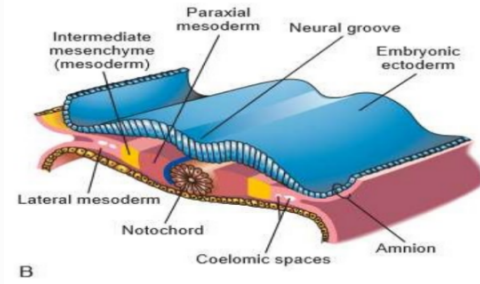
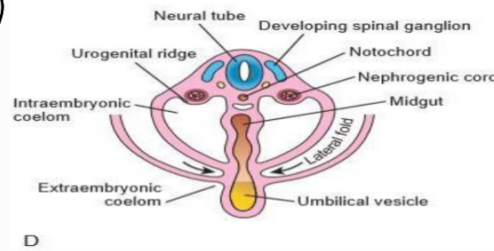
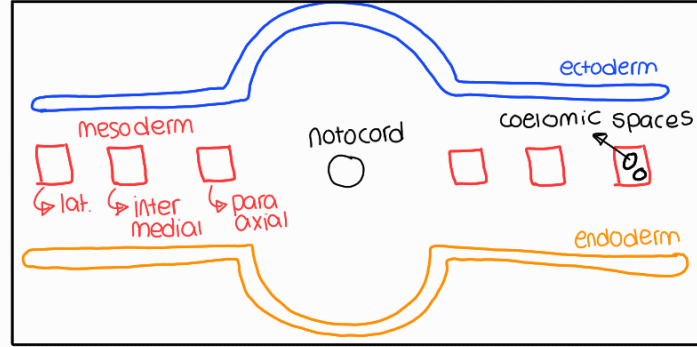


# LEC 1: DEVELOPMENT OF URINARY SYSTEM

- \* **Nephron** → Bowman Capsule, glomerulus, prox. convoluted tubule, hense loop, distal convoluted tubule
- \* **collecting system** → Collecting duct, Calyces, pelvis, Ureter

## \* Upper Urinary System (Kidneys)

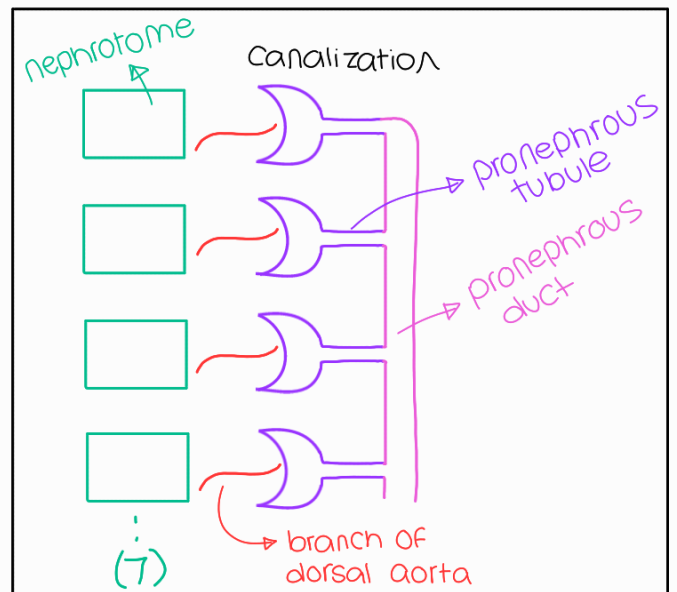
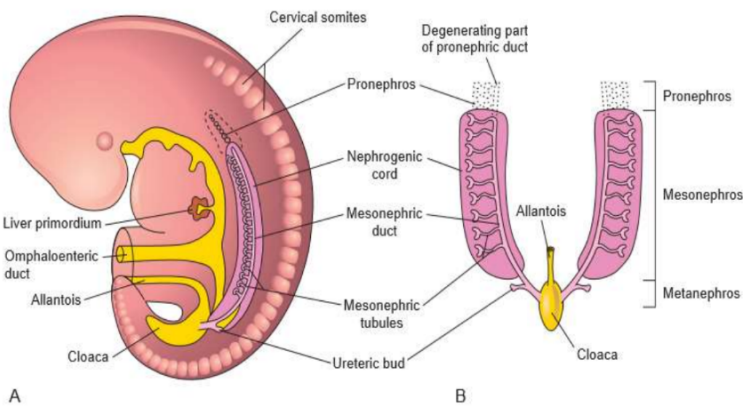
- From **intraembryonic intermediate mesoderm**
- After folding, mesoderm is behind intraembryonic coelum **ON SIDES OF descending aorta** (coelum forms peritoneum, pericardium, pleura)
- Kidney is retroperitoneal



## • 3 successive stages:

### ① pronephric stage

- ↳ in **Cervical region**, **4<sup>th</sup> week**
- ↳ mesoderm forms **7** small blocks (nephrotome)
- ↳ tubules have 2 ends:
  - a) medial → receives branches of aorta, forms **internal glomerulus**
  - b) lateral → grows caudally & unite into a duct which descends to cloaca
- ↳ **tubules degenerate**, **duct transforms into mesonephric duct**



## ② mesonephrous stage:

↳ in thoracic & upper lumbar

↳ 70 blocks

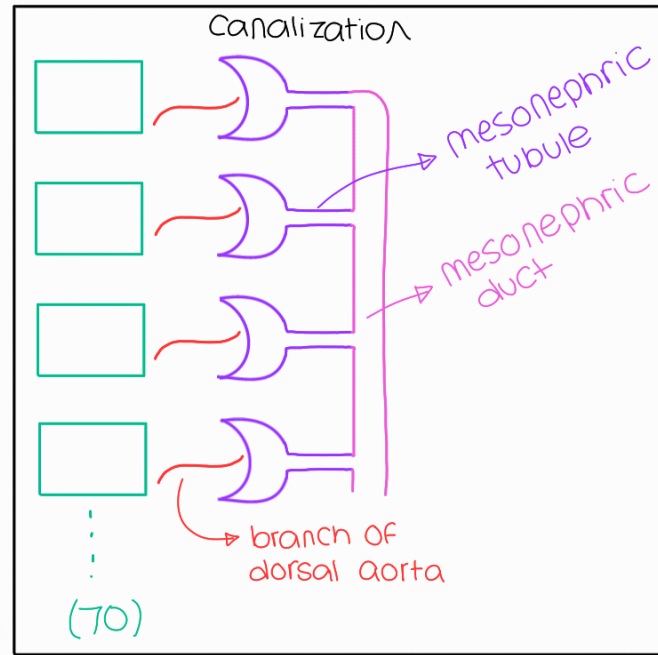
↳ S shaped tubules

↳ tubules have 2 ends:

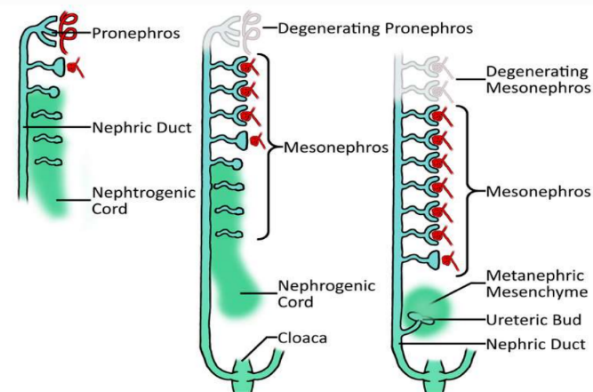
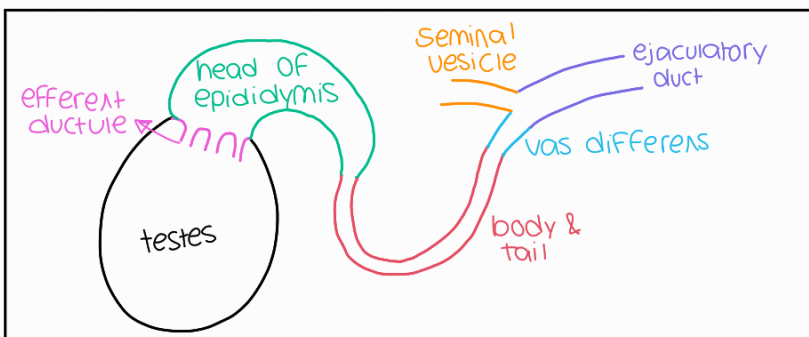
a) medial → invaginated by capillary plexus & form primitive glomerulus, tubules form bowman's capsule around glomerulus (together form renal corpuscle)

b) lateral → joins mesonephric (Wolffian duct)

↳ mesonephrous degenerates, replaced by metanephrous (permanent kidney), except for some persistent tubules & ducts that form urogenital structures



	♂	♀
mesonephric tubule gives:	<ul style="list-style-type: none"> <li>- efferent ductule</li> <li>- head of epididymis</li> <li>- paradidymis</li> </ul>	<ul style="list-style-type: none"> <li>- epooporn</li> <li>- paroophorn</li> </ul>
mesonephric duct gives (genital)	<ul style="list-style-type: none"> <li>- body &amp; tail (epididymis)</li> <li>- vas deferens</li> <li>- Seminal vesicle</li> <li>- Ejaculatory duct</li> </ul>	<ul style="list-style-type: none"> <li>- duct of epophorn</li> <li>- Gartner's duct</li> </ul>
mesonephric duct gives (uro)	<ul style="list-style-type: none"> <li>- Ureteric bud (ureter, pelvis, calyces, collecting tubules)</li> <li>- trigone of bladder</li> <li>- post. wall of supra collicular prostatic urethra</li> </ul>	<ul style="list-style-type: none"> <li>- Ureteric bud (//)</li> <li>- trigone of bladder</li> <li>- post. wall of urethra</li> </ul>



### ③ Metanephros Stage

↳ in **Sacral** region, **5th** week

↳ from 2 mesodermal structures:

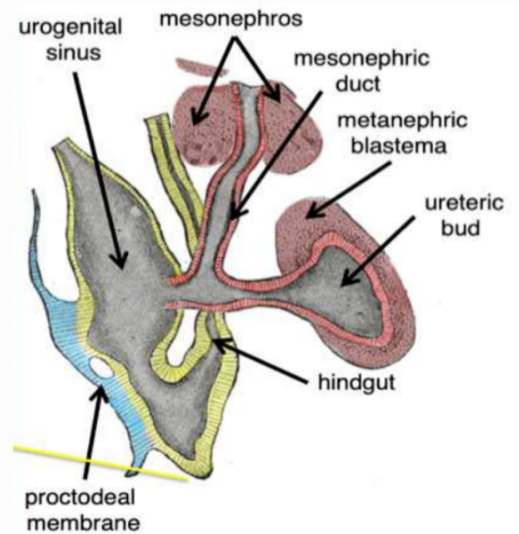
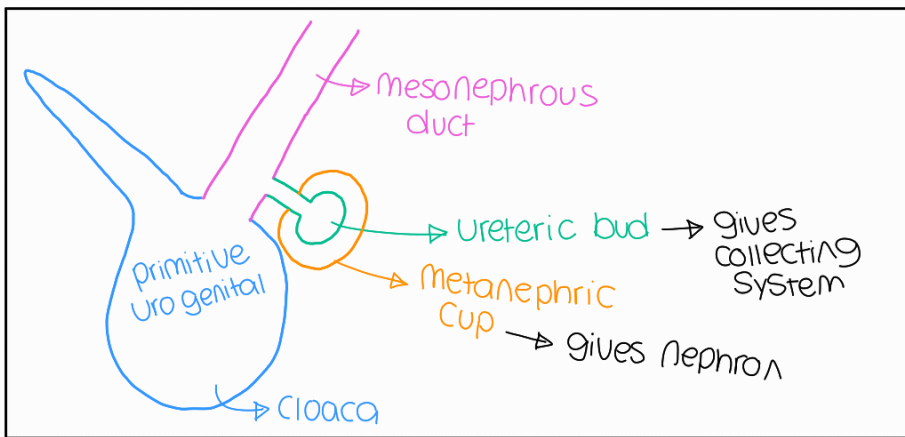
#### a) Ureteric bud:

At lower part of mesonephric duct near Cloaca, gives **Collecting System**

Note: renal pelvis divides into 2 Calyces then 7-11 minor calyces

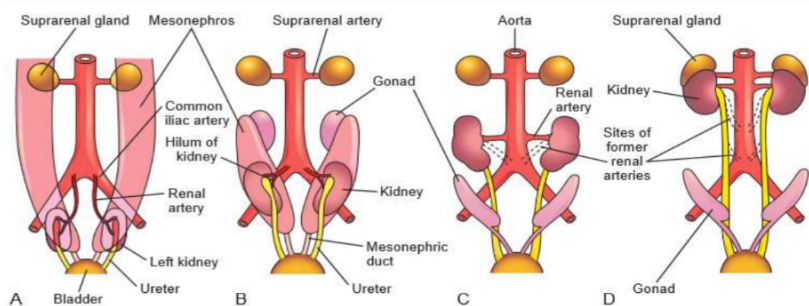
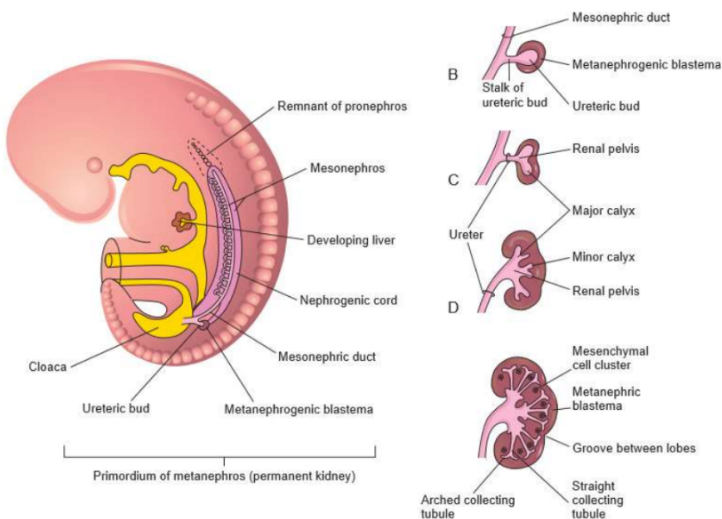
#### b) Metanephric cap

it's the caudal part of intermediate mesoderm, induced by ureteric bud to give clusters of cells around it → clusters canalize into renal vesicle → **Nephron**



### • postnatal changes in metanephros:

	was	becomes
shape	lobulated	X lobulation in early infancy
position	pelvic	ascends to abdomen
blood supply	medial sacral A	common iliac A → abdominal aorta
direction	hilum anteriorly	rotates 90° → hilum medially

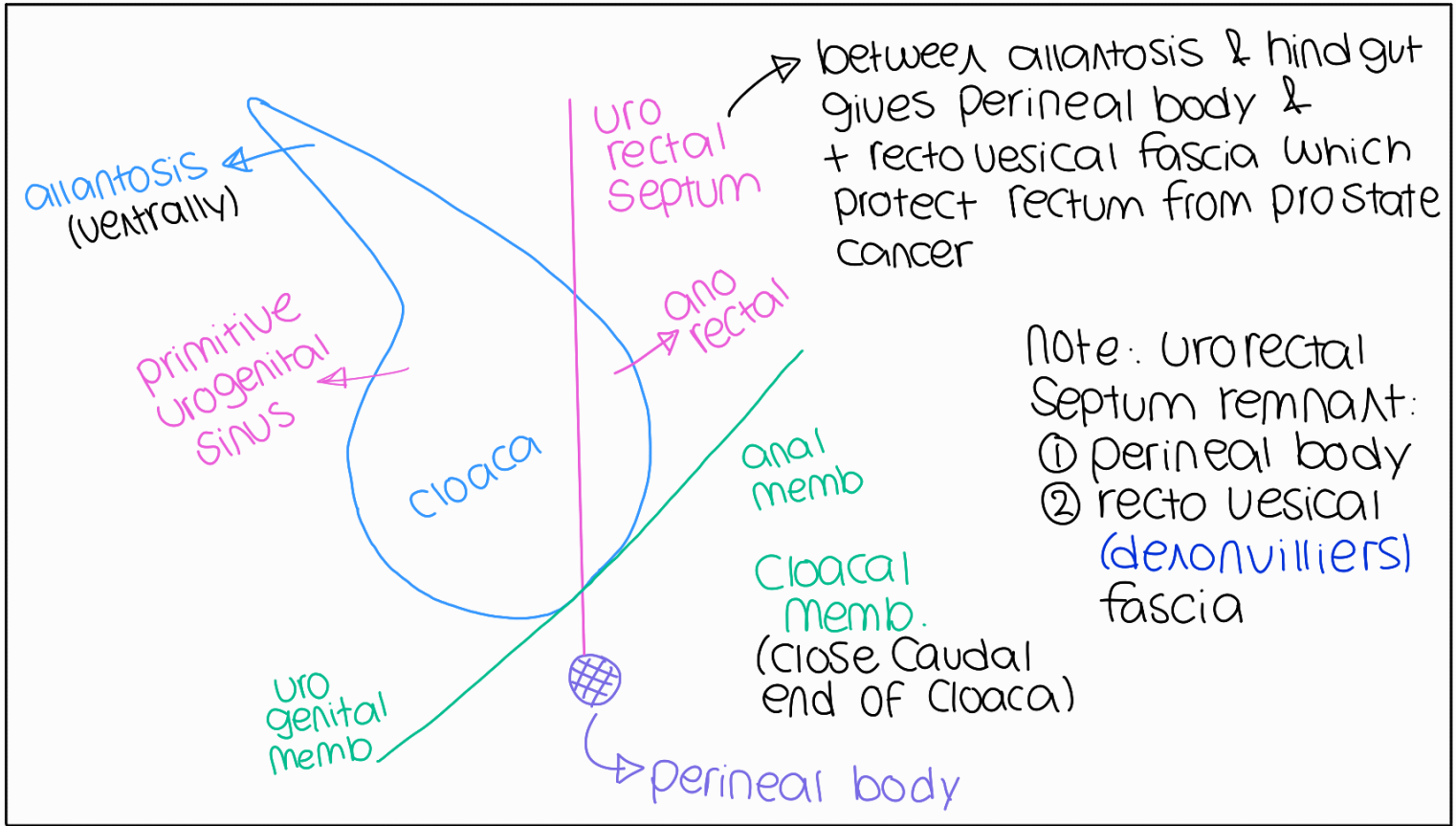




# \* Urinary bladder

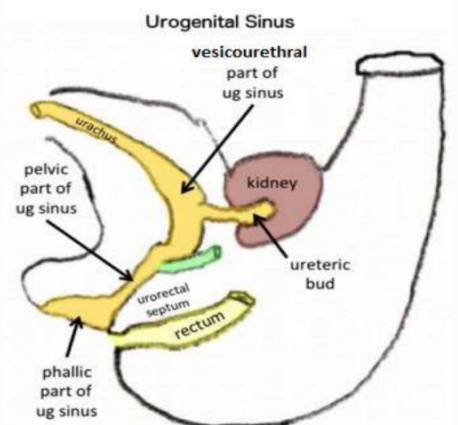
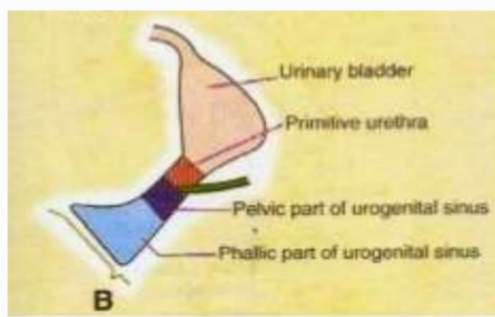
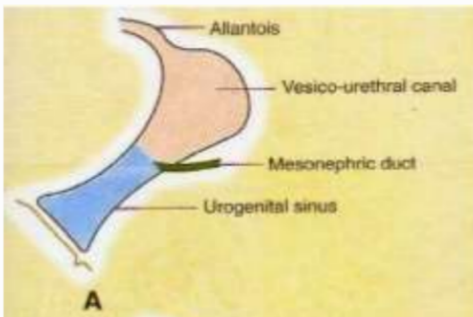
## Cloaca development:

- dilatation lined by endoderm, terminal part of hindgut

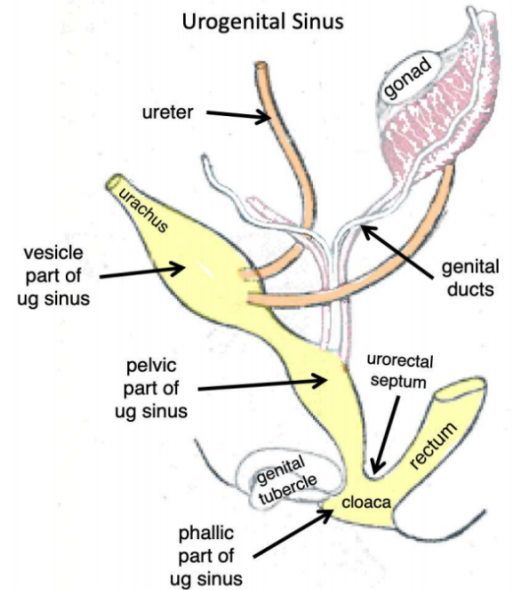
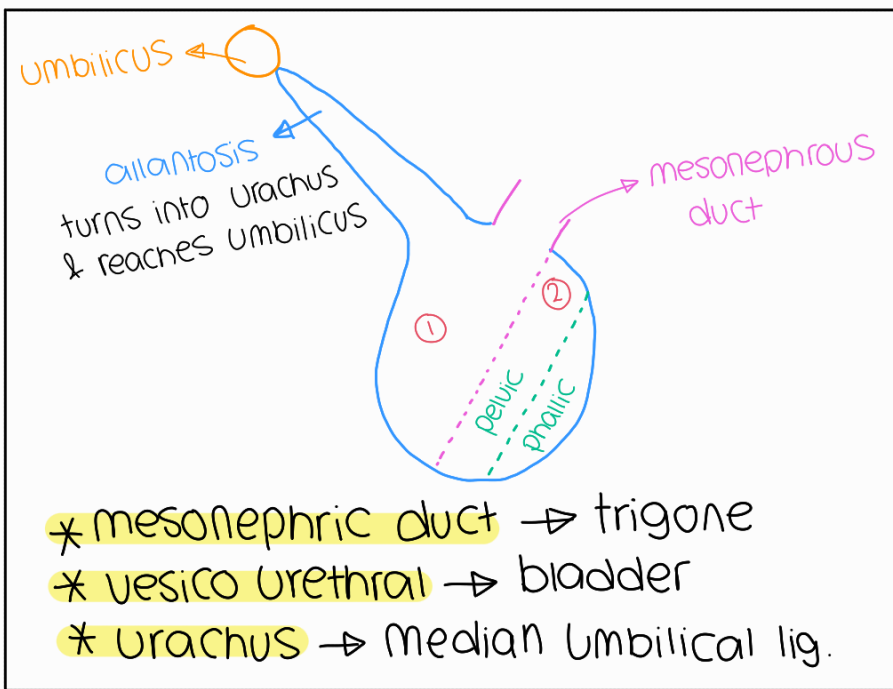


## • Urorectal Septum divided:

- a) Cloaca → ventrally: primitive Urogenital Sinus (cont. with allantosis, receives it & its Mesonephric duct)  
 → dorsally: ano rectal canal (cont. with hindgut, gives rectum & upper anal canal)
- b) Cloacal memb. → Urogenital (below Urogenital Sinus)  
 → Anal (below ano rectal canal)







• mesonephric duct divided cloaca into:

- ① vesicourethral (cranially, cont. with allantois)
- ② definitive urogenital (caudally, subdivided:):
  - ↳ pelvic
  - ↳ phallic (related to penis)

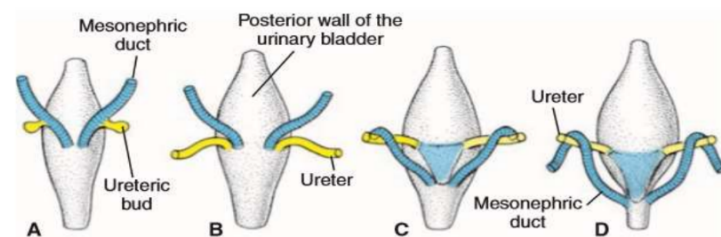
• allantois

Constricts to form fibrous cord (urachus) → cont. with apex of bladder

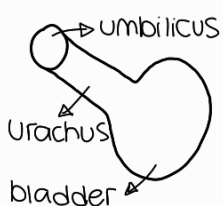
- Caudal part of duct (below ureteric bud) → absorbed into bladder wall forming trigone

• bladder development components:

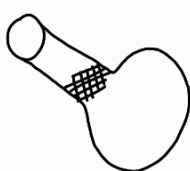
- a) Vesicourethral canal (endoderm) → major part
- b) lower absorbed parts of mesonephric duct (mesoderm) → trigone
- c) Splanchnic mesoderm → coats of bladder



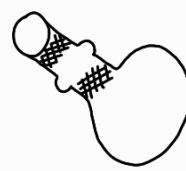
• anomalies drawings: (more about them later)



urachal fistula

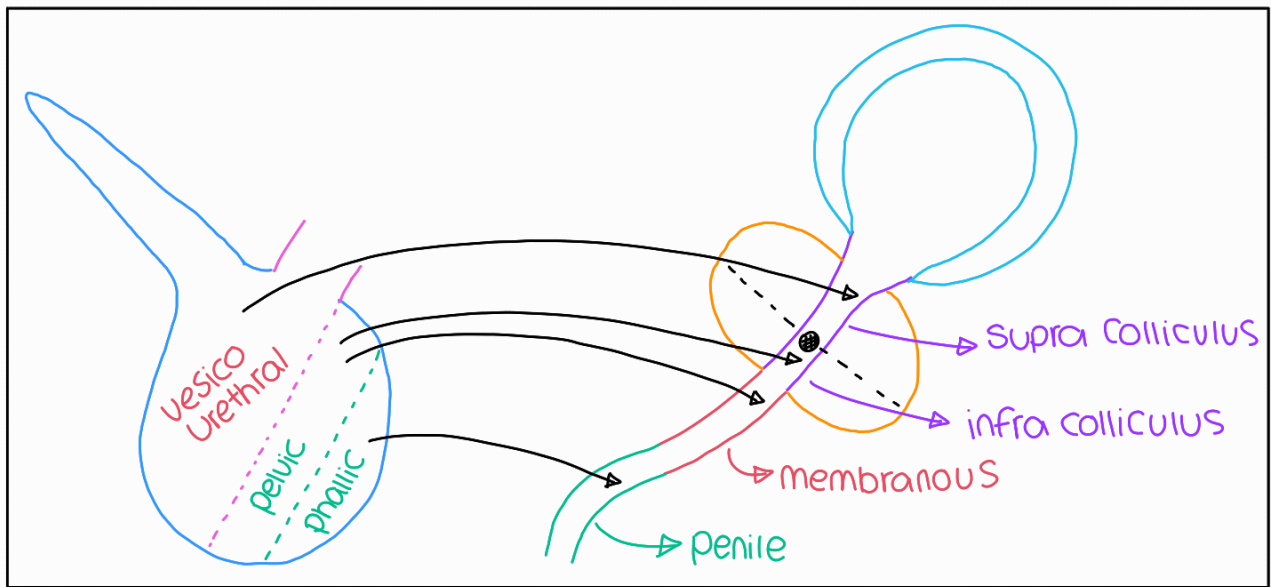
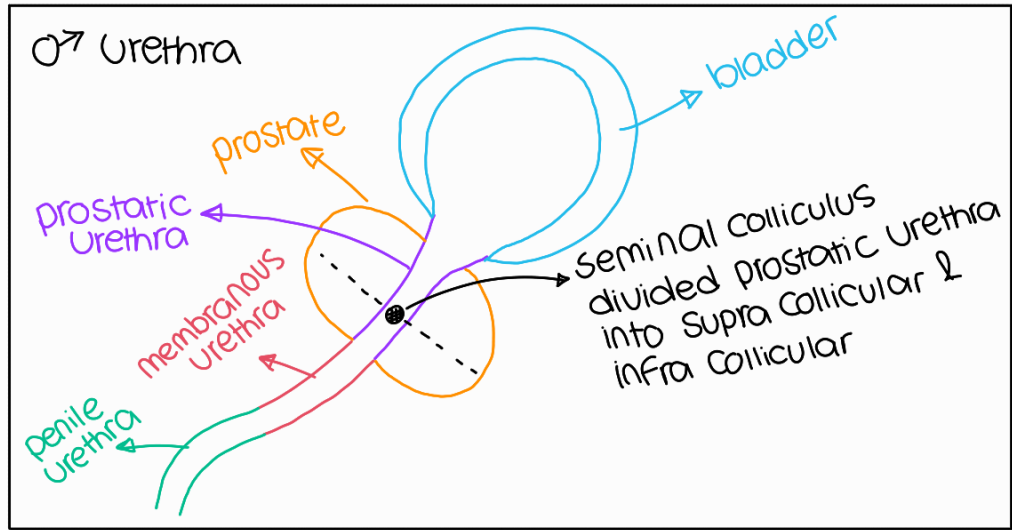
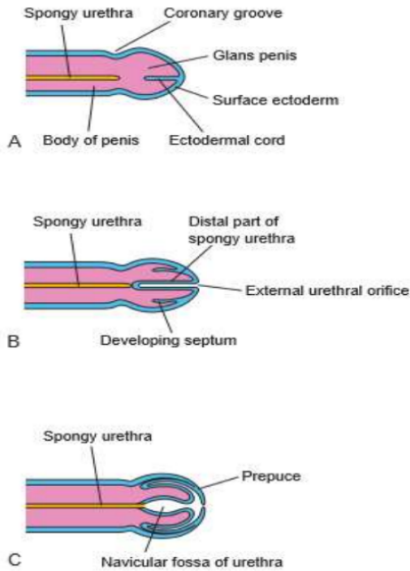


urachal sinus



urachal cyst (dilatation)

# \* Urethra



## Urogenital sinus derivatives

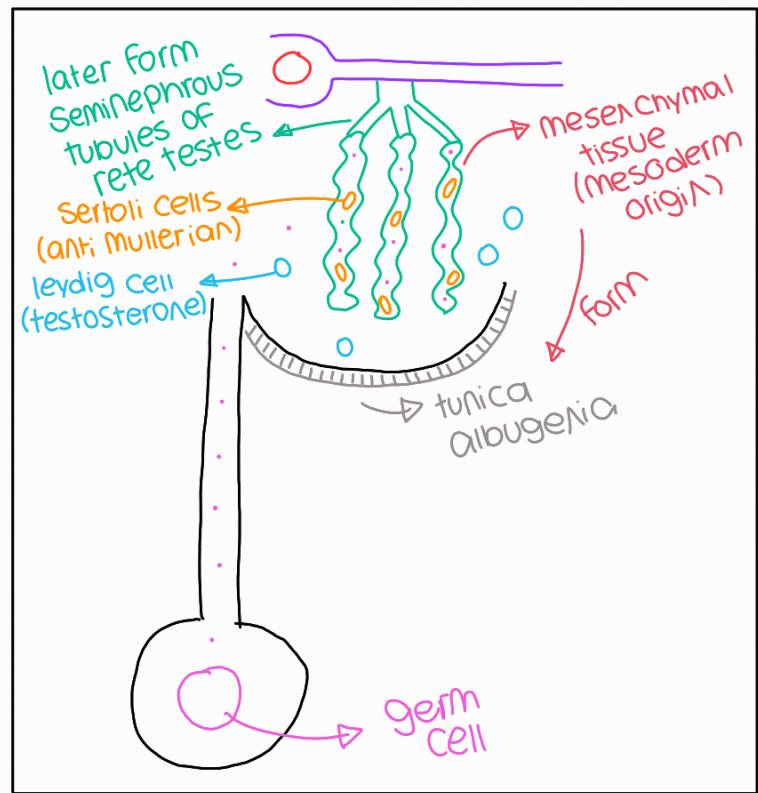
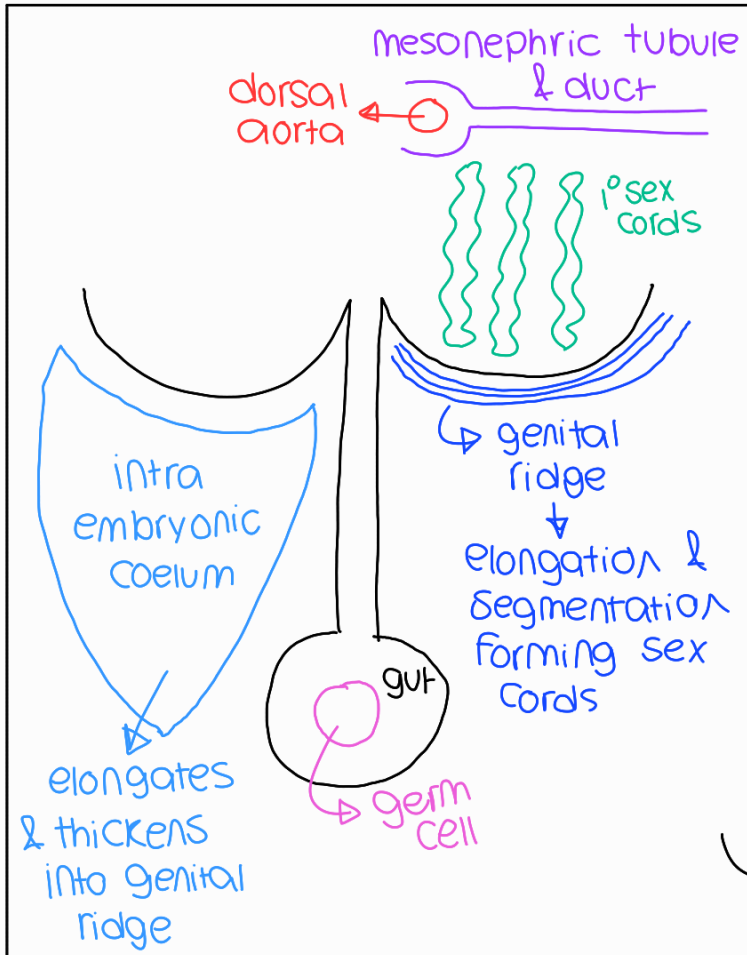
	♂	♀
<b>Vesico Urethral</b> (endoderm)	<ul style="list-style-type: none"> <li>- bladder except trigone (mesoderm)</li> <li>- <b>Supra collicular prostatic urethra</b> except dorsal wall (mesoderm)</li> </ul>	<ul style="list-style-type: none"> <li>- bladder except trigone (mesoderm)</li> <li>- <b>Whole urethra</b> except dorsal wall (mesoderm)</li> </ul>
<b>Pelvic</b> (endoderm)	<ul style="list-style-type: none"> <li>- <b>infra Collicular prostatic urethra</b></li> <li>- <b>membranous urethra</b></li> </ul>	Pelvic & phallic : <ul style="list-style-type: none"> <li>- lower 2/5 of vagina</li> <li>- vestibule of vagina</li> </ul>
<b>Phallic</b> (endoderm)	<ul style="list-style-type: none"> <li>- <b>Penile urethra</b> (fusion of 2 urethral folds) except its terminal part of glans penis (ectoderm)</li> <li>- <b>Glandular plate canalizes to form navicular fossa</b></li> </ul>	

# LEC 2: DEVELOPMENT OF GONADS

\* development sources of gonads:

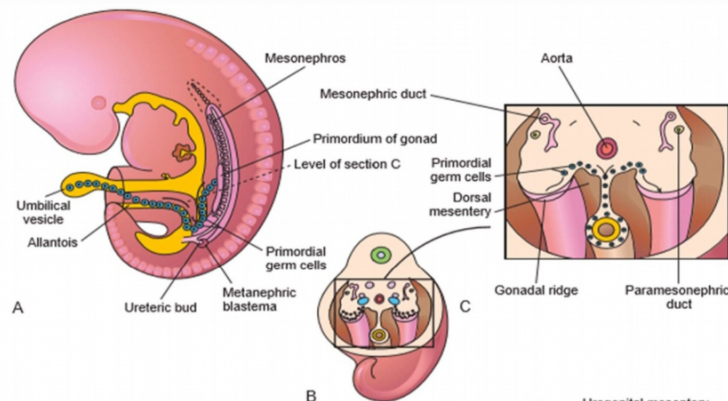
- ① proliferating Coelomic epithelium (meso) → medial to mesonephros, form Sertoli cells
- ② adjacent mesenchyme (meso) → dorsal to ①
- ③ primordial germ cells (endo) → develop in yolk sac & migrate along dorsal mesentery to reach gonad

\* the indifferent stage of developing gonads:



germ cell goes to cords

- Coelomic epithelium (on each side of aorta) proliferates & becomes multilayered → forms longitudinal projection into coelomic cavity (genital ridge)
- genital ridge forms epithelial 1° sex cords that invade mesenchyme
- Sex differentiation → week 6,7  
Sex cords turn to:  
♂: seminiferous tubules  
♀: ovarian follicle





# \* testes development & descent

• testes determining factor (TDF) on Y chromosome (short arm)

## ① Coelomic epithelium

a) 1° sex cords → elongate & form testes cords →

b) Seminiferous tubules

↳ ventrally → lose contact with surface epithelium by tunica albuginea

↳ dorsally → connect to each other & form rete testes

↳ internally → invaded by primitive germ cells

c) testes cords become surrounded by 2 layers:

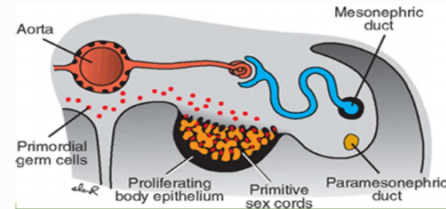
- Sertoli cells (meso, secrete Mullerian inhibitory factor (MIF))
- primitive germ cells

## ② Subjacent mesenchyme

- forms tunica albuginea that surrounds testes
- forms interstitial cells of Leydig (secrete testosterone)

## ③ primitive germ cells (endo)

reach genital ridge, form spermatozoa



## • testes position:

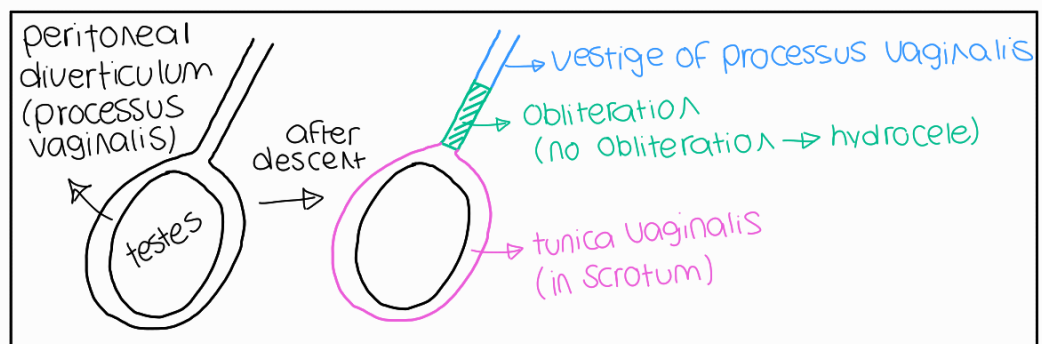
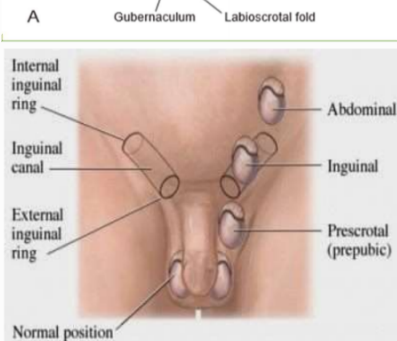
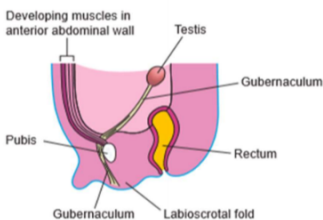
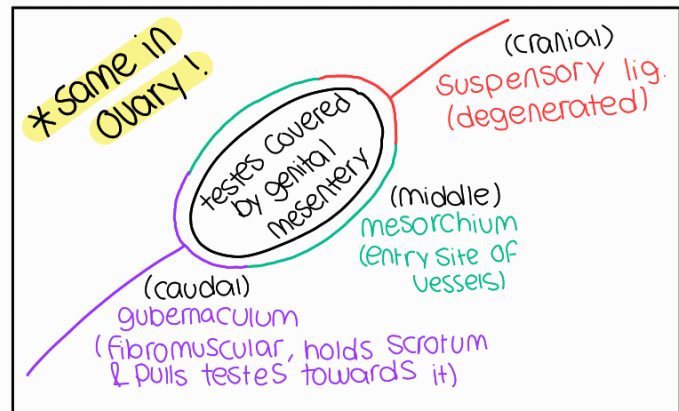
forms at L2 (in post. abdominal wall, receives testicular A from abdominal aorta) 4-6<sup>th</sup> mo. iliac fossa (int. descent)

7<sup>th</sup> mo. (ext. descent) deep ring 8<sup>th</sup> mo. inguinal canal 9<sup>th</sup> mo.

superficial ring → Scrotum

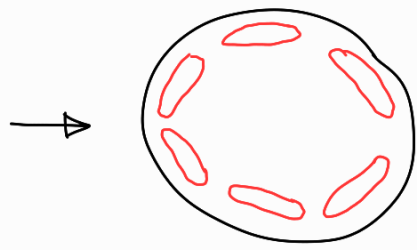
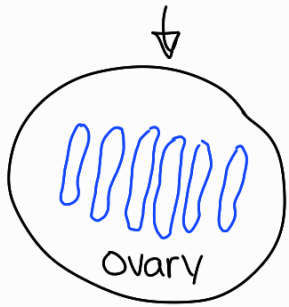
## • testes need 3 things to descend

- ① gubernaculum shortening
- ② ↑ intra abdominal pressure
- ③ hormonal factor (androgens, gonadotropins)

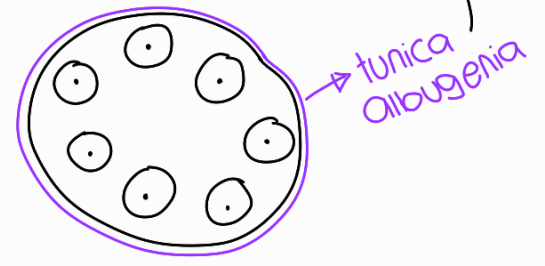


# \* Ovary development (No TDF → ovary formation)

coelomic epithelium: 1° sex cords invade mesenchyme & form



Subadjacent mesenchyme forms ovary stroma + thin tunica albuginea (bet. ovary & epithelium)



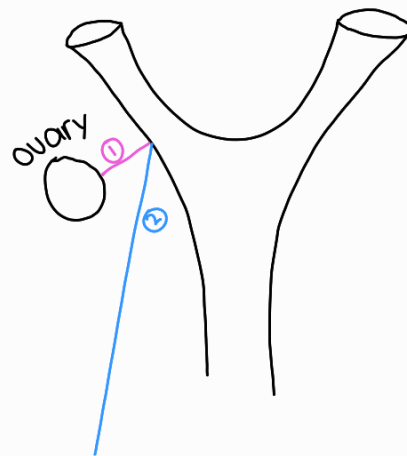
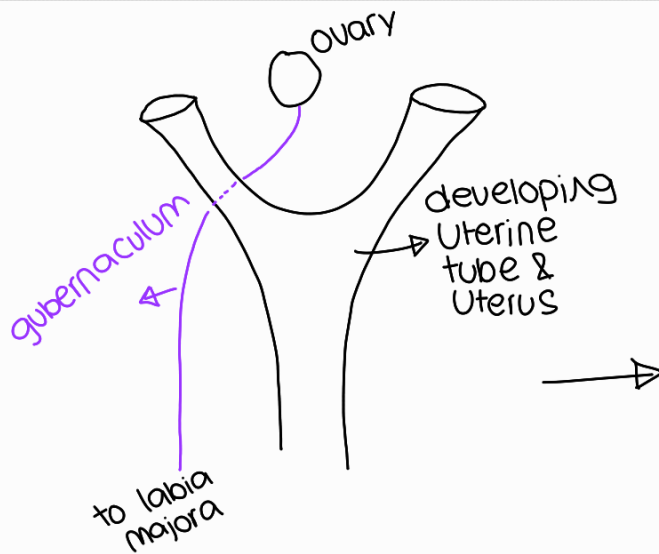
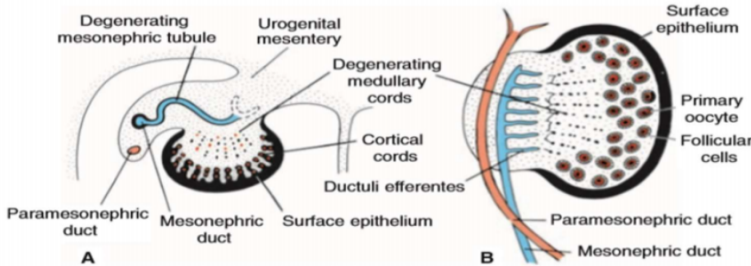
6 medullary sex cords (replaced by fibromuscular stroma forming medulla of ovary)

Other 6 cords form (cortical sex cords) remain near coelomic epithelium forming cortex (germ cells come here)

Cortical cords break to cell clusters → form follicles

primitive germ cells form 1° oocyte (invade follicles proliferate by mitosis)

at week 12: 1<sup>st</sup> meiosis  
prophase till puberty



## \* ovaries position

ovary formed at L2 level

↓ 3rd mo.

greater pelvis

↓ after birth

lesser pelvis

\* genital mesentery: same as ♂

guberniculum divides into:

① links ovary & uterotubal junction (round lig. of ovary)

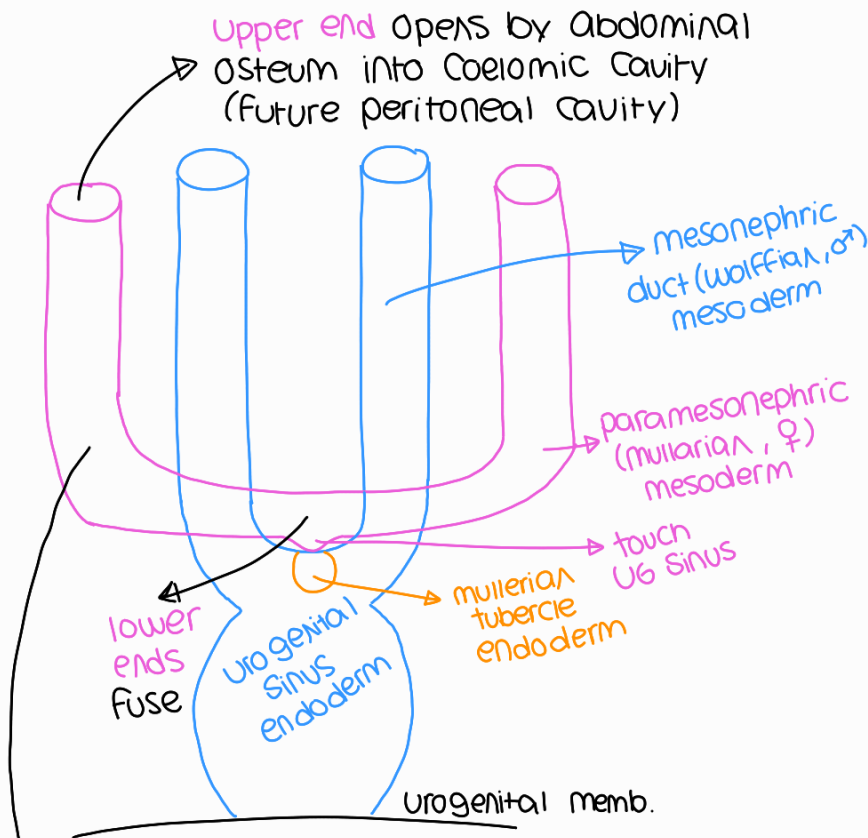
② links uterotubal junction & labia majora (round lig. of uterus)

persistance of small

processus vaginalis gives rise to canal of Nuck



# \* genital duct development



## • indifferent Stage:

till week 6, both sexes have both ducts

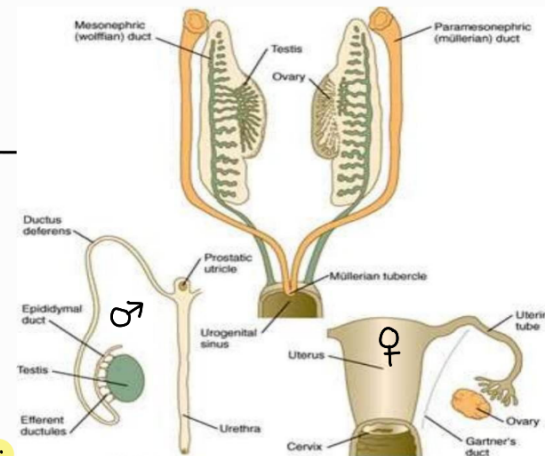
- paramesonephric duct develops in the Coelomic epithelium & continues caudally then crosses ventral to mesonephric duct & descends medially

## • ♂ has antimullarian factor (AMF):

- ① Wolffian develop
- ② Mullarian regress leaving vestigial structures

## mullarian duct in ♂ forms:

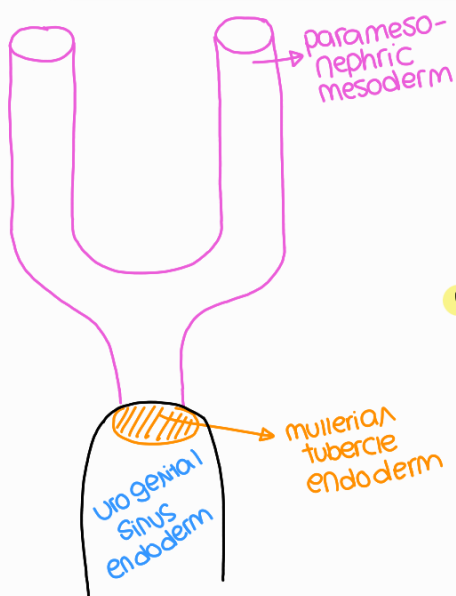
- Cranial → appendix of testes
- caudal → prostatic utricle
- mullarian tubercle → Seminal Colliculus



▶ Middle parts drag transverse folds of peritoneum → broad lig. of uterus

## lower ends of paramesonephric ducts

- fuse to form Y shaped uterovaginal canal
- project to dorsal wall of urogenital sinus to induce formation of mullarian tubercle

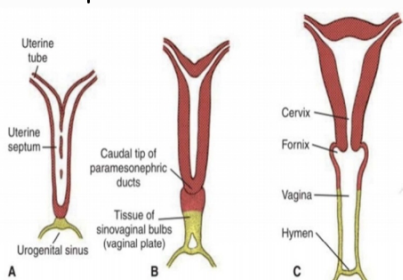


## ♀ has no AMF:

- ① Mullarian develop
- ② Wolffian regress leaving vestigial structures

## mullarian duct in ♀ forms:

- cranial & middle → uterine tube
- caudal → uterus & upper 3/5 of vagina (uterovaginal canal)
- mullarian tubercle → proliferates & forms sinovaginal bulb → unite into vaginal plate → canalizes forming lower 2/5 of vagina leaving a perforated membrane (hymen) at the lower end



Vagina: → upper 3/5 (meso): uterovaginal canal

↳ lower 2/5 (endo): mullarian tubercle

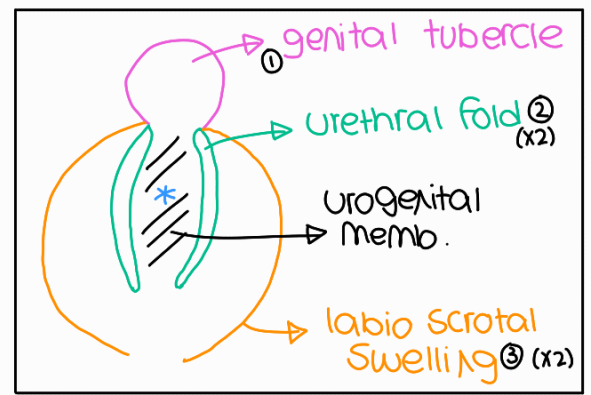
↳ vestibule (endo): urogenital sinus



## \* ext. Genitalia development

### • indifferent stage (week 4-6)

Mesenchyme around urogenital memb. & produce 5 elevations covered by ectoderm marked on pic (1-3)



### • ext. genitalia in ♀:

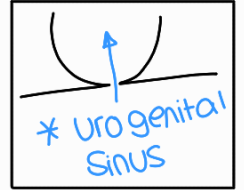
Formed under the effect of maternal & placental estrogen!

Genital tubercle → clitoris (its mesenchyme forms corpora cavernosa)

Urethral fold → labia minora (remain separate)

labio scrotal → labia majora ( " )

Urogenital sinus → shortened to form vestibule



### • ext. genitalia in ♂:

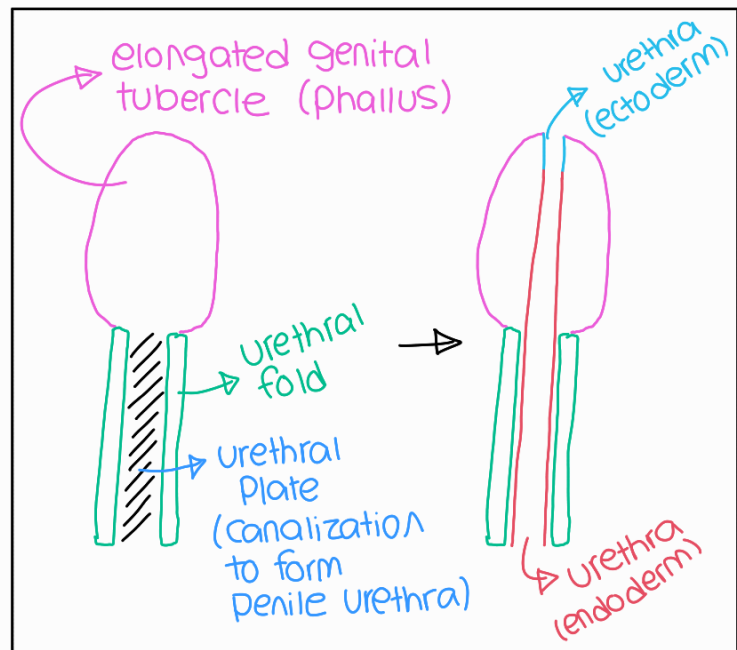
formed under the effect of testosterone from developing testes

Genital tubercle → phallus  
(corpora cavernosa, lateral & dorsal aspects of penis)

Urethral fold → fuse around penile urethra (corpus spongiosum, ventral aspect of penis)

labio scrotal → scrotum

Urethral plate → urethra



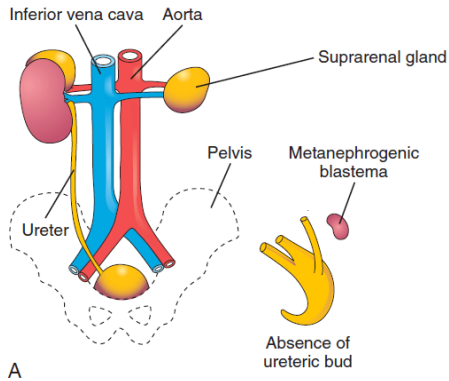
rupture of urogenital memb. → urethral groove becomes lined by endodermal urethral plate continuous with urethral folds → edges of plate fuse to form penile urethra except terminal part (ecto)

## Summary of congenital anomalies – UGS

### Lecture 1 Anomalies

#### 1) Renal agenesis (Absence of one or two kidneys)

**Due to;** Ureteric bud failing to induce the metanephric cap to divide

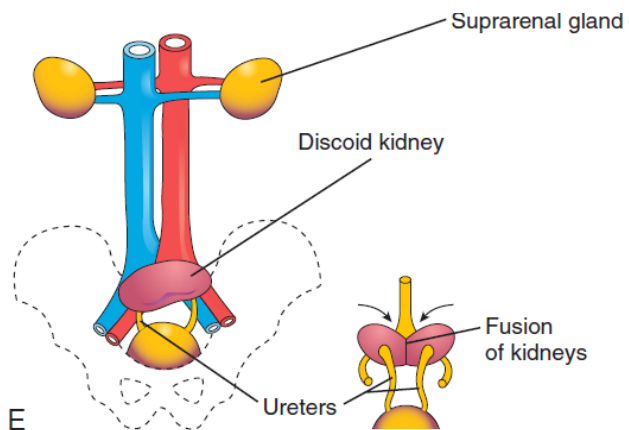


#### 2) Congenital polycystic kidney (Kidney shows many cysts filled with urine, from the collecting ducts)



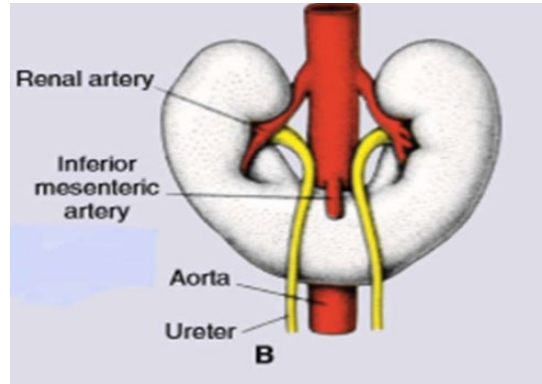
#### 3) Ectopic kidney (pelvic kidney)

**Due to;** Kidney failing to ascend.

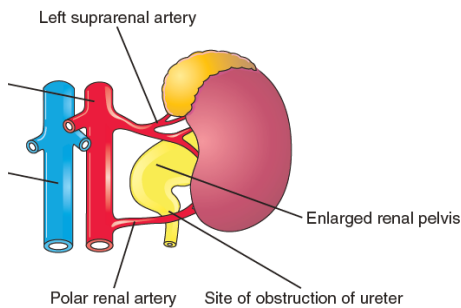


4) **Horse-Shoe kidney** (Two kidneys fused at their lower poles)

**Due to;** As they're fused from their lower poles, they're stopped ascending by the origin of the *Inferior mesenteric artery*.

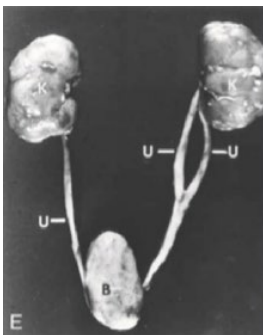


5) **Accessory renal artery** (Additional artery that enters either; upper/lower pole of the kidney)

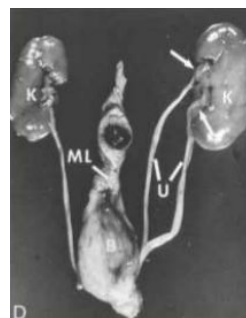


6) **Bifid ureter** (Doubled renal pelvis and thus 2 ureters at the upper end only)

**Due to;** Bifurcation of the upper end of the ureteric bud



6) Bifid ureter



7) Duplicated Urinary Tract

7) **Double ureter and duplicated urinary tract** (Either a double kidney/duplicated ureter and renal pelvis)

**Due to;** When the ureteric bud prematurely divides before penetrating the metanephric cup.



8) **Bladder anomalies – Ectopia Vesicae** (Exposed posterior wall of the bladder to the outside)

**Due to;** Defective formation of the infraumbilical part of the anterior abdominal wall, anterior wall of the bladder

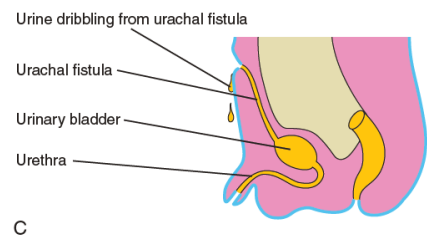
**Important:** This is associated with **Epispadias** (mentioned below)



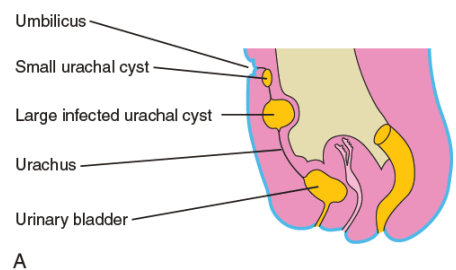
9) **Urachal anomalies Due to;** (Persistence of different parts of the urachal lumen)

**A. Urachal Fistula** (Completely **patent urachus**)

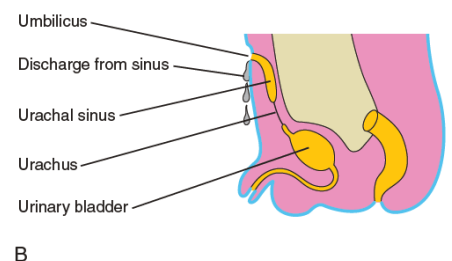
There's communication between the bladder and umbilical orifice (Allows urine to escape)



**B. Urachal cyst** (Fluid-filled dilation of the **mid urachus**)



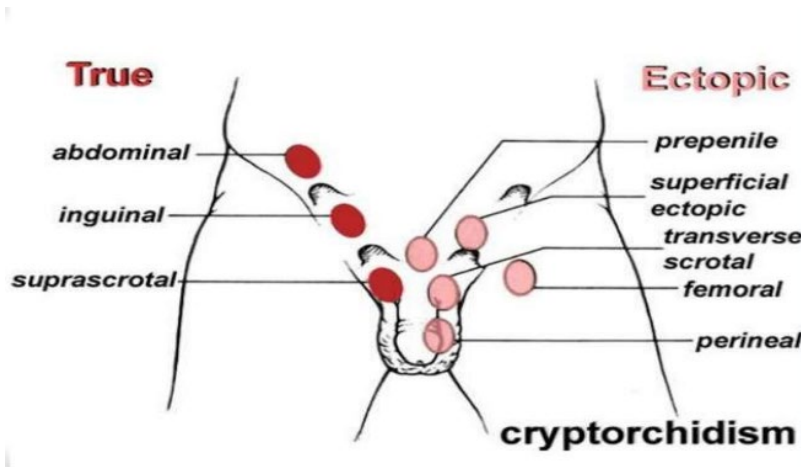
**C. Urachal sinus** (Blind dilation (At either end) of the urachus (Umbilical/Bladder ends))



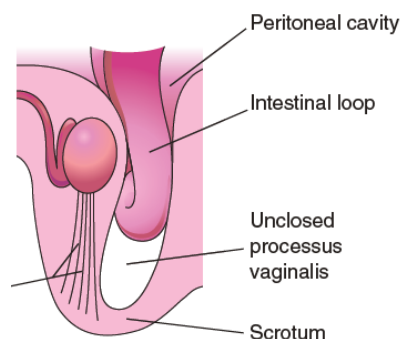
## Lecture 2 Anomalies (Testis anomalies)

1) **Cryptorchidism (Undescended testis)** testis may remain in any position during its descent (iliac fossa / inguinal canal) – Susceptible to damage spermatogenesis and occurrence of malignancy.

2) **Ectopic testis (Maldescended testis)** testis descend through inguinal canal but then is located outside the scrotum (At roof of penis /upper part of front thigh)



3) **Congenital oblique inguinal hernia**; loop of intestine descends to the scrotum  
**Due to**; unobliterated processus vaginalis

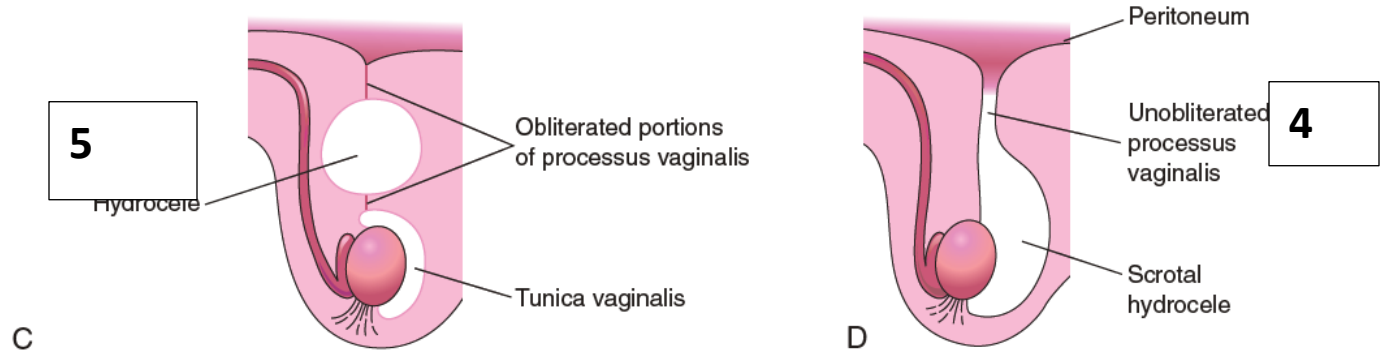


4) Scrotal **Hydrocele** (Peritoneal fluid passes into the patent processus vaginalis and forms this hydrocele)

**Due to**; Opened abdominal end of processus vaginalis (Small, doesn't permit herniation of intestine)

### 5) Hydrocele of the spermatic cord

Same as the previous one, the difference is that here we have **only the middle part of processus vaginalis opened**.



Ovarian anomalies

### 6) Ovarian Agenesis

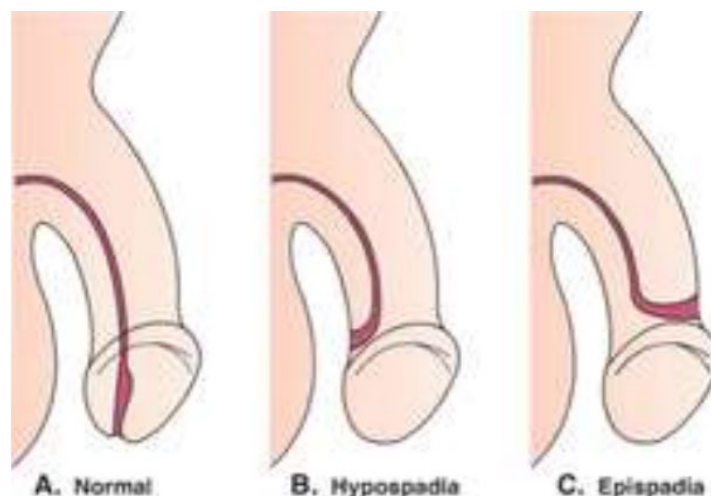
7) **Congenital inguinal hernia** Ovary may undergo external descent via the inguinal canal **Due to**; Gubernaculum is not attached to the angle of the developing uterus (this occurs in persistent canal of Nuck)

**Persistent canal of Nuck** is associated with **bilateral labial fullness**

Male genitalia anomalies

8) **Hypospadias**, Urethral orifice is in the **Ventral** aspect of the penis  
**Due to**; Incomplete fusion of the two urethral folds

9) **Epispadias**, Urethral orifice is in the **Dorsal** aspect of the penis  
Remember, **this is associated** with **Ectopia vesica**





## Female genitalia anomalies

10) Uterus **bicornis unicollis**, uterus has 2 horns that open into 1 single vagina

11) Uterus **bicornis bicolis**, uterus completely divided into 2 horns, each has a separate cervix

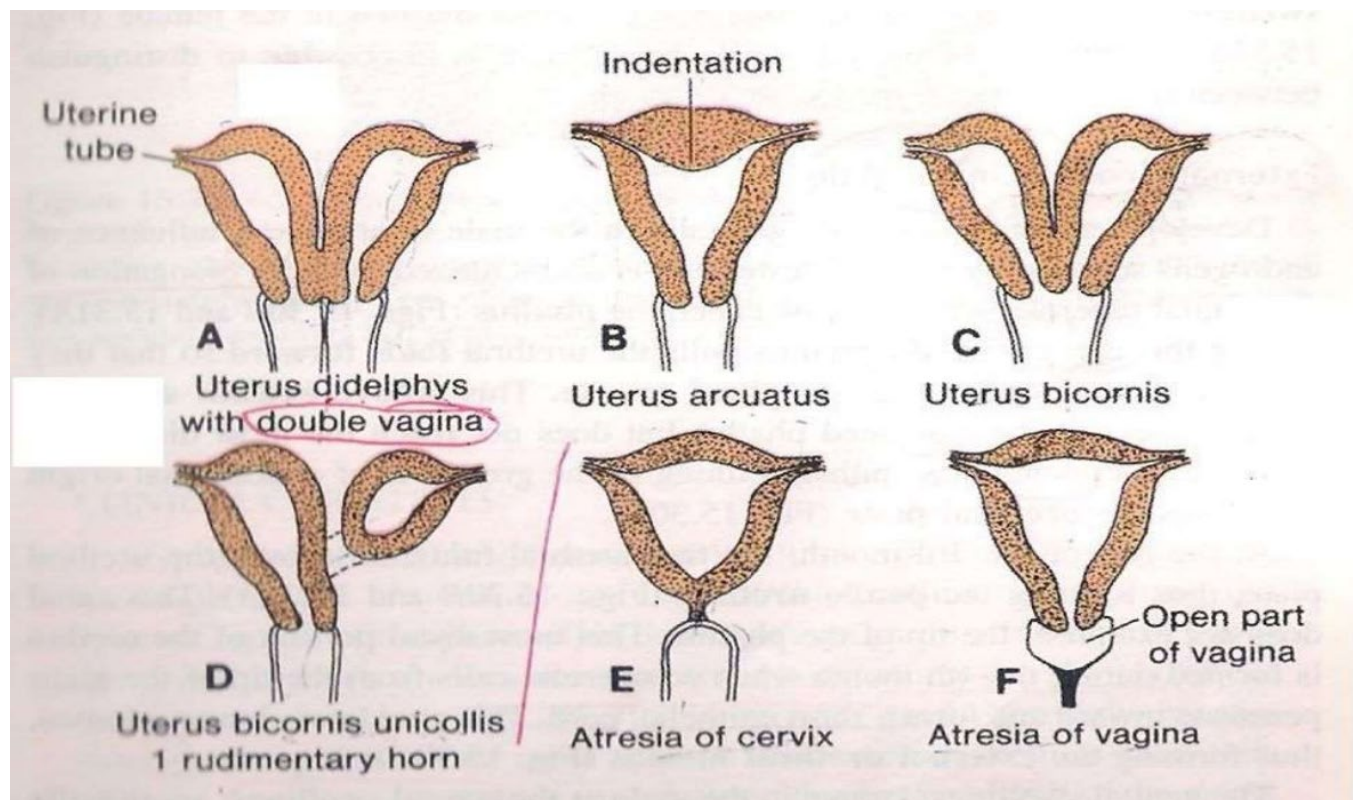
12) Uterus **unicornis unicollis**, uterus is formed by a single horn with the other being rudimentary

13) **Septate Vagina**, where only the vagina is divided into two parts by a median septum

14) **Atresia of the vagina, Due to**; failure of canalization of the vaginal plate

15) **Imperforate hymen**

16) **Congenital rectovaginal fistula, Due to**; Incomplete development of the urorectal septum.



Period	Event	Notes
4th week	Mesenchyme around urogenital membrane proliferates to produce five elevations	1 genital tubercle 2 genital folds 2 genital swellings
Early 4th week	Pronephros stage	Cervical region
Late 4th week	Mesonephros stage	Thoracic and upper lumbar regions
5th week	Metanephros stage	Sacral region
6th/7th week	Sex differentiation	
12th week	Primary <b>oocyte</b> enter meiosis 1	
20th week	Primary <b>oocyte</b> arrested at prophase 1	They remain until puberty
3rd month	<b>Ovaries</b> reach the greater pelvis	(from L2)
4th to 6th month	Internal descent of <b>testis</b>	They descend into the iliac fossa (from L2)
7th to 9th month	External descent of <b>testis</b>	7th -> Traverse deep inguinal ring 8th -> Traverse the inguinal canal 9th -> Traverse superficial inguinal ring
After birth	<b>Ovaries</b> reach the lesser pelvis	From the greater pelvis - 3rd month-

Germ layer	Its derivatives	Notes
<b>Ectoderm</b>	<ul style="list-style-type: none"> <li>* Terminal part of penis within glans penis (Glandular urethra)</li> <li>* Covering of the <i>urogenital membrane proliferations</i></li> </ul>	Urogenital membrane proliferations are the genital tubercle, folds, swellings, they're mesodermal but their <b>covering</b> is ectodermal
<b>Mesoderm</b>	<ul style="list-style-type: none"> <li>* Upper urinary system (Intraembryonic intermediate mesoderm)</li> <li>* <b>Pronephros</b> stage</li> <li>* <b>mesonephric tubules</b></li> <li>* <b>mesonephric duct (Wolffian duct) giving us:</b> <ol style="list-style-type: none"> <li>1) Urinary bladder <b>Trigone</b></li> <li>2) (<b>dorsal wall of Supracollicular part</b>) of prostatic urethra</li> <li>3) (<b>dorsal wall</b> of Female urethra)</li> </ol> </li> <li>* <b>metanephros</b> (cranially <b>Ureteric bud</b>, caudally <b>Metanephric Cap</b>)</li> <li>* <b>Urorectal septum</b></li> <li>* <b>Coats of the urinary bladder</b></li> <li>* <b>Paramesonephric duct (Mullerian duct) giving us:</b> <ol style="list-style-type: none"> <li>1) Cranial and mid - <b>uterine tube</b></li> <li>2) Caudal - <b>uterus</b> and <b>upper 3/5 of the vagina</b></li> </ol> </li> <li>* <b>Sertoli cells</b> (coelomic epithelium)</li> <li>* <b>Genital tubercle, genital folds, genital swellings</b></li> </ul>	<ul style="list-style-type: none"> <li>* Upper urinary system is developed <b>behind</b> the intraembryonic coelom</li> <li>* Splanchnic mesoderm gives the coats of the urinary bladder</li> <li>* <b>Corpus spongiosum</b> comes from mesenchyme of the urethral folds</li> <li>* <b>Corpus cavernosa</b> comes from mesenchyme of the phallus</li> </ul>
<b>Endoderm</b>	<ul style="list-style-type: none"> <li>  <b>Vesico-urethral canal</b> of urogenital sinus giving us:             <ol style="list-style-type: none"> <li>1) <b>Major part of Urinary bladder</b> (except trigone and coats)</li> <li>2) <b>Supracollicular part of prostatic urethra</b> (Except dorsal wall)</li> <li>3) The <b>whole Female urethra</b> (Except dorsal wall)</li> </ol> </li> <li>   <b>Pelvic part</b> of urogenital sinus giving us:             <ol style="list-style-type: none"> <li>1) <b>Infracollicular part of prostatic urethra</b></li> <li>2) <b>Membranous urethra</b></li> </ol> </li> <li>    <b>Phallic part</b> of urogenital sinus giving us:             <ol style="list-style-type: none"> <li>1) <b>Penile urethra</b> except terminal part</li> </ol> </li> <li>* <b>Primitive germ cells (from the yolk sac)</b></li> <li>* <b>(Genital - urethral) plate</b></li> </ul>	<ul style="list-style-type: none"> <li>* Urogenital sinus has 3 derivatives:             <ol style="list-style-type: none"> <li>1) Vesico-urethral</li> <li>2) Pelvic part</li> <li>3) Phallic part</li> </ol> </li> <li>Pelvic and phallic parts give:             <ol style="list-style-type: none"> <li>A) Lower 2/5 of the <b>Vagina (Mullerian Tubercle)</b></li> <li>B) Vestibule of the <b>Vagina</b></li> </ol> </li> </ul>



Embryo collected – Ahmad AlHurani

1) **Choose the WRONG statement:**

- A. Urachal cyst is fluid-filled dilatation of the mid urachus
- B. The ureteric bud gives rise to collecting system of the kidney
- C. In case of Horseshoe kidney superior mesenteric artery prevent kidney ascent
- D. The metanephric cap gives rise to nephron
- E. The prostatic urethra is endodermal and mesodermal in origin

Answer: C

2) **Which of the following structures is endodermal in origin?**

- A. Seminal vesicle
- B. The whole dorsal wall of the female urethra
- C. Gartner's duct
- D. Lower 2/5 of the vagina
- E. Uterine tube

Answer: D

3) **A remnant of gubernaculum seen in adult females:**

- A. Round ligament of uterus
- B. Suspensory ligament of the ovary
- C. Mesovarium
- D. Tunica albuginea

Answer: A

4) **Failure of fusion of the urethral folds leads to:**

- A. Uterine anomalies
- B. Hypospadias
- C. Vaginal vestibule anomalies
- D. Epispadias

Answer: B

**5) Failure of fusion of the paramesonephric ducts mostly leads to:**

- A. Uterine anomalies
- B. Hypospadias
- C. Vaginal vestibule anomalies
- D. Epispadias

Answer: A

**6) All of the following originate from mesonephric duct except:**

- A. Appendix of the testis
- B. Appendix of the epididymis
- C. Vas deferens
- D. Ejaculatory duct

Answer: A

**7) Which of the following is not a derivative of urogenital sinus in females?**

- A. Vaginal vestibule
- B. Ventral part of urethra
- C. Urinary bladder
- D. Labia minora

Answer: D

**8) Regarding development of genital system; Choose the WRONG match:**

- A. Hypospadias.....the urethral orifice opens in the ventral aspect of the penis
- B. The caudal part of paramesonephric ducts.....forms the uterus and upper 3/5 of the vagina.
- C. Mullarien tubercle.....forms seminal colliculus .
- D. Corpus spongiosum.....mesenchyme of the urethral folds .
- E. The Caudal part of genital mesentery.....forms suspensory ligament of the ovary.

Answer: E

**9) The part of the prostatic urethra inferior to seminal colliculus is developed from:**

- A. Mesonephric tubules
- B. Vesico-urethral part of the urogenital sinus
- C. Phallic part of the urogenital sinus
- D. Mesonephric ducts
- E. Pelvic part of the urogenital sinus.

Answer: E

**10) Wrong statement** - both Testis & epididymis possess an appendix that is derived from mesonephric duct

**11) A remnant of gubernaculum seen in adult females** – round ligament of uterus

**12) Not a derivative of UG sinus in females** – labia minora

**13) Not of a dual embryonic origin** – cervix

**14) Not of a mesonephric duct origin** – appendix of testis

**15) Most common uterine and vaginal developmental anomaly** – uterus bicornes \*\*\*

**16) Cryptorchidism happens when:** - the testes don't descend properly to the scrotum.

**17) Which of the following is wrong about renal development?**

-in men, the mesonephric duct forms the ureteric bud then the rest disappears