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.

The retroperitoneal space lies on the posterior abdominal wall behind the parietal peritoneum.
The adrenal glands are covered with a thick connective tissue capsule from which trabeculae extend into the parenchyma carrying blood vessels and nerves.
They have a flattened triangular shape and are embedded in the perirenal fat at the superior poles of the kidneys.

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.

- 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 phrenic* 

*interior 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 gland

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

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

<table>
<thead>
<tr>
<th>Right Suprarenal</th>
<th>Left Suprarenal</th>
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<tbody>
<tr>
<td>[Image of Right Suprarenal]</td>
<td>[Image of Left Suprarenal]</td>
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<tr>
<td>Triangular (pyramidal)</td>
<td>Crescentic (semilunar)</td>
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<tr>
<td>Does NOT reach the hilum of the right kidney</td>
<td>Reaches the hilum of the left kidney</td>
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<tr>
<td>The hilum is directed upwards</td>
<td>The hilum is directed downwards</td>
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<tr>
<td>Its vein is short and drains to the IVC</td>
<td>Its vein is long and drains to the left renal vein.</td>
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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.
The capsule is penetrated by ~ 60 arterioles.

A) **short capsular capillaries** 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.**

**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?
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
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
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 3\textsuperscript{rd} month of development, a second wave of smaller \textbf{basophilic 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.

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

Fetal cortex produce steroid during gestation.

Dr. Shatarat, The University of Jordan
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
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
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).

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

**Note**: *Agenesis*: refers to the failure of an organ to develop during embryonic growth.

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 *agensis* or hypoplasia.
IN HYDROCEPHALUS

- 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.
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, or 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
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%.

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).