Jordan University
Faculty Of Medicine

Development of the Urinary System

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Development of The kidney

Dr Ahmed Salman

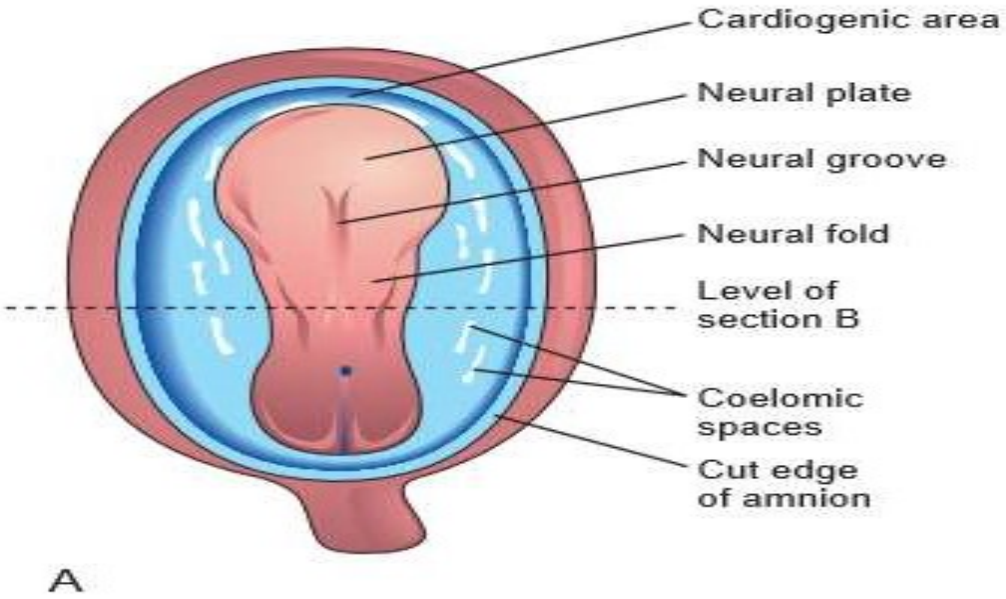
Development of the upper urinary system

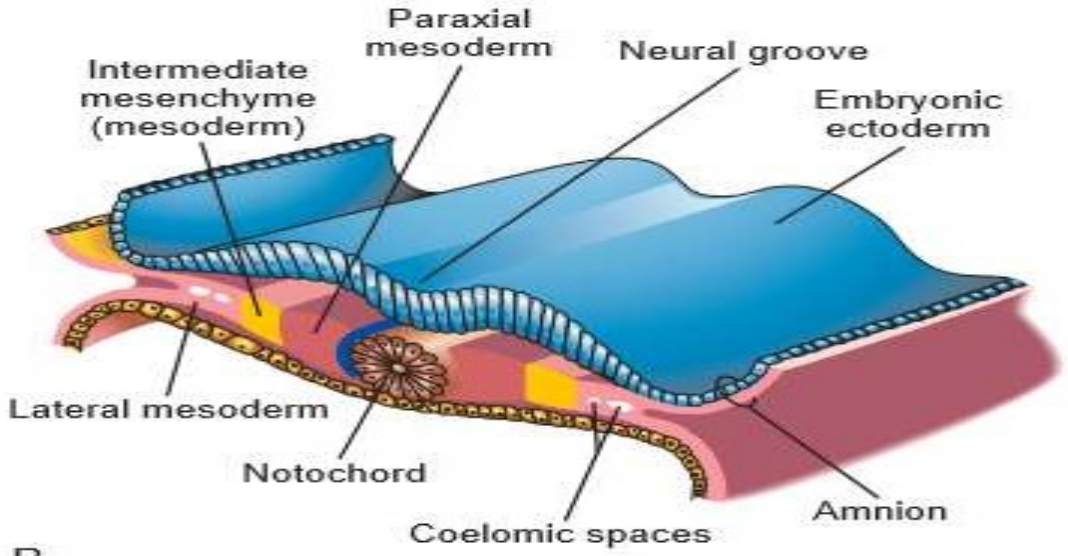
It is developed from the intraembryonic intermediate mesoderm.

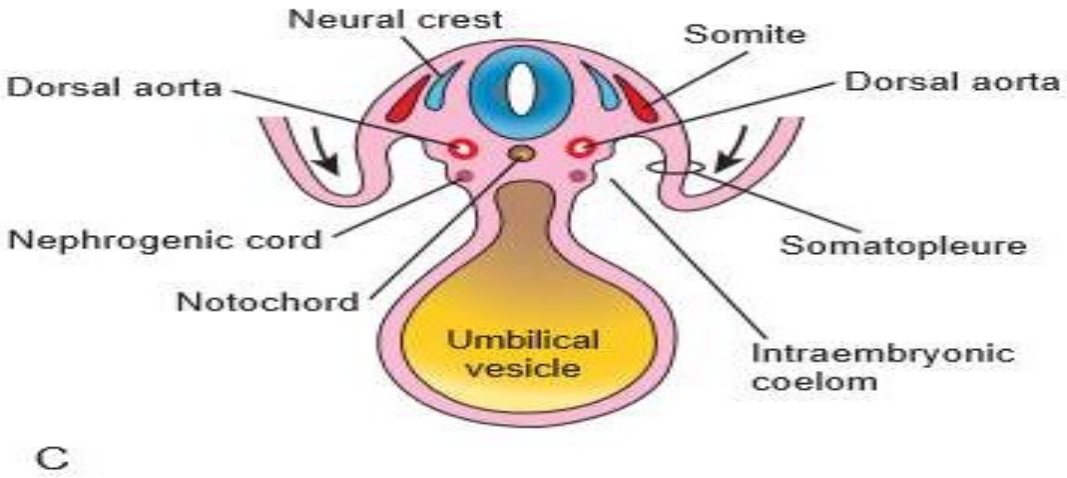
- After folding of the embryo, this mesoderm lies behind the intraembryonic coelom on each side of the descending aorta.

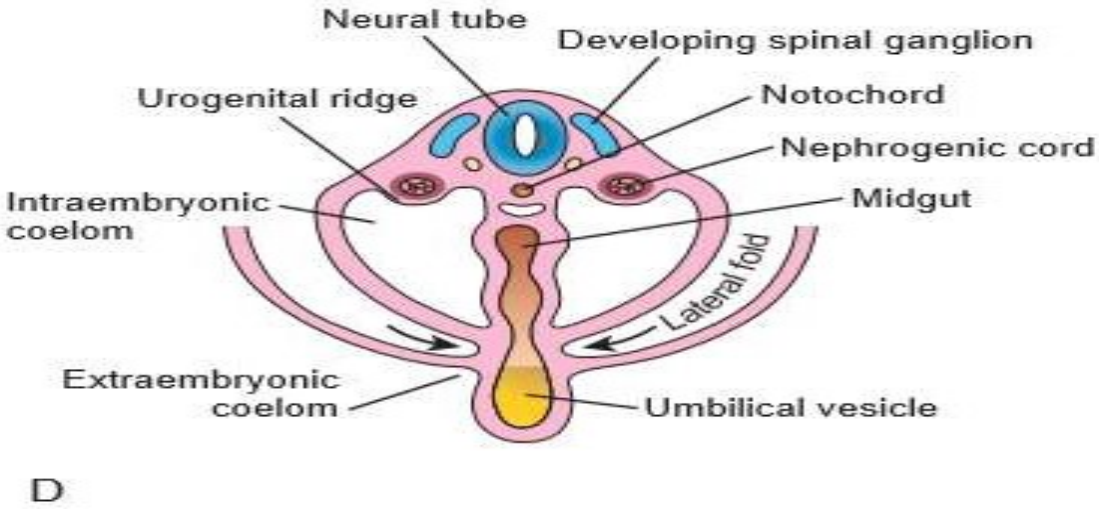
- The kidney development passes in ***three*** successive stages :

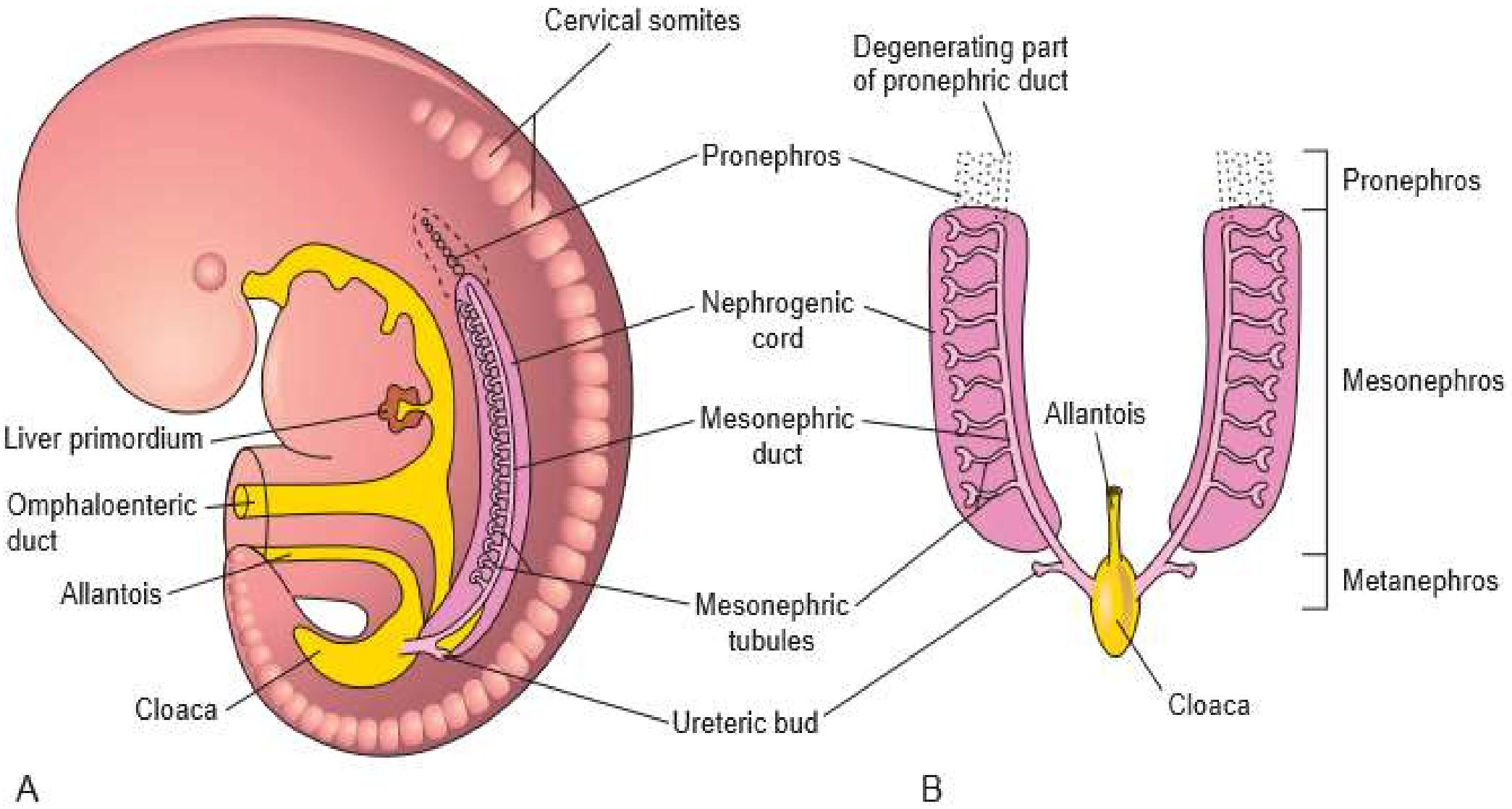
1. Pronephros.
2. Mesonephros.
3. Metanephros.


Cardiogenic area
Neural plate
Neural groove
Neural fold
Level of section B
Coelomic spaces
Cut edge of amnion
A


Paraxial mesoderm
Neural groove
Intermediate mesenchyme (mesoderm)
Embryonic ectoderm
Lateral mesoderm
Notochord
Amnion
Coelomic spaces
B


Neural crest
Somite
Dorsal aorta
Dorsal aorta
Nephrogenic cord
Somatopleure
Notochord
Umbilical vesicle
Intraembryonic coelom
C


Neural tube
Developing spinal ganglion
Urogenital ridge
Notochord
Nephrogenic cord
Intraembryonic coelom
Midgut
Lateral fold
Extraembryonic coelom
Umbilical vesicle
D


Cervical somites
Pronephros
Nephrogenic cord
Mesonephric duct
Liver primordium
Omphaloenteric duct
Allantois
Mesonephric tubules
Cloaca
Ureteric bud
A
Degenerating part of pronephric duct
Pronephros
Mesonephros
Metanephros
Allantois
Cloaca
B

The Pronephros

It develops from the intermediate mesoderm of the **cervical region** the embryo at **4th week**

- The intermediate mesoderm is segmented into 7 cell clusters called nephrotomes.
- The nephrotomes elongate and become canalized to form pronephros tubules.
- Each tubule has ***two*** ends:

• **Medial end** receives a capillary plexus from the adjacent aorta, forming an internal glomerulus

• **Lateral end** grows in a caudal direction and unites with the succeed tubules to form the pronephric duct, which descends to open in cloaca.

Fate of the pronephros:

- The pronephric tubules degenerate.
- The pronephric duct is transformed into the mesonephric duct, serves the second kidney

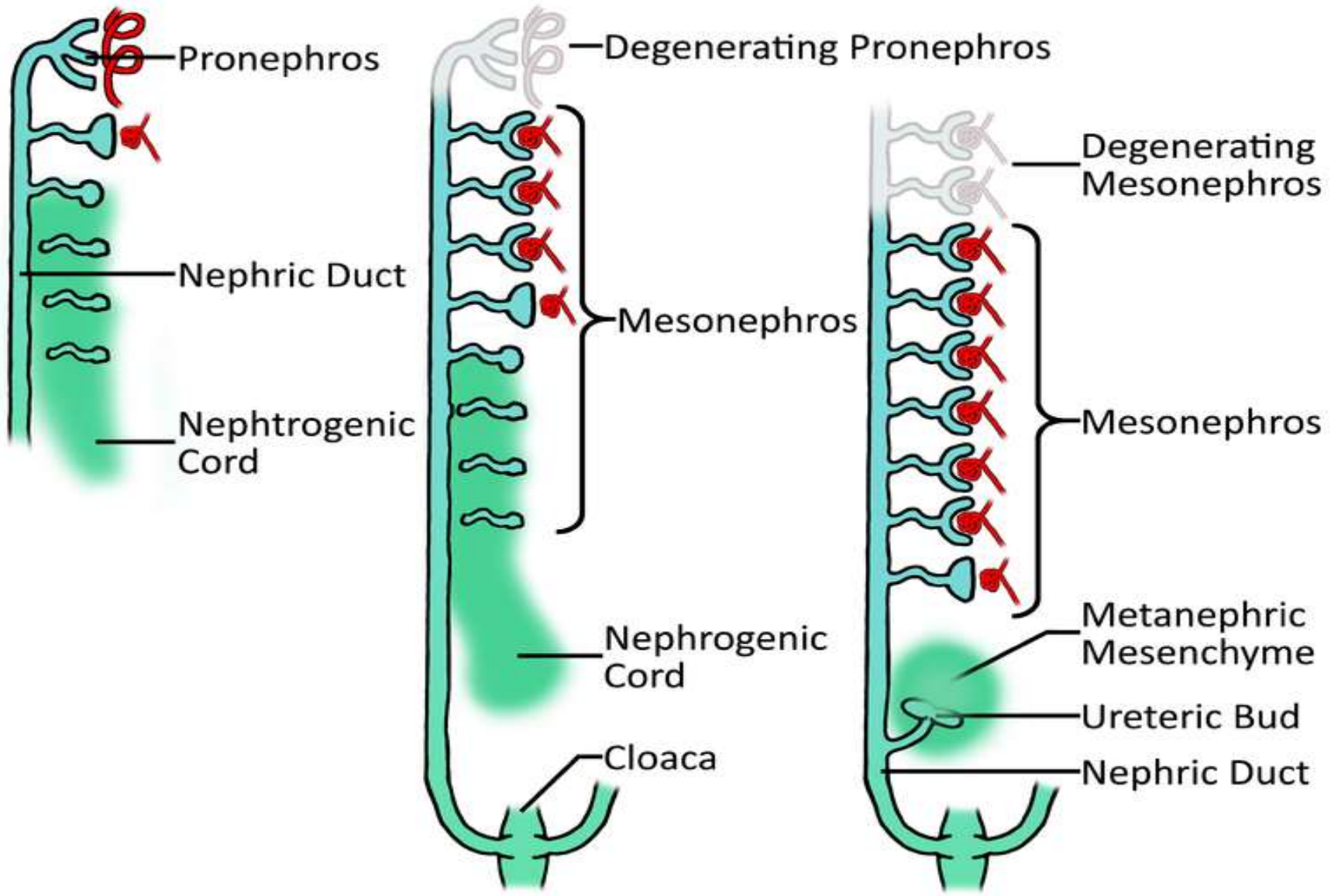
The mesonephros

It develops from the intermediate mesoderm of the **thoracic and upper lumbar** regions.

Development:

- The intermediate mesoderm is segmented into about 70 clusters.
- These clusters elongate and become canalized to form S- shaped mesonephric tubules.
- Each tubule has *two* ends:

- **Medial end** is invaginated by a capillary plexus to form a primitive glomerulus. Around the glomerulus the tubules form **Bowman's capsule**, and together these structures constitute a **renal corpuscle**
- **Lateral end** joins the mesonephric duct or **wolffian duct**


Pronephros
Nephric Duct
Nephtrogenic Cord
Degenerating Pronephros
Mesonephros
Nephrogenic Cord
Cloaca
Degenerating Mesonephros
Mesonephros
Metanephric Mesenchyme
Ureteric Bud
Nephric Duct

Fate of the mesonephros:

-The mesonephros degenerates and is replaced by the metanephros (permanent kidney).

- However, parts of the mesonephors persist to form urogenital structure which differ in male and female.

1. The mesonephric tubules form :

Male	Female
Efferent ductules of the testis Head of epididymis Paradidymis	Epoophorn paroophoron

2. Mesonephric ducts In the MALE form

Genital structures	Urinary structures
- Body and tail of epididymis and its appendix - Vas deferens - Seminal vesicle. - Ejaculatory duct	- Ureteric bud and its derivatives (ureter, renal pelvis, calyces and collecting tubules) - Trigone of the urinary bladder - Posterior wall of the supra collicular part of the prostatic urethra

2. Mesonephric ducts In the FEMALE form

Genital structures	Urinary structures
- Duct of epoophorn. - Gartner's duct.	- Ureteric bud and its derivatives (ureter, renal pelvis, calyces and collecting tubules). - Trigone of the urinary bladder. - The whole dorsal wall of the female urethra.

Metanephros

Site: in the **sacral** region **at 5th month** of development

It develops from ***two*** mesodermal structures, ureteric bud and Metanephric cap.

A. The ureteric bud.

It arises as a diverticulum from the lower part of the mesonephric duct near the cloaca.

The bud gives rise to the collecting system of urine:

- Ureter from its stem.
- Renal pelvis from its cranial end which divides to form 2 calyces which in turn divide to form 7-11 minor calyces.
- Collecting tubules.

B. Metanephric cap

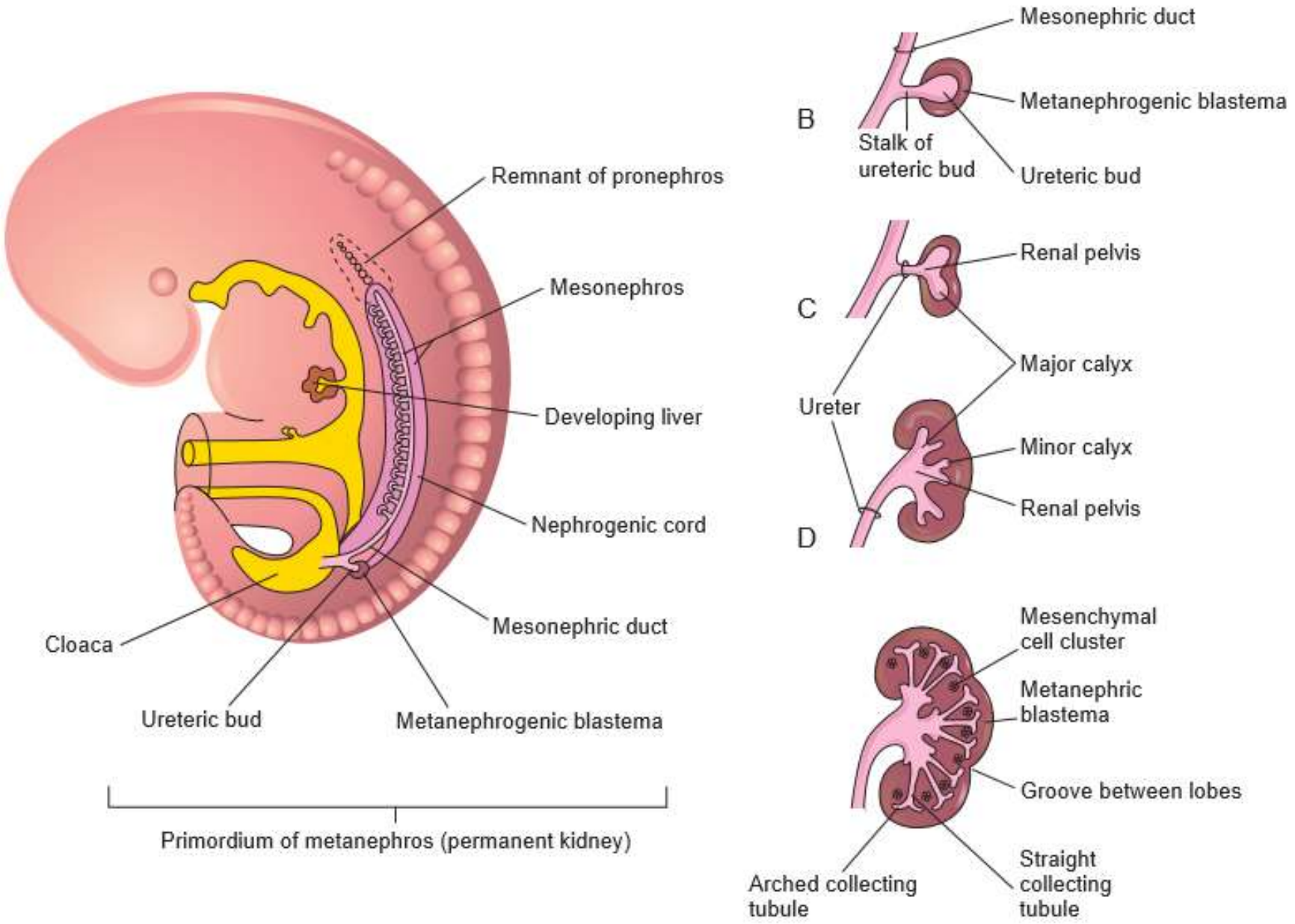
- It is the caudal part of the intermediate mesoderm.

- This mesoderm (is induced by the ureteric bud) to divide into thousands of cell clusters which lie close to the collecting tubules of the ureteric bud.

- The cell clusters elongate and become canalized to form renal vesicle which give rise to **nephrons**, which are the active excretory units of the kidney.

- Each nephron gives rise to:

- Bowman's capsule which receives an afferent arteriole to form glomerulus.
  The capsule and the glomerulus constitute together a renal corpuscle.
- Proximal convoluted tubule.
- Loop of Henle.
- Distal convoluted tubule, which joins a nearby collecting tubule to form a complete functional unit.


Remnant of pronephros
Mesonephros
Developing liver
Nephrogenic cord
Mesonephric duct
Cloaca
Ureteric bud
Metanephrogenic blastema
Primordium of metanephros (permanent kidney)
B
Mesonephric duct
Metanephrogenic blastema
Stalk of ureteric bud
Ureteric bud
C
Renal pelvis
Major calyx
Ureter
Minor calyx
Renal pelvis
D
Mesenchymal cell cluster
Metanephric blastema
Groove between lobes
Arched collecting tubule
Straight collecting tubule

Postnatal changes in the metanephros :

1. Change in shape: the fetal kidney is lobulated with irregular surface.

Lobulation disappears during early infancy.

2. Change in position and blood supply:

At first it is a pelvic organ, which receives its blood supply from the median sacral artery.

As it ascends into the abdomen, it changes its blood supply to be derived from the common iliac artery and finally from the abdominal aorta.

3. Change in direction: originally, the hilum of the kidney is directed ***anteriorly*** but with its ascent, the kidneys rotate medially almost 90 degrees the hilum rotates to face ***medially.***

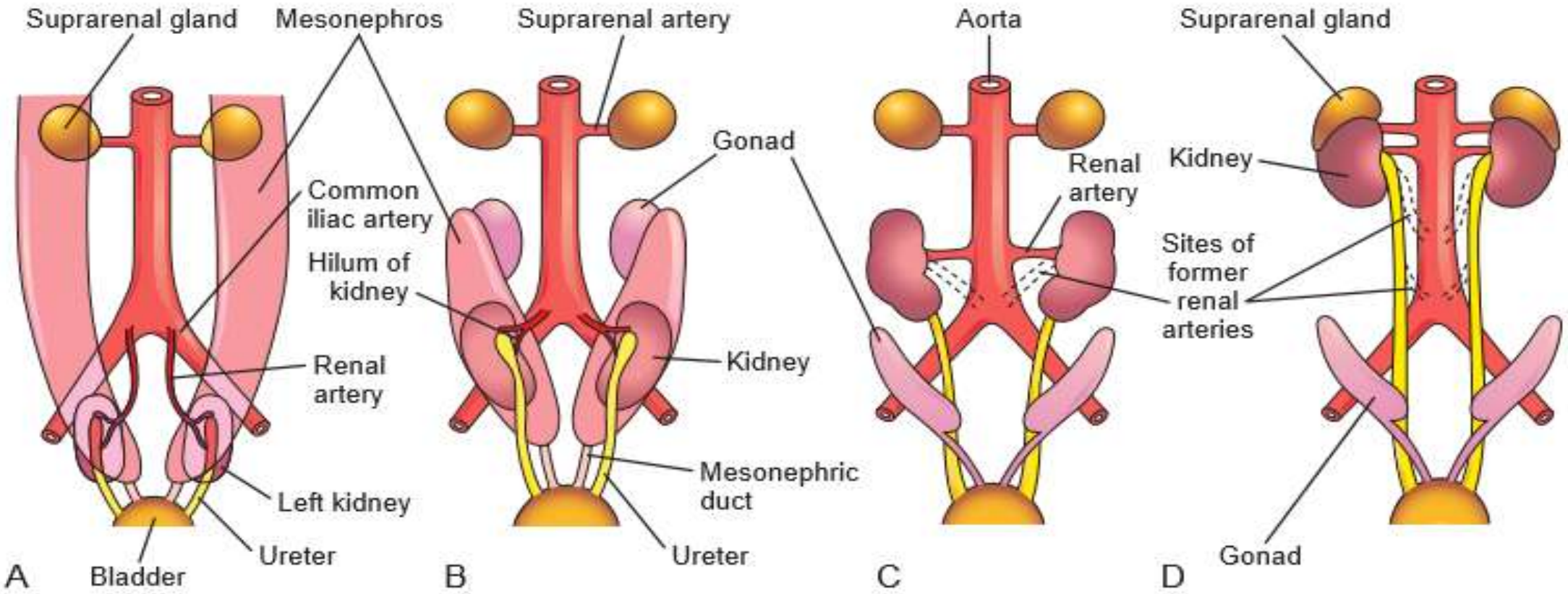


Figure 13–7 **A** to **D,** Diagrammatic ventral views of the abdominopelvic region of embryos and fetuses (sixth to ninth weeks), showing medial rotation and relocation of the kidneys from the pelvis to the abdomen. **C** and **D,** Note that, as the kidneys relocate (ascend), they are supplied by arteries at successively higher levels and that the hila of the kidneys (where the vessels and nerves enter) are directed anteromedially.

Congenital anomalies

1- Renal agenesis with absence of one or the two kidneys .

In this case the ureteric bud fails to induce the metanephric cap to divide

2. Congenital polycystic kidney

- Cysts form from collecting ducts
- kidney shows many cysts filled with urine

3. Ectopic kidney, **(Pelvic Kidney)** in which case it fails to ascend.

4. Horse - shoe kidney

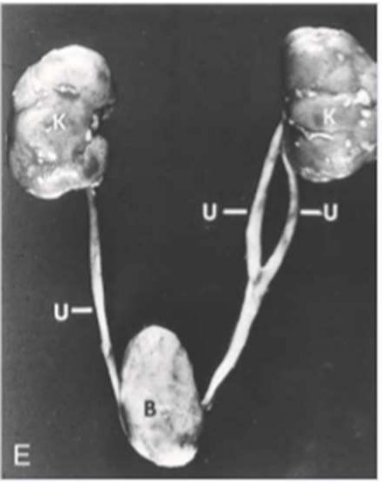
- Two kidneys are fused at their lower poles.
- Ascent of the kidneys is prevented by the origin of the inferior mesenteric artery.

5. Accessory renal artery: an additional artery may enter the upper or lower pole of the kidney.

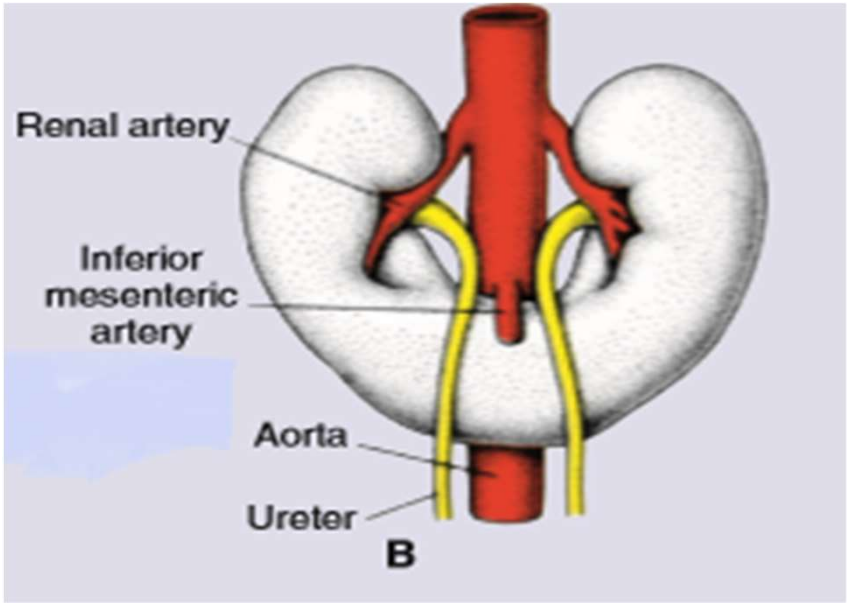
6. Bifid ureter is due to the bifurcation of the upper end of the ureteric bud with double renal pelvis.

7.Double ureter duplication of the urinary tract

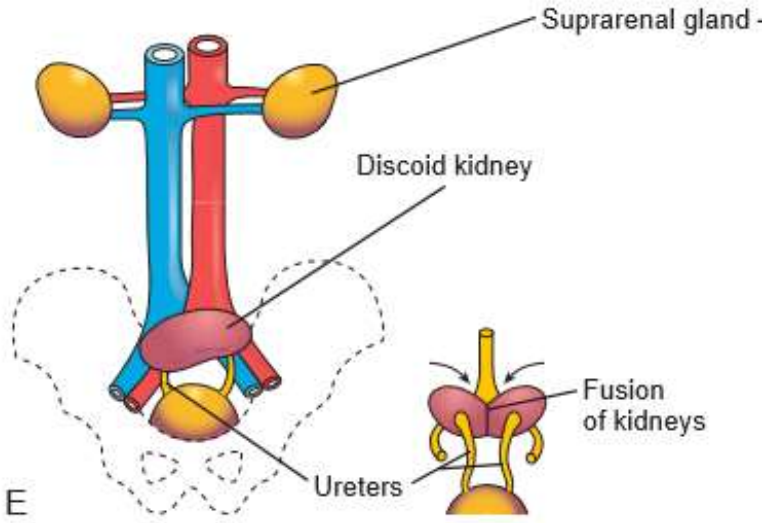
Occurs when the ureteric bud prematurely divides before penetrating the metanephric cup Results in either a double kidney or duplicated ureter and renal pelvis



Bifid ureter

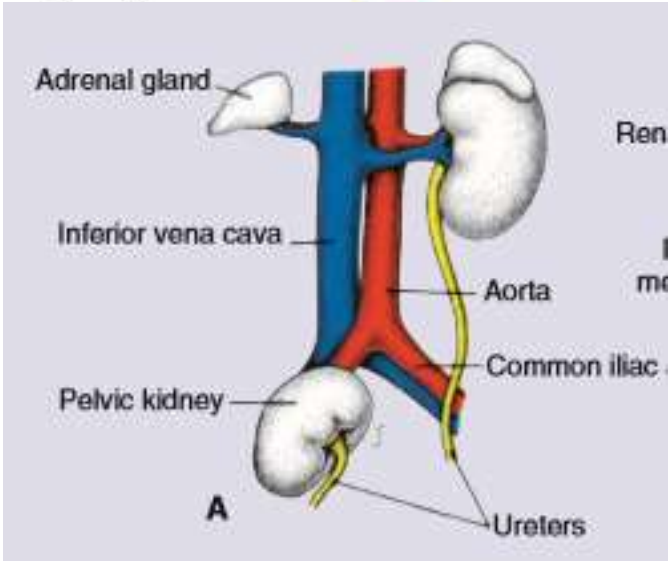


Horseshoe kidney



duplication of the urinary tract

Congenital polycystic kidney



Development of the urinary bladder

Dr Ahmed Salman

A. Development of the cloaca:

- The cloaca is a dilatation lined by endoderm at the terminal part of the Hindgut.

- The cloaca is

- Ventrally it is continuous with the allantois.
- Its sides receive the mesonephric ducts.
- Caudally it is closed by cloacal membrane.

- A mesodermal urorectal septum descends between the allantois and hindgut to reach the cloacal membrane.

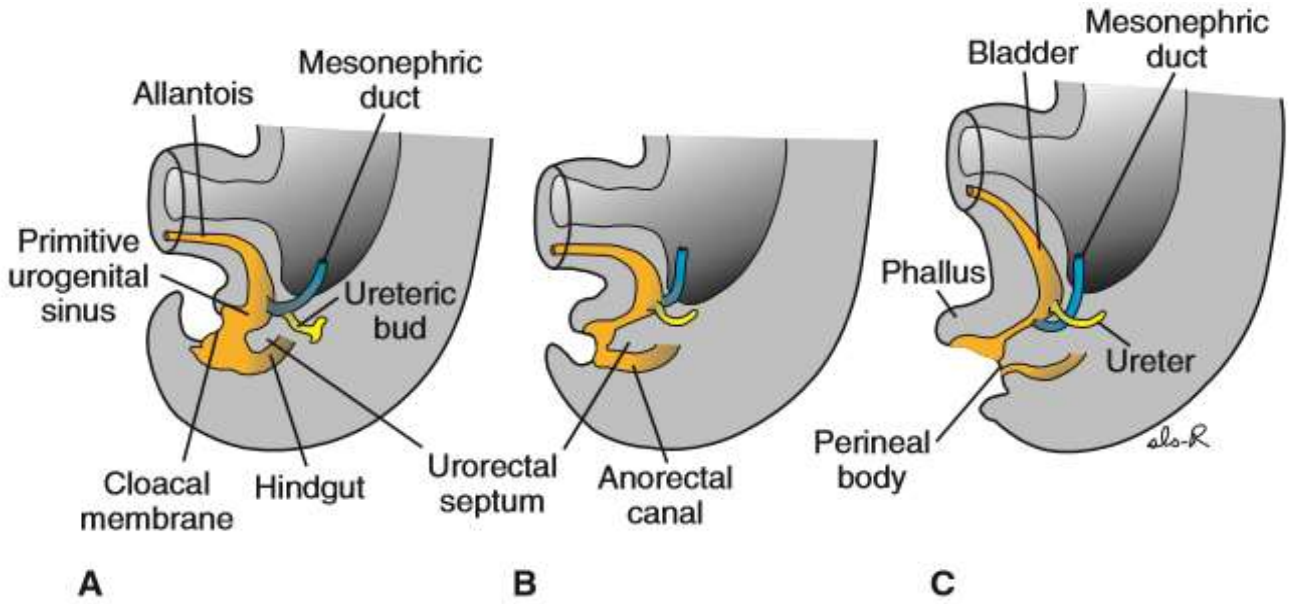
The remnant of urorectal septum is perineal body and recto vesical fascia (Denonvilliers' fascia)

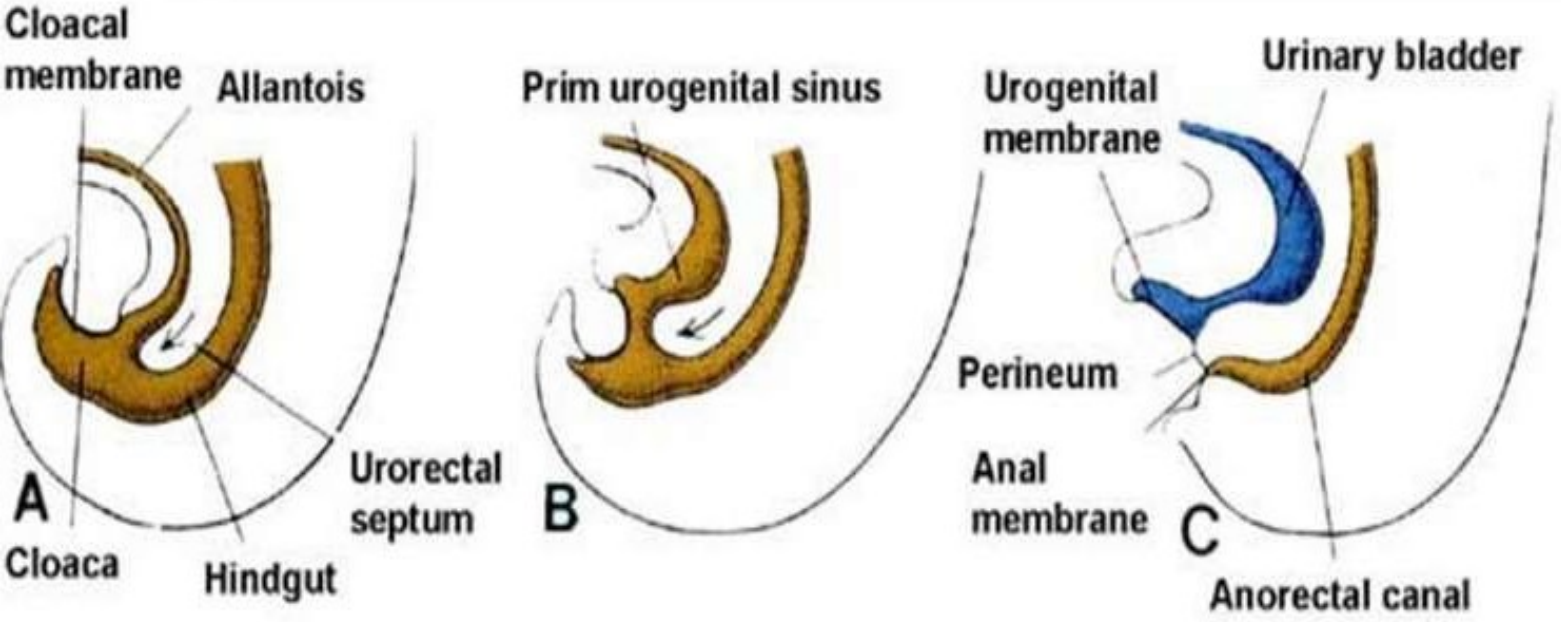
The cloaca is divided into two parts:

- **Ventral part** called the primitive urogenital sinus, which is continuous with the allantois and still receives the right and left mesonephric ducts.
- **Dorsal part** called anorectal canal, which is continuous with the hindgut and gives rise to the rectum and the upper part of the anal canal.

the cloacal membrane is also divided into two parts.

- **Ventral part** called the urogenital membrane closes the caudal end of the primitive urogenital sinus.
- **Dorsal part** called the anal membrane closes the caudal end of the anorectal canal.


Allantois
Mesonephric duct
Primitive urogenital sinus
Ureteric bud
Cloacal membrane
Hindgut
Urorectal septum
Anorectal canal
Bladder
Mesonephric duct
Phallus
Ureter
Perineal body
A
B
C


Cloacal membrane
Allantois
Urorectal septum
Cloaca
Hindgut
A
Prim urogenital sinus
B
Urinary bladder
Urogenital membrane
Perineum
Anal membrane
C
Anorectal canal

A-Urogenital sinus is subdivided by the openings of mesonephric ducts into ***two*** parts.

Cranial part (the vesico-urethral canal), whose apex is continuous with the allantois.

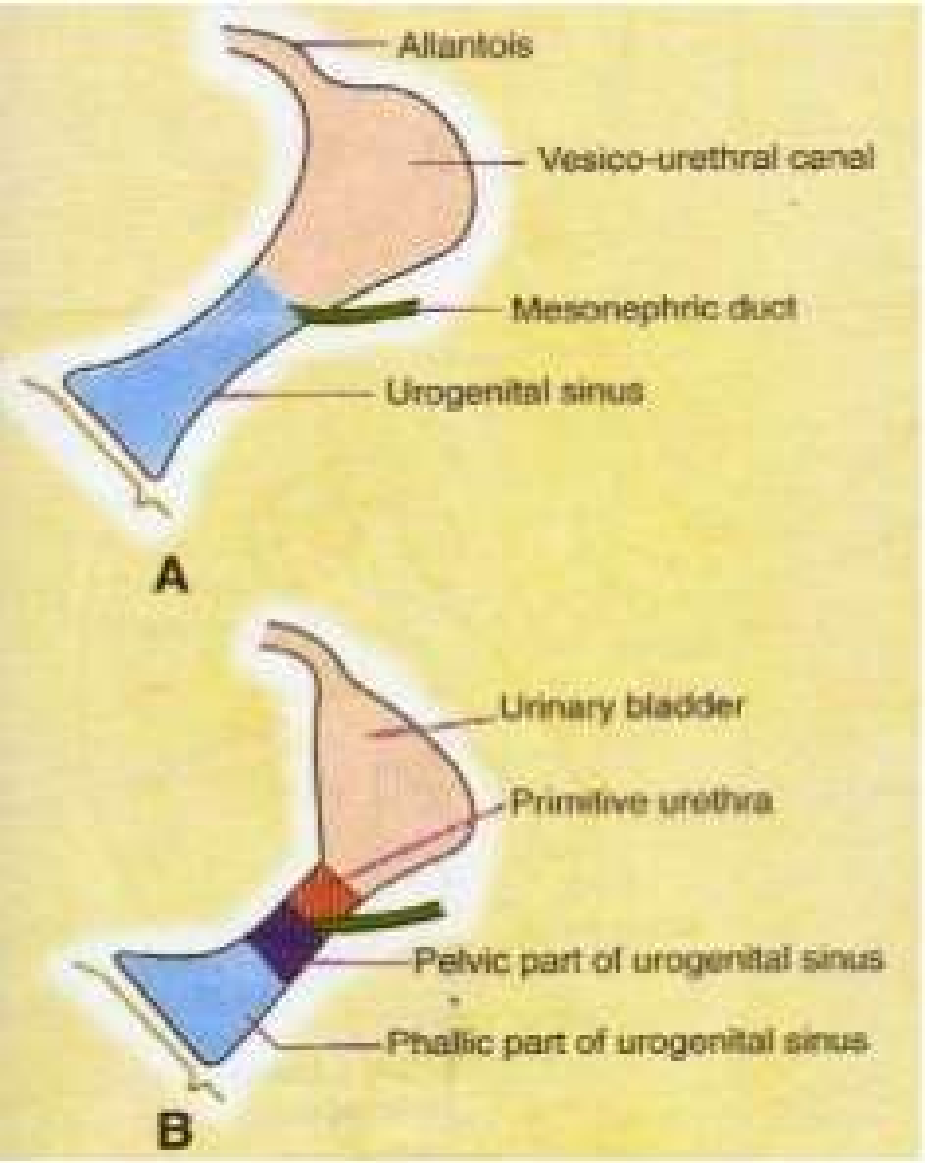
Caudal part called the definitive urogenital sinus, which is further subdivided, into : pelvic and phallic parts.

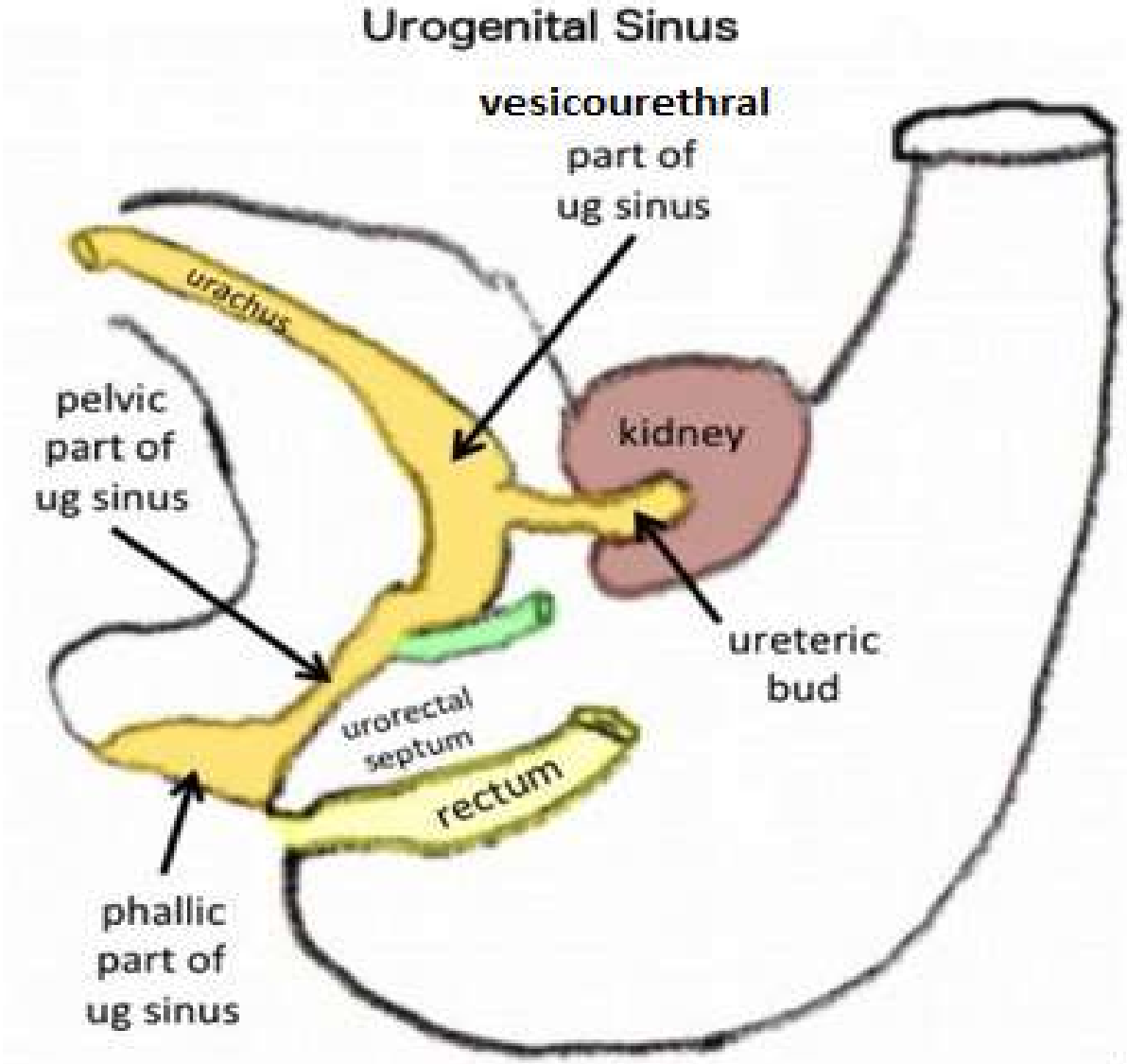
B- Allantois

- It constricts to form a fibrous cord called the ***urachus*** that is continuous with the apex of the urinary bladder.
- After birth, the urachus is transformed into the median umbilical ligament.

C- Caudal parts of the mesonephric ducts

- Below the ureteric buds, the caudal parts of the mesonephric ducts are absorbed into the wall of the urinary bladder forming its trigone.


Allantois
Vesico-urethral canal
Mesonephric duct
Urogenital sinus
A
Urinary bladder
Primitive urethra
Pelvic part of urogenital sinus
Phallic part of urogenital sinus
B

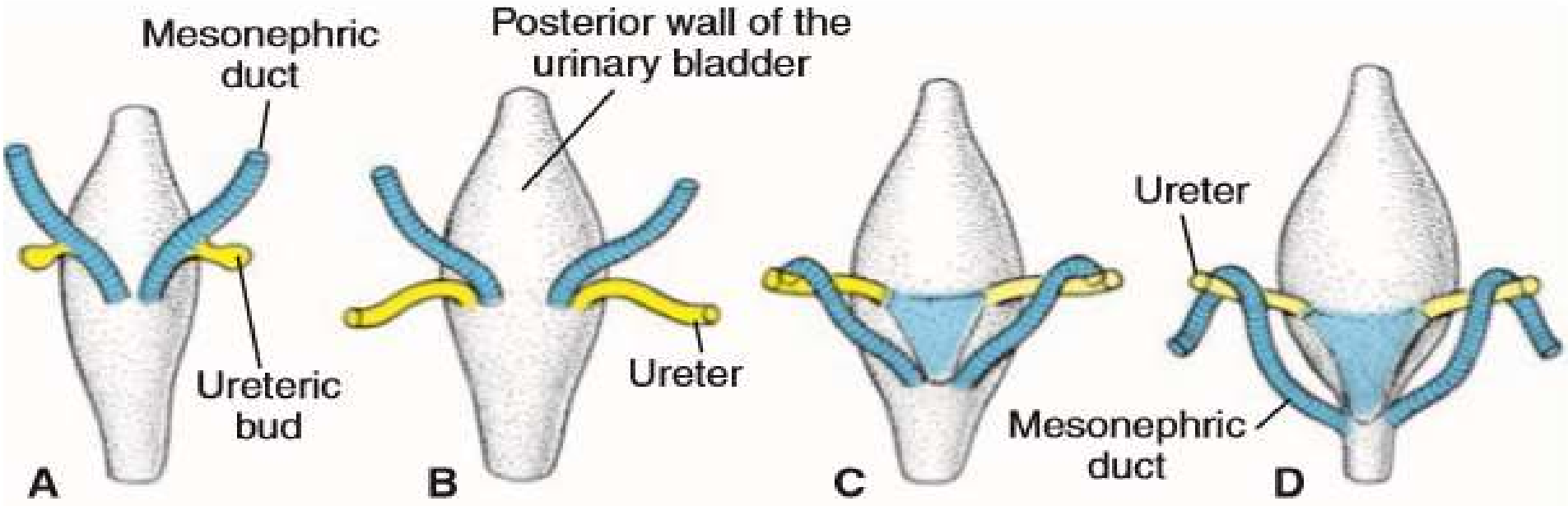

Urogenital Sinus
vesicourethral
part of
ug sinus
urachus
pelvic
part of
ug sinus
kidney
ureteric
bud
urorectal
septum
rectum
phallic
part of
ug sinus

The urinary bladder develops from :

1. Its major part develops from the vesico-urethral canal (endodermal).

2. The trigone (mesodermal) is formed by the lower absorbed parts of the mesonephric ducts.

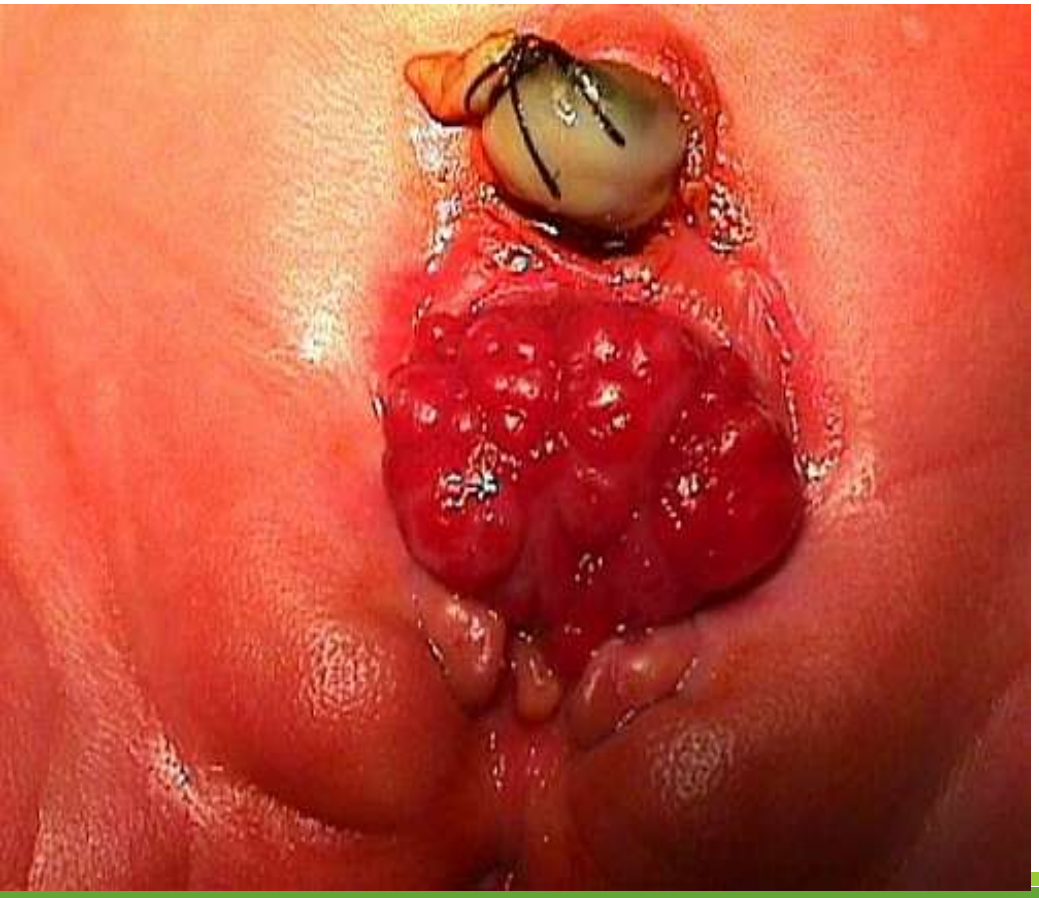
3- The coats of the urinary bladder are derived from the splanchnic mesoderm.

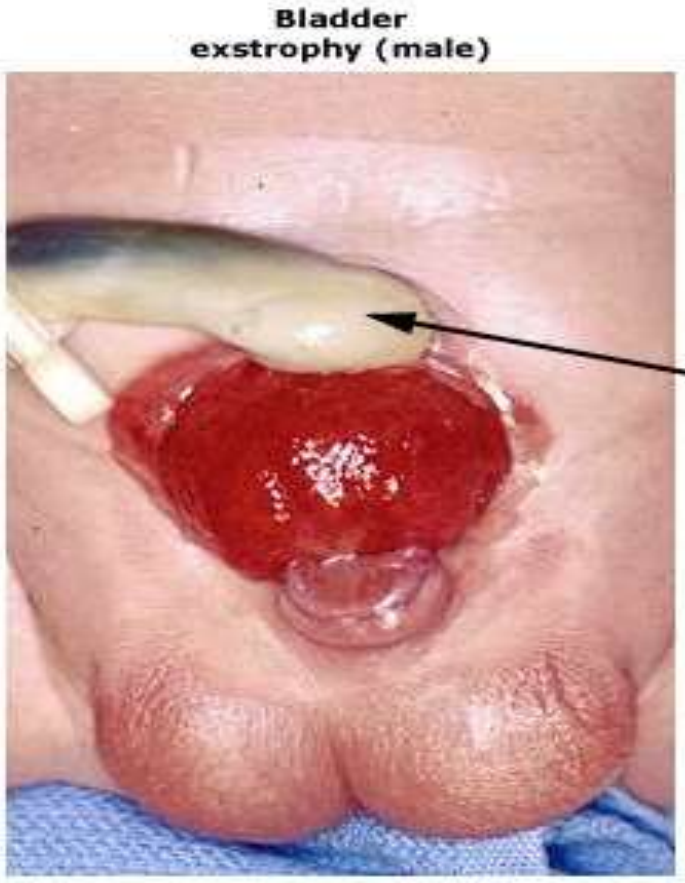


Congenital anomalies

Ectopia vesicae in which the mucosa of the posterior wall of the bladder is exposed to the outside due to defective formation of the infraumbilical of the anterior abdominal wall.

It is usually associated with Epispadias .





2. Anomalies of the urachus

- **Urachal Fistula (Patent urachus)**

  Communication between the bladder and umbilicus through a urachus
- **Urachal cyst :**a fluid-filled dilatation of the mid urachus
- **Urachal sinus :**blind focal dilatation of the umbilical end of the urachus

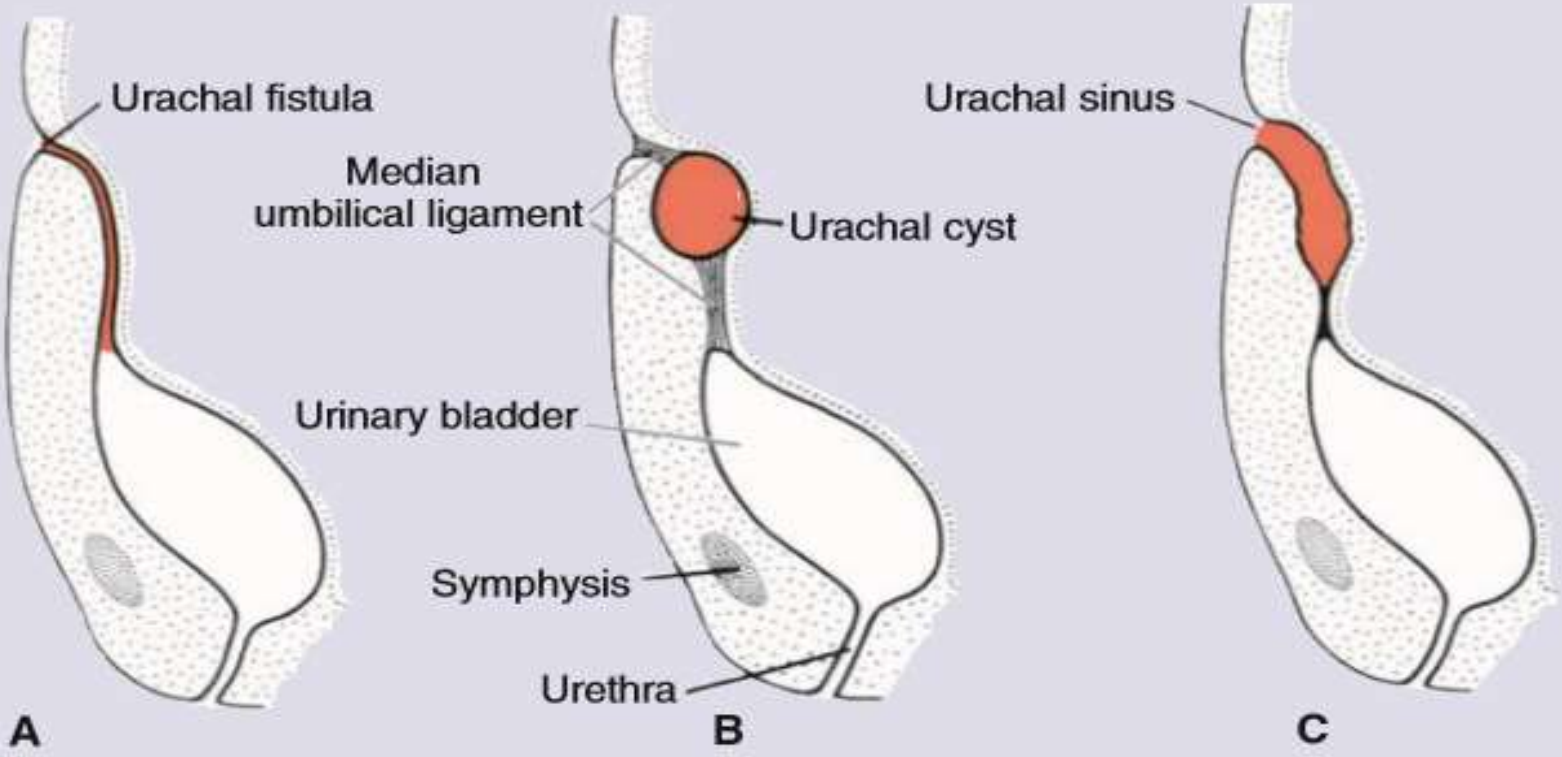


Figure 16.15 **A.** Urachal fistula. **B.** Urachal cyst. **C.** Urachal sinus. The sinus may or may not be in open communication with the urinary bladder.

Development of the urethra

Dr Ahmed Salman

A. Male urethra

1. Prostatic urethra.

- It is divided by the seminal colliculus into:

• **Supracollicular part** develops from the **vesico-urethral** part *(**endodermal**)* of the primitive urogenital sinus except its dorsal wall which develops from the absorbed lower parts of the mesonephric ducts *(**mesodermal**).*

•**Infracollicular part** develops from the pelvic part of the urogenital sinus.

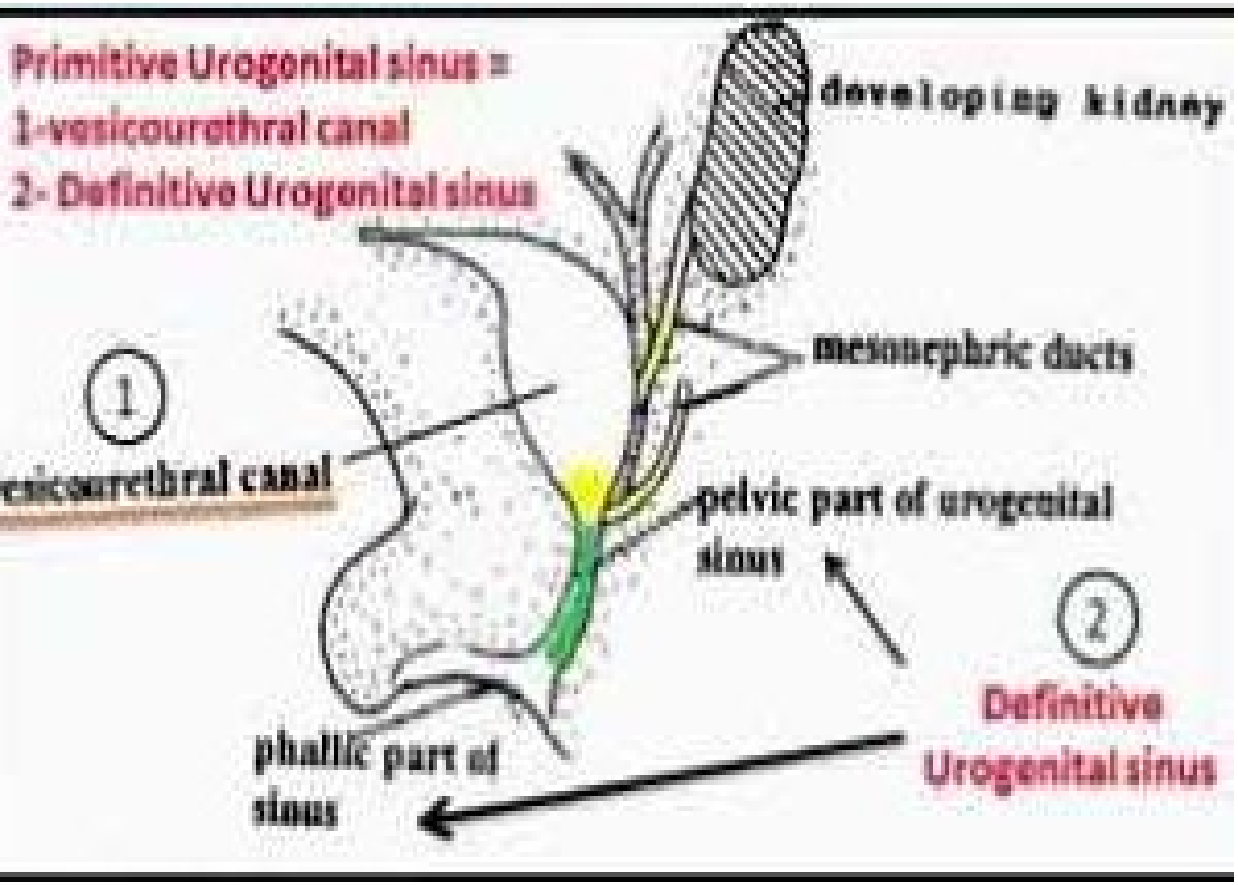
2. Membranous urethra: develops also from the ***pelvic*** part of the urogenital sinus.

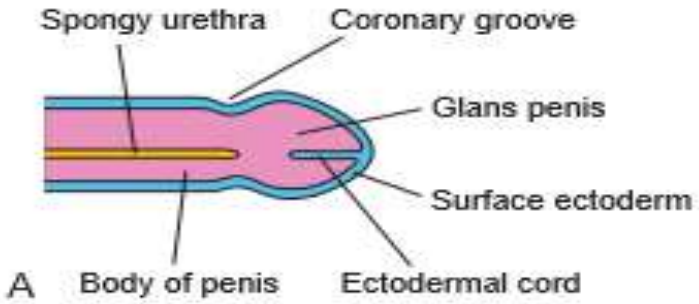
3. Penile (spongy) urethra :

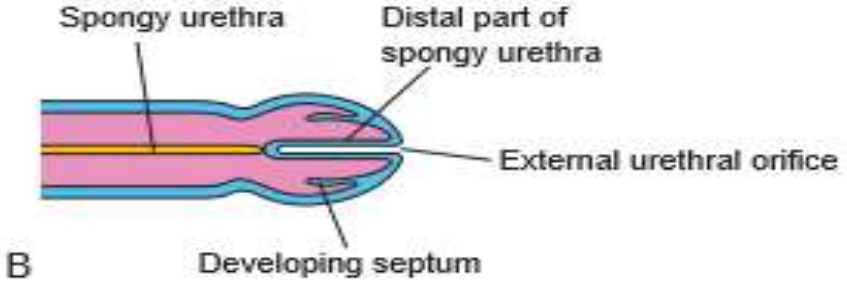
- Develops from the phallic part of the primitive urogenital sinus (due to fusion of the two urethral folds) ***except*** its terminal part within the glans penis, which develops from an ***ectodermal*** ingrowths.
- The glandular plate becomes canalized to form the navicular fossa.

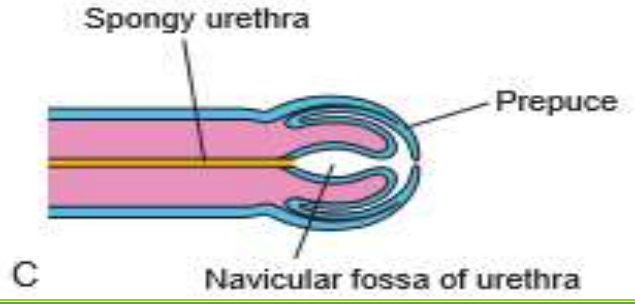
N.B. The male urethra develops from endoderm ***except*** two parts.

- The dorsal wall of the supracollicular part of the prostatic urethra (mesodermal).
- The terminal part within the glans penis (ectodermal).


Primitive Urogenital sinus =
1-vesicourethral canal
2- Definitive Urogenital sinus
developing kidney
mesonephric ducts
1
vesicourethral canal
pelvic part of urogenital sinus
2
Definitive Urogenital sinus
phallic part of sinus


Spongy urethra
Coronary groove
Glans penis
Surface ectoderm
A
Body of penis
Ectodermal cord


Spongy urethra
Distal part of spongy urethra
External urethral orifice
B
Developing septum


Spongy urethra
Prepuce
C
Navicular fossa of urethra

B. Female urethra

It develops from the vesico-urethral canal (endodermal) ***except*** its dorsal wall, which is ***mesodermal*** in origin, being derived from the absorbed lower parts of the mesonephric ducts.

Derivatives of the three parts of the urogenital sinus

	Male	Female
1.vesico-urethral	- The urinary bladder ***except*** its trigone, which is mesodermal in origin. - The supracollicular part of the prostatic urethra ***except*** its dorsal wall which is mesodermal in origin	- The urinary bladder ***except*** its trigone, which is mesodermal in origin. - The whole urethra ***except*** its dorsal wall, which is mesodermal in origin
2.Pelvic part	- The infracollicular part of the prostatic urethra. - Membranous urethra	- The pelvic and the phallic parts form: a) Lower 2/5 of the vagina.
3.Phallic part	- The penile urethra except its terminal part in the glans penis, which is ***ectodermal*** in origin.	b) Vestibule of the vagina

Development of the Genital System

Development of the gonads

Dr Ahmed Salman

The gonads develop form ***three*** sources (the first two are mesodermal, the third one is endodermal) .

1.Proliferating coelomic epithelium on the medial side of the mesonephros.

2. Adjacent mesenchyme dorsal to the proliferating coelomic epithelium.

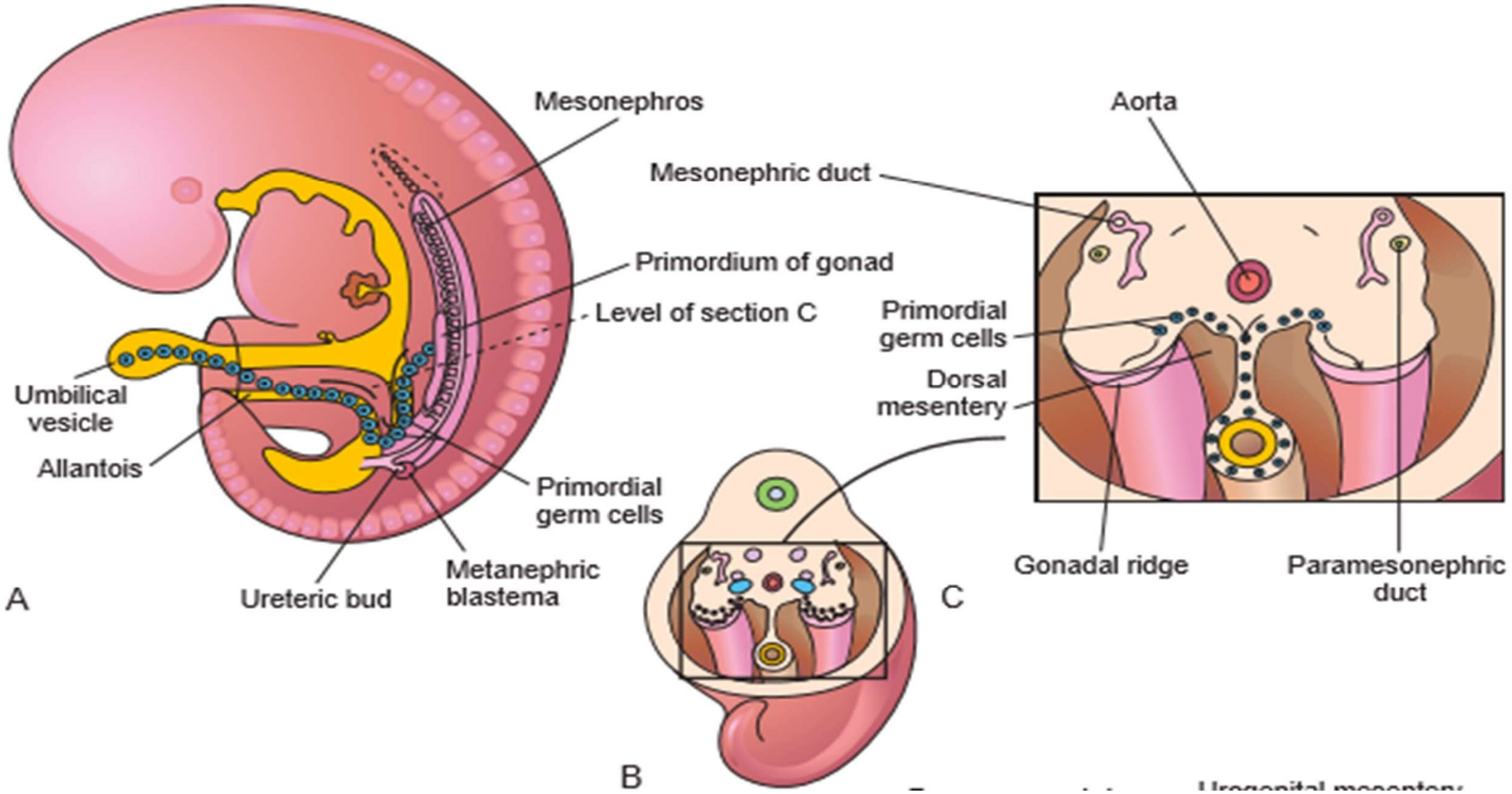
3. Primordial germ cells (endodermal), which develop in the wall of the yolk sac and migrate along the dorsal mesentery to reach the developing gonad.

The indifferent stage of the developing gonads

- The coelomic epithelium (on either side of the aorta) proliferates and becomes multi layered and forms a longitudinal projection into the coelomic cavity called the **genital ridge**.

- The genital ridge forms a number of epithelial cords called the **primary sex cords** that invade the underlying mesenchyme, which separate the cords from each other.

- Up to the 6th or 7th week, the developing gonad cannot be differentiated into testis or ovary.


Mesonephros
Primordium of gonad
Level of section C
Umbilical vesicle
Allantois
Primordial germ cells
Metanephric blastema
Ureteric bud
A
B
C
Aorta
Mesonephric duct
Primordial germ cells
Dorsal mesentery
Gonadal ridge
Paramesonephric duct

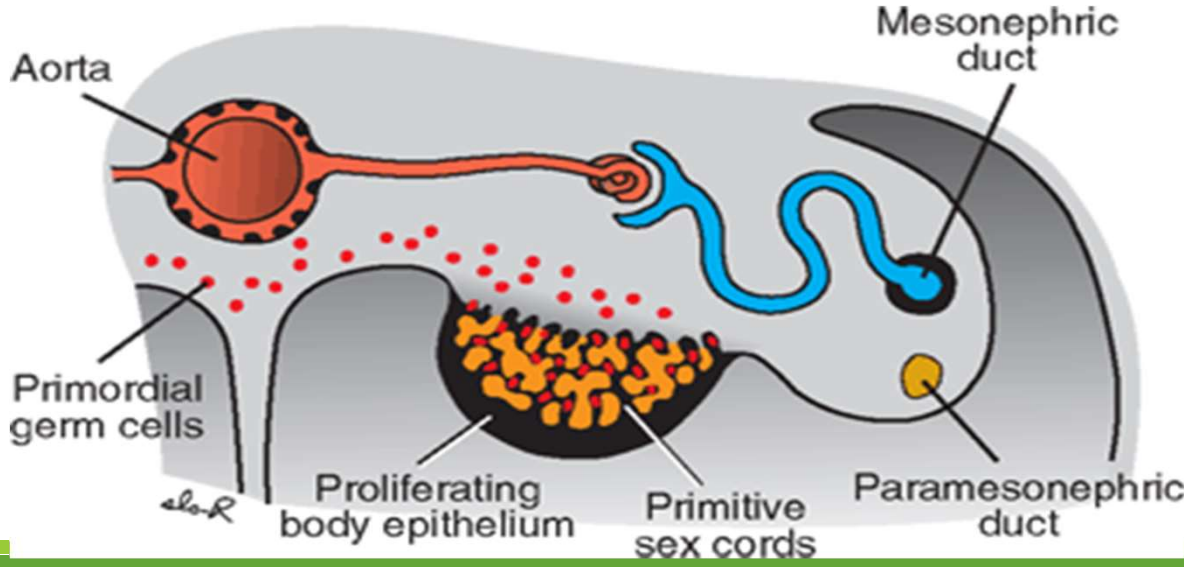
Development of the testis and its descent

Under the effect of the **testis determining factor (T.D.F)** present on the short arm of Y - chromosome, the undifferentiated gonad is switched to form a testis.

1. The coelomic epithelium.

- The primary sex cords elongate to form testis cords (future seminiferous tubules) which undergo ***three*** important events :

  - **Ventrally,** they lose contact with the surface epithelium by the developing tunica albuginae.
  - **Dorsally,** they communicate with each other to form rete testis.
  - **Internally,** they are invaded by the primitive germ cells.



The testis cords become lined by two types of cells:

A. Sertoli supporting cells (mesoderml) from the coelomic epithelium.

They synthesize **mullarian inhibitory factor (M.I.F),** which affects the development of the genital ducts.

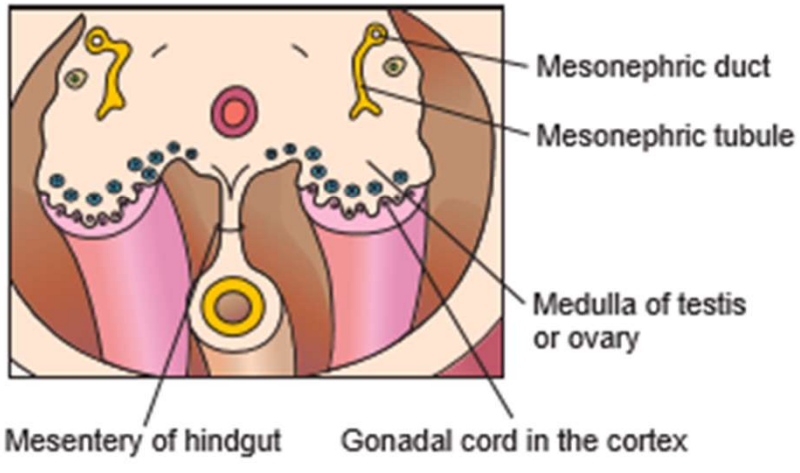
B. Primitive germ cells (endodermal) from the wall of the yolk sac, they give rise to spermatogonia

2-The subjacent mesenchyme.

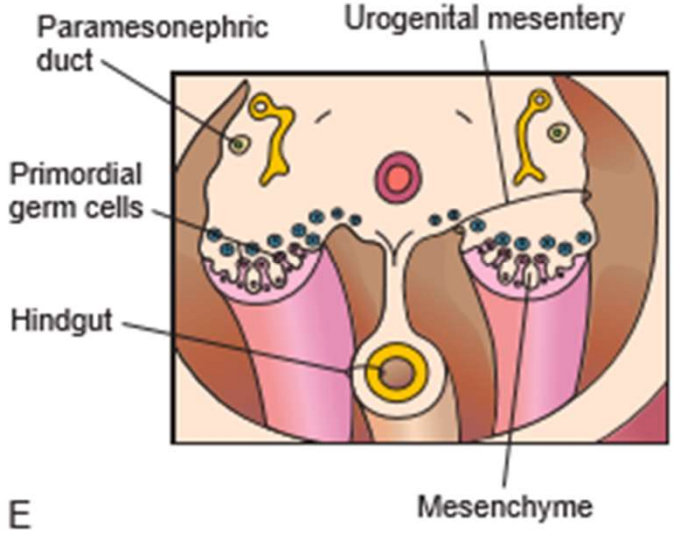
- It forms tunica albuginae that surrounds the testis.
- It forms the interstitial cells of Leydig, which secrete testosterone.

3. The primitive germ cells.

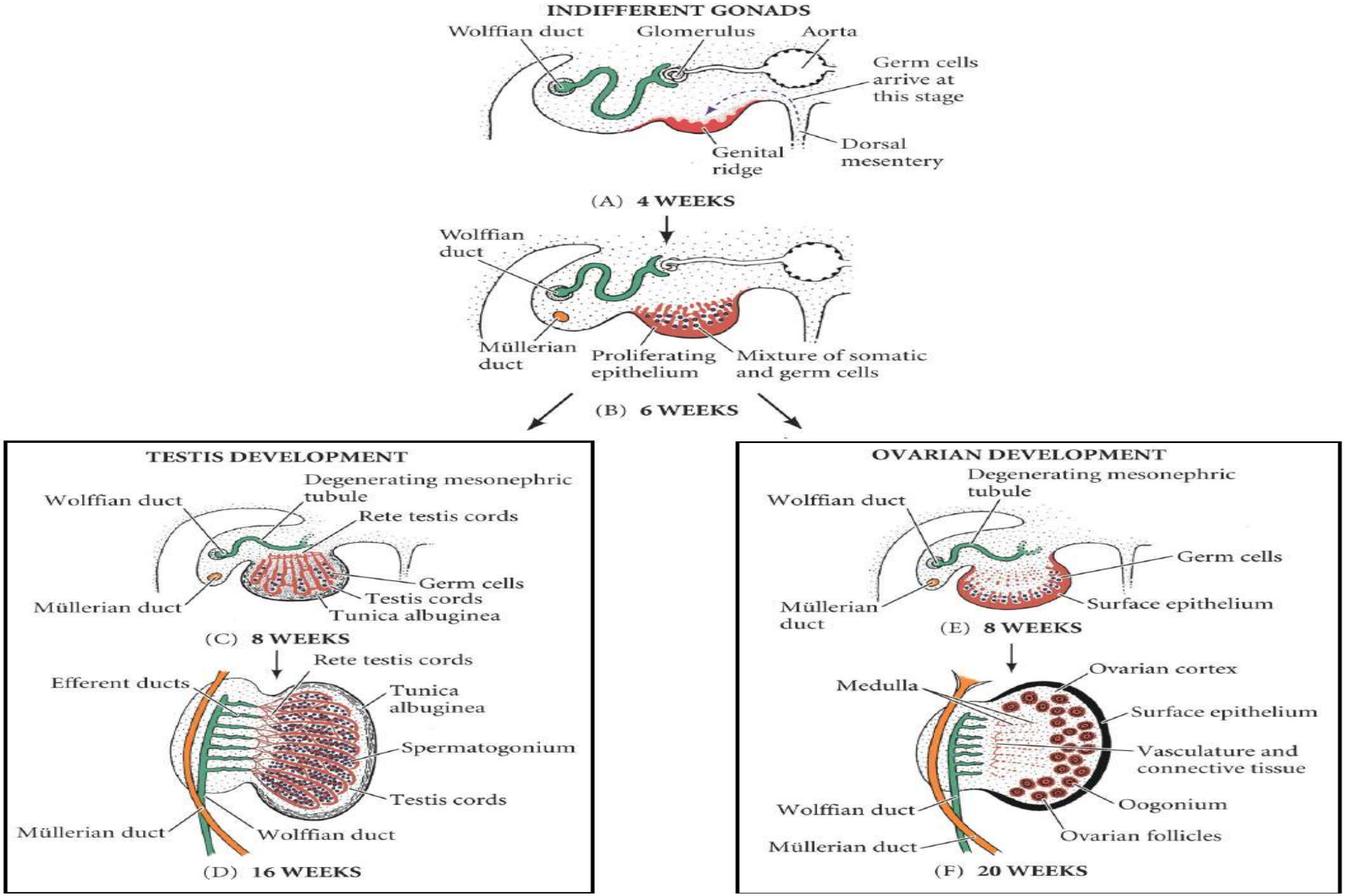
They reach the genital ridge and give rise to spermatogonia, which (at puberty) differentiate to form spermatozoa.



D



E


INDIFFERENT GONADS
Wolffian duct
Glomerulus
Aorta
Germ cells arrive at this stage
Genital ridge
Dorsal mesentery
(A) 4 WEEKS
Wolffian duct
Müllerian duct
Proliferating epithelium
Mixture of somatic and germ cells
(B) 6 WEEKS
TESTIS DEVELOPMENT
Degenerating mesonephric tubule
Wolffian duct
Rete testis cords
Germ cells
Testis cords
Tunica albuginea
Müllerian duct
(C) 8 WEEKS
Rete testis cords
Efferent ducts
Tunica albuginea
Spermatogonium
Testis cords
Müllerian duct
Wolffian duct
(D) 16 WEEKS
OVARIAN DEVELOPMENT
Degenerating mesonephric tubule
Wolffian duct
Germ cells
Müllerian duct
Surface epithelium
(E) 8 WEEKS
Ovarian cortex
Medulla
Surface epithelium
Vasculature and connective tissue
Oogonium
Wolffian duct
Ovarian follicles
Müllerian duct
(F) 20 WEEKS

Descent of the testis :

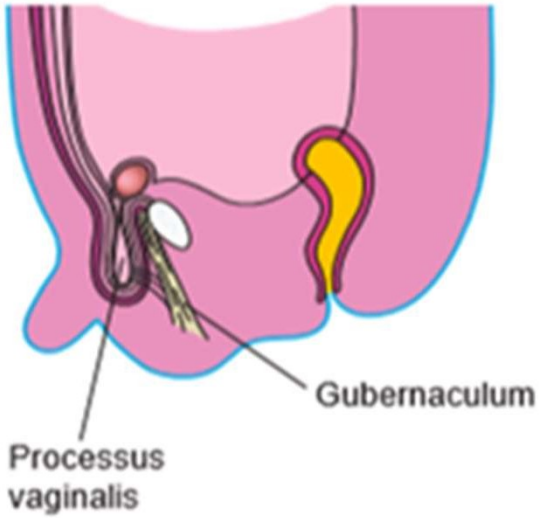
- The testis develops in the posterior abdominal wall opposite the 2nd lumbar vertebra. Here, it receives its testicular artery from the abdominal aorta.
- The genital mesentery of the testis is divided into ***three*** parts:

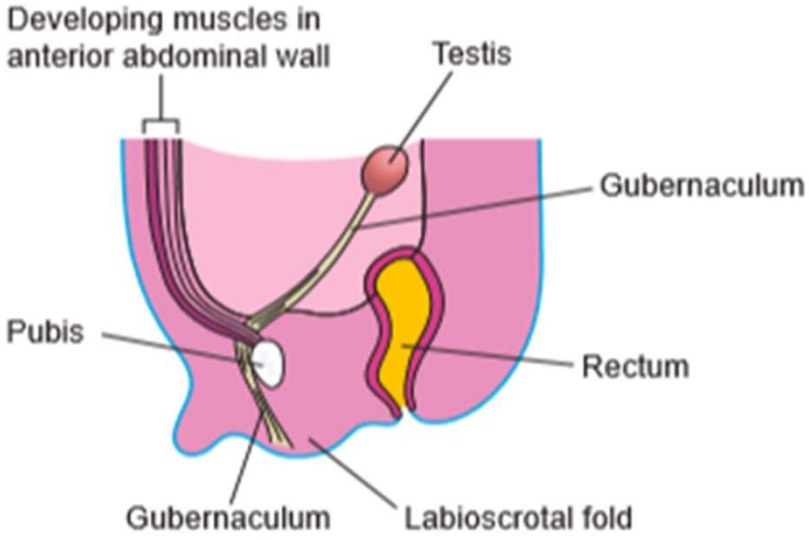
• Its **cranial part** forms the ***suspensory ligament of the testis***. It soon degenerates.

• Its **middle part** forms the ***mesorchium,*** which forms the site at which blood vessels, and lymphatics enter and leave the testis.

• Its **caudal part** is transformed into a fibromuscular structure called **gubernaculum** of the testis.

- It extends between the caudal end of the testis to the developing scrotum.
- It is aiding its descent into the scrotum .





A

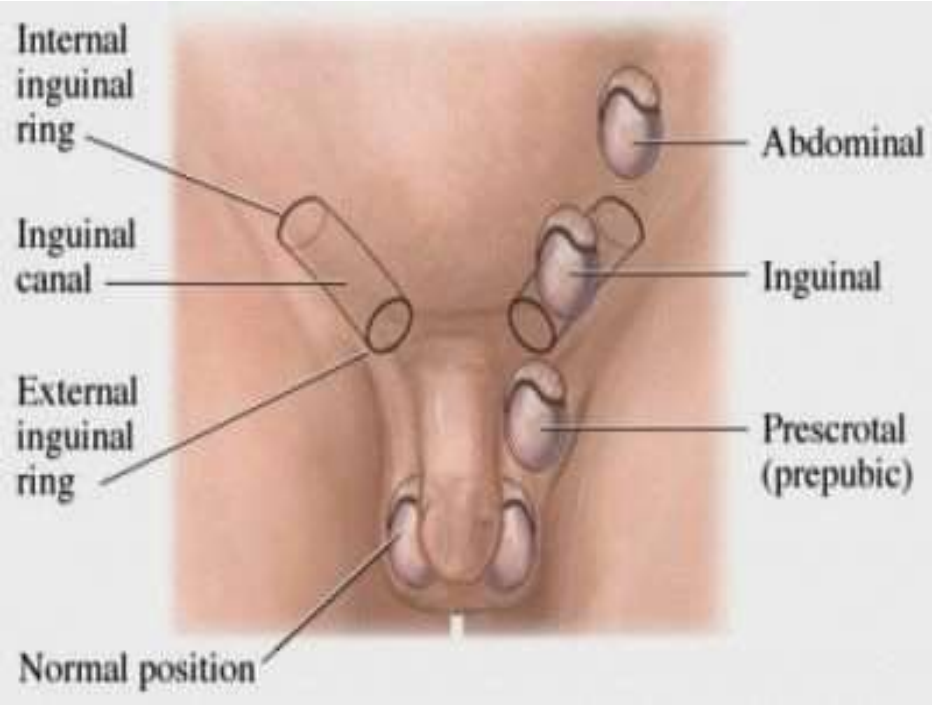
The testis undergoes ***two*** steps of descent:

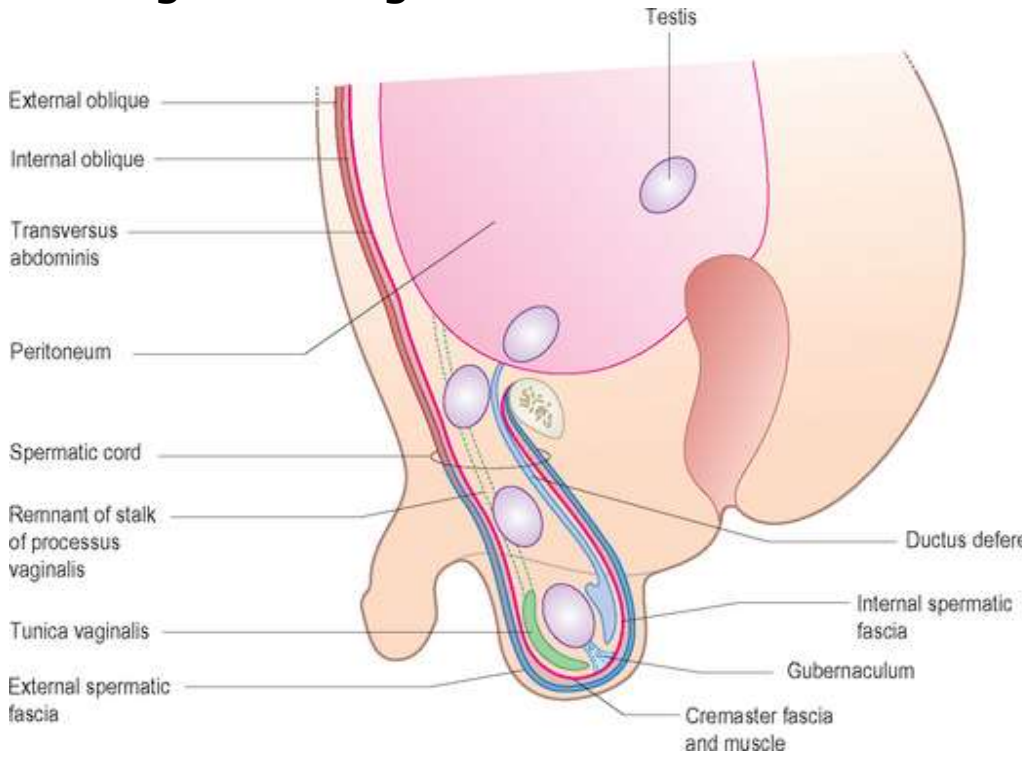
1.Internal descent: occurs from the 4th to the 6th month of development.

The testis descends into the iliac fossa close to the deep inguinal ring.

2.External descent: occurs from the 7th to the 9th month of development

- At 7th month, it traverses the deep inguinal ring.
- At 8th month, it traverses the inguinal canal.
- At 9th month, it begins to traverse the superficial inguinal ring.





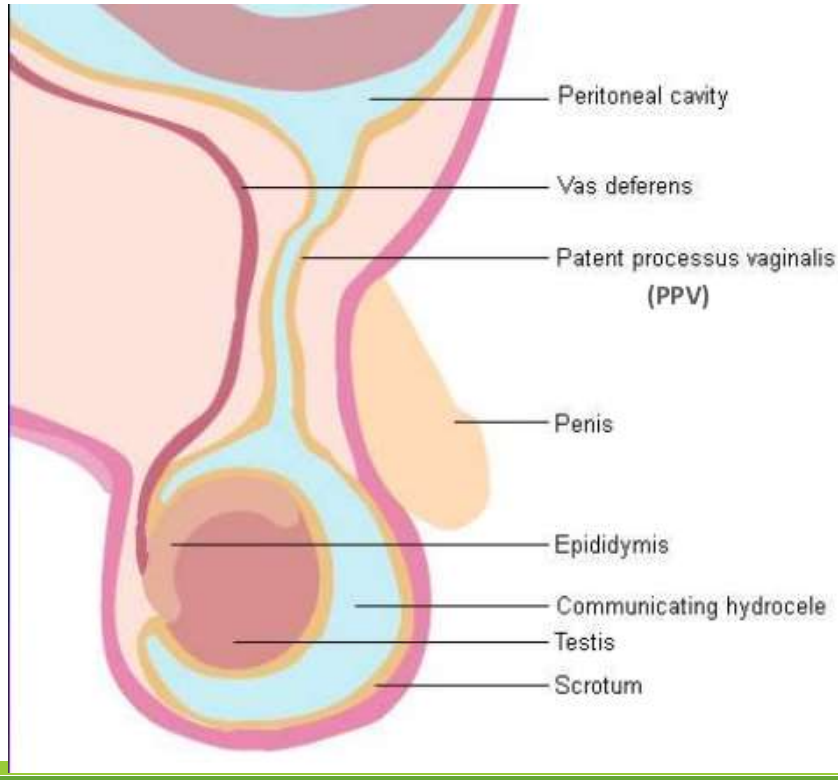
Before descent of the testis, a peritoneal diverticulum called ***processus vaginalis*** creates and traverses the inguinal canal down to the scrotum.

After descent of the testis the tunica vaginalis is divided into ***three*** parts:

- **Proximal part** forms the **vestige of processus vaginalis** at the deep inguinal ring.
- **Intermediate part is obliterated** .
- **Distal part** (in the scrotum) persists and forms the tunica vaginalis

Factors helping descent of the testis:

1. Shortening of the gubernaculum.
2. Hormones as androgens and gonadotrophins.
3. Increased intra - abdominal pressure.



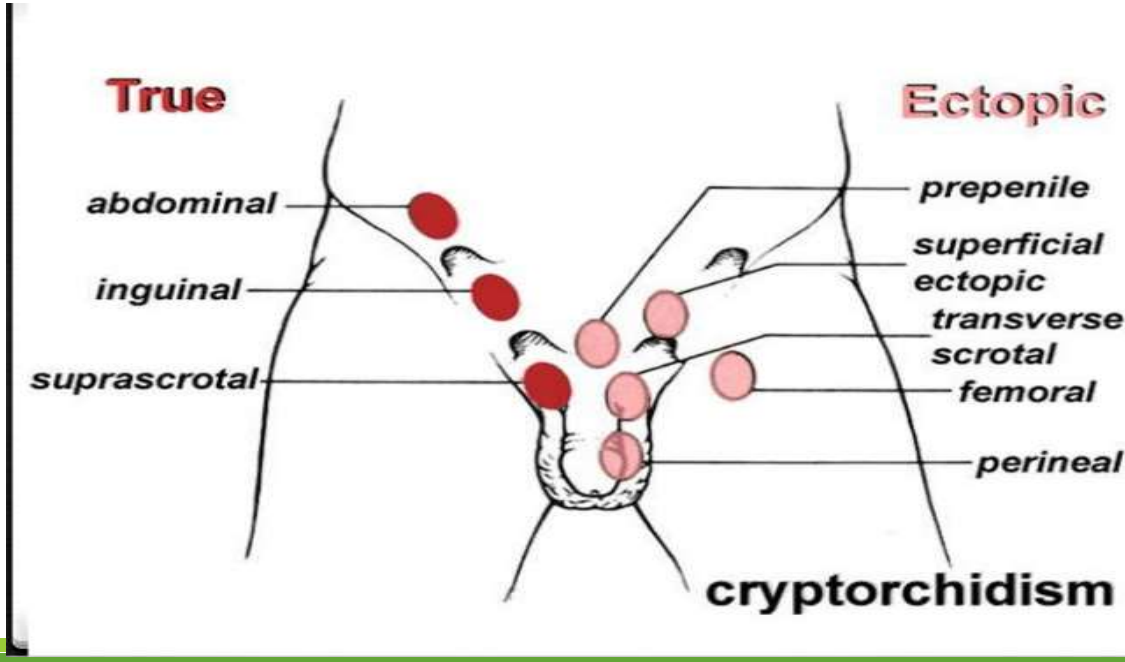
Congenital anomalies:

1. Cryptorchidism (undescended testis): in which the testis may remain in the iliac fossa or in any part of the inguinal canal.

Undescended testis is susceptible to damage of the process of spermatogenesis and occurrence of malignancy .

2. Ectopic testis (maldescended testis) in which, the testis descends in the inguinal canal but is located ***outside*** the scrotum at root of penis or in the upper part in the front of the thigh .

3.Congenital oblique inguinal hernia, in which a loop of intestine descends via unobliterated tunica vaginalis .

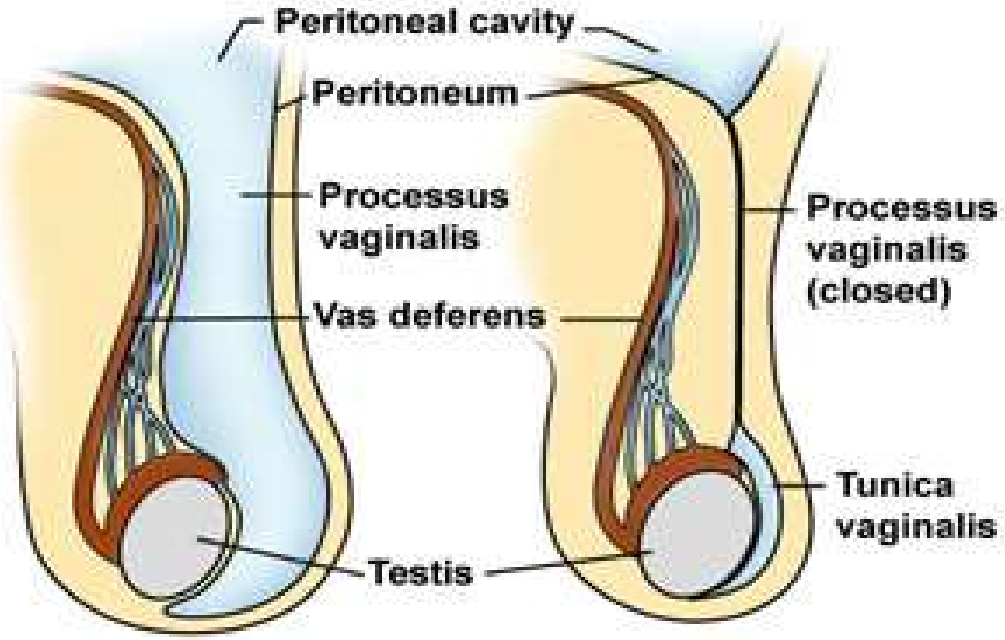


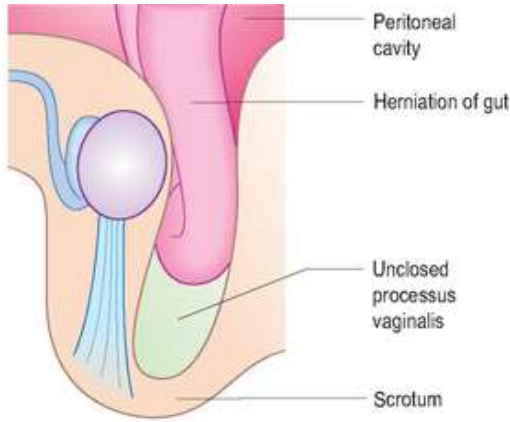
4-Hydrocele : the abdominal end of the processus vaginalis remains open but is too small to permit herniation of intestine .

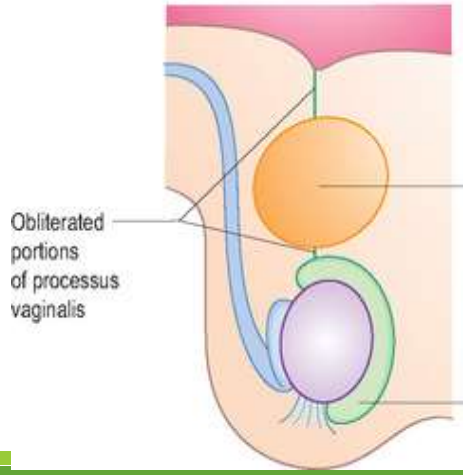
Peritoneal fluid passes into the patent processus vaginalis and forms a scrotal hydrocele.

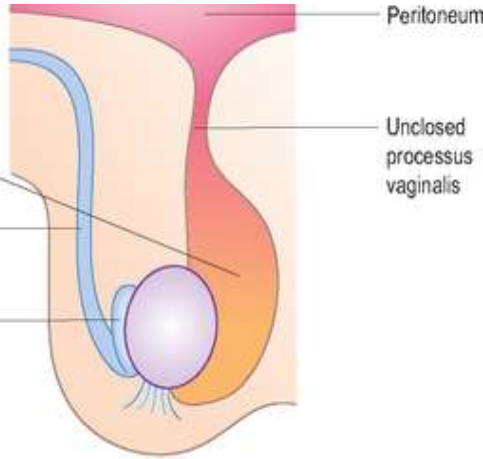
If only the middle part of the processus vaginalis

remains open, fluid may accumulate and give rise to a hydrocele of the spermatic cord







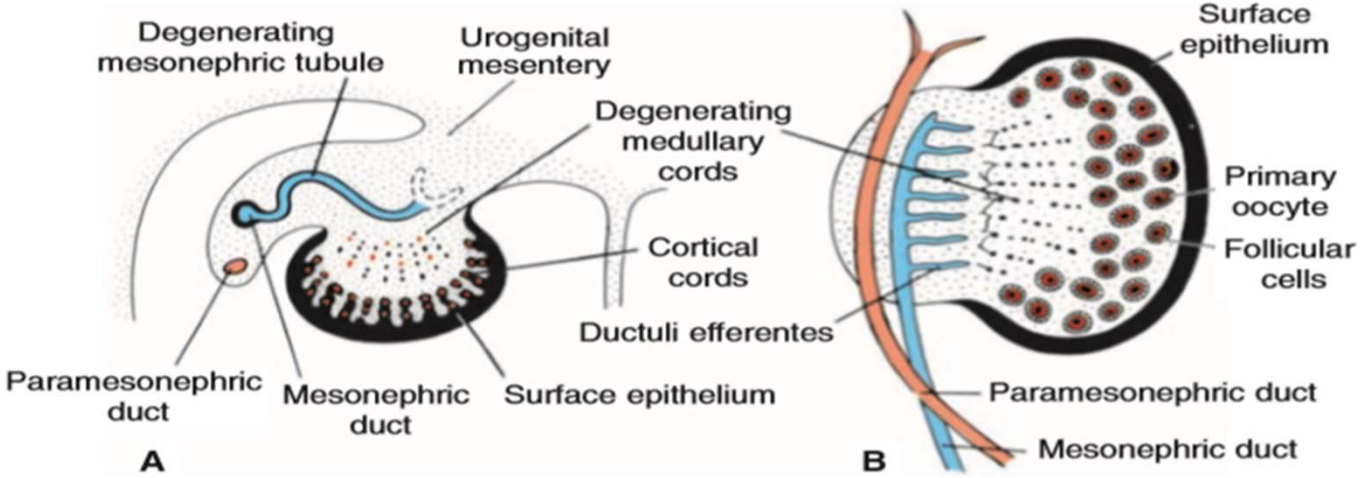


Development of the ovary

- In the absence of **T.D.F. ,** the undifferentiated gonad is switched on to form an ovary.

1. Coelomic epithelium:

- The primary sex cords invade into the subjacent mesenchyme to form ***medullary*** **sex cords.**
- It replaced by fibromuscular stroma, forming the medulla of the ovary.
- The coelomic epithelium proliferates to form a second generation of sex cords called the secondary ***(cortical)*** **sex cords**, which remain near the coelomic epithelium, forming the cortex of the ovary.
- The cortical sex cords break down to form cell clusters which form perimordial ovarian follicles



2. Subjacent mesenchyme: it forms:

- The stroma of the ovary.
- Very thin tunica albuginae, which intervenes between the ovary and the surface epithelium.

3. Primitive germ cells:

- They invade the primordial follicles and proliferate by ***mitosis*** to form Primary oocytes.
- At 12^{lh} week of the intrauterine life, the primary oocytes enter the first meiotic division and are arrested (at 20th week) in its prophase till puberty.

Descent of the ovary :

- The ovary developed (like the testis) in the posterior abdominal wall opposite at 2nd lumbar vertebra, where it is suspended by a genital mesentery.
- It reaches the greater pelvis at 3rd month of gestation
- Then reach the lesser pelvis shortly after birth

The genital mesentery of the ovary is divided into ***three*** parts:

- **Cranial part** forms the ***suspensory ligament of the ovary***
- **Middle part** forms the ***mesovarium.***
- **Caudal part** is transformed into the ***gubernaculum of the ovary***, which extends between the lower end of the ovary and the developing labium majora.

- The middle of: **the gubernaculum** is attached to the lateral angle of the developing uterus and thus gives rise to ***two*** ligaments.

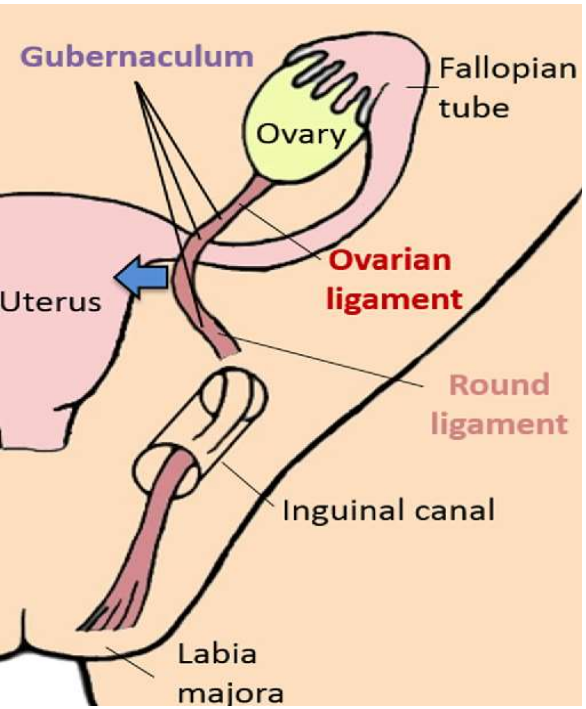
- ***Ligament of the ovary***, between the ovary and uterus.
- ***Round ligament of the uterus***, between the uterus and labium majora.

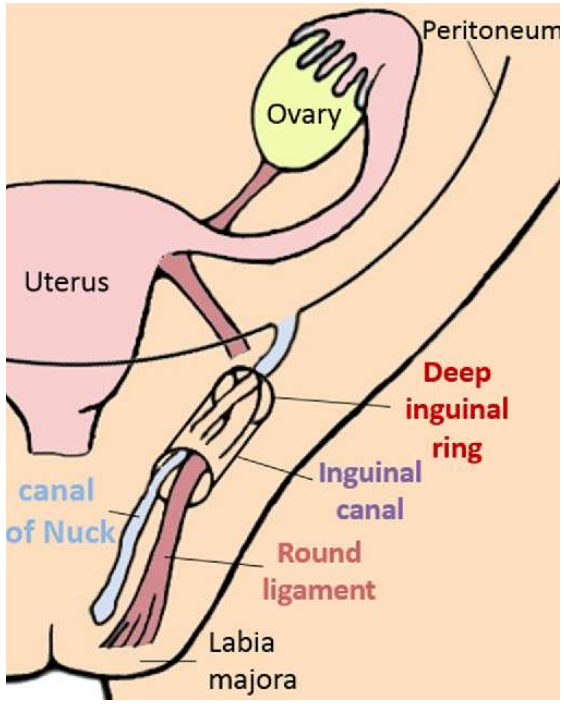
Persistence of small processus vaginalis, gives rise to canal of Nuck.

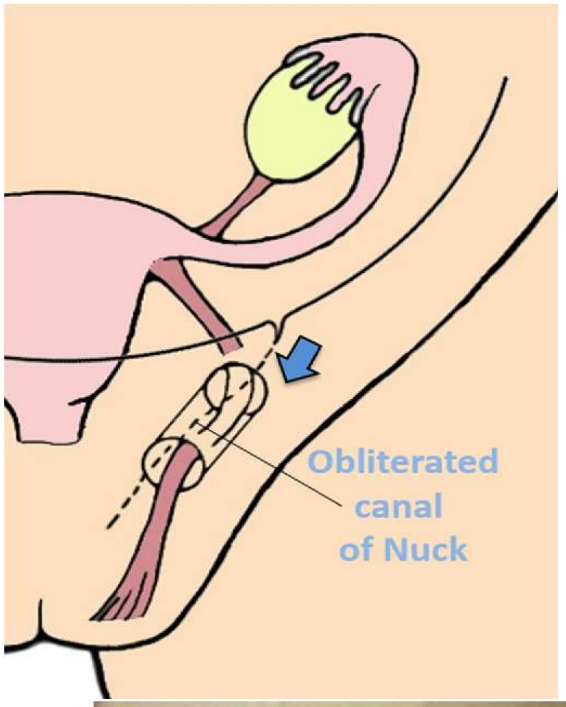
Congenital anomalies

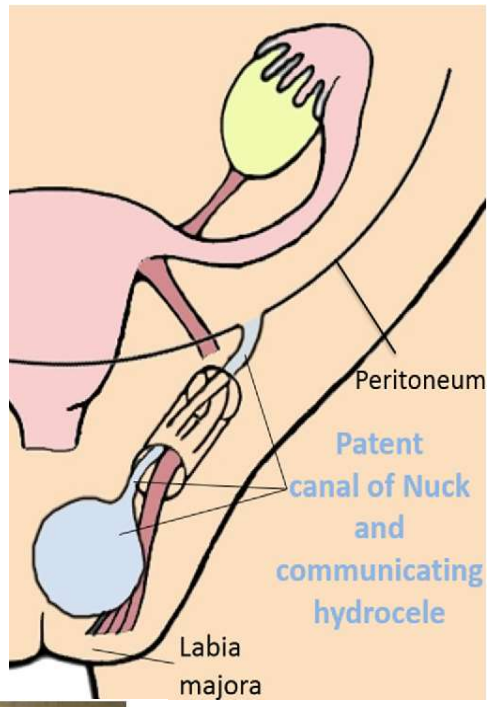
1. Ovarian agenesis.
2. Congenital inguinal hernia

The ovary may undergo external descent via the inguinal canal when the gubernaculum is not attached to the angle of the developing uterus may occur in a persistent canal of Nuck



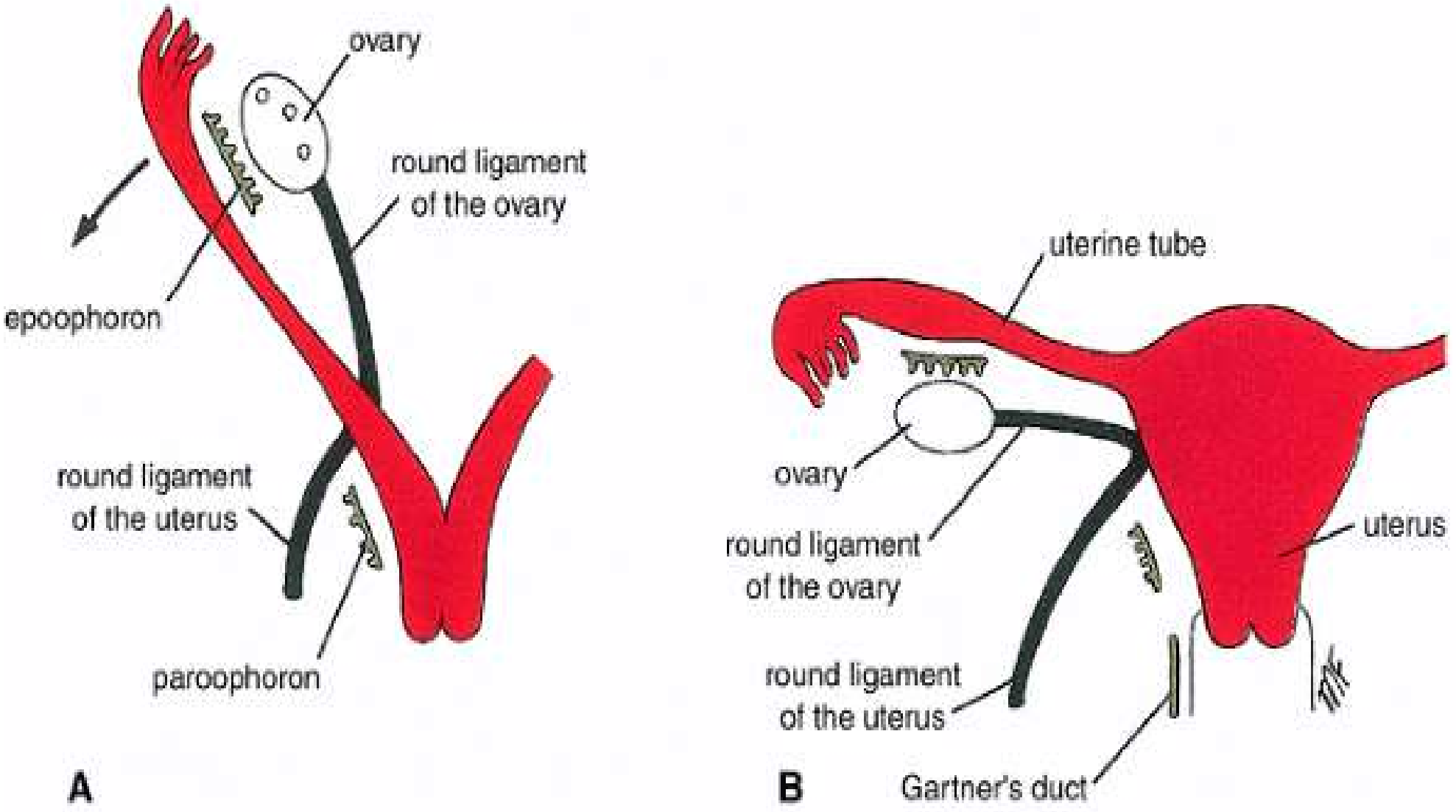


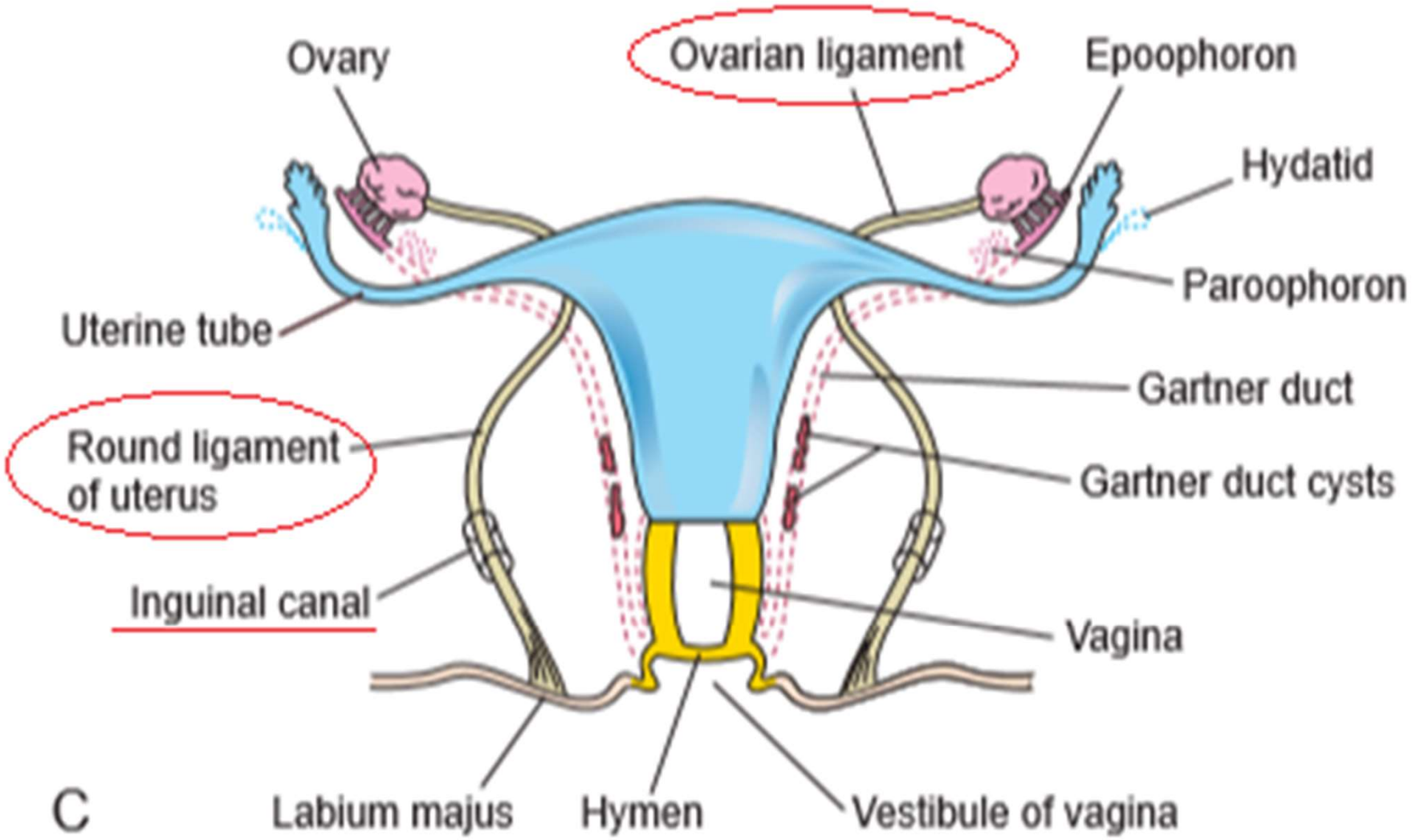




bilateral labial fullness in a 4-monthold girl

6- Clinical photograph shows bilateral labial fullness in a 4-mo


ovary
round ligament
of the ovary
epoophoron
round ligament
of the uterus
paroophoron
A
uterine tube
ovary
round ligament
of the ovary
uterus
round ligament
of the uterus
Gartner's duct
B


Ovary
Ovarian ligament
Epoophoron
Hydatid
Paroophoron
Uterine tube
Gartner duct
Round ligament of uterus
Gartner duct cysts
Inguinal canal
Vagina
C
Labium majus
Hymen
Vestibule of vagina

Development of the genital ducts

Dr Ahmed Salman

- In either the male or female, there are two genital ducts on each side:

Mesonephric (Wollfian) duct and a laterally located **paramesonephric (Mullerian)** duct

All are ***mesodermal*** in origin.

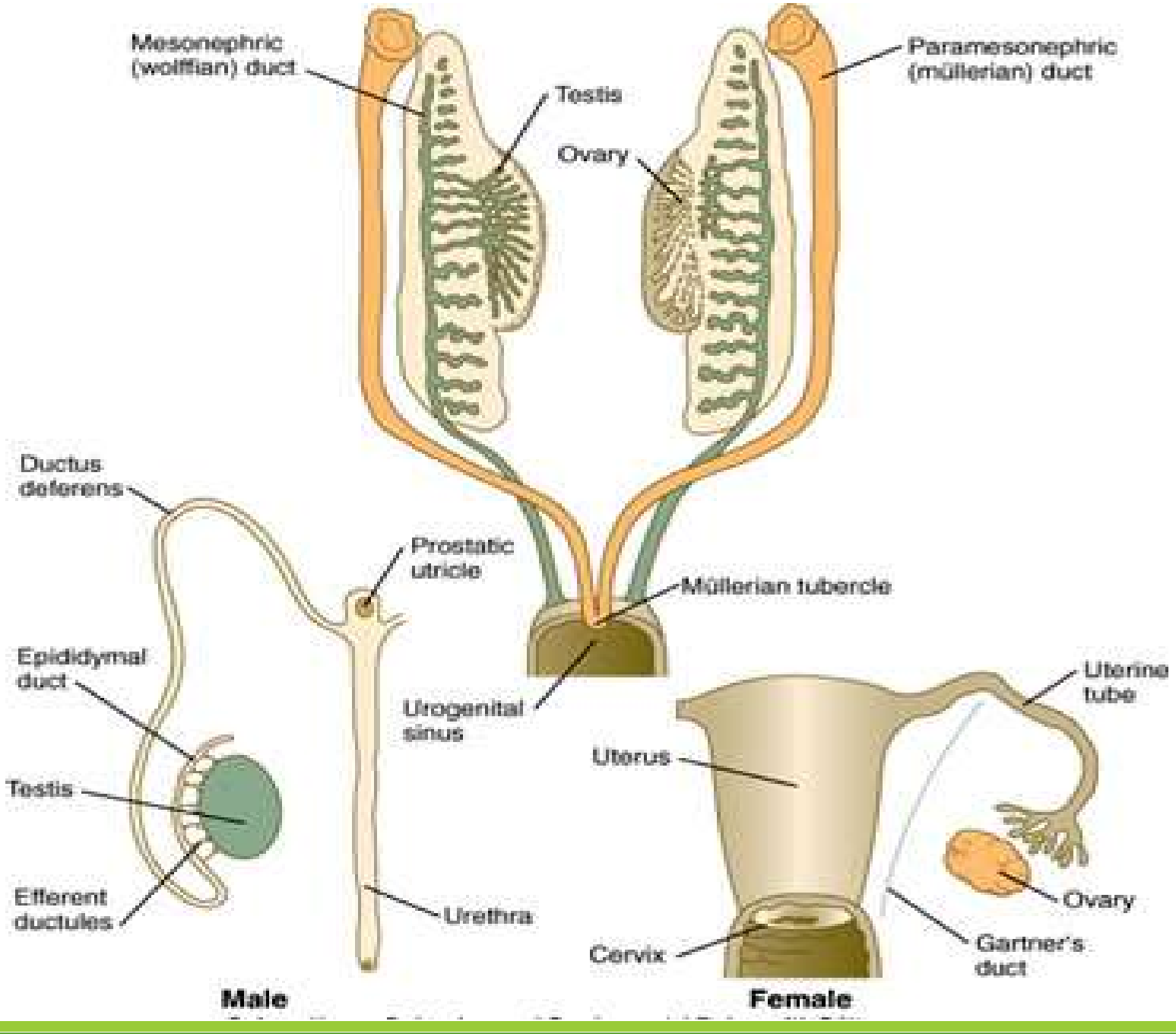
- **In the male**, under the effect of **antimullerian factor (A.M.F)** synthesized by Sertoli cells of the testis, mesonephric ducts will develop .
- Paramesonephric ducts will regress, leaving ***vestigial*** structures.
- **In the female**, in the ***absence*** of A.M.F, paramesonephric ducts will develop.
- The mesonephric ducts will regress leaving ***vestigial*** structures.

1-Indifferent stage of genital ducts

- Up to the 6th week of development, male or female embryos have two pairs of genital ducts.

- Two (right and left) mesonephric ducts.
- Two (right and left) paramesonephric ducts.

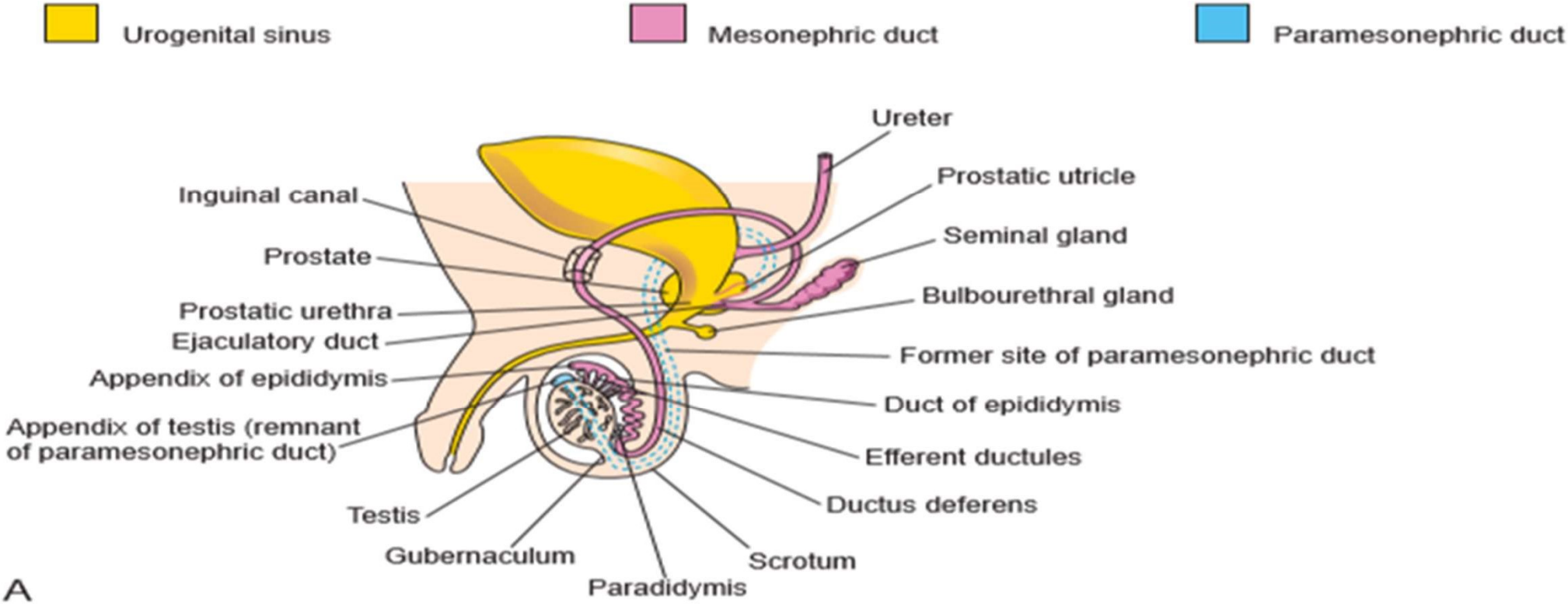
- **The paramesonephric duct** develops in the coelomic epithelium ***lateral*** to the cranial end of the mesonephric duct and continues to grow caudally lateral to that duct
- Then crosses ventral to it and then descends ***medial*** to it.
- The upper end of each paramesonephric duct opens by an abdominal ostium into the coelomic cavity (future peritoneal cavity).
- Their lower parts fuse to form a Y - shaped **uterovaginal canal** project into dorsal wall of the urogenital sinus to induce formation of ***Mullerian tubercle.***


Mesonephric (wolffian) duct
Testis
Ovary
Paramesonephric (müllerian) duct
Ductus deferens
Prostatic utricle
Müllerian tubercle
Epididymal duct
Urogenital sinus
Uterine tube
Uterus
Testis
Efferent ductules
Urethra
Ovary
Cervix
Gartner's duct
Male
Female

A. Paramesonephric ducts in the male

- They regress under the effect of M.I.F synthesized by Sertoli cells of the testis.

- Its **cranial** end forms **appendix of the testis.**
- Their **caudal** fused parts form **utricle** inside the prostate.
- **Mullarien tubercle** gives rise to **seminal colliculus** in the posterior wall of the prostatic urethra



A. Paramesonephric ducts in the female

- The **cranial and middle** parts of each duct form the **uterine tube**, which opens in the coelomic cavity close to the ovary

- Their **caudal** vertical parts (utrovaginal canal) form the **uterus and upper 3/5 of the vagina** *(**mesodermal**).*

- ❖ The ***Mullerian tubercle*** form two ***solid*** invaginations called sino-vaginal bulbs which unite to form a single ***vaginal plate***.
- ❖ The vaginal plate is ***canalized*** to form the lower 2/5 of the vagina.
- ✓ At the lower end of the vagina, the vaginal plate form a thin membrane which form the hymen .
- ✓ The vaginal vestibule is formed from definitive urogenital sinus

- So, the vagina is formed as follows:

- ➢ Upper 3/5 ***(mesodemral)*** develops from the lower part of the utrovaginal canal.
- ➢ Lower 2/5 ***(endodermal)*** develops from the vaginal plate derived from the Mullerian tubercle
- ➢ The vaginal vestibule ***(endodermal)*** develops from definitive urogenital sinus.

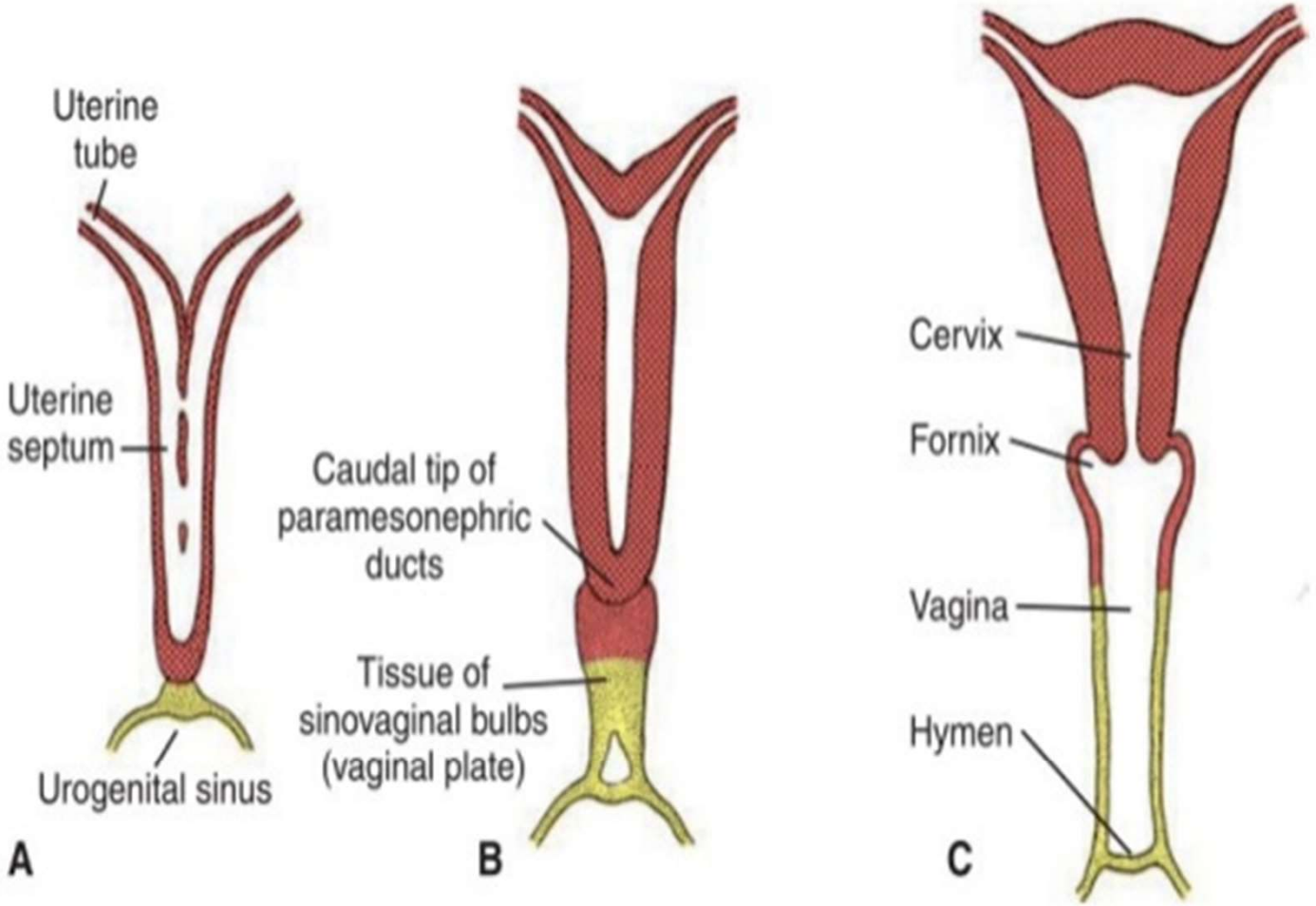
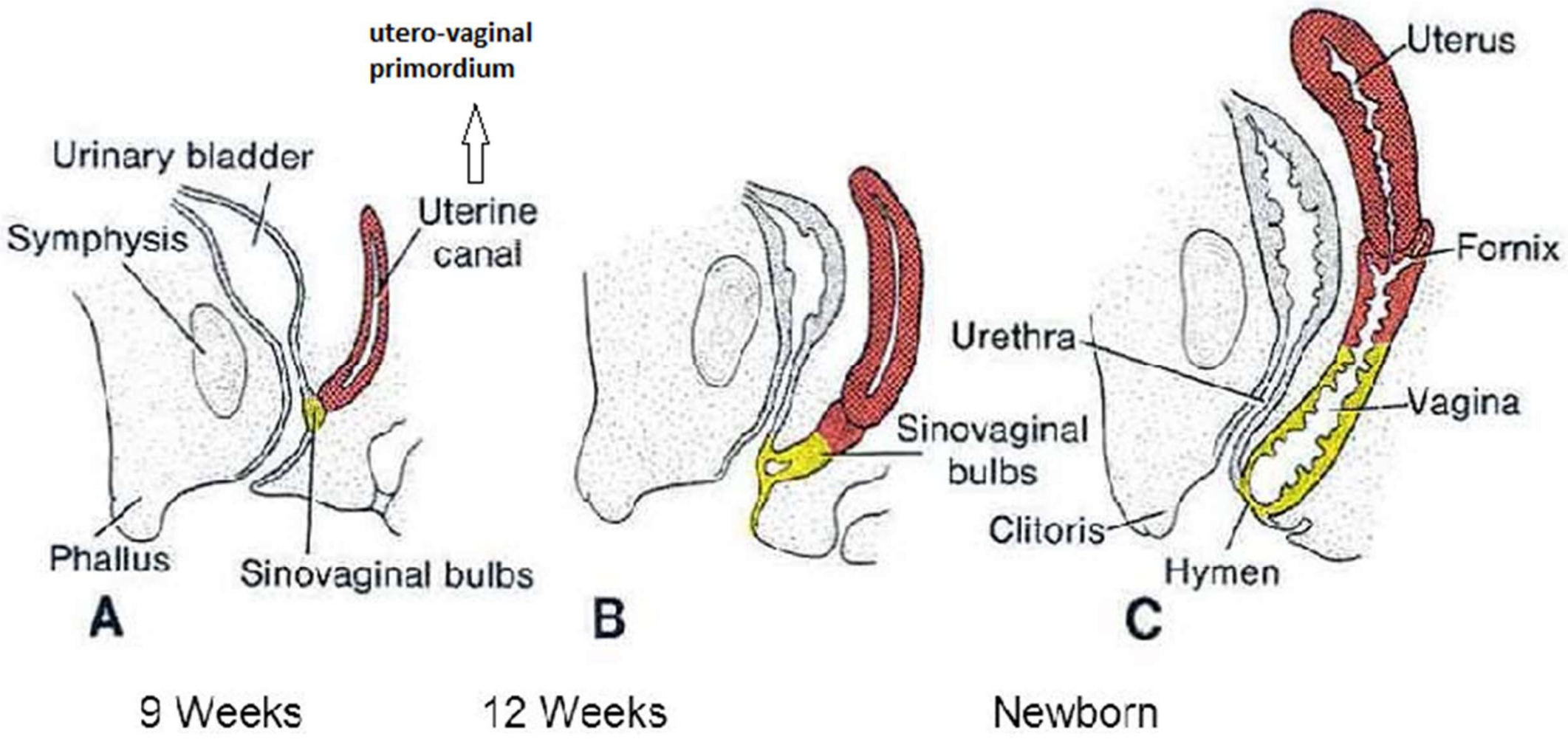
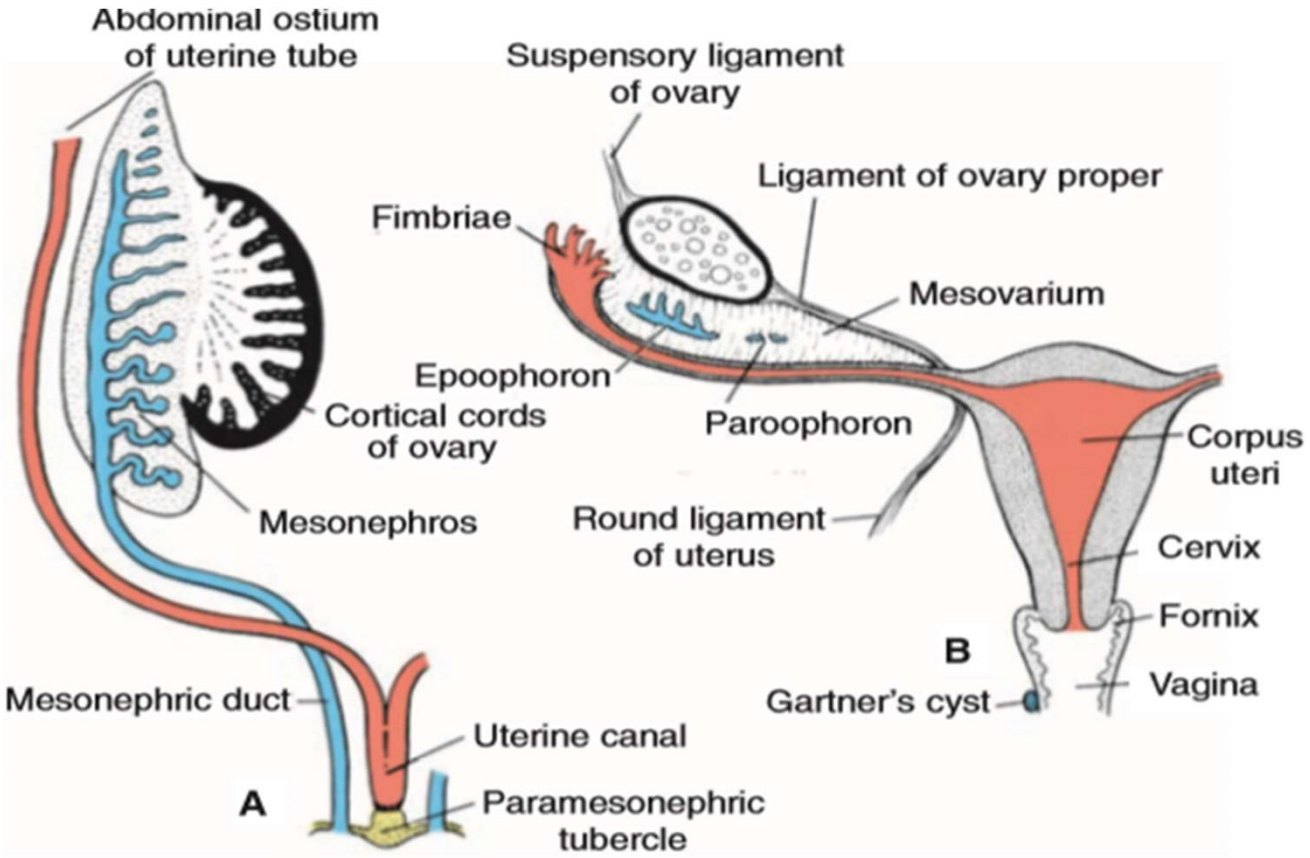


Figure 16.29 Formation of the uterus and vagina. **A.** 9 weeks. Note the disappearance of the uterine septum. **B.** At the end of the third month. Note the tissue of the sinovaginal bulbs. **C.** Newborn. The fornices and the upper portion of the vagina are formed by vacuolization of the paramesonephric tissue, and the lower portion of the vagina is formed by vacuolization of the sinovaginal bulbs.


utero-vaginal primordium
Urinary bladder
Symphysis
Uterine canal
Phallus
Sinovaginal bulbs
A
B
Uterus
Fornix
Urethra
Vagina
Sinovaginal bulbs
Clitoris
Hymen
C
9 Weeks
12 Weeks
Newborn

As the middle parts of the paramesonephric ducts cross medially to reach the midline, they drag with them transverse folds of peritoneum, which will form the broad ligaments of the uterus



Congenital anomalies

1. Uterus **bicornis unicollis** (collis = cervix), the uterus has two horns, which open into a ***single*** vagina.

2. Uterus **bicornis bicollis**, the uterus is divided completely into two horns and each has a **separate** cervix.

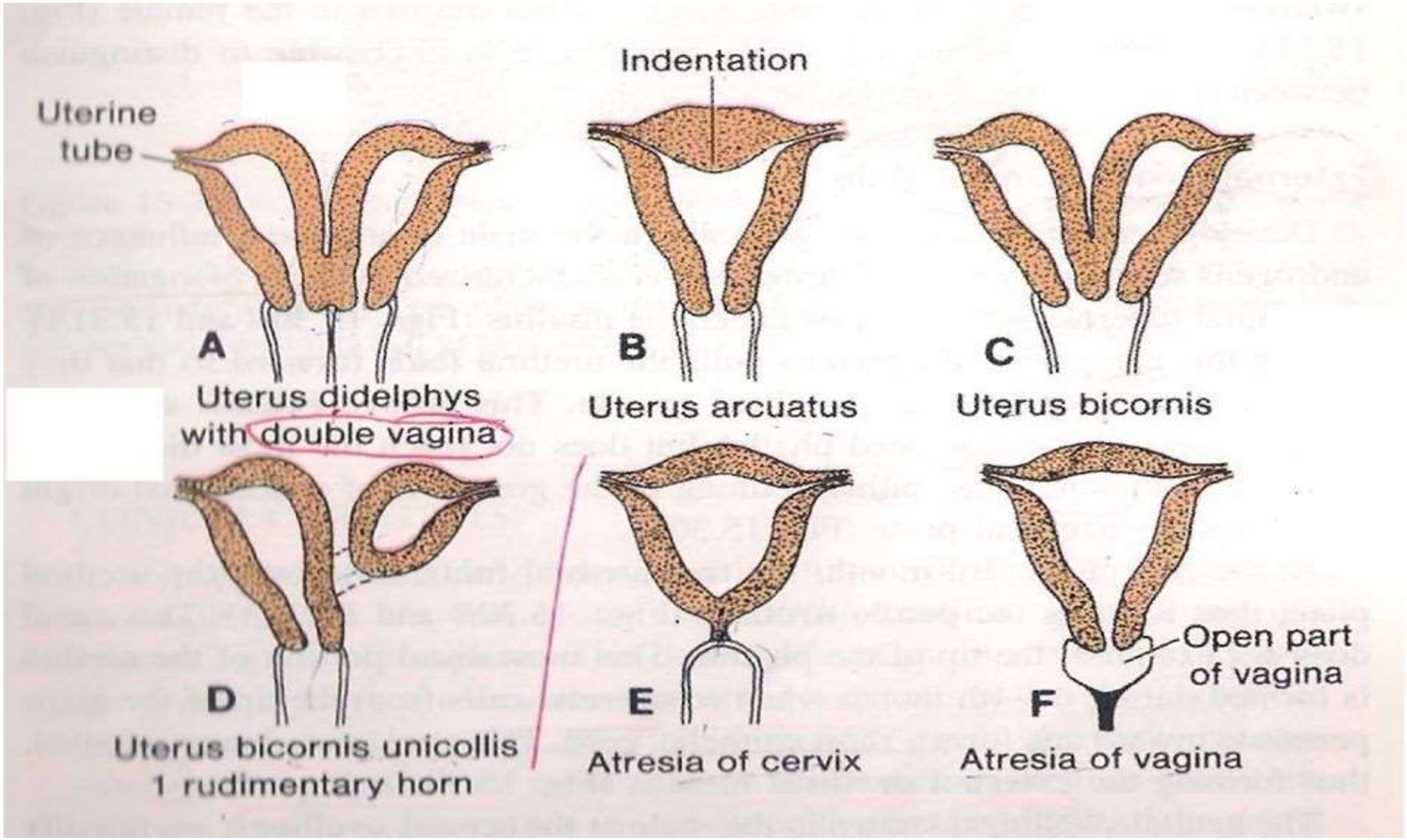
3. Uterus **unicornis unicollis** , the uterus is formed only of a single horn and the other horn is rudimentary.

4. **Septate vagina**, in which ***only*** the vagina is divided into two parts by a median septum.

5. **Atresia of the vagina** due to failure of canalization of the vaginal plate.

6. **Imperforate hymen**.

9. **Congenital rectovaginal fistula** due to incomplete development of urorectal septum.


Uterine tube
A
Uterus didelphys with double vagina
Indentation
B
Uterus arcuatus
C
Uterus bicornis
D
Uterus bicornis unicollis 1 rudimentary horn
E
Atresia of cervix
Open part of vagina
F
Atresia of vagina

Development of external genitalia

Dr Ahmed Salman

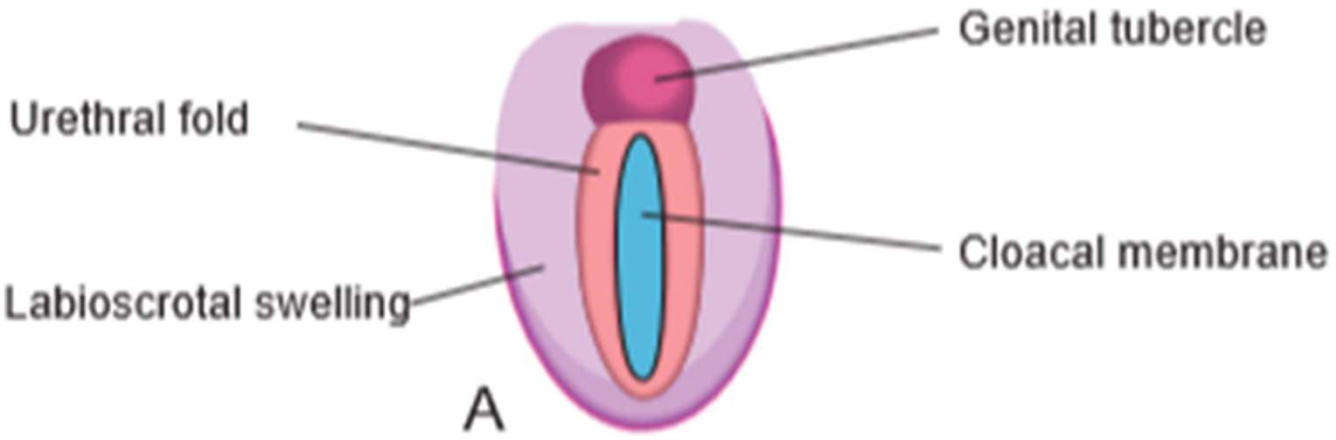
Indifferent stage of the external genitalla

- From the 4th to the 7th week of development, the external genitalia can not be differentiated into male or female.
- In the 4th week, the mesenchyme around the urogenital membrane proliferates to produce five elevations, all are covered by ectoderm.

1- A single **genital tubercle** at the cranial end of the urogenital membrane elongates to form the phallus.

2-Right and left **genital (urethral) folds** on the sides of the urogenital membrane.

3-Right and left genital **(labio - scrotal) swellings** on the sides of the genital folds.



Development of the male external genitalia

- Due to the secretion of **testosterone** by the developing testis, the undifferentiated external genitalia are switched to form male type external genitalia.

1. Genital tubercle: it elongates to form the phallus, whose mesenchyme forms two corpora cavernosa.

2. The genital (urethral folds):

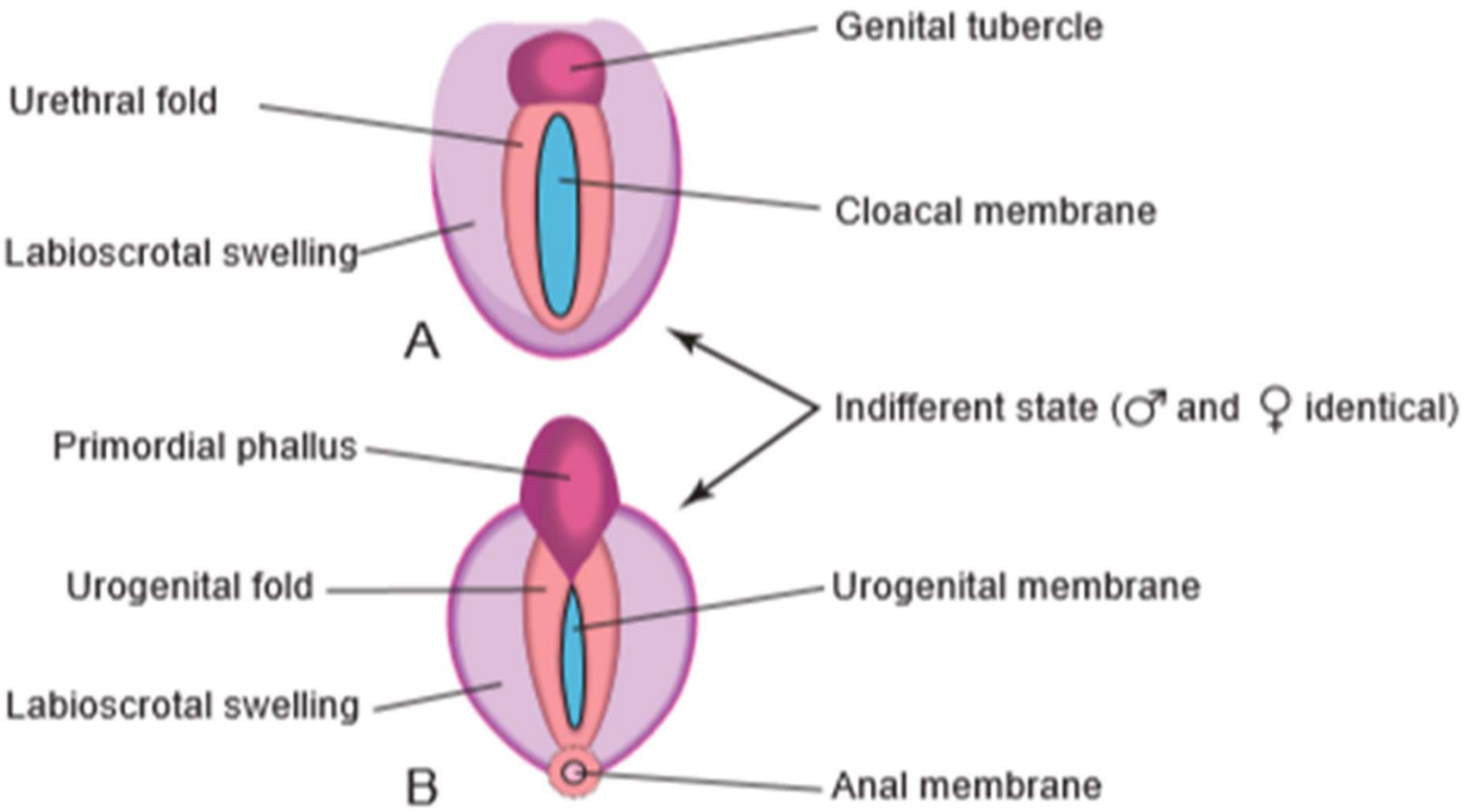
- Rupture of the urogenital membrane
- A longitudinal ***urethral groove*** appears on the ventral aspect of the developing penis. The sides of that groove are bordered by the urethral folds.

- The floor and sides of the ***urethral groove*** become lined with an **endodermal *urethral plate.***
- The edges of that plate are continuous with those of the urethral folds.

- The edges of the **endodermal** urethral plate are fused with each other to form the penile urethra ***except*** its terminal part within the glands penis.

• The edges of the mesenchyme within the urethral folds fuse around the penile urethra and form the single corpus spongiosum.

The two **genital swellings**: fuse in the midline to form the scrotum

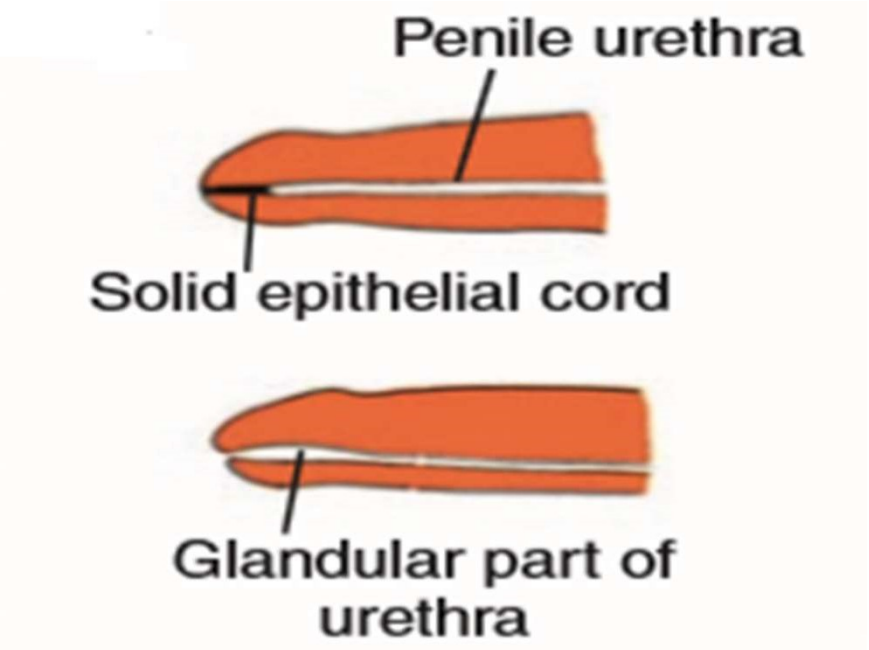


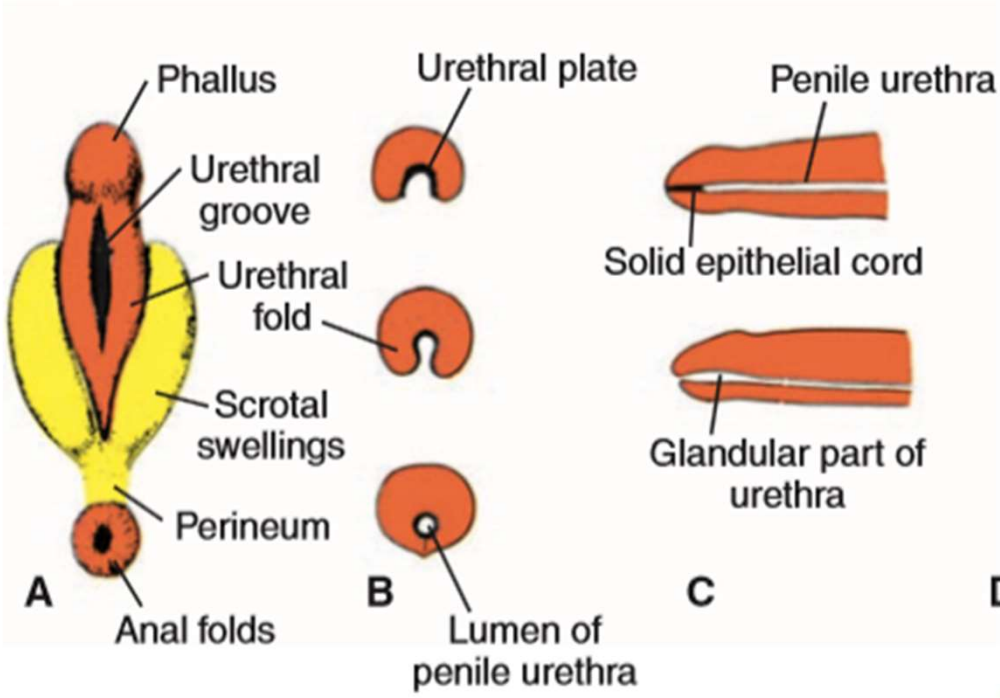
Development of the penis:

- Its **dorsal and lateral aspects** are formed by the **mesenchyme of the phallus,** whose mesenchyme forms the two corpora cavernosa.
- Its **ventral aspect** is formed by the **mesenchyme of the urethral folds,** whose mesenchyme forms the single corpus spongiosum.

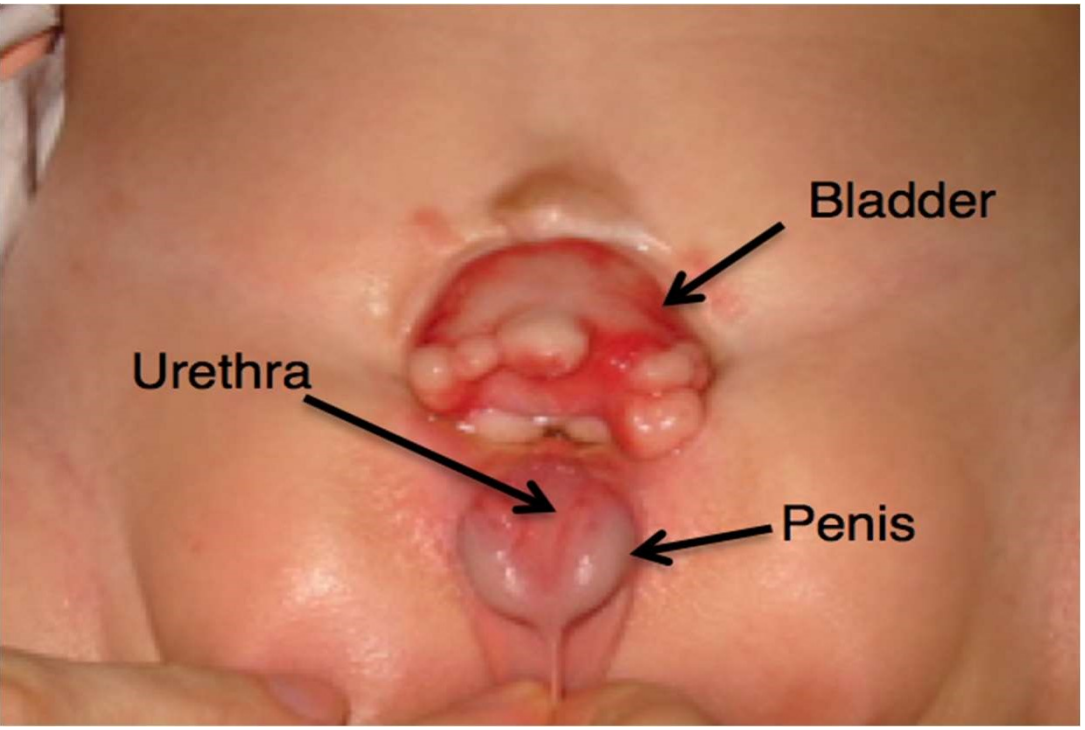
Congenital anomalies:

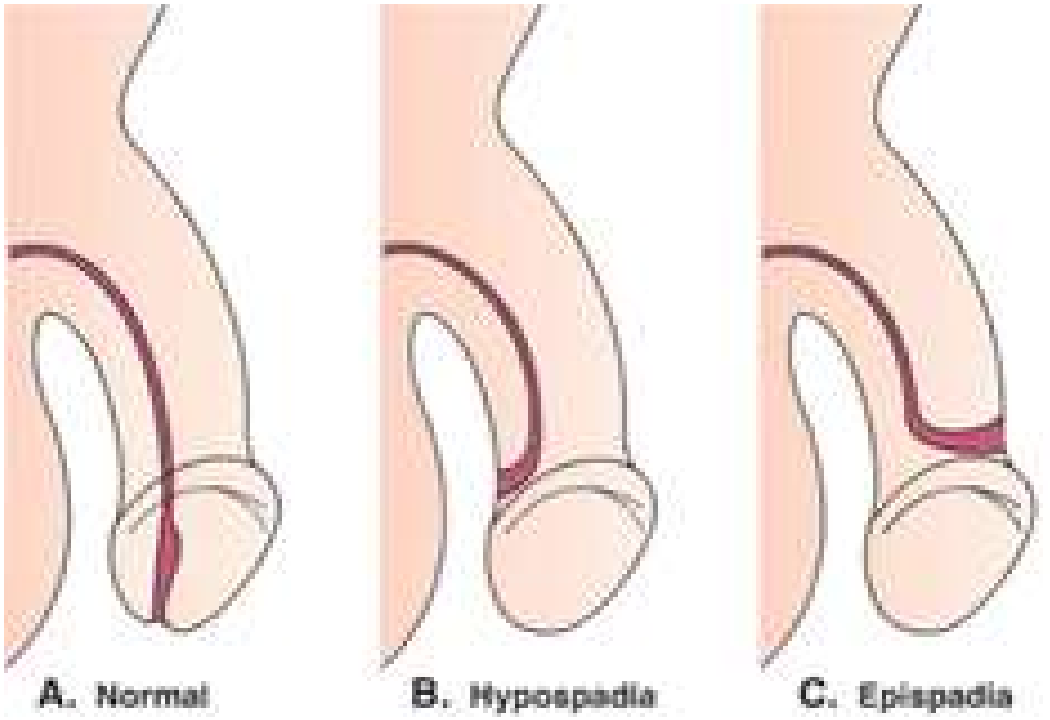
1. Hypospadius: the urethral orifice is present in the ***ventral*** aspect of the penis due to incomplete fusion of the two urethral folds .
2. Epispadius: an abnormal orifice is present on the ***dorsal*** aspect of the penis, usually associated with ectopia vesicae .





Hypospadius





Epispadius

Development of the female external genttalla

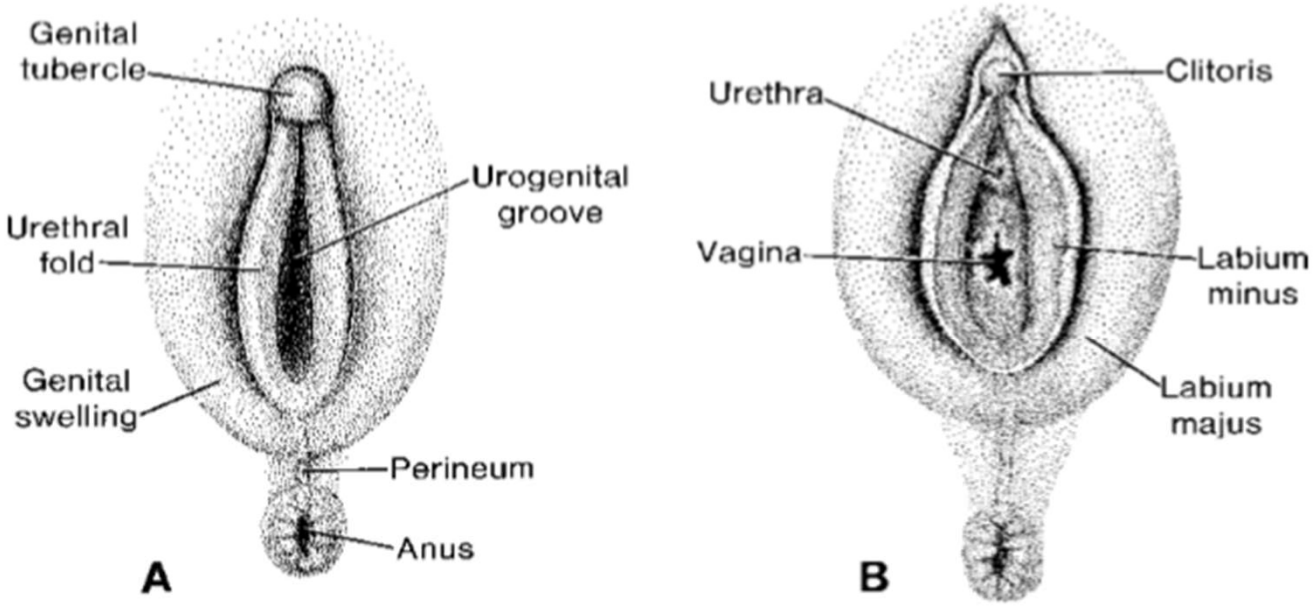
- Under the affects of the maternal and placental oestrogen, the external genitalia are switched to Form Female type of genitalia.

1. Genital tubercle: it elongates to form the clitoris, whose mesenchymef Forms its two corpora cavernosa (note that, the clitoris has ***no*** corpus spongiosum).

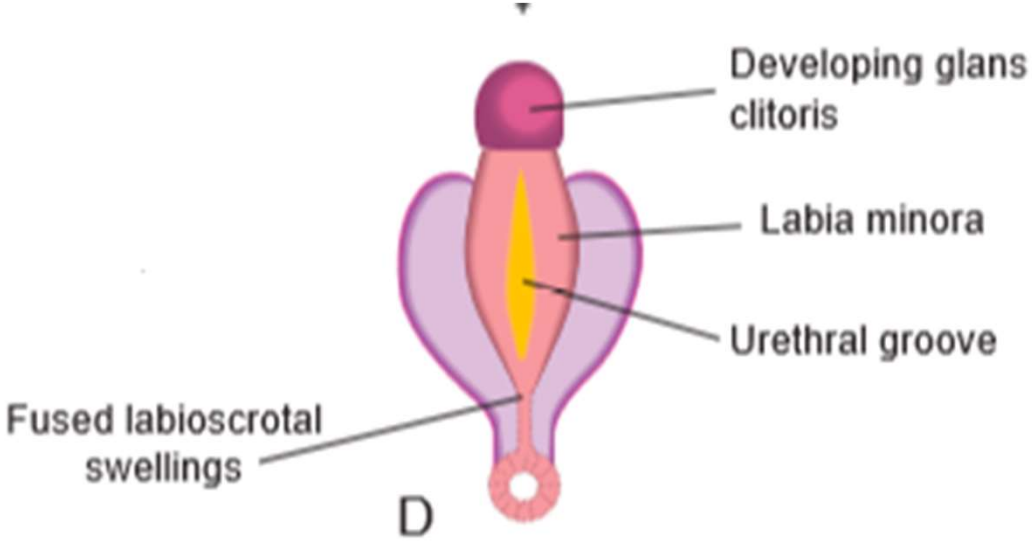
2. Genital (urethral folds): they remain ***separate*** to form the two labia minora.

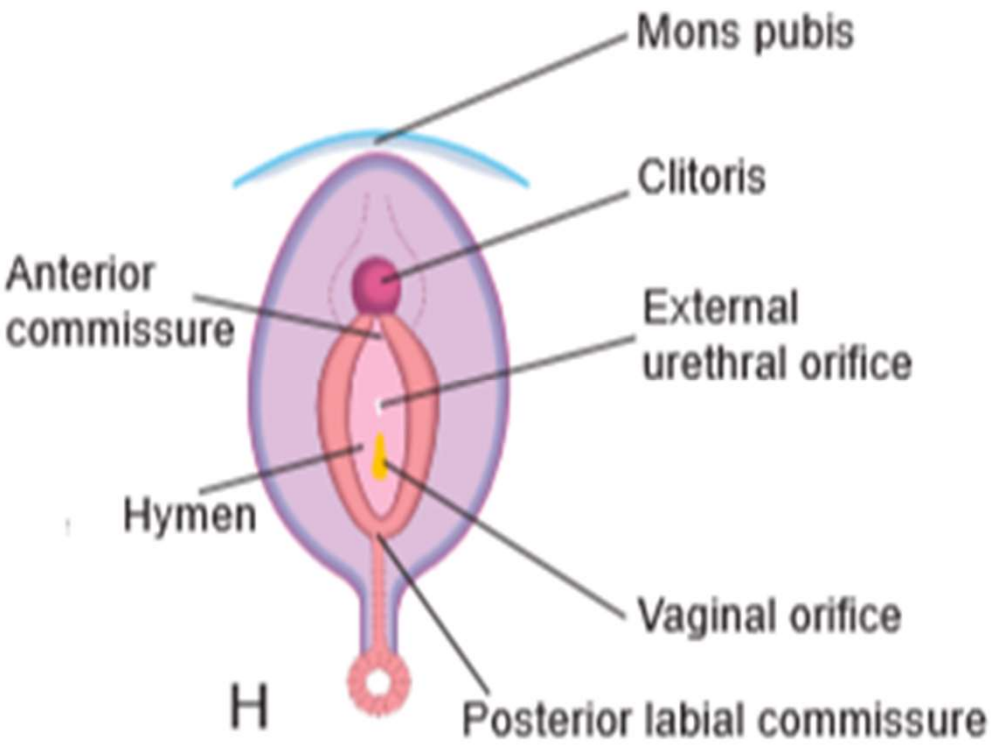
3. Genital swellings: they remain ***separate*** to form the two labia majora.

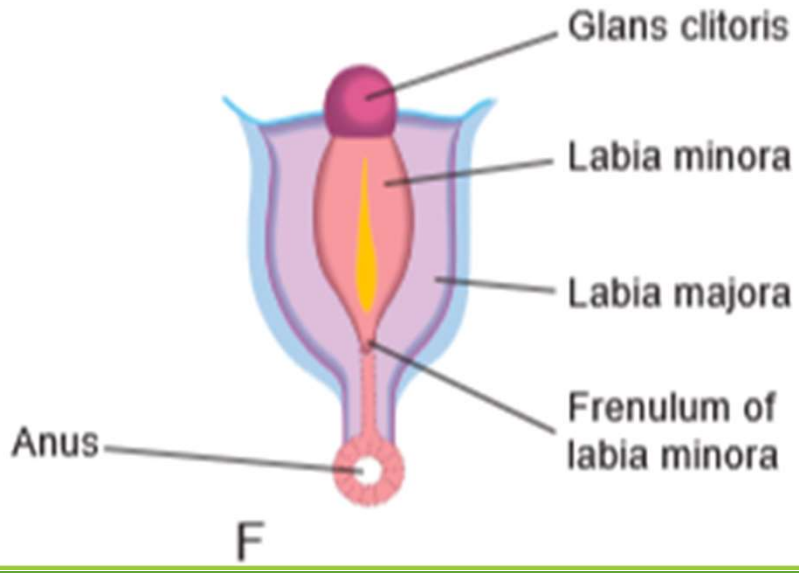
4. The vaginal vestibule: is formed when primitive urogenital sinus are ***shortened*** to form the vestibule between the two labia minora.



6.36 Development of the external genitalia in the female at 5 months **A** and in the newborn **B**.


Developing glans clitoris
Labia minora
Urethral groove
Fused labioscrotal swellings
D


Mons pubis
Clitoris
Anterior commissure
External urethral orifice
Hymen
Vaginal orifice
Posterior labial commissure
H


Glans clitoris
Labia minora
Labia majora
Frenulum of labia minora
Anus
F

Thank you for attention!