

Kidney and Ureter

Anatomy
and
Surgical Anatomy



Persistent



॥वसुधैव कुटुम्बकम्॥

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Director Academics,
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DIAPHRAGM

R. SUPRARENAL
GLAND

R. KIDNEY

R. RENAL ARTERY
AND VEIN

R. SUBCOSTAL NERVE

TRANSVERSUS
ABDOMINIS MUSCLE

QUADRATUS
LUMBORUM MUSCLE

ILIAC CREST

PSOAS MAJOR MUSCLE

ILIACUS MUSCLE

R. URETER

R. COMMON
ILIAC ARTERY

R. EXT. ILIAC
ARTERY

R. INT. ILIAC
ARTERY

URINARY BLADDER

GLAND

CELIAC

L. KIDN

L. RENAL
AND V

SUP. M.
ARTERY

SUBCOS

AORTA

ILIOHYP
NERVE

ILIOING
NERVE

LATERAL
CUTANE

GENITO
NERVE

L. TESTIC
ARTERY

INF. ME
ARTERY

PERITON

MESOSIC

RECTUM

*F. Netter
M.D.*

ESOPHAGUS

INF. VENA CAVA

AREA FOR BARE
AREA OF LIVER

R. SUPRARENAL
GLAND

CUT EDGE OF
PERITONEUM

AREA FOR LIVER

DUODENUM

CUT EDGE OF
PERITONEUM

AREA FOR
COLON

AREA FOR
SMALL BOWEL

GASTROPH

GASTROSP

L. SUPRARE
GLAND

LIENORENA

AREA FOR

AREA FOR

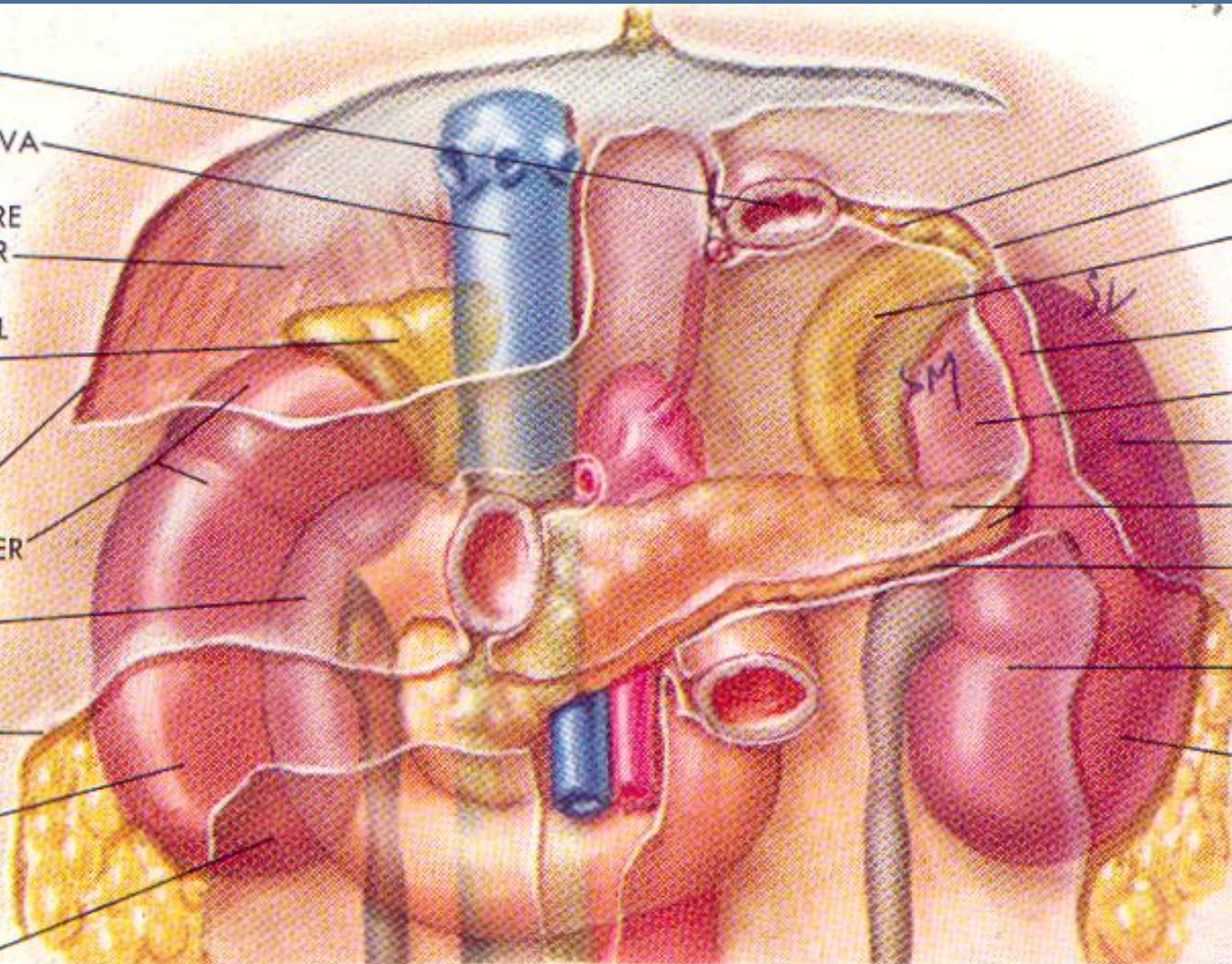
PANCREAS

TRANSVERS
MESOCOLC

AREA FOR
SMALL BOW

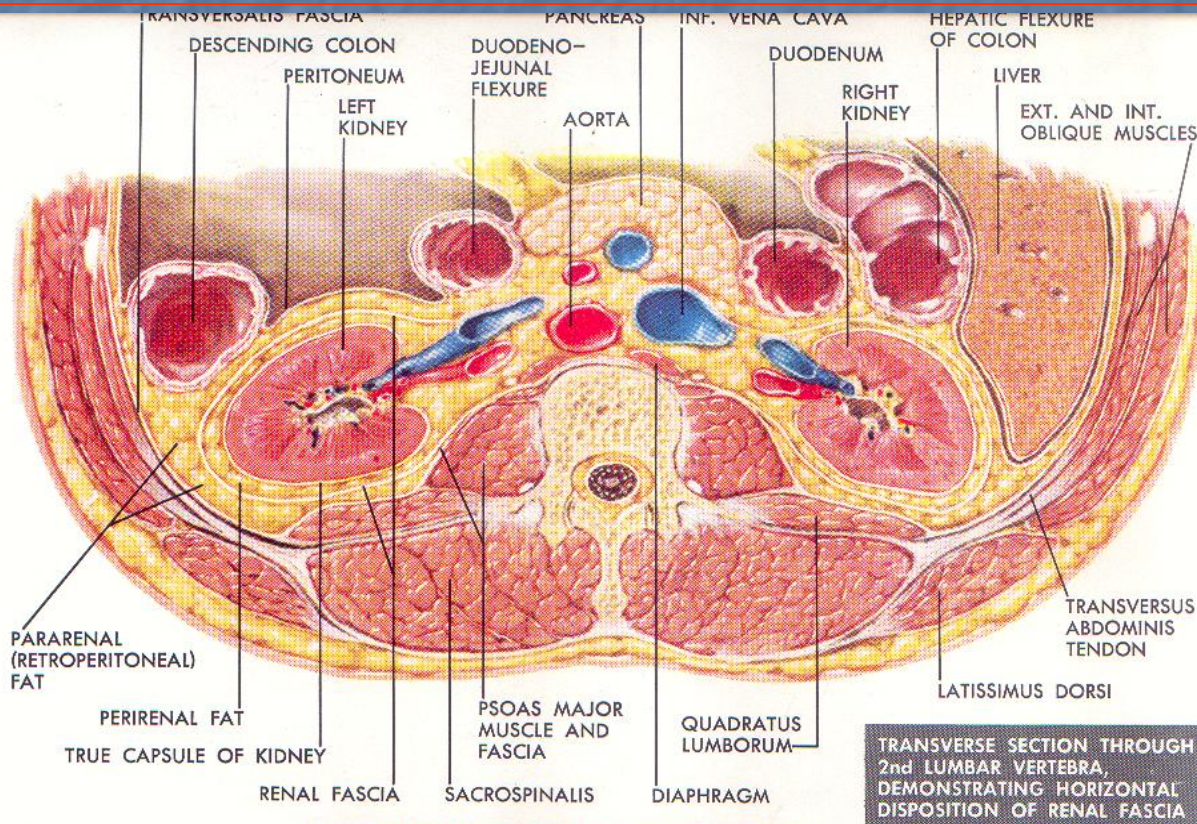
AREA FOR
DESC. COLC

ANTERIOR RE
OF THE KIDN

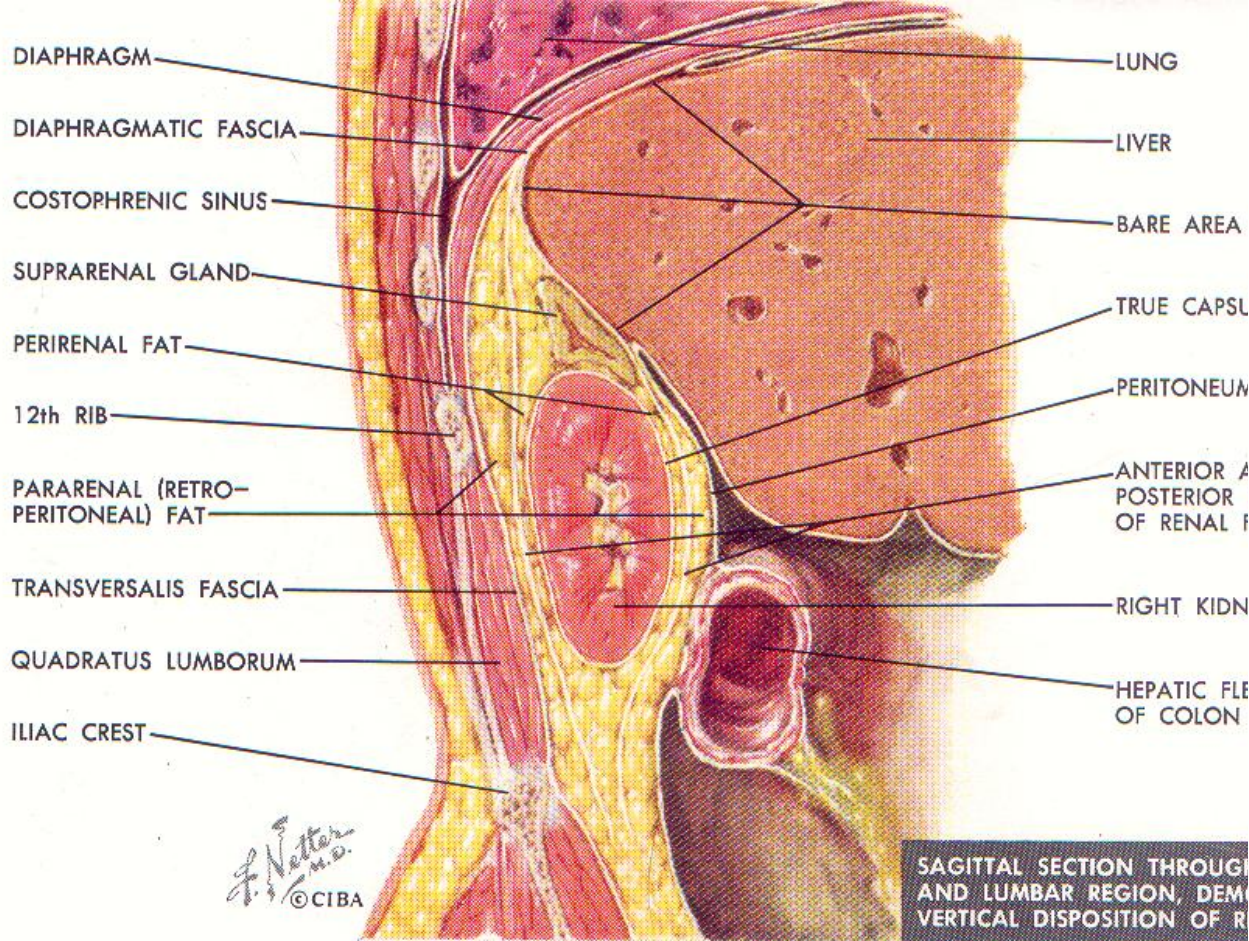


Gerota's Fascia

- Surrounds the kidney and Adrenal gland
- Thicker Post layer
- Medially fuses at level of great vessels
- Retroperitoneal Infection will not cross midline



- Anterior layer fuses with parietal peritoneum in the region of Toldt's Line



■ Gerota's Fascia Sagittal Section

- Superiorly the layers are approximated at the level of Diaphragm
- Inferiorly it is open
- It encompasses the Ureter and descends to pelvis

- Kidney and ureter move in Peri renal fat in Gerota's Fascia
- Renal tumours Hemorrhage Abscess Urinary Extravasations limits to Gerota's Fascia
- Fluid can go up to Diaphragm and down along the ureter but not medially.

LATISSIMUS
DORSI
MUSCLE

SERRATUS
POSTERIOR
INFERIOR
MUSCLE

EXTERNAL
OBLIQUE
MUSCLE

TENDON OF
TRANSVERSUS
ABDOMINIS
MUSCLE

INTERNAL
OBLIQUE
MUSCLE

LUMBODORSAL
FASCIA
(POST. LAYER)

ILIAC CREST

SACROSPINALIS
MUSCLE

GLUTEUS
MEDIUS
MUSCLE

GLUTEUS
MAXIMUS
MUSCLE

PLEURA
(COSTOPHRENIC
SINUS)

LUMBOCOSTAL
LIGAMENT

QUADRATUS
LUMBORUM
MUSCLE (CUT)

DIAPHRAGM

SUBCOSTAL
NERVE

R. KIDNEY

ASCENDING
COLON

TRANSVERSUS
ABDOMINIS
MUSCLE

ILIOHYPOGASTRIC
NERVE

ILIOINGUINAL
NERVE

QUADRATUS
LUMBORUM
MUSCLE (CUT)

PSOAS MAJOR
MUSCLE

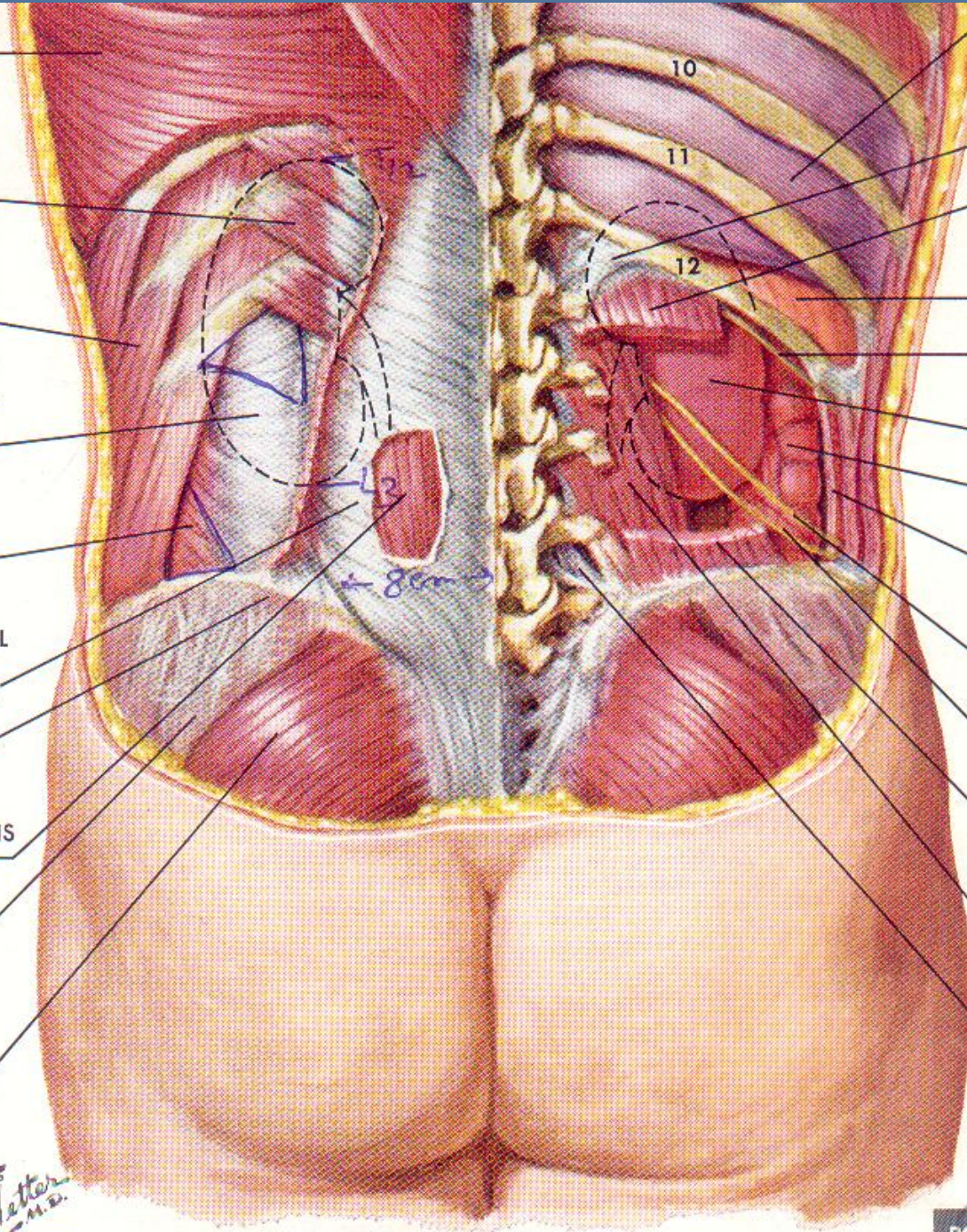
ILIOLUMBAR
LIGAMENT

*F. Netter
M.D.*
© CIBA

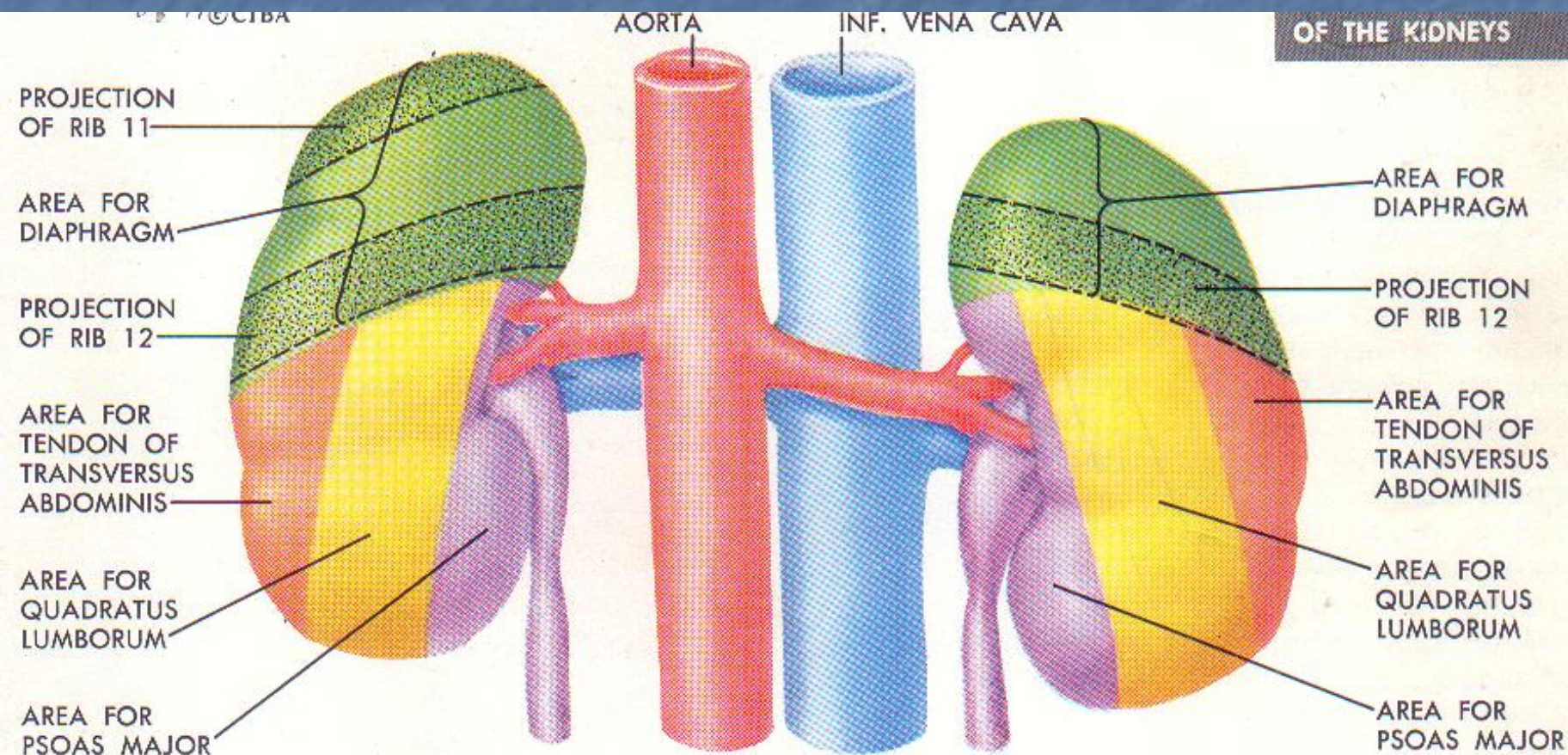
AORTA

INF. VENA CAVA

POSTERIOR RELATIONS
OF THE KIDNEYS



OF THE KIDNEYS



**URETERS IN THE MALE
(VIEWED FROM IN FRONT)**

RIGHT KIDNEY

DUODENUM

SUPERIOR MESENTERIC
ARTERY

RIGHT COLIC ARTERY

RIGHT URETER

ILEOCOLIC ARTERY

TESTICULAR VESSELS

COMMON ILIAC
ARTERY

INTERNAL ILIAC
ARTERY

EXTERNAL ILIAC
ARTERY

LEFT KIDNEY

LEFT URETER

INFERIOR MESEN-
TERIC ARTERY

LEFT COLIC ARTERY

GENITOFEMORAL
NERVE

SIGMOID ARTERIES

OBTURATOR ARTERY
AND NERVE

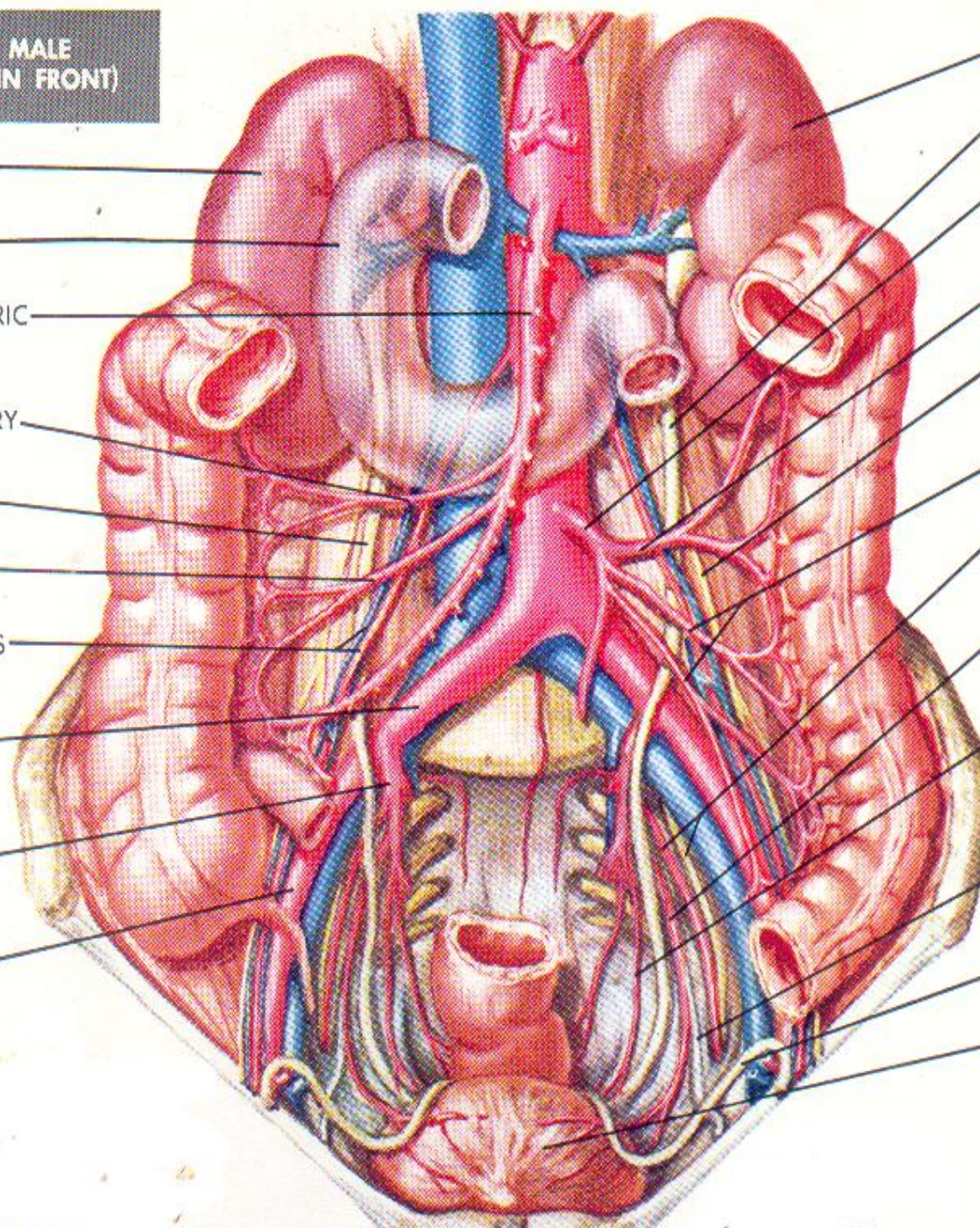
SUPERIOR VESICAL
ARTERY

INFERIOR VESICAL
AND DEFERENTIAL
ARTERY

OBLITERATED
UMBILICAL ARTERY

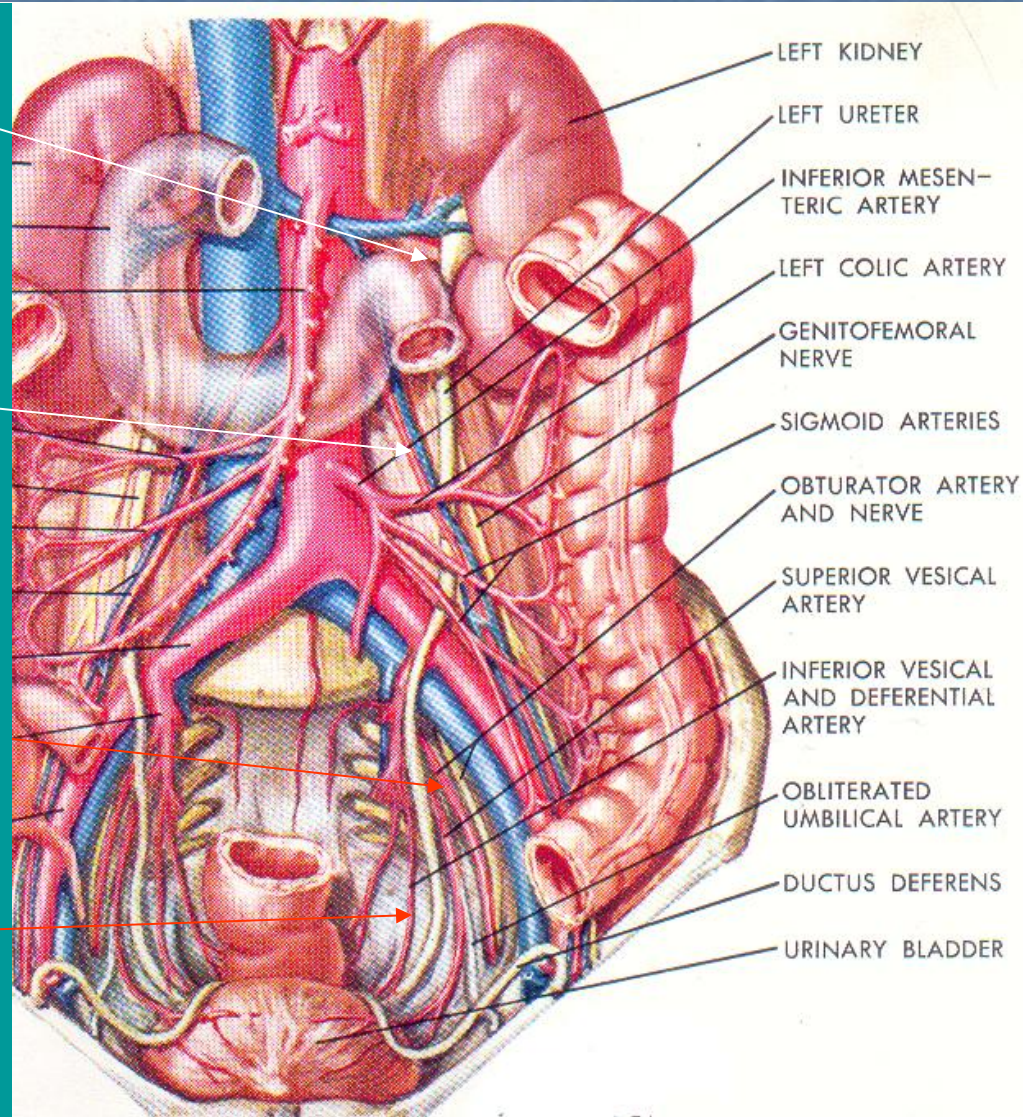
DUCTUS DEFERENS

URINARY BLADDER



Blood supply of Ureter

- Renal Artery
- Internal Spermatic Artery
- Aorta
- Hypogastric Artery
- Superior Vesical Artery
- Inferior Vesical Artery



URETER
THROUGH
BLADDER
WALL

BROAD LIGAMENT

UTEROSACRAL
FOLD

URETER
(RETRO-
PERITONEAL)

INTERSIGMOID
FOSSA

MESOSIGMOID

**URETERS IN FEMALE
PELVIS (VIEWED FROM
ABOVE)**

URINARY BLADDER

MEDIAL
UMBILICAL LIG.
(OBLITERATED
UMBILICAL ARTERY)

ROUND LIGAMENT

SUPERIOR VESICAL
ARTERY

UTERINE ARTERY

OBTURATOR
ARTERY AND NERVE

INFERIOR VESICAL
AND VAGINAL ARTERY

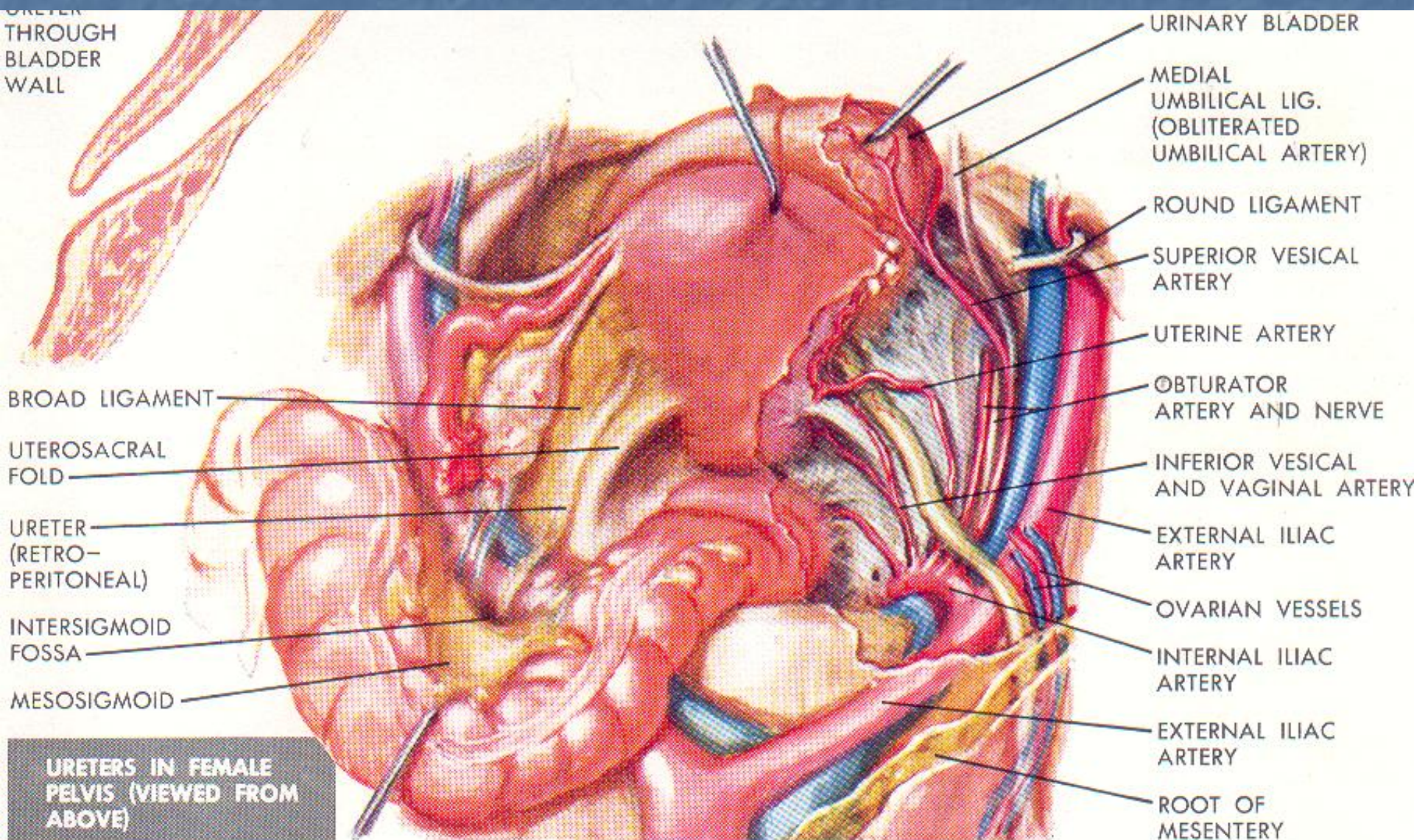
EXTERNAL ILIAC
ARTERY

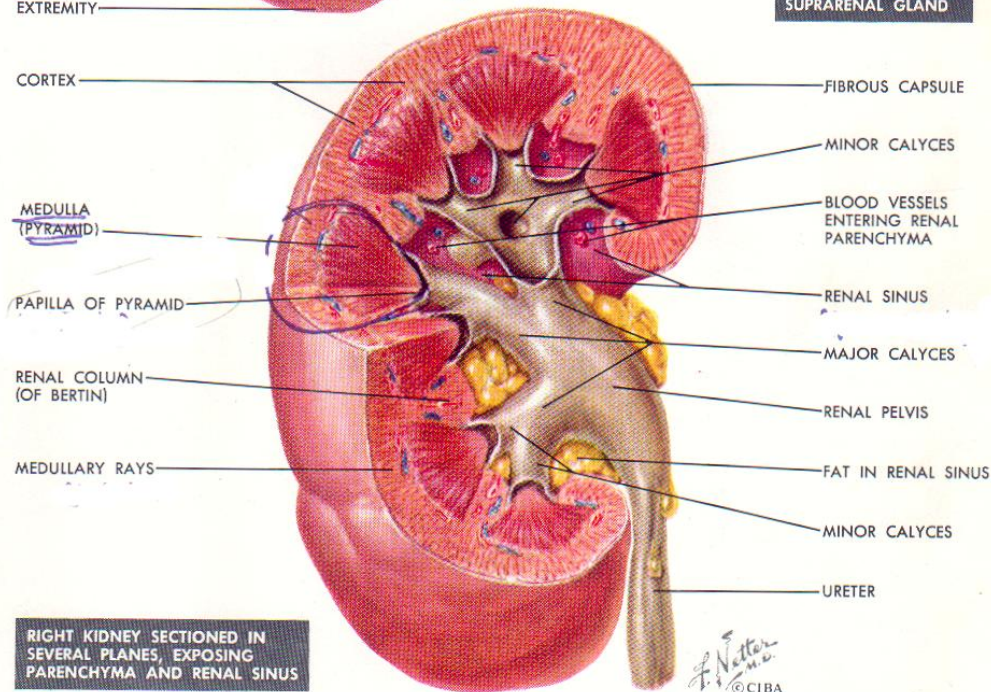
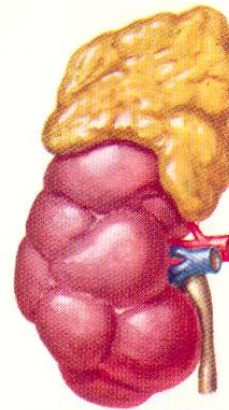
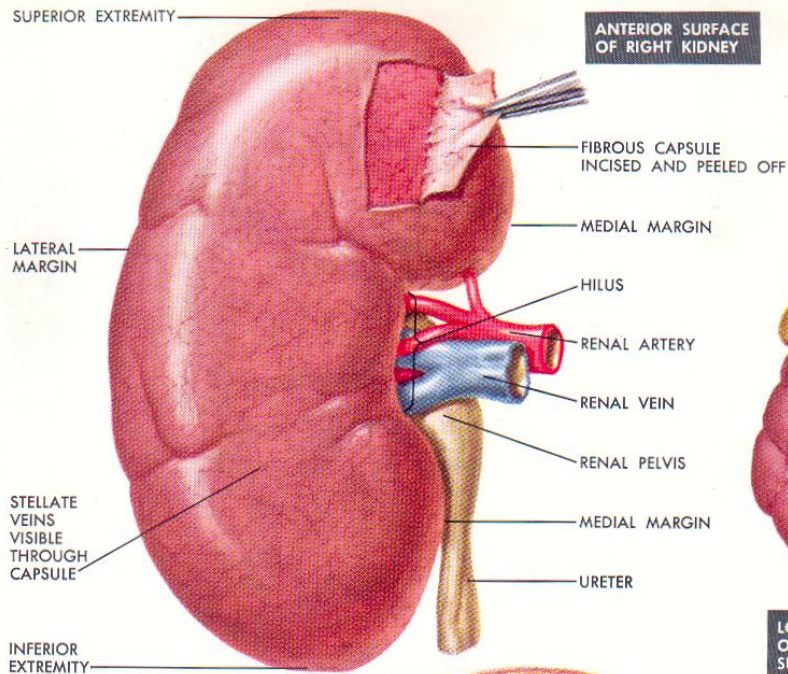
OVARIAN VESSELS

INTERNAL ILIAC
ARTERY

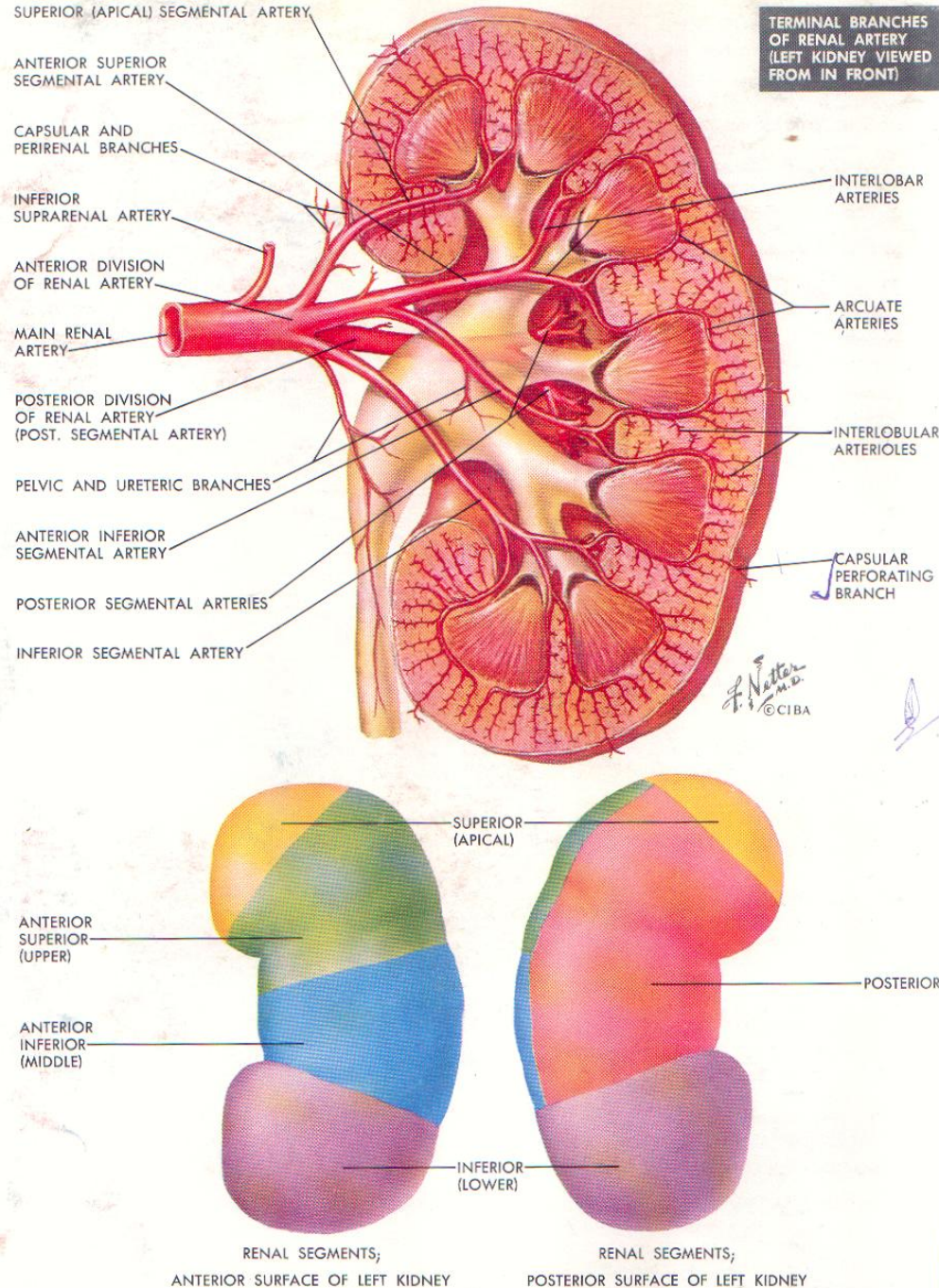
EXTERNAL ILIAC
ARTERY

ROOT OF
MESENTERY

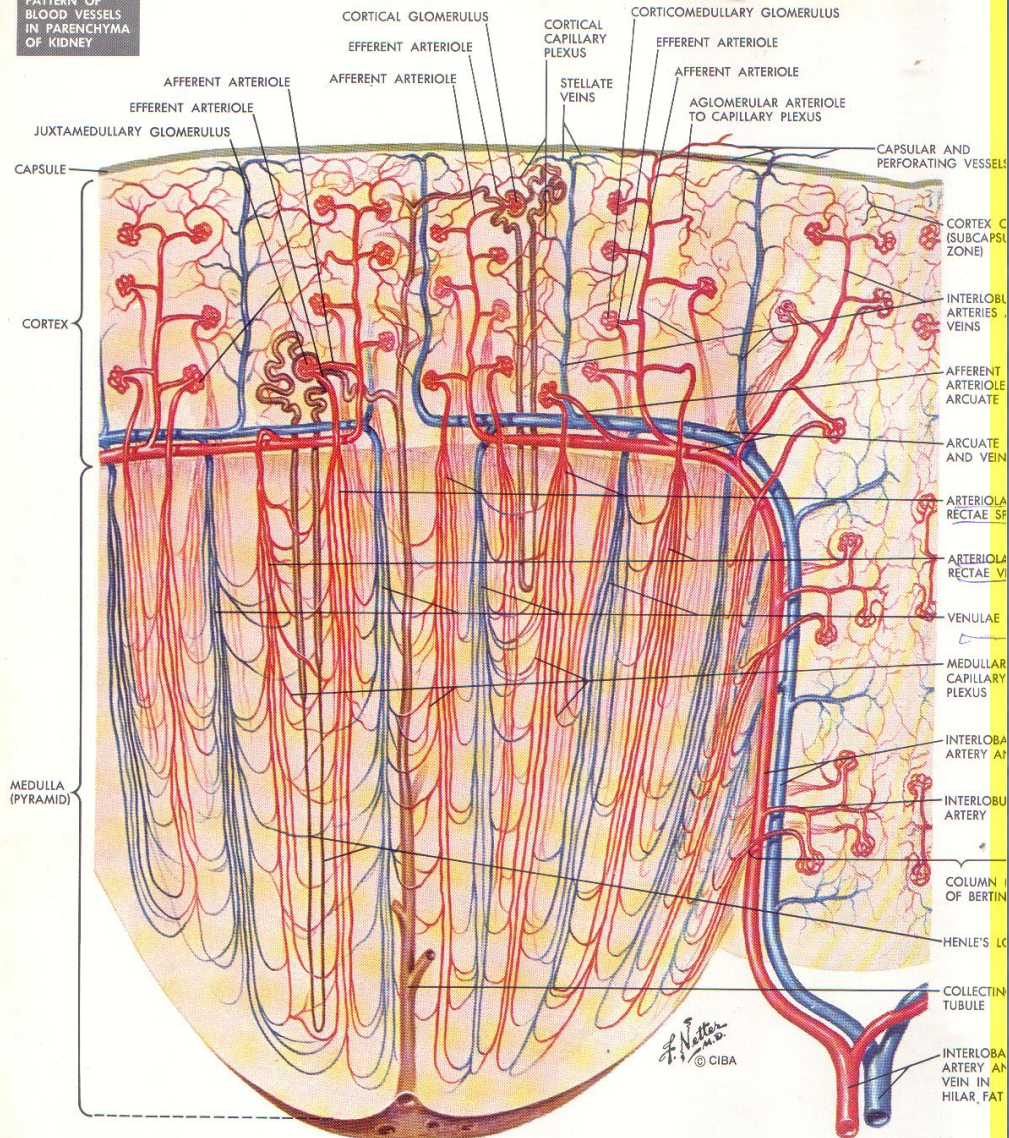




Renal Artery



- Anterior and Post Branch
 - Anterior Surface Total and Both the poles
 - Post supplies to mid segment on Post Surface
- Interlobar artery
- Arcuate Artery
- Interlobular Artery

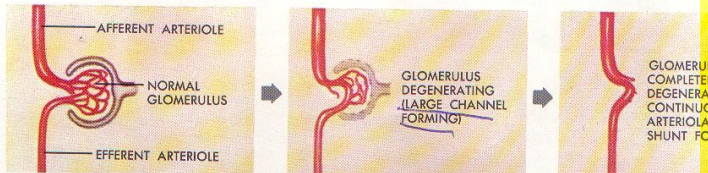


Interlobular Artery

Arcuate Artery

Interlobar artery

HYPOTHESIS OF FORMATION
OF AGLOMERULAR SHUNTS
(LUDWIG-ISAACS ARTERIOLES,
ARTERIOLE RECTAE VERA, ETC.)
BY DEGENERATION OF GLOMERULI



SUBCAPSULAR PLEXUS

CORTICAL LYMPH VESSELS ALONG INTERLOBULAR ARTERIES

LYMPH VESSELS ALONG ARCUATE ARTERIES

LYMPH VESSELS ALONG INTERLOBAR ARTERIES

MEDULLARY LYMPH VESSELS

ARROWS INDICATE DIRECTION OF FLOW

R. LUMBAR LYMPH TRUNK TO CISTERNA CHYLI

LATERAL AORTIC (LUMBAR) NODES

COMMON ILIAC NODES

NODE OF PROMONTORY

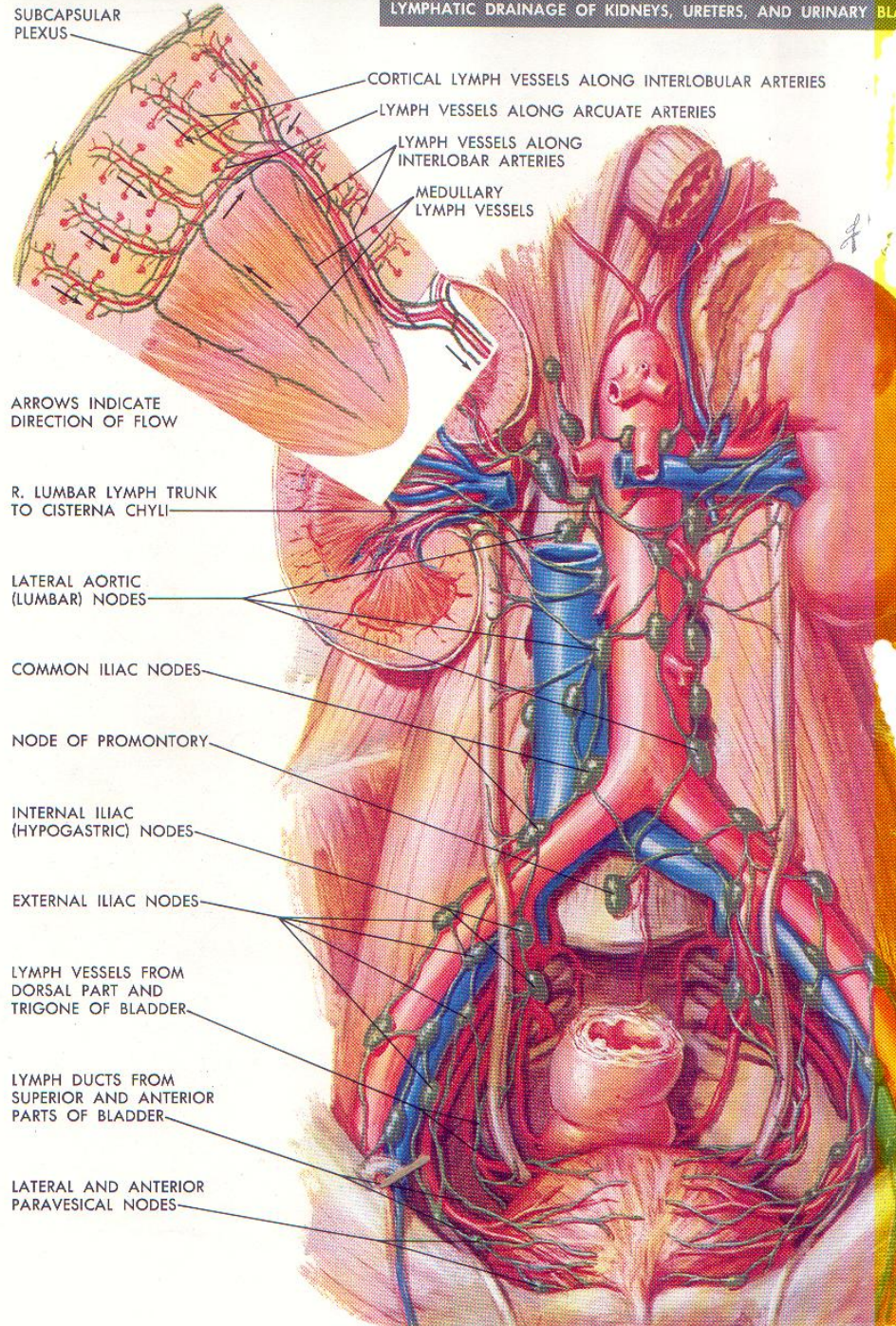
INTERNAL ILIAC (HYPOGASTRIC) NODES

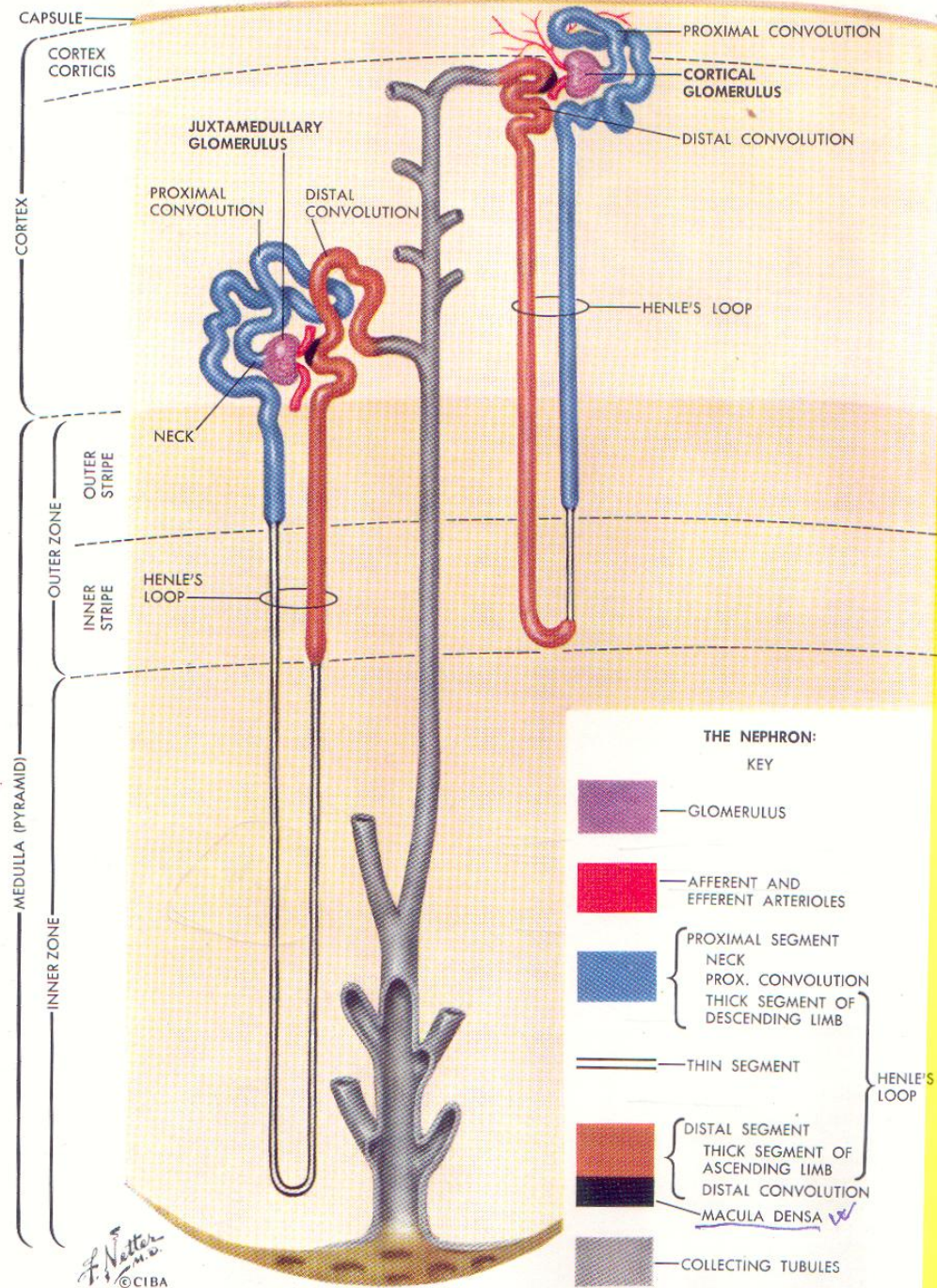
EXTERNAL ILIAC NODES

LYMPH VESSELS FROM DORSAL PART AND TRIGONE OF BLADDER

LYMPH DUCTS FROM SUPERIOR AND ANTERIOR PARTS OF BLADDER

LATERAL AND ANTERIOR PARAVESICAL NODES





Extraperitoneal Compartments

- Anterior Para-renal space
- Para renal space
- Post renal space.

Gerotas Facia

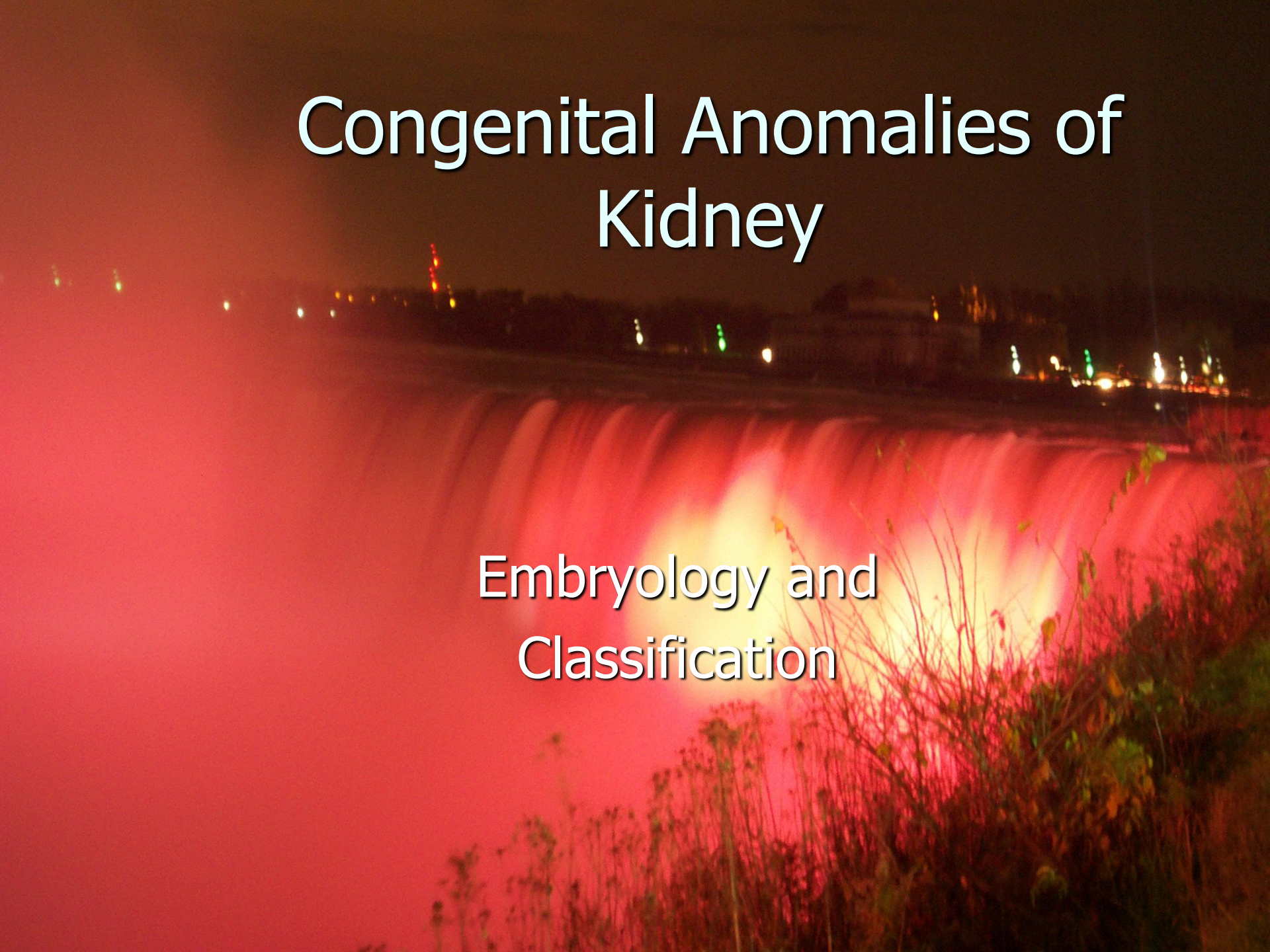
- Surrounds the kidney and adrenal gland.
- Thickers postly
- Curves ant. Parallel to peritoneum
- Medially ant and post layers partially fuse at the levels of great vessels (Retroperitoneal infection will not spread to other side)
- Infly Gerotas space is open (presacral insufflation of air) but continue as double layer across the midline.
- Super. The layers are approximated at the level of diaphragm. Inf. It is encompassing the ureter and descend in to the pelvis.
- Ant. Layer of Peri-renal fascia on Lat. Extent fuses with parietal peritoneum in the region of Toldt's limb.
- The kidney and ureter moves in Perirenal fat in Gerota's fascia.
- Renal Tumours, Haemorrhage, abscess, urinary extravasation usually limit to Gerota's fascia.
- Fluids can go up to Diaphragm and along ureter
- Not medially.

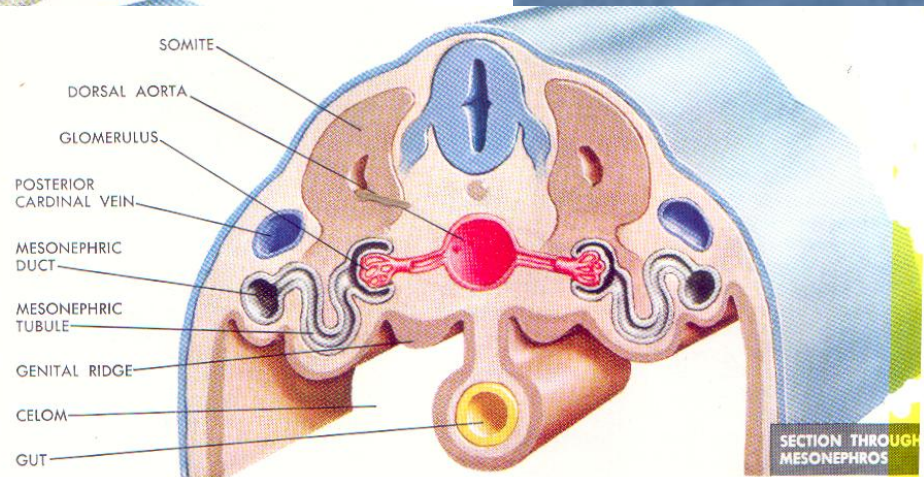
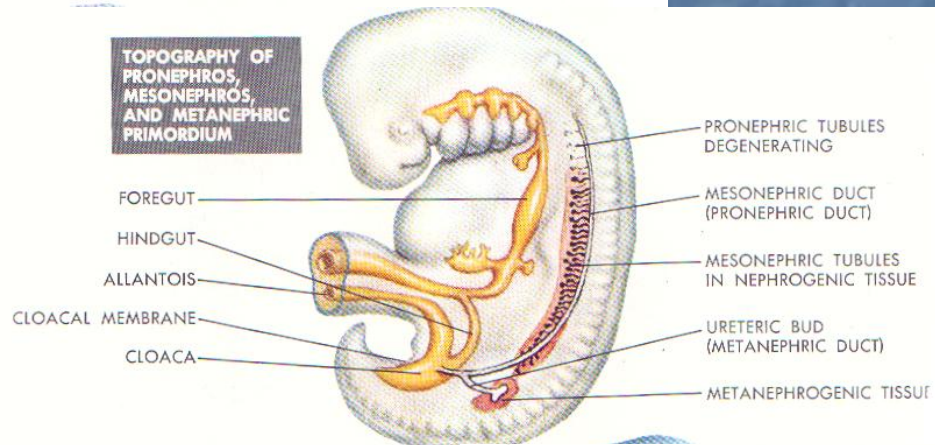
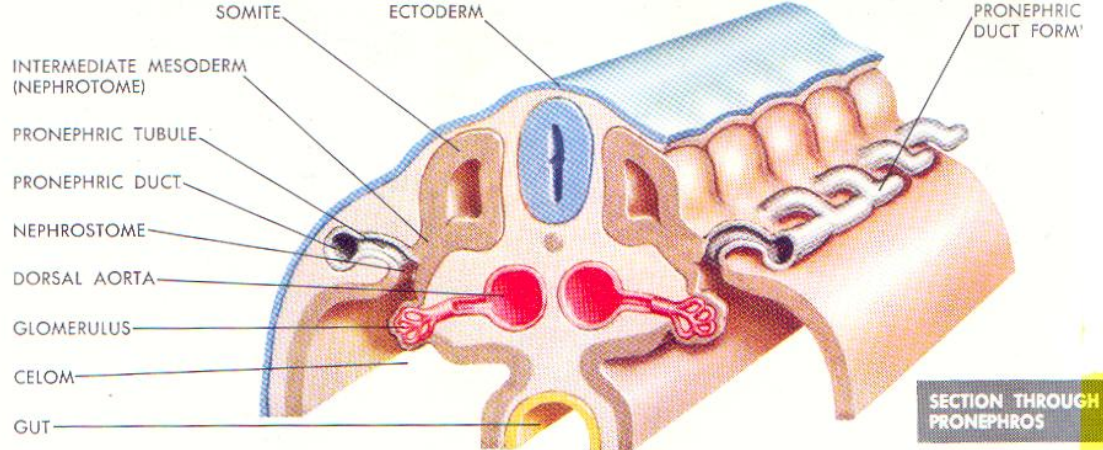
Blood Supply of Kidney

- Usually One renal artery VAP
enters between pelvis & renal vein.
- Sometimes two separate arteries:
RA: Post: Mid Segment of post. Surface.
Ant.: ANT surface completely
Both the poles.
- Inter Lobar artery: ascends in column of Bertin
- Arcuate Artery: Base of Pyramids.
- Interlobular artery
- Afferent Art.: Glomeruli
- Ascending Renal artery:
1) Renal Transplant
2) Lower Polar Artery: Vascular cause of Hydronephrosis
- Renal Calyces, Pelvis and upper ureter: Renal artery
- Mid Ureter: Internal spermatic artery.

Congenital Anomalies of Kidney

Embryology and
Classification

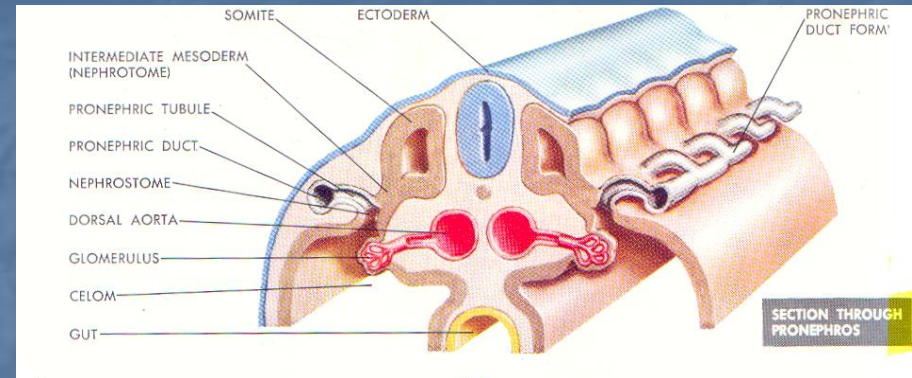




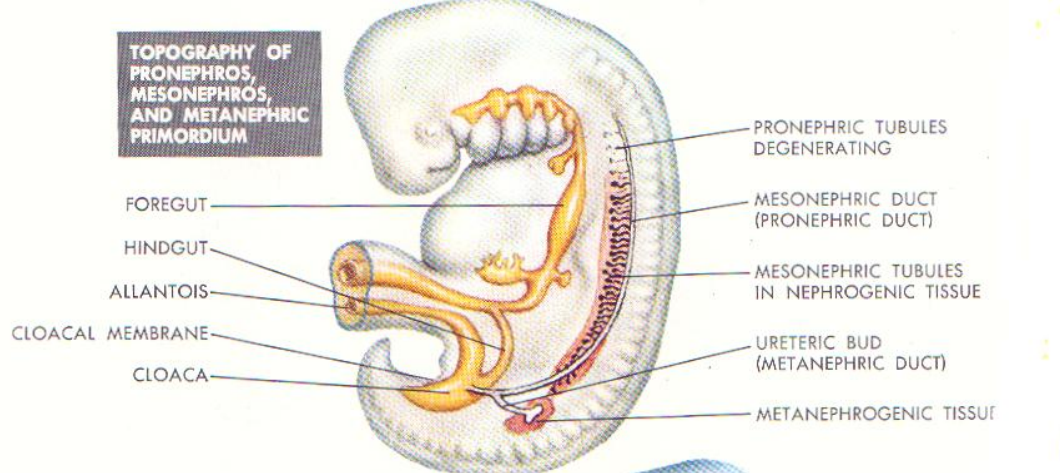
Development of Kidney

Pronephros:

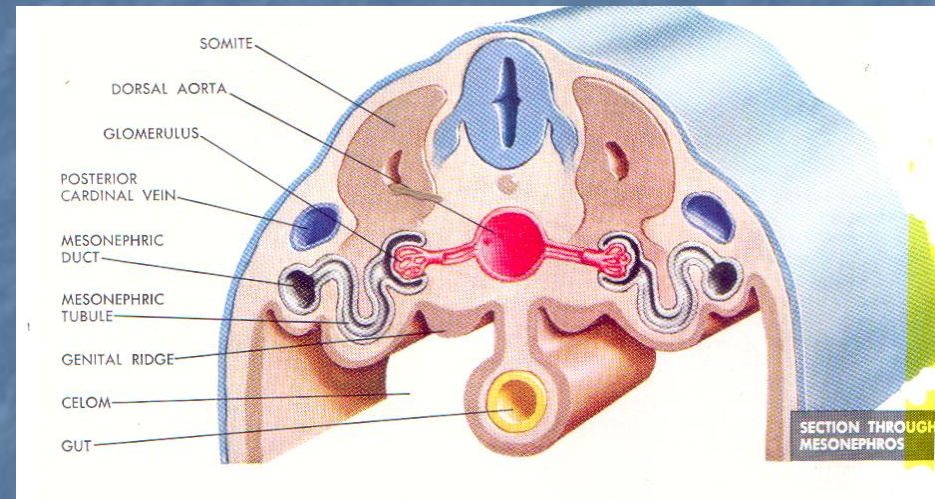
Nephrotome:
Mother tissue of pronephros
appears in 3rd week

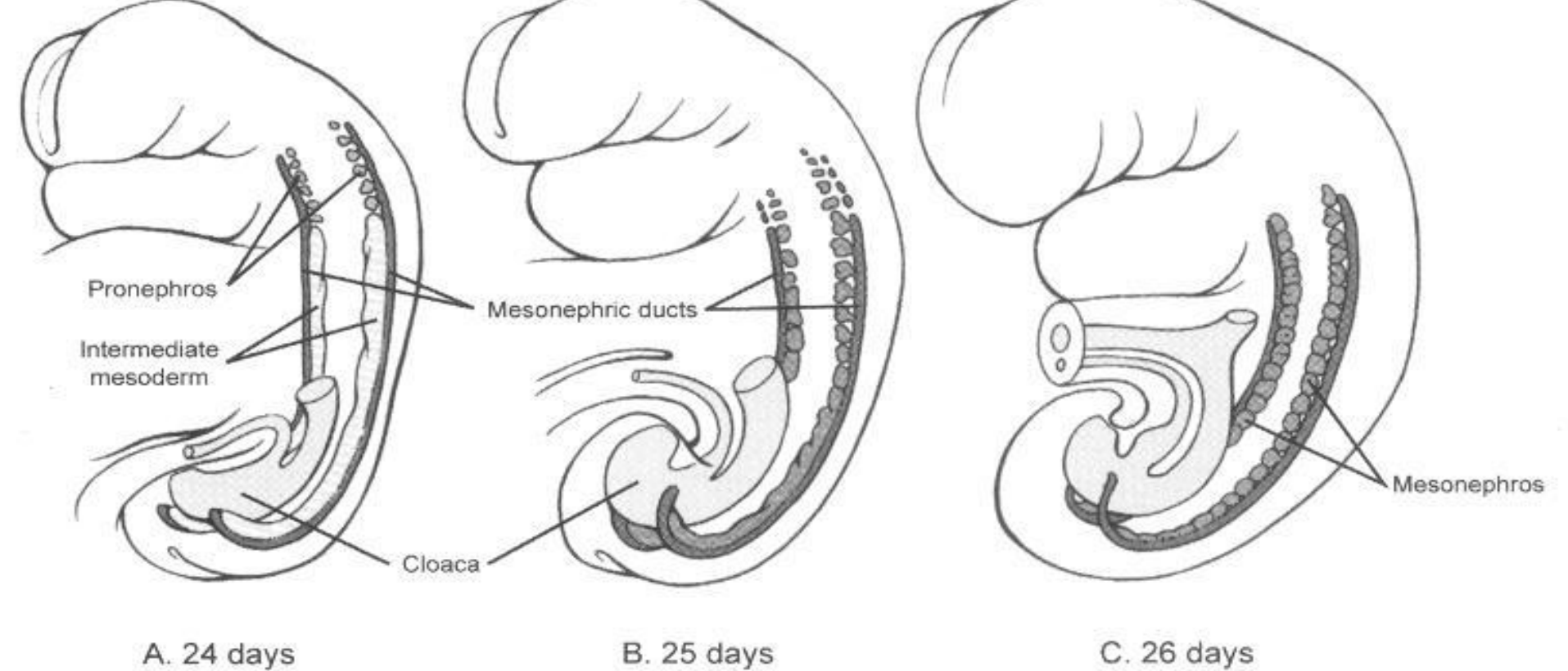


- Pronephros:
3rd week : Extends from 4th to 14th somite:
- Blood supply : Direct branch from aorta:
Pronephric Tubule (7) Pairs (6 to 10)
Pronephric duct : Duct extends upto cloaca:
degenerates
Appears in all vertebrate: vestigial absort
Lamprey: Permanent Kidney: 4 pairs No Glomerular
Mature excretory organ of higher fist.



- Mesonephros:
- Replaces the Pronephros
- Higher fishes, amphibian final excretory organ
- 4th week to 2 months.
Fuse with Mesonephric duct: Wolfian





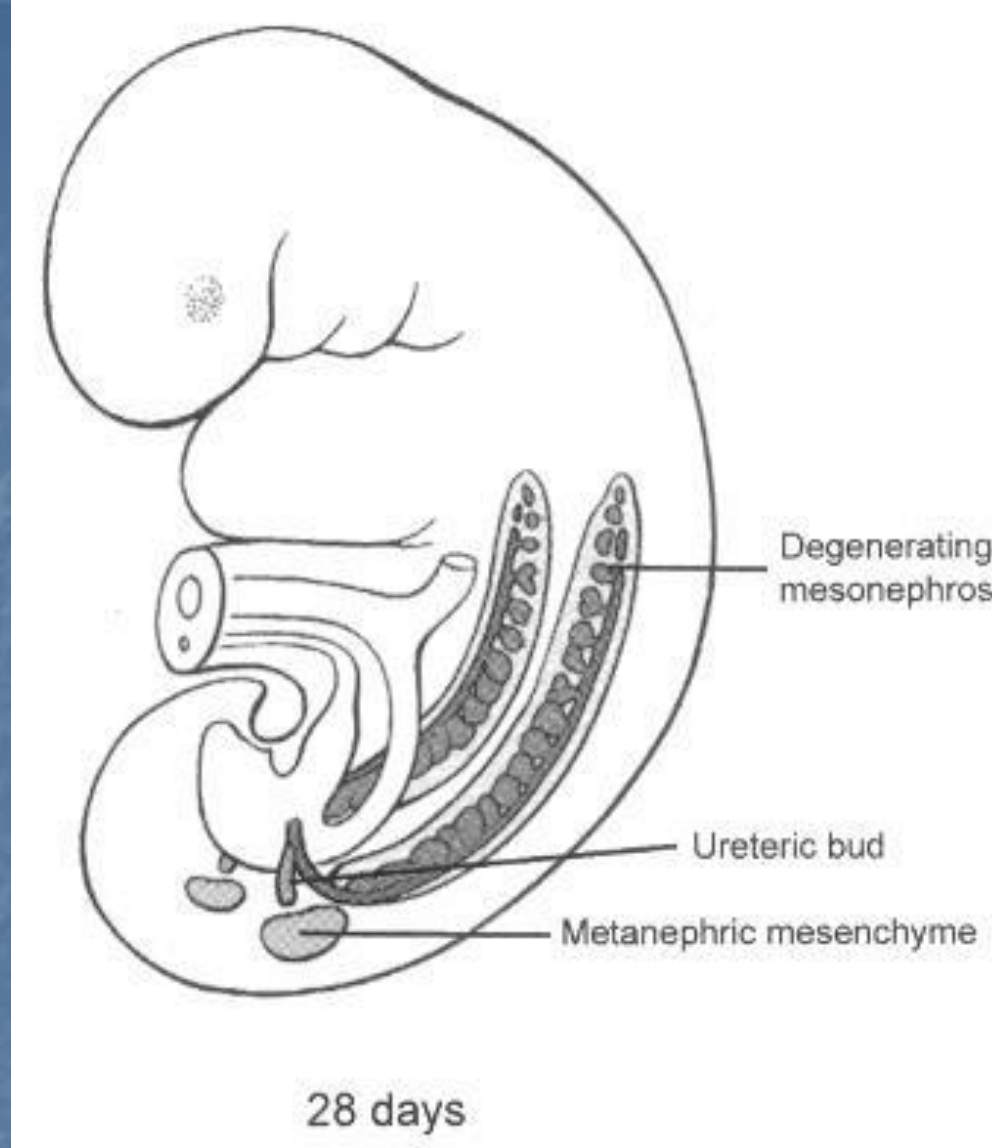
Development of pronephros and mesonephros.

A, Pronephroi develop in each of five to seven cervical segments, but these primitive renal structures degenerate quickly during the 4th week. The mesonephric ducts first appear on day 24.

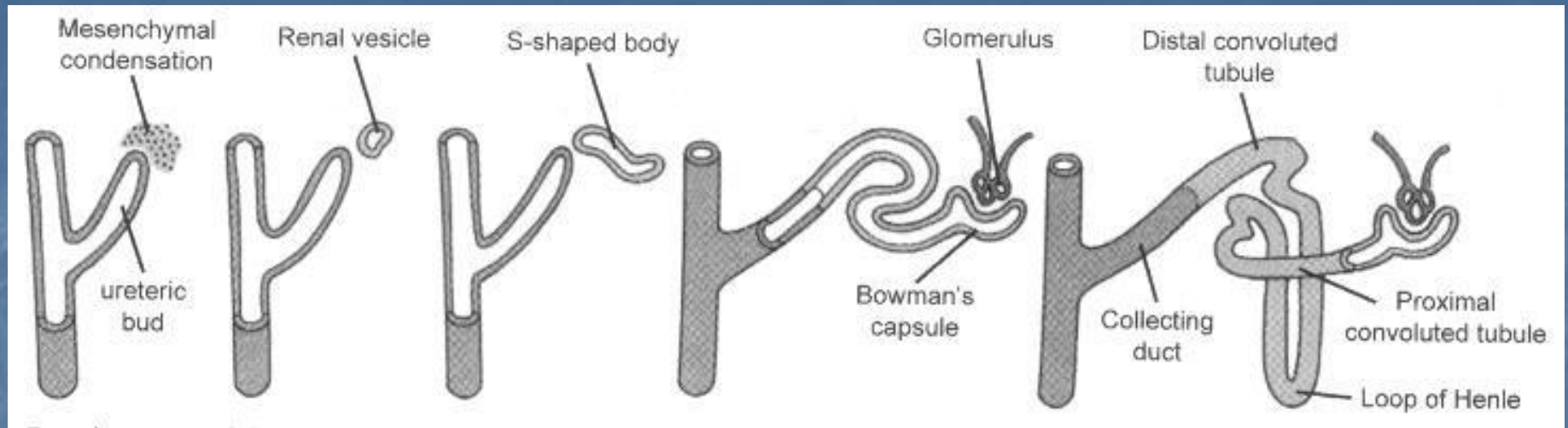
B and *C*, Mesonephric vesicles and tubules form in a craniocaudal direction throughout the thoracic and lumbar regions. The cranial pairs degenerate as caudal pairs develop, and the definitive mesonephroi contain about 20 pairs confined to the first three lumbar segments

Metanephros:

- Metanephros:
- Two components
 - Ureteric bud :starts in the vicinity of Wolfian duct opening in to cloaca
- Metanephric cap
 - Mesenchymal condensation around the Ureteric bud : Differentiates into Nephrons



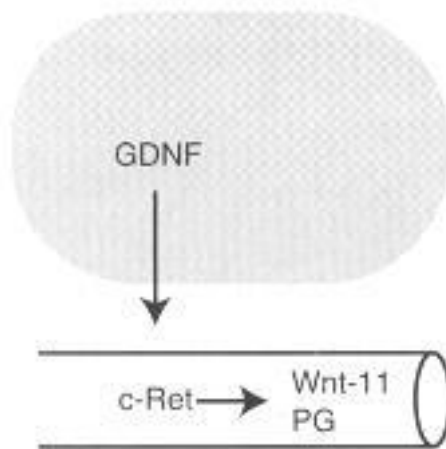
The ureteric bud divides to form enlarged tips, called ampullae, around which the metanephric mesenchyme condenses and begins nephron differentiation



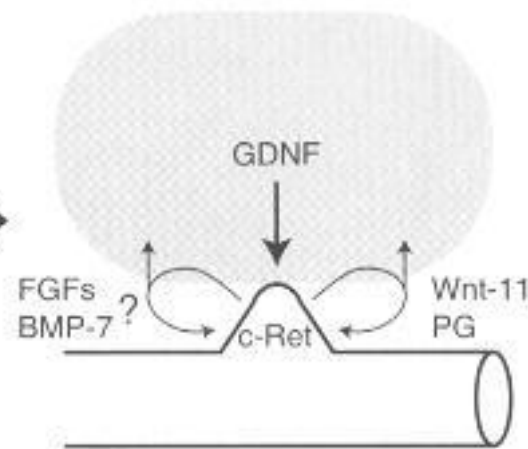
- Development of the renal collecting ducts and nephrons. The tip of dividing ureteric bud induces the metanephric mesenchyme to condense; it then differentiates into a renal vesicle. This vesicle coils into an S-shaped tubule and ultimately forms Bowman's capsule as well as the proximal convoluted tubules, distal convoluted tubules, and loops of Henle. The ureteric bud contributes to the formation of collecting ducts

A. Ureter Induction

a. Initiation

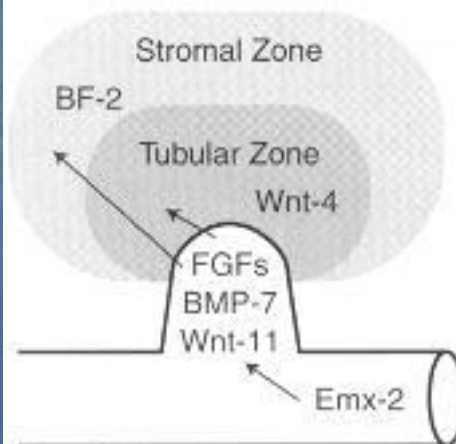


b. Growth & Differentiation

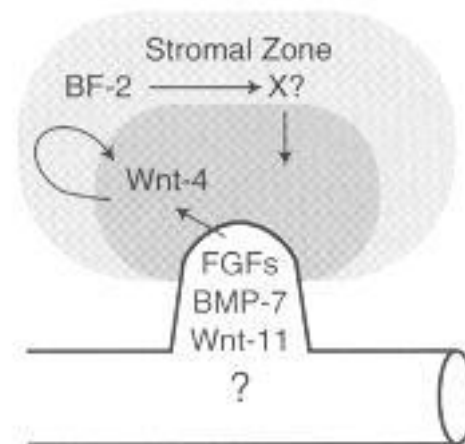


B. Tubule Induction

a. Patterning



b. Tubulogenesis



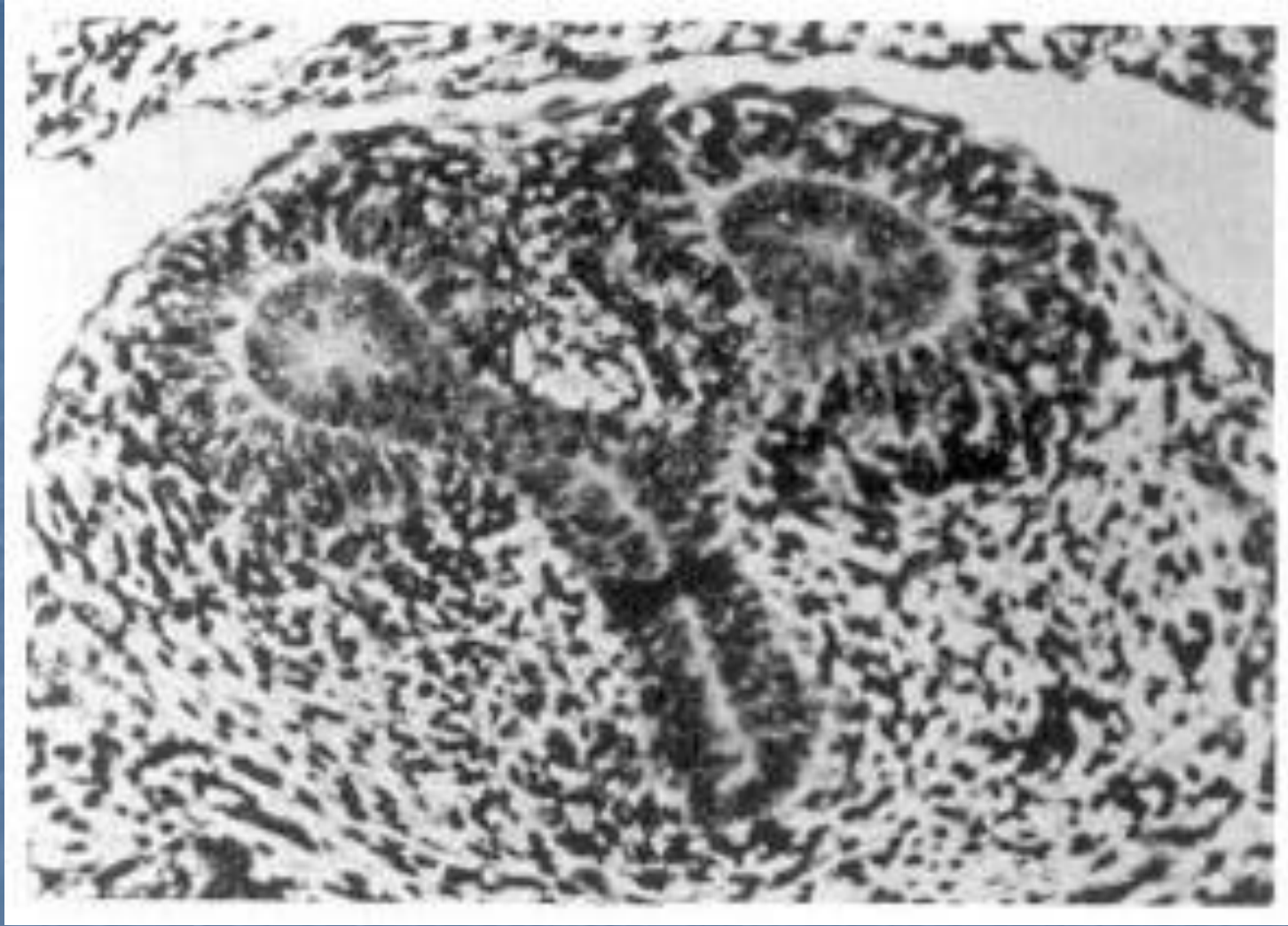
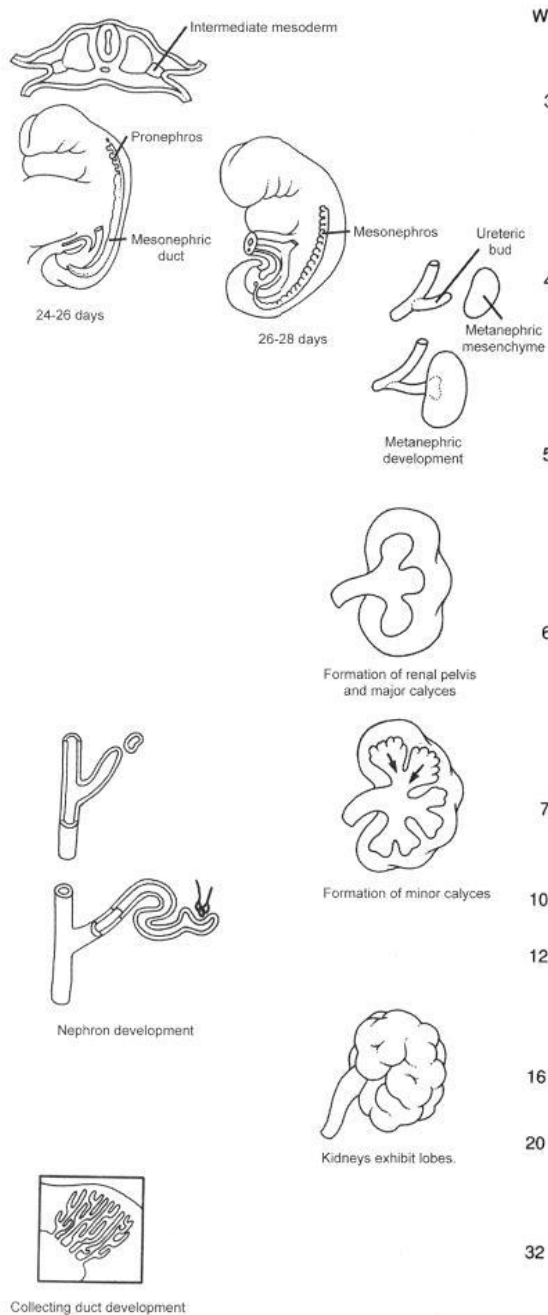


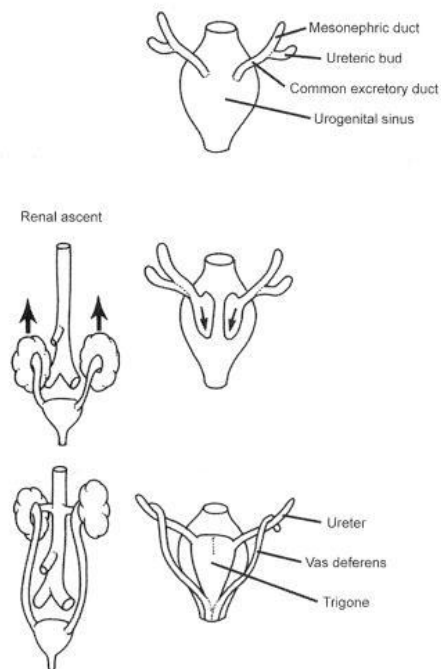
Figure 49-4 Metanephric mesenchyme condenses from the intermediate mesoderm during the early part of the 5th week and comes into contact with the ureteric bud, while the cranial mesonephroi continue to degenerate

Phases in development of kidney

- Period I(5th to 14th wk):
 - Primitive calyx. Pevis- Collecting tubules
- Period II(15th to 22nd wk):
 - Pronephros- consical
- Period III(22nd to 36wk):
 - Mesonephric: Th Lumber
- Period IV(32nd to 36wks)
 - Metanephros

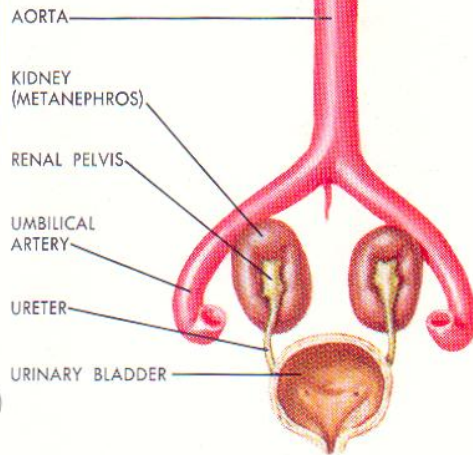


A. Kidney development

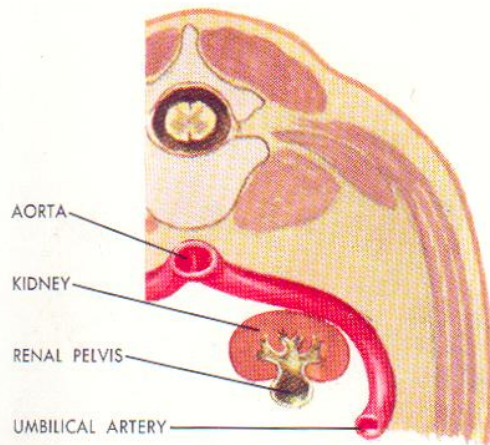


B. Ureter and bladder development

6 WEEKS

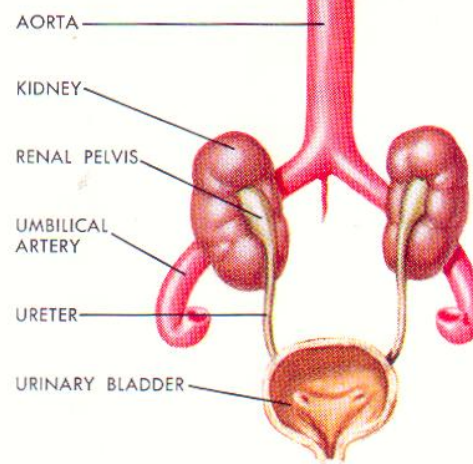


FRONTAL VIEW

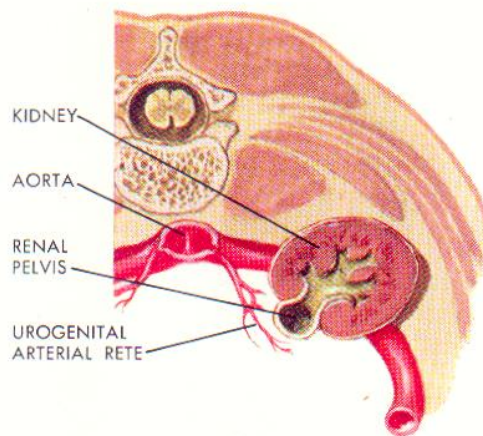


CROSS SECTION

7 WEEKS

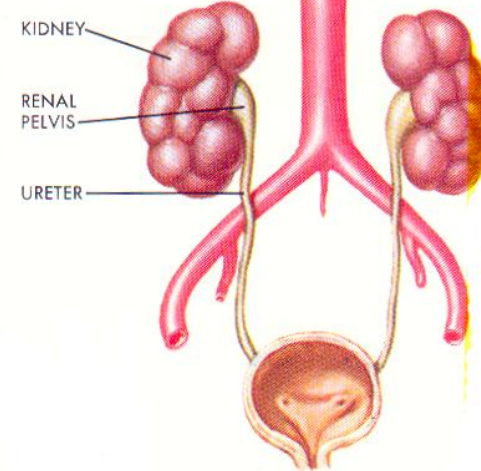


FRONTAL VIEW

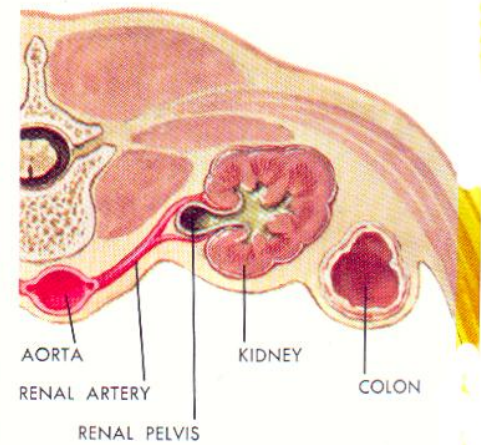


CROSS SECTION

9 WEEKS



FRONTAL VIEW



CROSS SECTION

Ascent of Kidney

DEVELOPMENT OF URINARY SYSTEM

Development of Renal Artery

- Dorsal aorta:

Intestine

Ventral

Intermediate Mesoderm: Lateral

Body wall & spine: Dorso lat.

- Lateral: Well developed in areas of Intermediate Mesonephros

Lateral Plexus

Curvature of spine

Vascular

size of Metanephros

Involutes : Single artery

Persist : Multiple

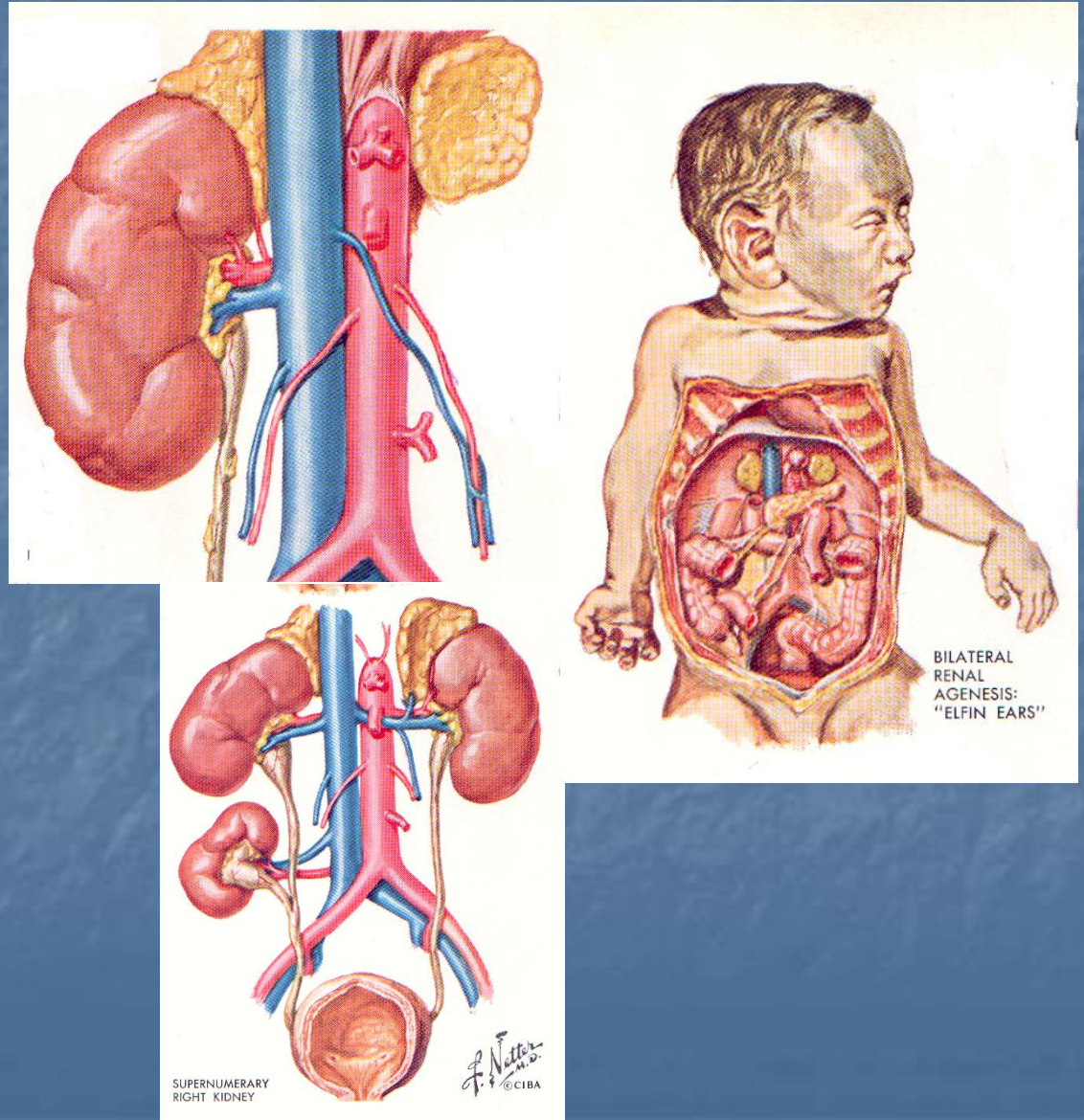
Congenital Anomalies of Kidney

- **Anomalies of number**
- **Anomalies of volume and structure**
- **Anomalies of ascent**
- **Anomalies of form and fusion**
- **Anomalies of rotation**
- **Anomalies of renal vasculature**
- **Anomalies of the collecting system**

Congenital Anomalies of Kidney

Anomalies of number

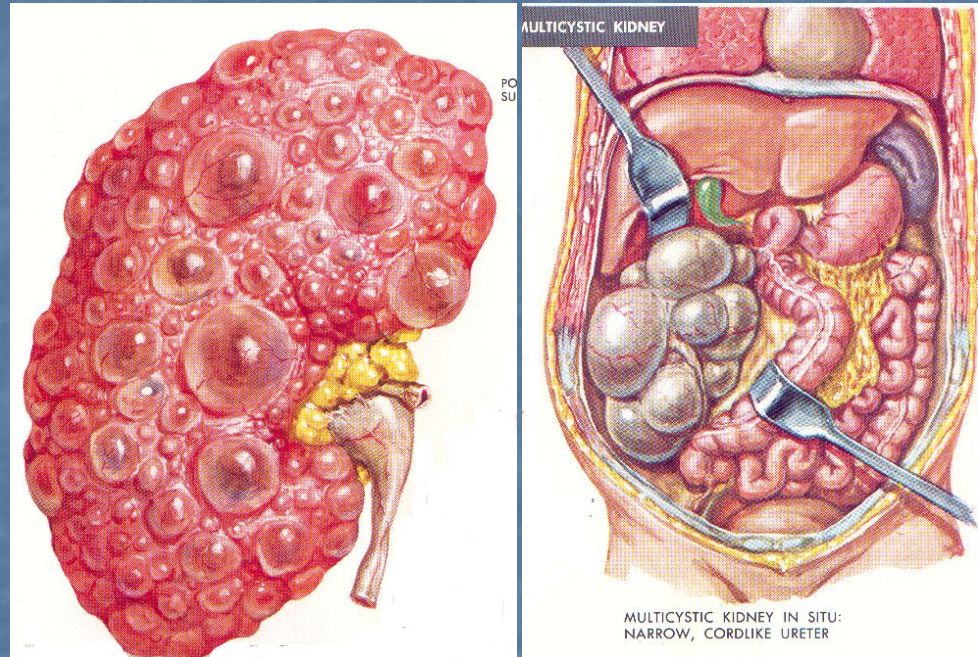
- Agensis
 1. Bilateral
 2. Unilateral
- Supernumerary kidney



Congenital Anomalies of Kidney

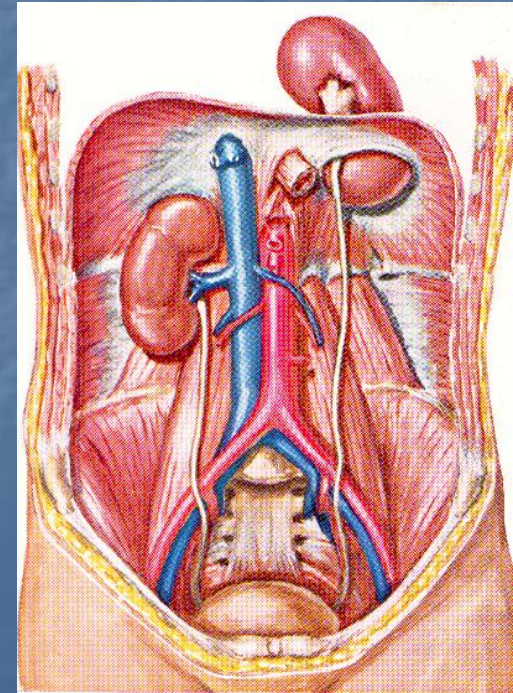
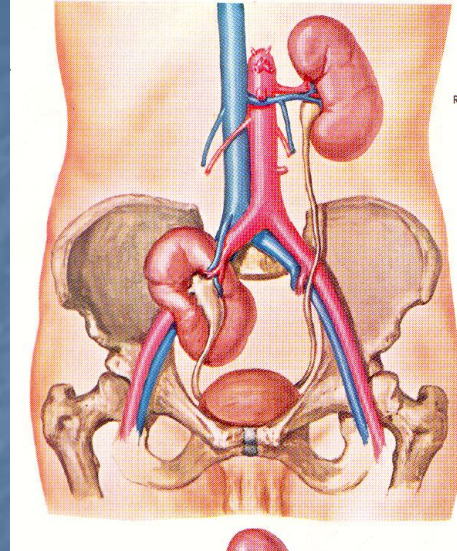
Anomalies of volume and structure

- Hypoplasia
- Multicystic kidney
- Polycystic kidney Infantile
- Polycystic kidney Adult
- Other cystic disease
 - Solitary cyst of Kidney
- Medullary cystic disease



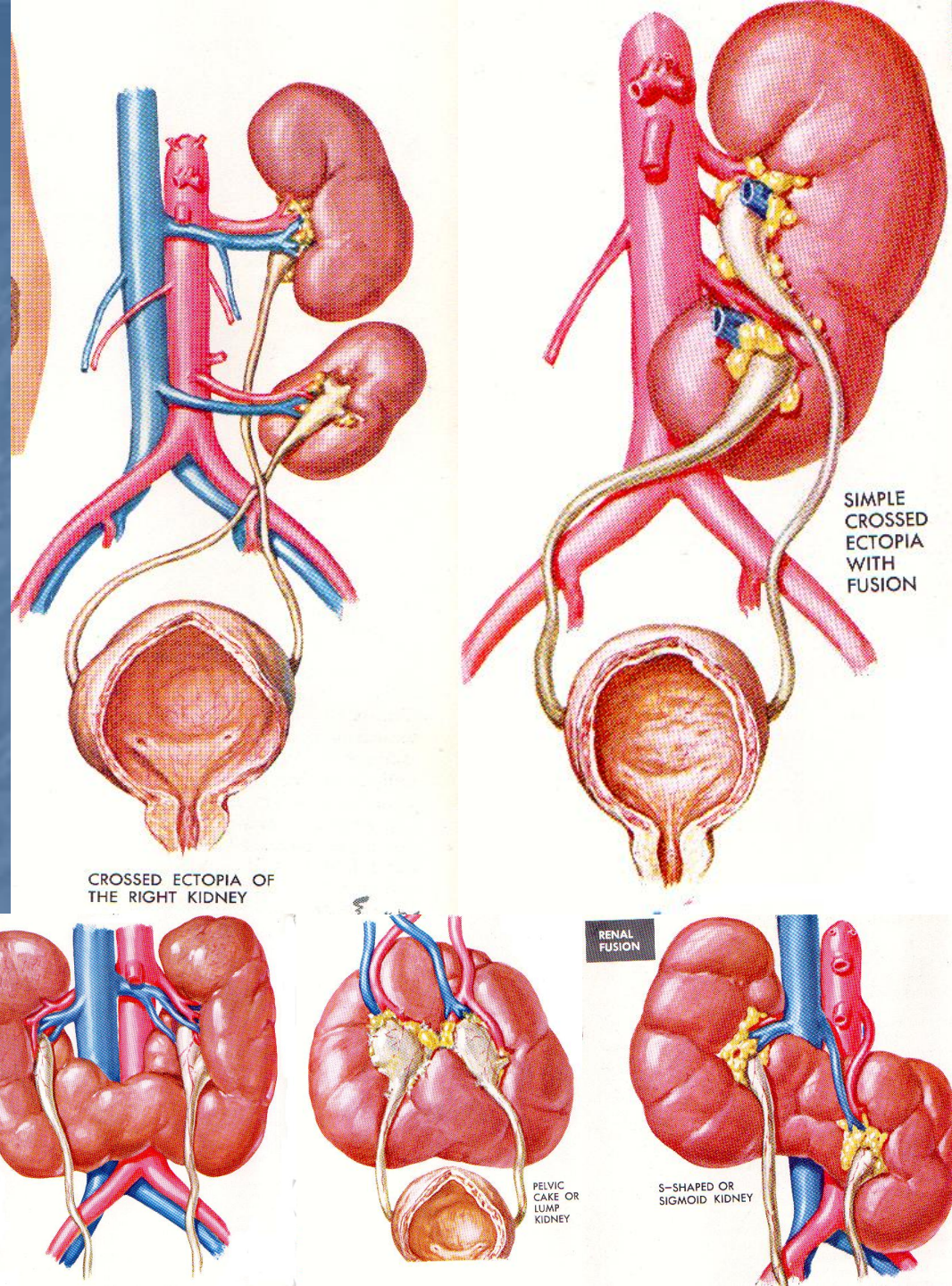
Anomalies of ascent

- Simple ectopia
- Cephalad ectopia
- Thoracic kidney

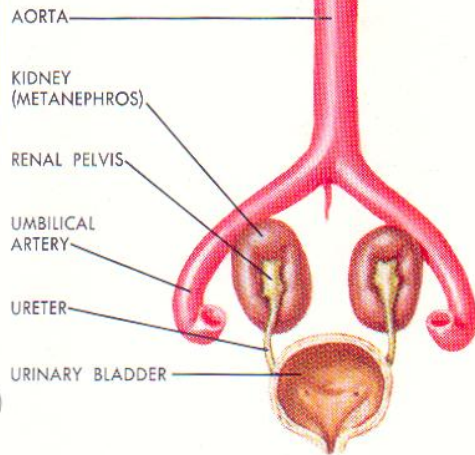


Anomalies of form and fusion

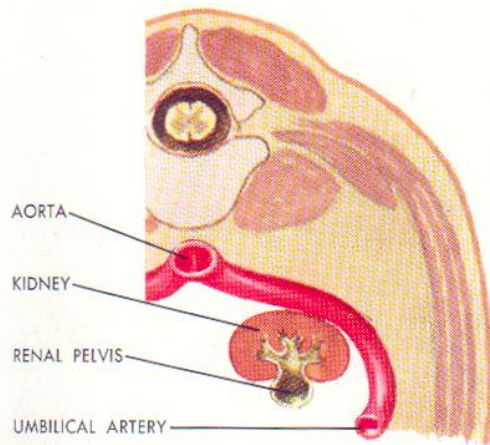
- Crossed ectopia with and without fusion
 - Unilateral fused kidney (inferior ectopia)
 - Sigmoid or S-shaped kidney
 - Lump kidney
 - L-shaped kidney
 - Disc kidney
 - Unilateral fused kidney (superior ectopia)
- Horseshoe kidney



6 WEEKS

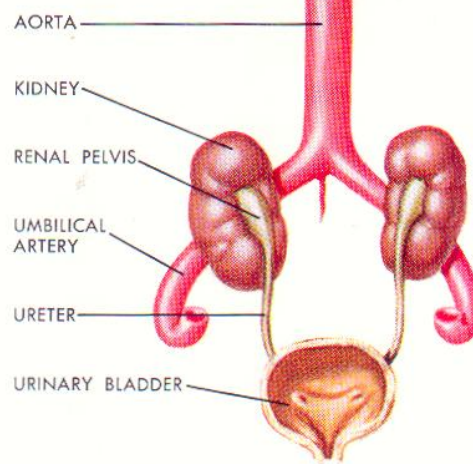


FRONTAL VIEW

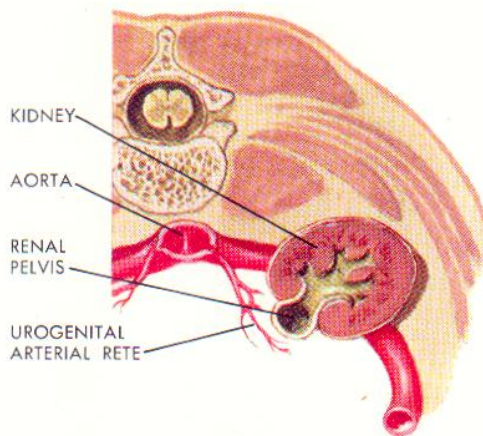


CROSS SECTION

7 WEEKS

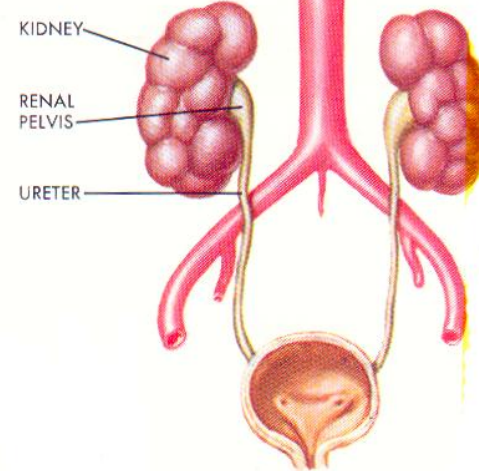


FRONTAL VIEW

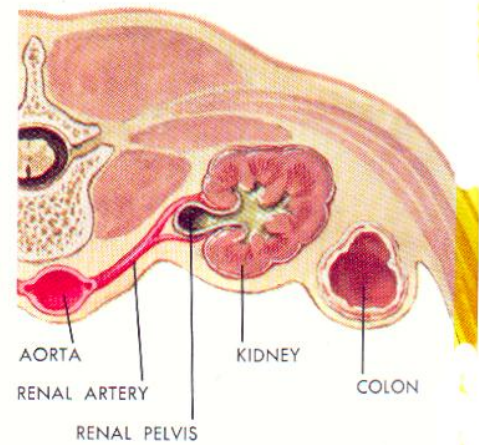


CROSS SECTION

9 WEEKS



FRONTAL VIEW

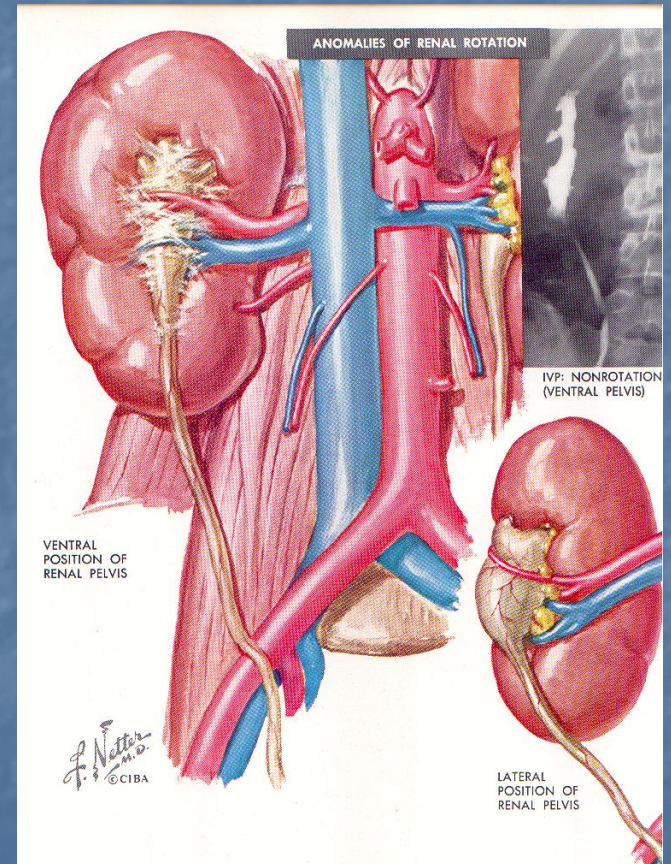


CROSS SECTION

Ascent of Kidney

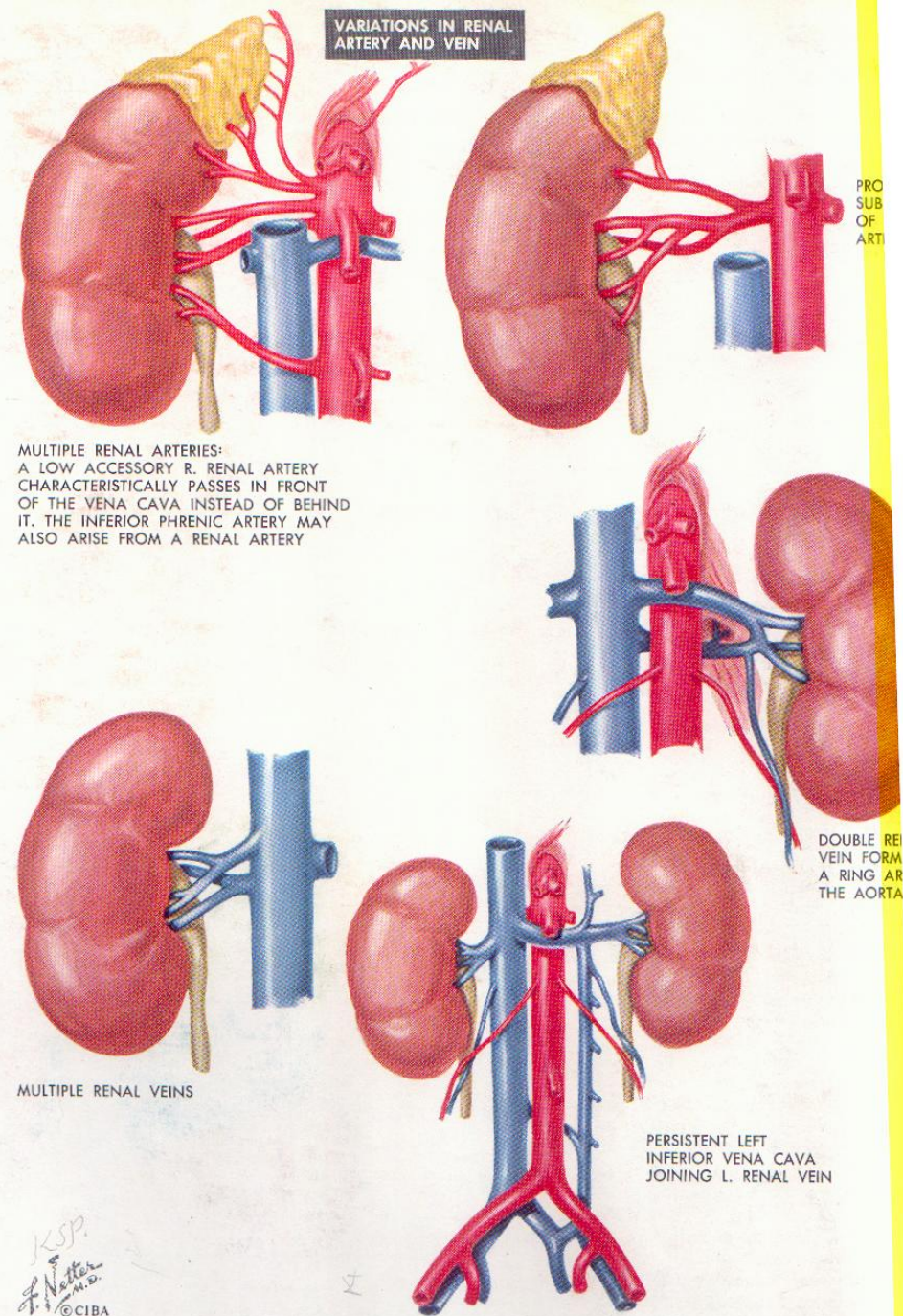
■ Anomalies of rotation

- Incomplete
- Excessive
- Reverse



Anomalies of renal vasculature

- Aberrant,
- accessory, or
- multiple vessels
- Renal artery aneurysm
- Arteriovenous fistula



Variations in Renal Artery

■ 1 Hilar artery:	71.1%
■ 1 HA + Upper Polar Br.:	12%
■ Two hilar artery	10.8%
■ 1HA +Upper Polar Artery:	6.2%
■ 1HA+ Lower Polar	3.1%
■ 3HA	1.7%
■ 2HA+UPB	2.7%

■ **Anomalies of the collecting system**

■ Calyx and infundibulum

- Calyceal diverticulum
- Hydrocalyx
- Megacalycosis
- Infundibulopelvic dysgenesis

■ Pelvis

- Extrarenal pelvis
- Bifid pelvis

Congenital Anomalies of the Kidney and Urinary Tract

- The genetics of congenital kidney disorders is a broad field, but it is primarily defined by a spectrum known as **CAKUT** (Congenital Anomalies of the Kidney and Urinary Tract). These disorders result from disruptions in embryonic development, specifically during the interaction between the **ureteric bud** and the **metanephric mesenchyme**

. The CAKUT SpectrumCAKUT

- Renal Agenesis: Total absence of one or both kidneys.
- Renal Hypo dysplasia: Small, underdeveloped kidneys with fewer nephrons.
- Mult cystic Dysplastic Kidney (MCDK): The kidney is replaced by non-functioning cysts.
- Ureteric Defects: Such as vesicoureteral reflux (VUR) or ureteropelvic junction obstruction (UPJO)

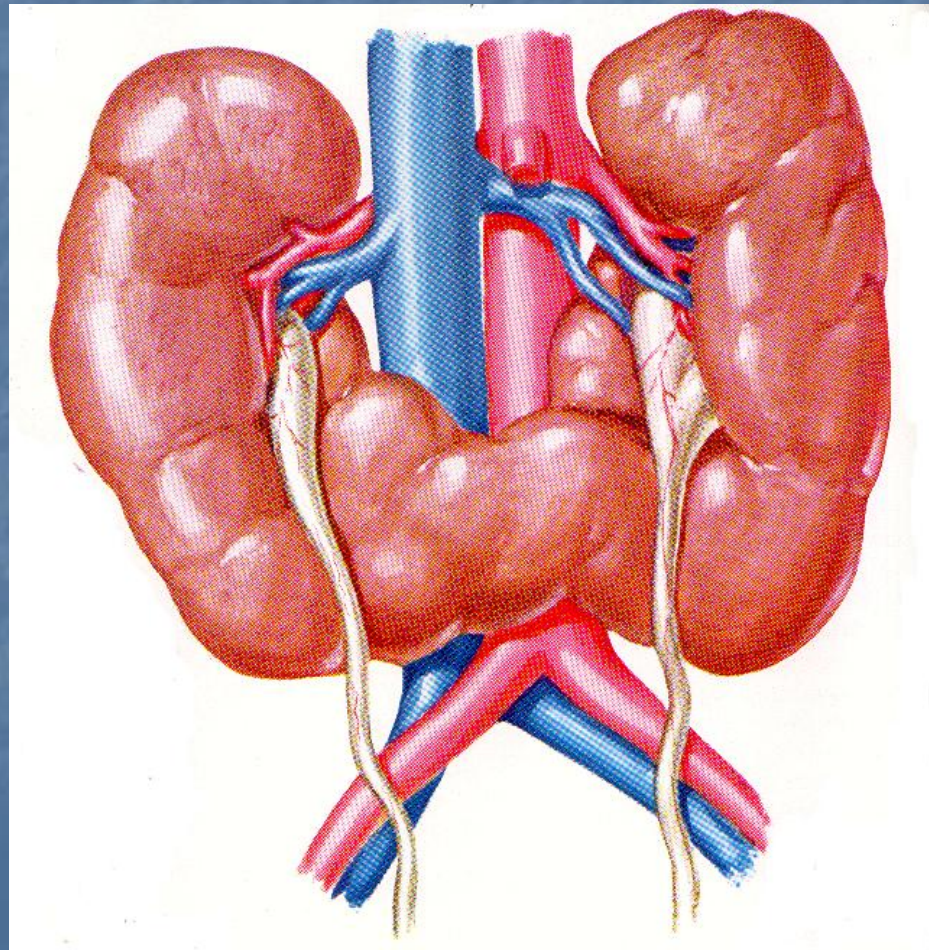
Researchers have identified over **50 genes** associated with CAKUT.
The most significant include

Gene	Role in Development	Associated Condition
HNF1B	Regulates gene expression in the ureteric bud.	Renal Cysts and Diabetes (RCAD) Syndrome; 17q12 deletion.
PAX2	Essential for the branching of the ureteric bud.	Renal-Coloboma Syndrome (affects kidneys and eyes).
EYA1 / SIX1	Involved in early signal exchange for kidney formation.	Branchio-Oto-Renal (BOR) Syndrome (affects ears, neck, and kidneys).
RET	A receptor crucial for the initiation of kidney growth.	Isolated renal agenesis or hypodysplasia.
SALL1	Transcription factor for kidney mesenchyme.	Townes-Brocks Syndrome.

Syndromic vs. Non-Syndromic

- Genetics differentiates these disorders into two main categories:
- Non-Syndromic (Isolated): The anomaly only affects the kidney or urinary tract. These are often harder to pin down to a single gene but may involve genes like PAX2 or BMP4.
- Syndromic: The kidney defect is part of a larger multi-organ syndrome.
- Examples: Fraser Syndrome (FRAS1 gene), Alagille Syndrome (JAG1 gene), and VACTERL association.

Horse Shoe Kidney



Renal Fusion

Horse Shoe Kidney

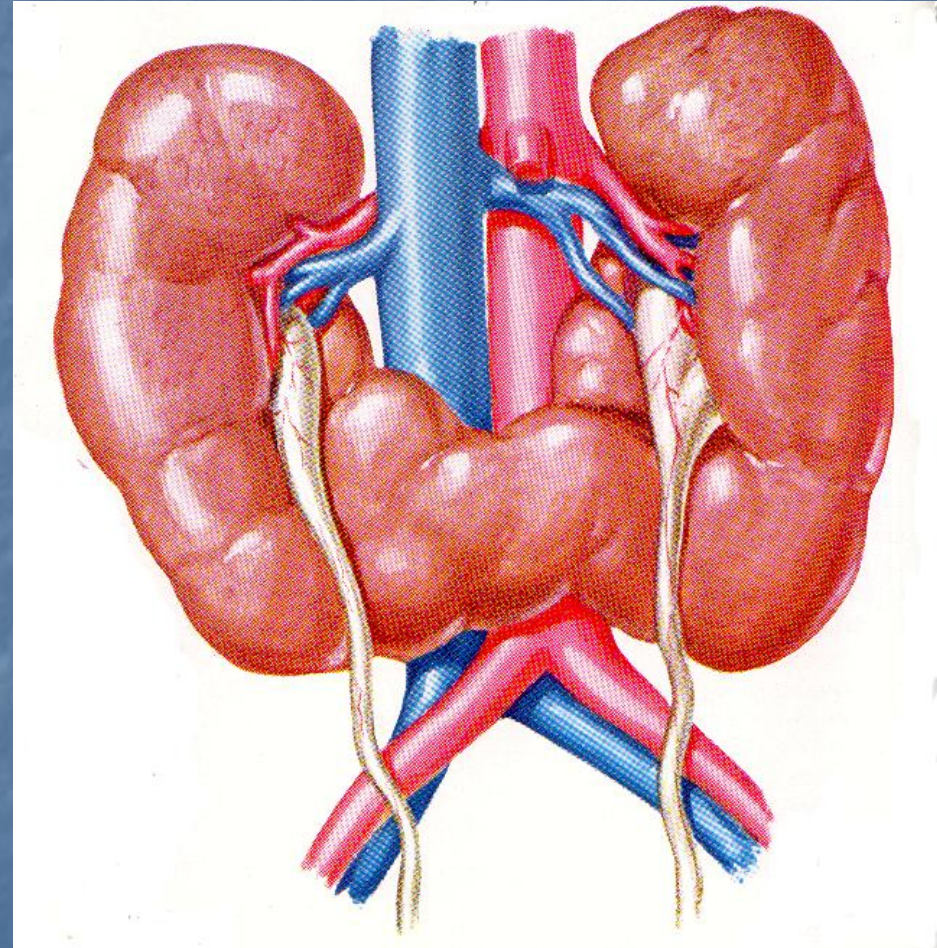
- Fused mass always contains
Two excretory System
- Incidence 1 in 1000
- Commonest Is Horse shoe Kidney

Etiology And Pathogenesis

- Fusion of 2 metanephros in Embryonic life
- Kidney in pelvis : Seldom ascend up to normal position
- Derive blood supply from Aorta or Iliac Artery
- Ectopia + Fusion
- 78% Extra urological Abnormality.
- 65% Other GUT abnormality

Pathology

- Early fusion :
- Normal rotation absent
Pelvis lies on Ant.Surface
- Ureter has to cross
Isthmus
or ant. surface of kidney
- Ureteric Compression:
Aberrant Artery
- Hydronephrosis, Infection,
- Vesico Ureteric Reflux



Clinical Findings

- **Symptoms:**

- Usually Silent,
- Ureteric Compression,
- Hydronephrosis, Infection, Urinary Stones
- Renodigestive Reflexes:
 - Peptic Ulcer, Gallstones, Appendicitis

- **Signs:**

- Usually no signs,
- Palpable mass

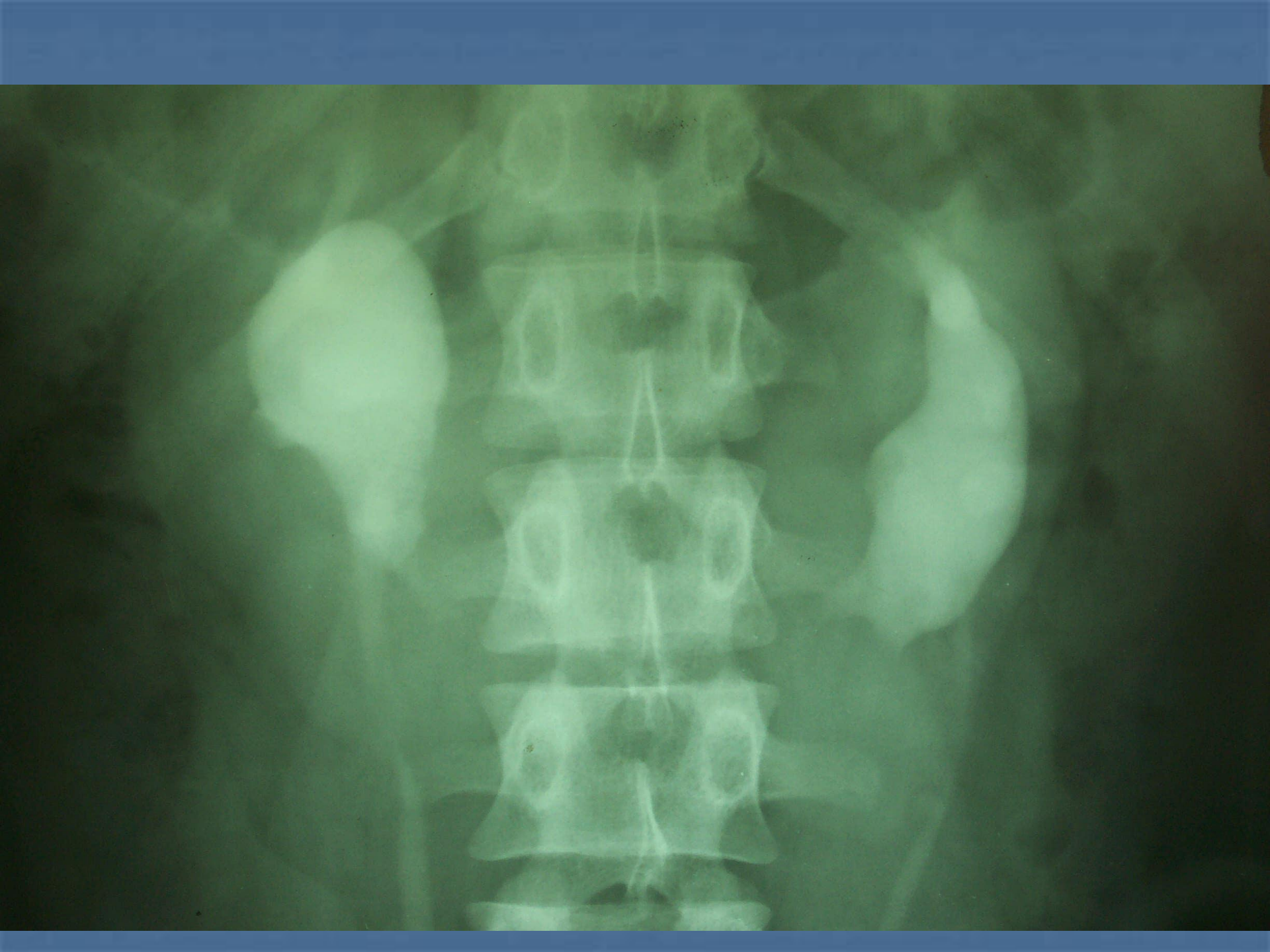
IVP: Horse shoe kidney



- Renal pelvis on anterior surface of kidney; Presence of renal pelvis in the region of lower pole that points out medially and lie medial to ureter
- Cross renal ecopia : One ureter must cross midline









Treatment

- **No treatment in silent cases**
- **Treatment of infection if present**
- **Treatment of Urinary obstruction or Urinary stones**
- **Drainage may improve with division of Isthmus: Functioning renal tissue may be present in isthmus**

Surgical approaches for Horse shoe kidney

- **Tran abdominal approach**
- **Extra-peritoneal approach**
- **Laparoscopic Wedge resection**
- **Surgical procedure depending on pathology**