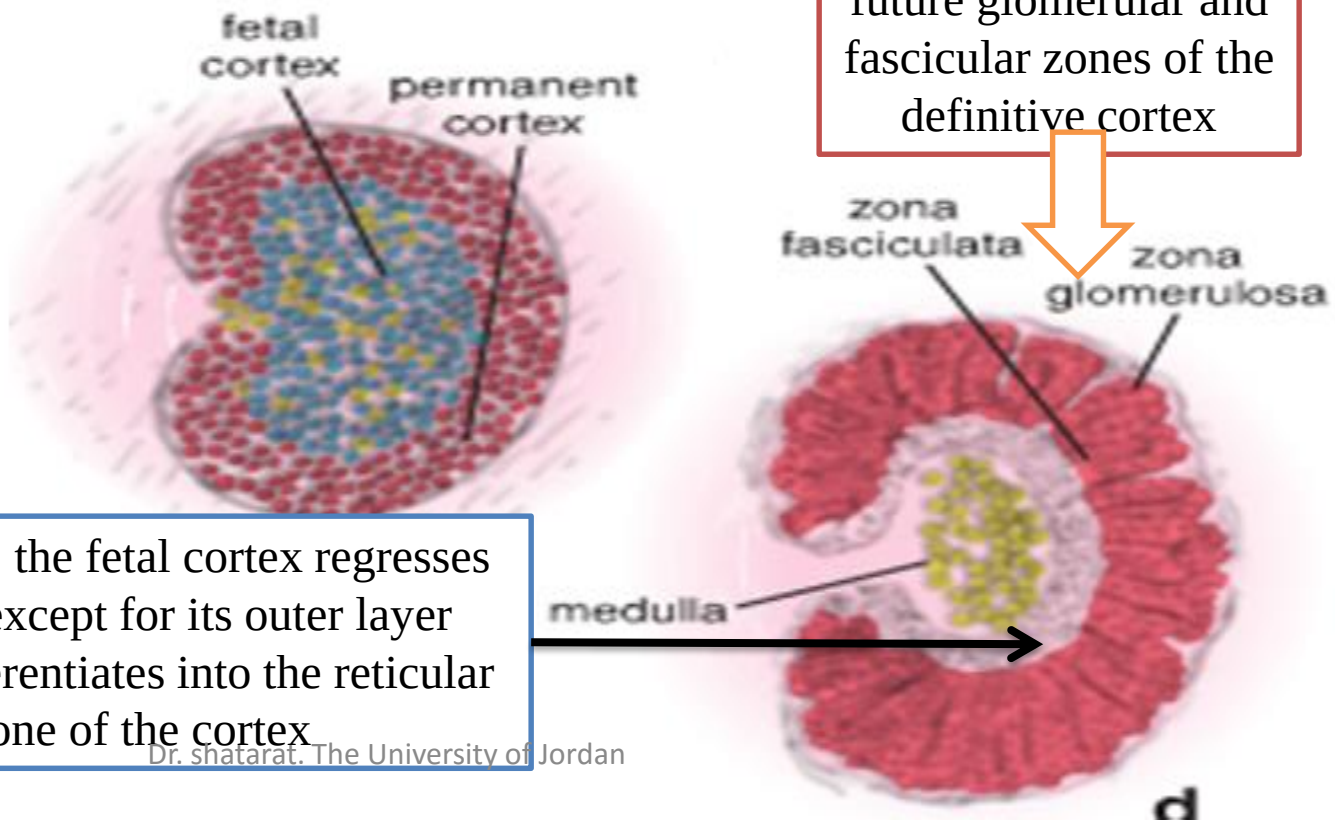


Definite cortex develop into functional adrenal cortex

At the end of the 3ed month of development
a second wave of smaller
basophlic mesothelial cells surround the original acidophilic cell mass.

These smaller cells form the definitive cortex of the gland

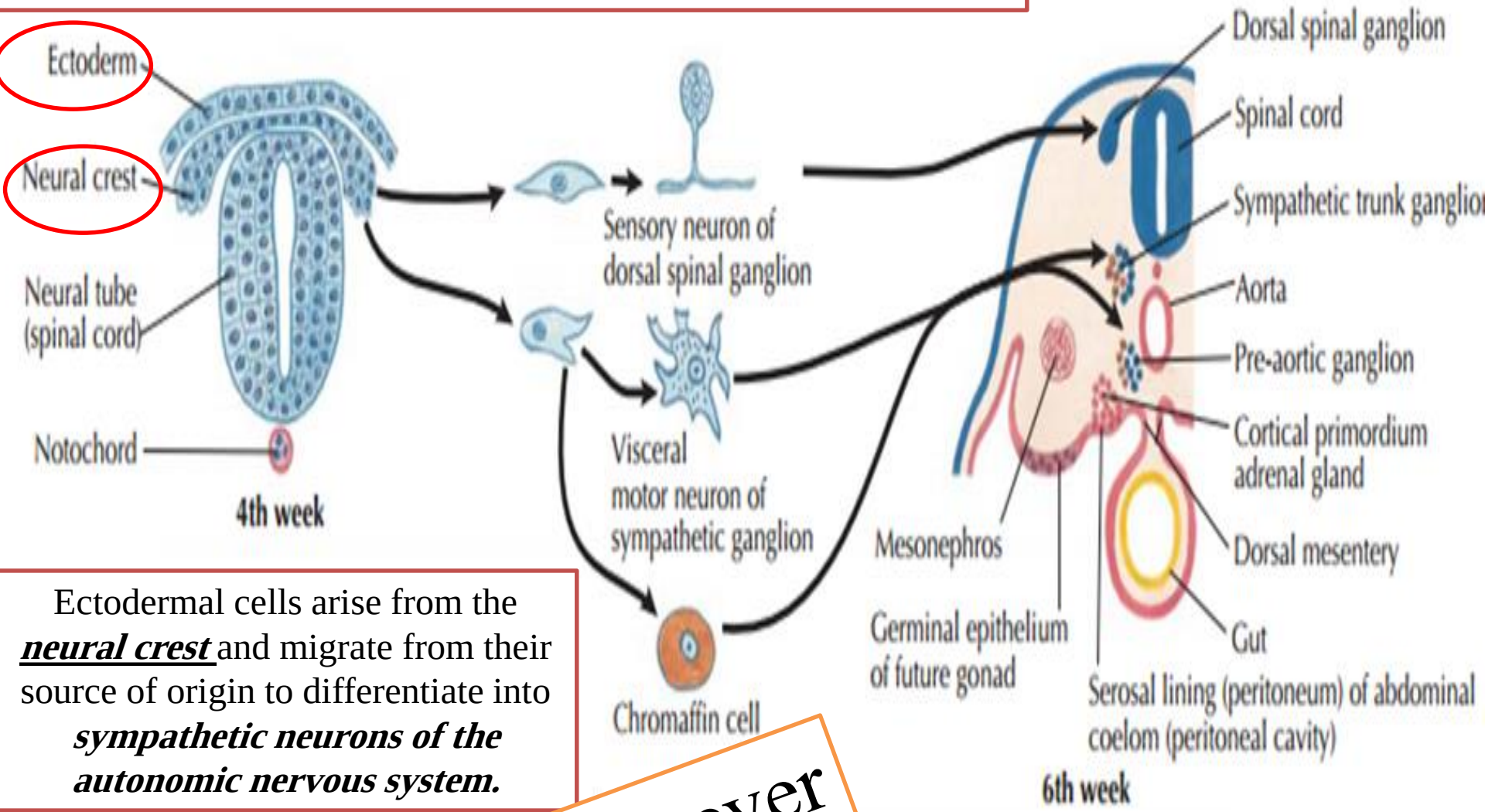
The small basophilic cells will form the future glomerular and fascicular zones of the definitive cortex



Fetal cortex produce steroid during gestation

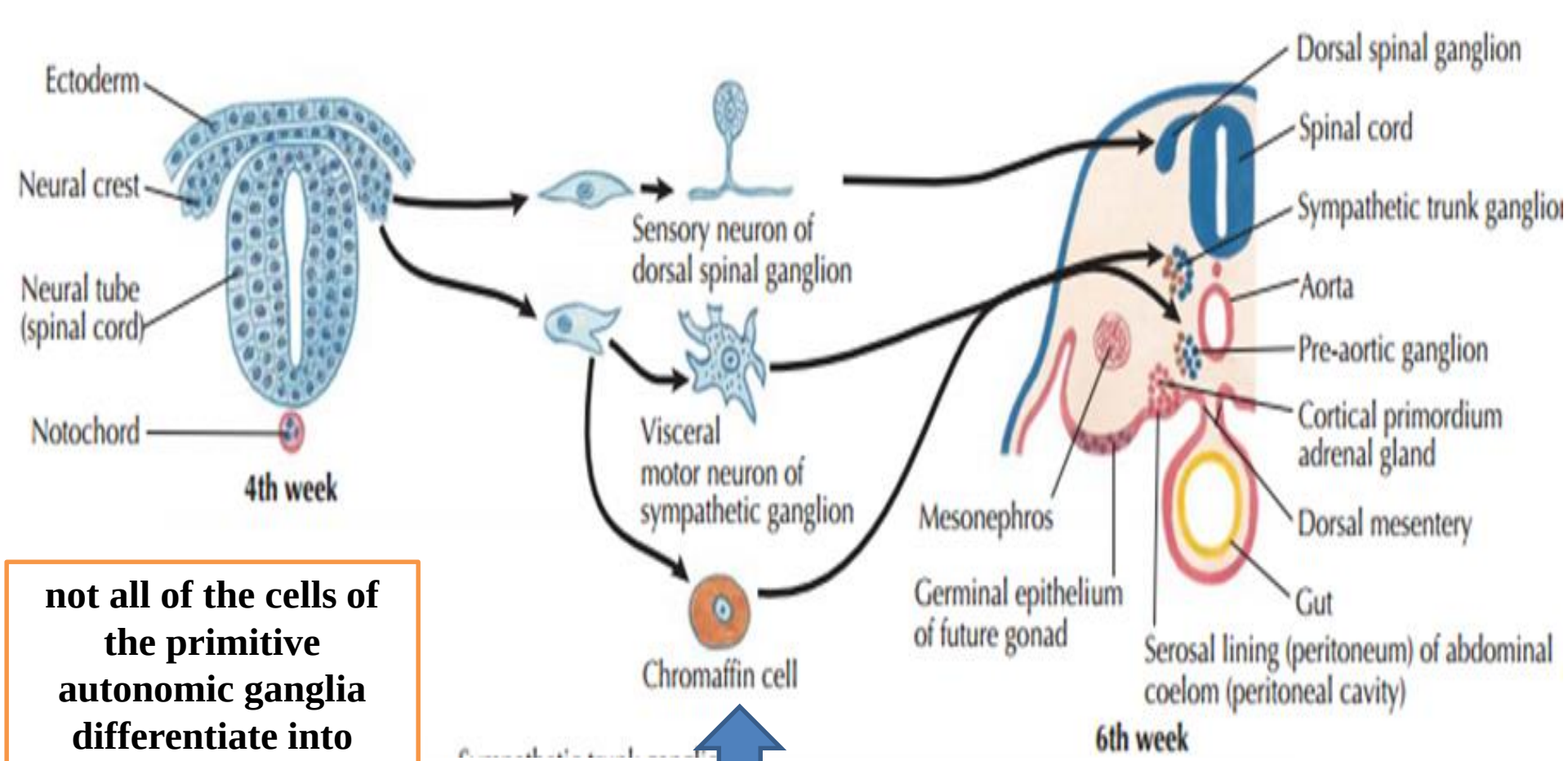
After birth, the fetal cortex regresses rapidly, except for its outer layer which differentiates into the reticular zone of the cortex

2-Development of the MEDULLA of the suprarenal gland



Ectodermal cells arise from the ***neural crest*** and migrate from their source of origin to differentiate into ***sympathetic neurons of the autonomic nervous system.***

However

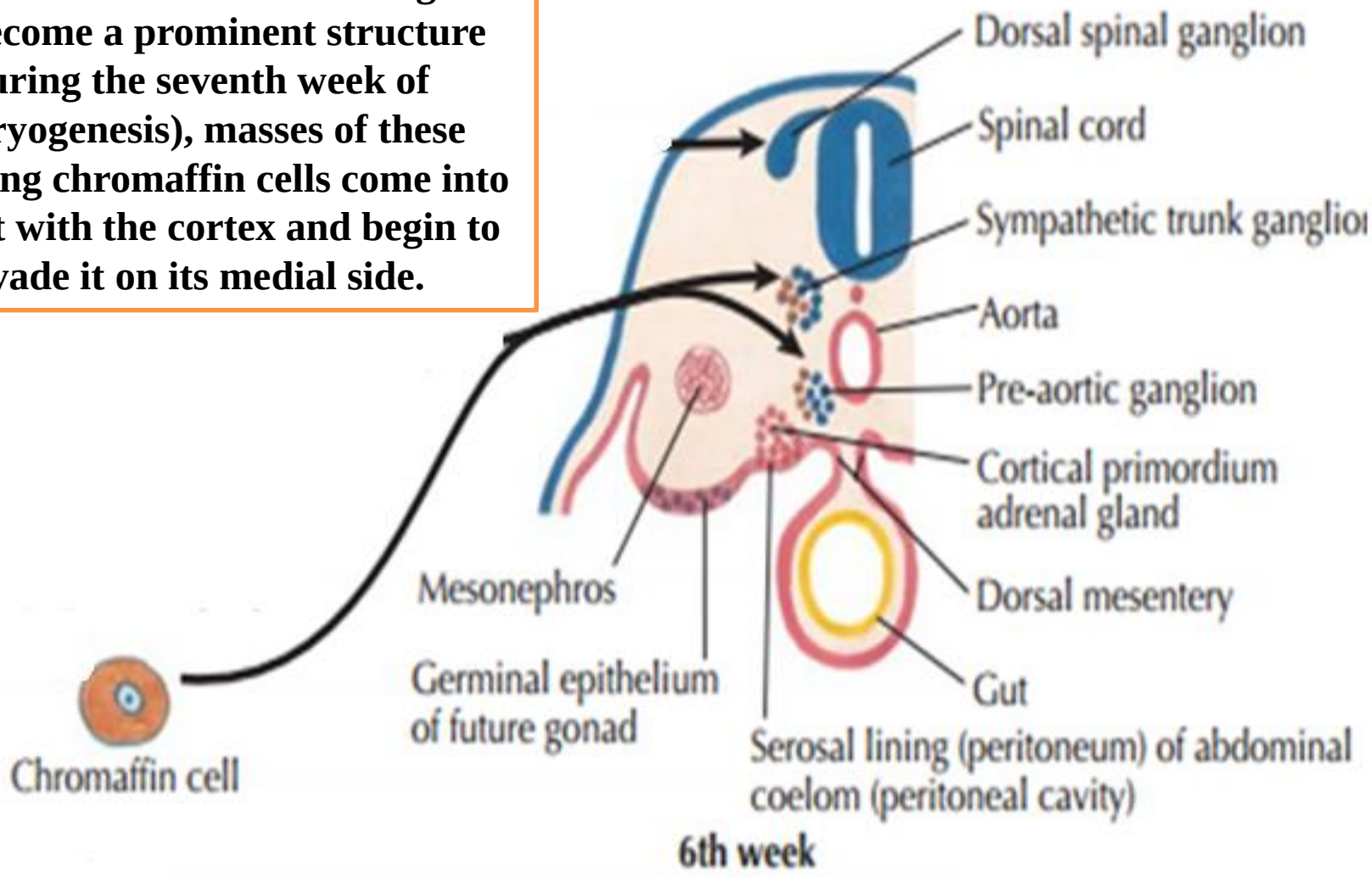


not all of the cells of the primitive autonomic ganglia differentiate into neurons.

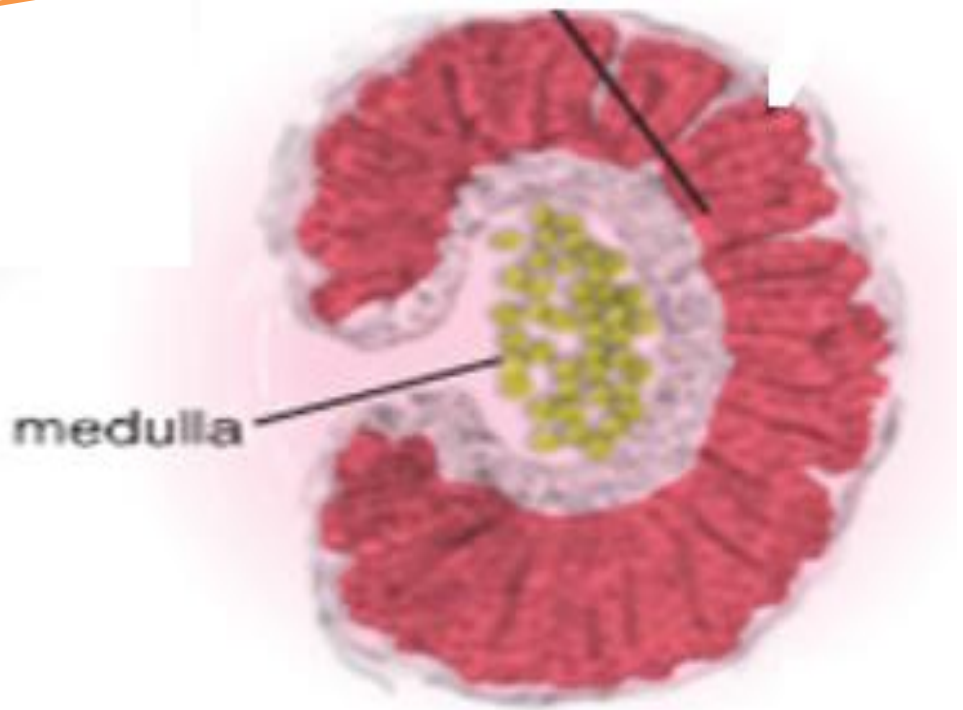
Some become **endocrine cells**, designated as **chromaffin cells because they stain brown with chromium salts**

Certain chromaffin cells migrate from the primitive autonomic ganglia adjacent to the developing cortex to give rise eventually to the medulla of the adrenal glands.

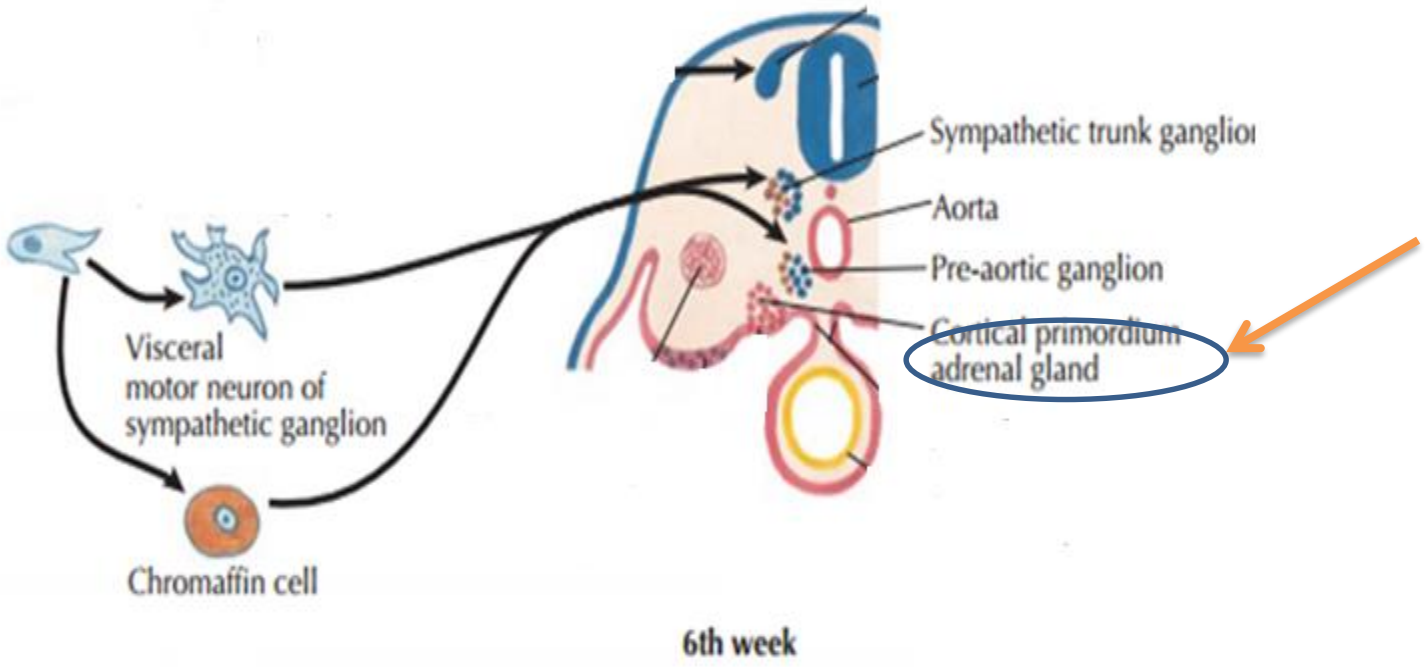
When the cortex of the adrenal gland has become a prominent structure (during the seventh week of embryogenesis), masses of these migrating chromaffin cells come into contact with the cortex and begin to invade it on its medial side.



By the middle of fetal life, some of the chromaffin cells have migrated to the central position within the cortex



Some chromaffin cells also migrate to form paraganglia, collections of chromaffin cells on both sides of the aorta.



The largest cluster of chromaffin cells outside the adrenal medulla is near the level of the inferior mesenteric artery and is referred to as the organ of **Zuckerkandl**, which is quite prominent in fetuses and is a major source of catecholamines in the first year of life

Congenital anomalies of the suprarenal gland

Read only

Prior to month 5 of **intrauterine development**

The cortex appears to develop autonomously

After the 5th month, the development of the adrenal gland depends on hypophyseal corticotropic hormone (ACTH)

Therefore, In case of anencephaly

Anencephaly: is a serious birth defect in which a baby is born without parts of the brain and skull. It is a type of neural tube defect (NTD). As the neural tube forms and closes, it helps form the baby's brain and skull (upper part of the neural tube), spinal cord, and back bones (lower part of the neural tube)

Read only

has little effect **before month 5** of fetal life since development of the adrenal up to this point appears to be autonomous

After month 5, development of the fetal cortex cannot occur without **ACTH,** thus, in the anencephalic, there is an involution of the adrenal cortex leading to **agenesis** or **hypoplasia**

note

agenesis : refers to the failure of an organ to develop during embryonic growth

IN HYDROCEPHALUS

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s a condition in which there is an accumulation of cerebrospinal fluid (CSF) within the brain.

The hypothalamus is undamaged.

↓

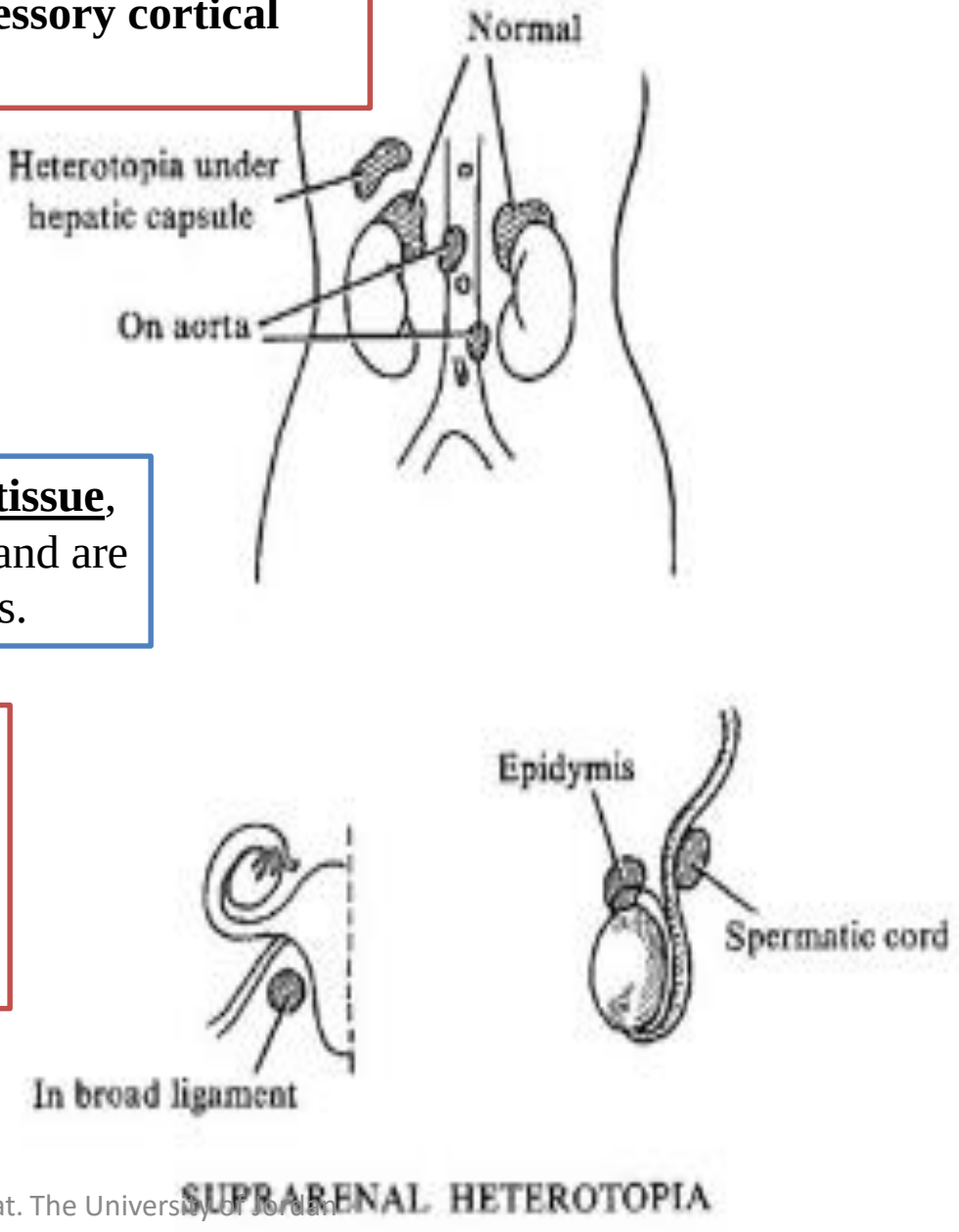
The adrenals develop normally

The origin of the cortex of the suprarenal gland is (near to urogenital ridge) which explains the presence of accessory para-testicular and para-ovarian accessory cortical masses

True accessory adrenal glands, consisting of **both cortex and medulla**, are **rarely** found in adults. When they are present, they may be within **the celiac plexus** or embedded in the **cortex of the kidney**..

Adrenal rests, **composed of only cortical tissue**, **termed cortical bodies,** occur **frequently** and are usually located near the adrenal glands.

In adults, accessory separate cortical or medullary tissue may be present in the spleen, in the retroperitoneal area below the kidneys, along the aorta, or in the pelvis.



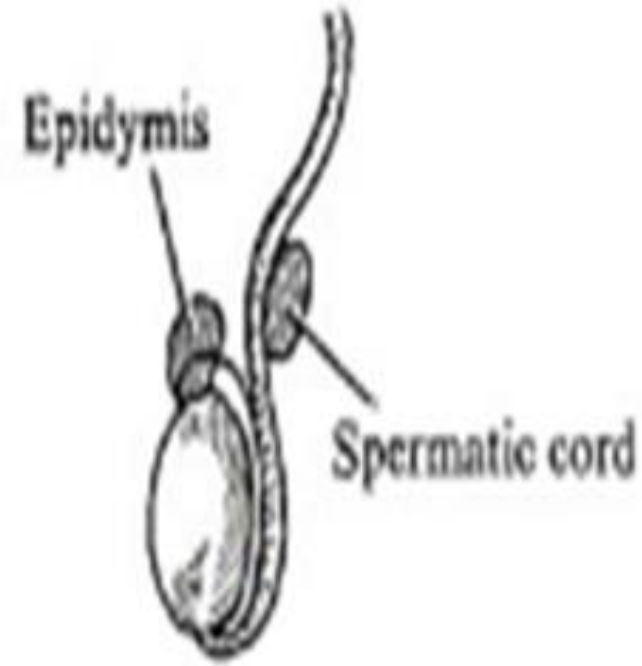
SUPRARENAL HETEROTOPIA

Because the adrenal glands are situated close to the gonads during their early development

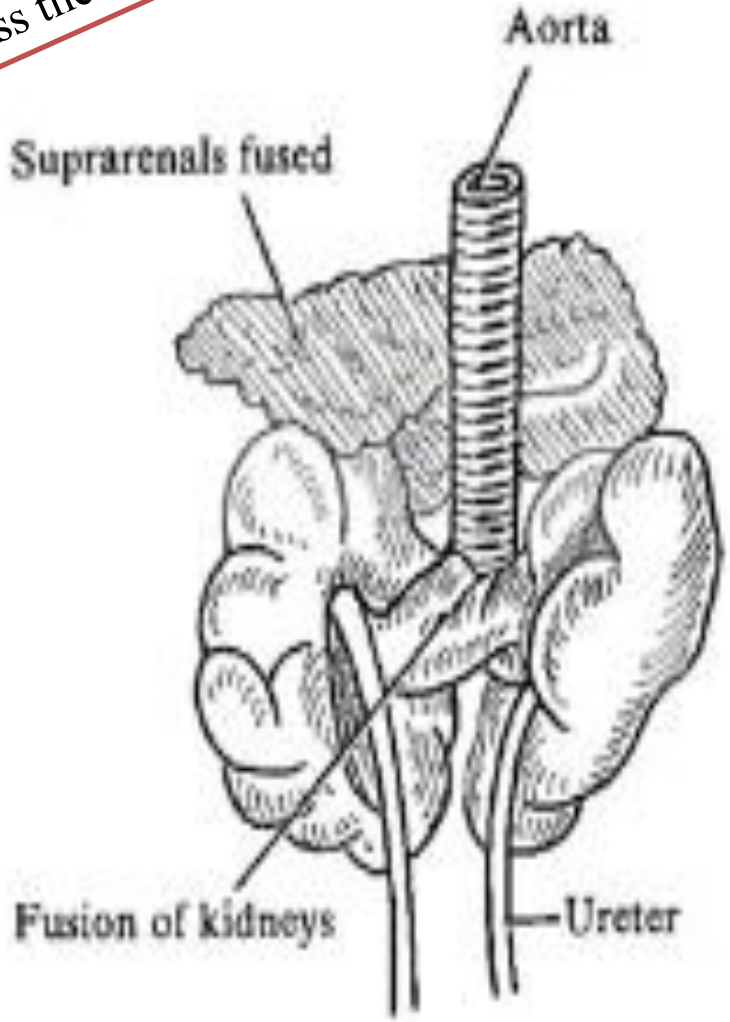
accessory tissue may also be present in the

spermatic cord, attached to the testis in the scrotum

attached to the ovary, or in the broad ligament of the uterus. Although one adrenal gland may be absent occasionally, complete absence of the adrenal glands is extremely rare



Fusion of the suprarenal glands: seen when kidneys are also fused across the midline



FUSION OF SUPRARENAL GLANDS BEHIND AORTA

Congenital adrenal hypoplasia
usually manifests itself shortly after birth with many of the symptoms of **Addison's disease**

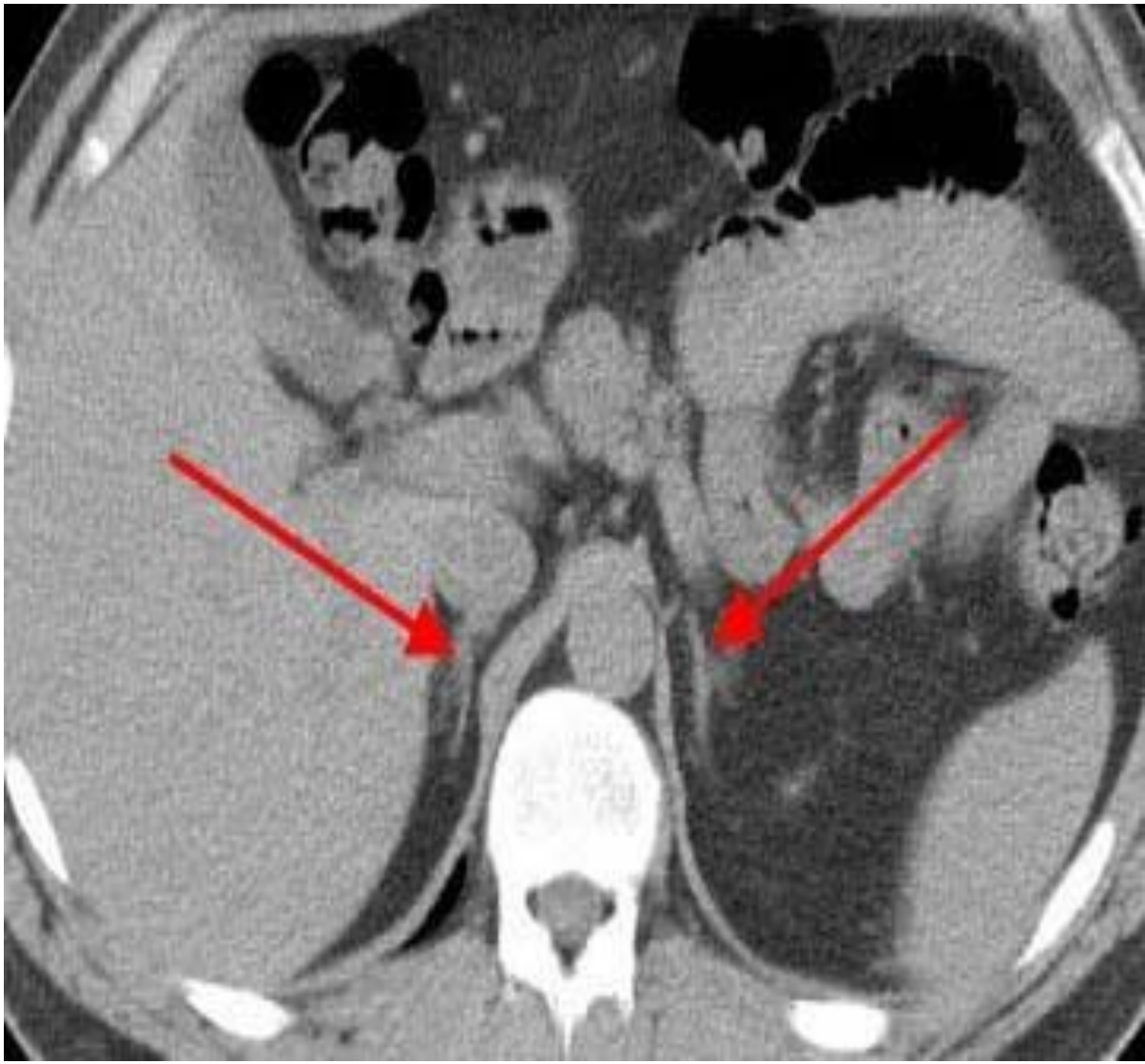
Agenesis of the adrenal: unilateral agenesis of the gland is almost always associated with agenesis of the kidney on the same side

IMAGING OF THE SUPRARENAL GLAND

The adrenal gland is ***the fourth most common site of metastasis***, and adrenal metastases may be found in as many as 25% of patients with known primary lesions

Adrenal cortical adenoma can be diagnosed with a high degree of accuracy: the specificity of imaging studies ranges from **95-99%, and the sensitivity is greater than 90%**

http://emedicine.medscape.com/article/376240-overview



Unenhanced CT scan through the level of the adrenal glands shows normal appearing bilateral adrenal glands in the suprarenal fossa. The glands take on the appearance of an upside down **"V" or "Y"** often (arrows).