DEVELOPMENT

OF THE

UROGENITAL SYSTEM

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Embryology Course

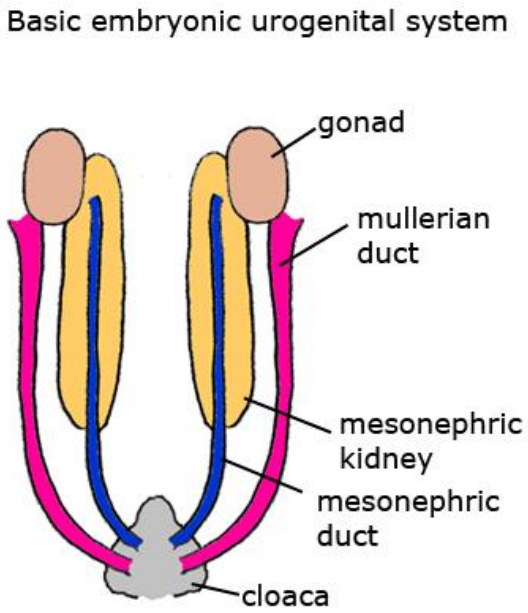
UROGENITAL SYSTEM

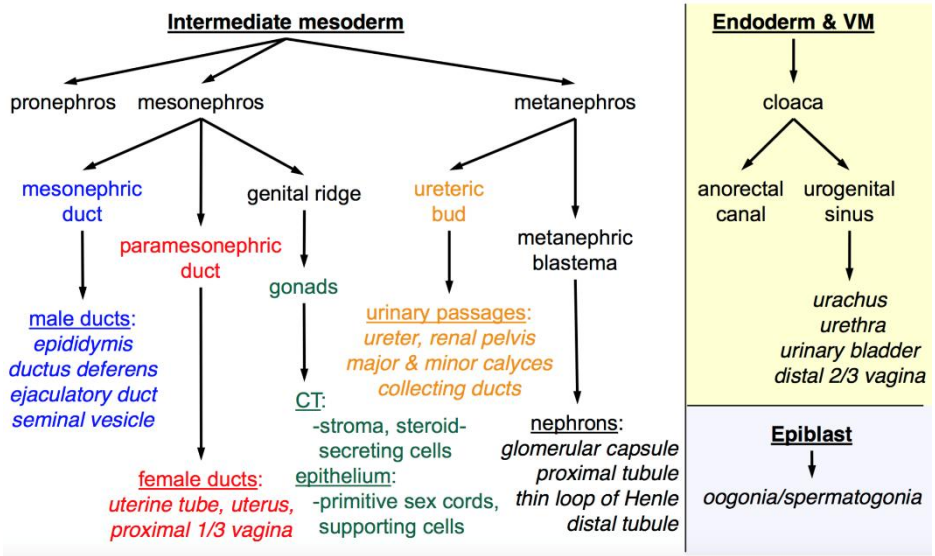
functionally divided into:

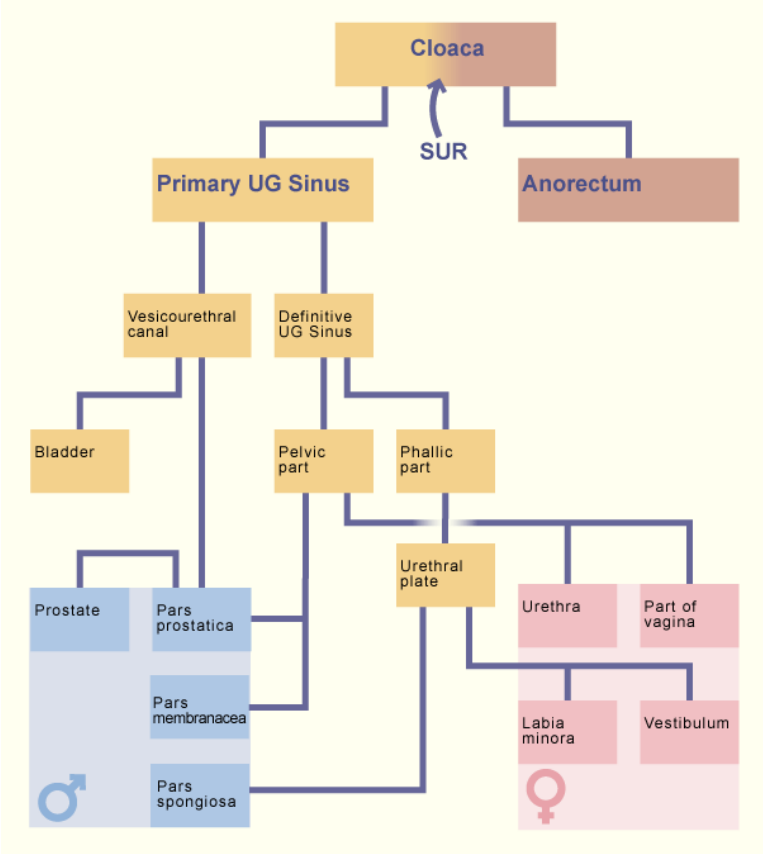
1. **the urinary system**
2. **the genital system**

embryologically:

- **these systems closely associated with one other – during the early stages of development**



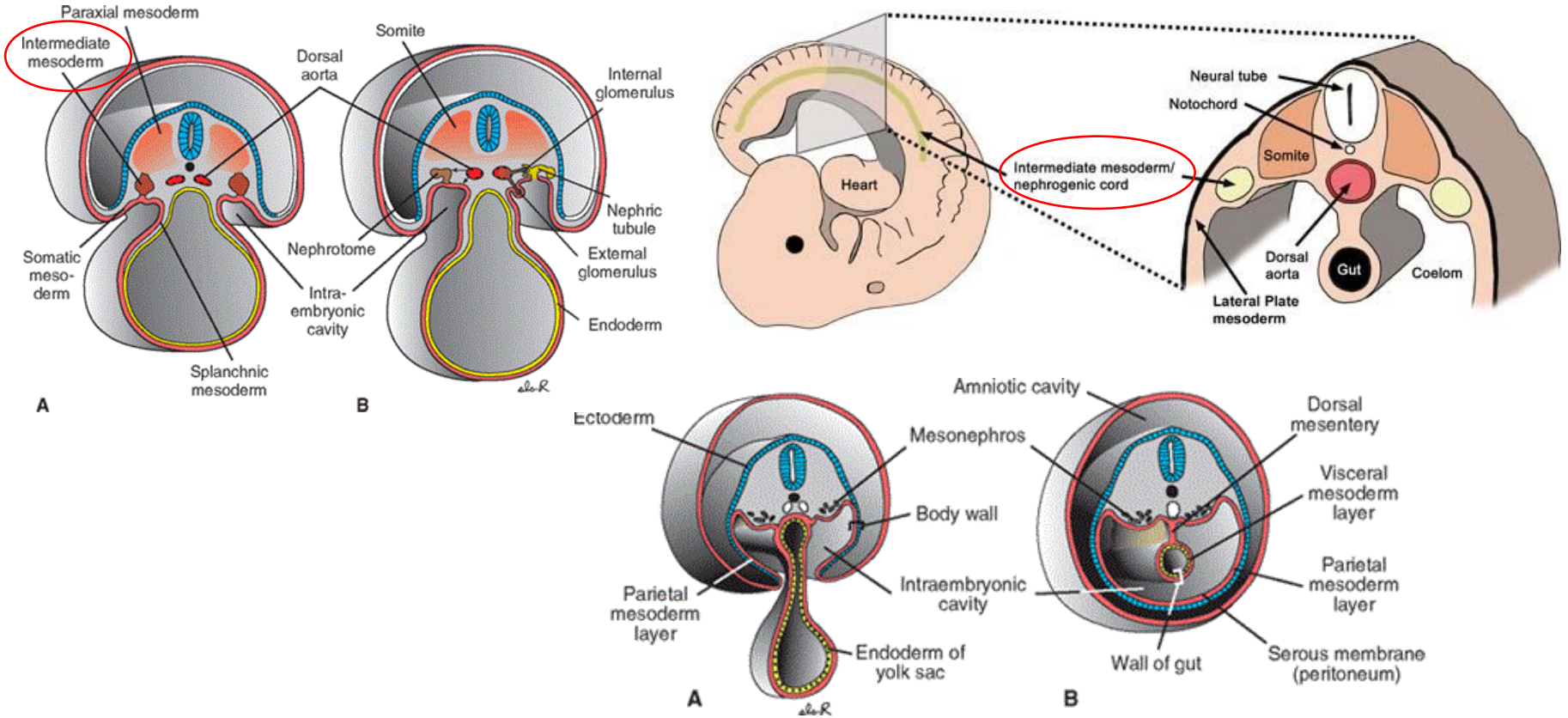


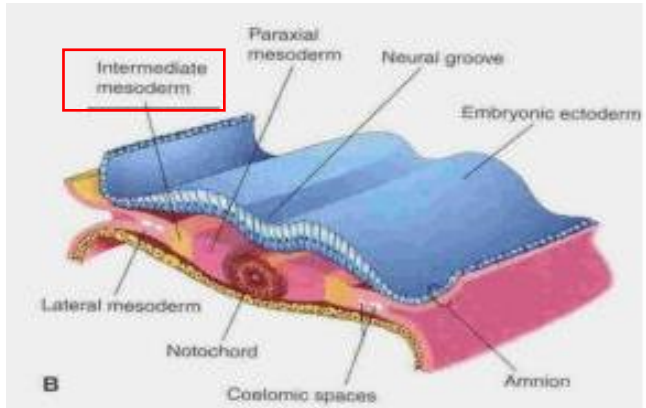


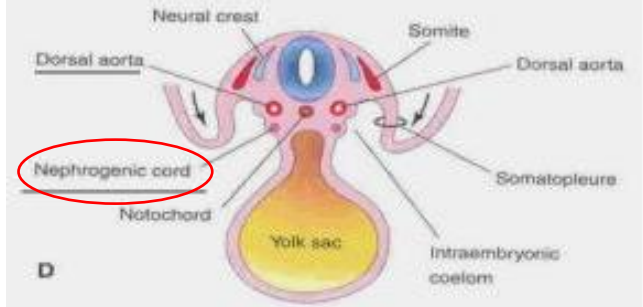
UROGENITAL SYSTEM

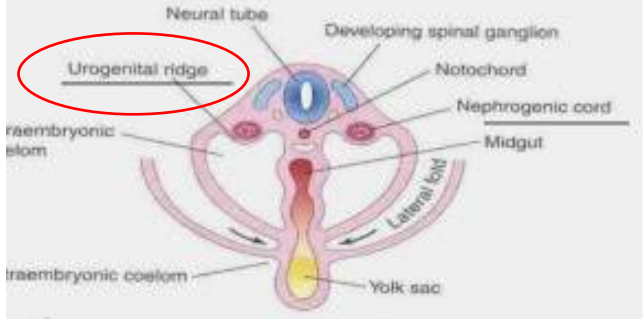
- develops from the intermediate mesoderm
- during folding of the embryo in the horizontal plane:

1. the intermediate mesoderm is carried ventrally
2. loses its connection with the somites
3. a longitudinal elevation of the mesoderm (UROGENITAL – RIDGE) forms on each side of the dorsal aorta









UROGENITAL SYSTEM

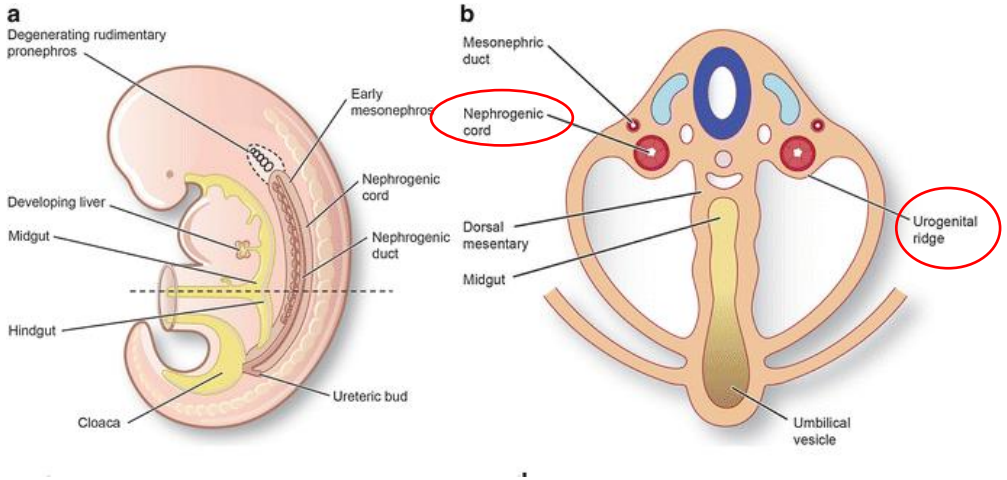
PARTS OF THE UROGENITAL RIDGE:

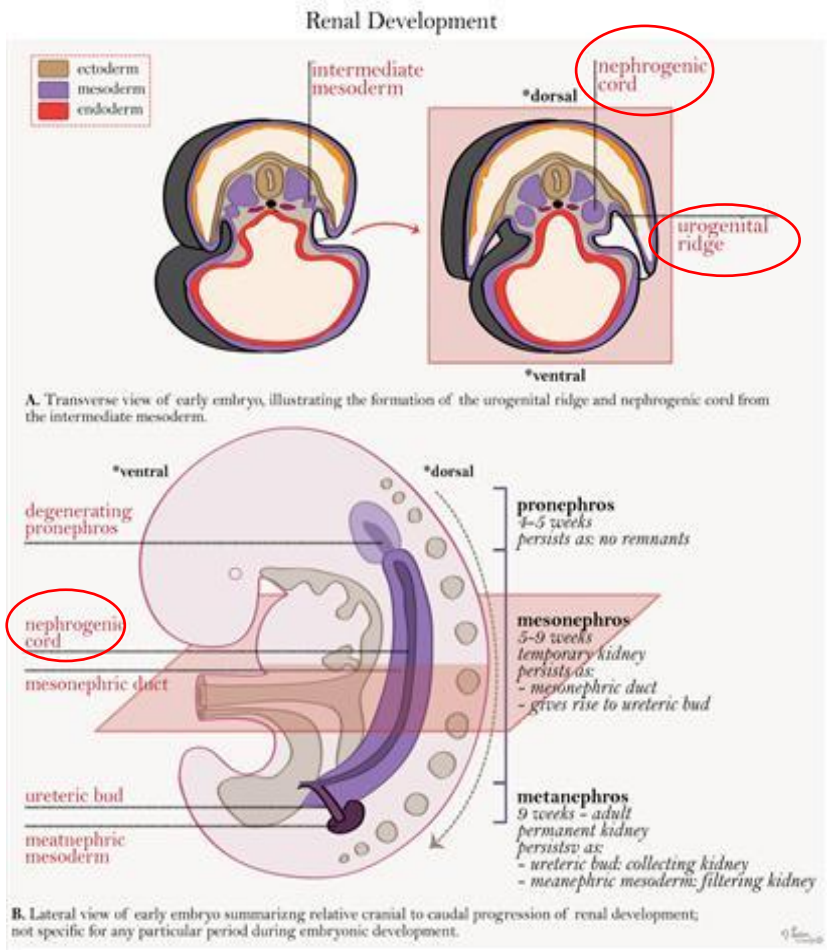
1. NEPHROGENIC CORD:

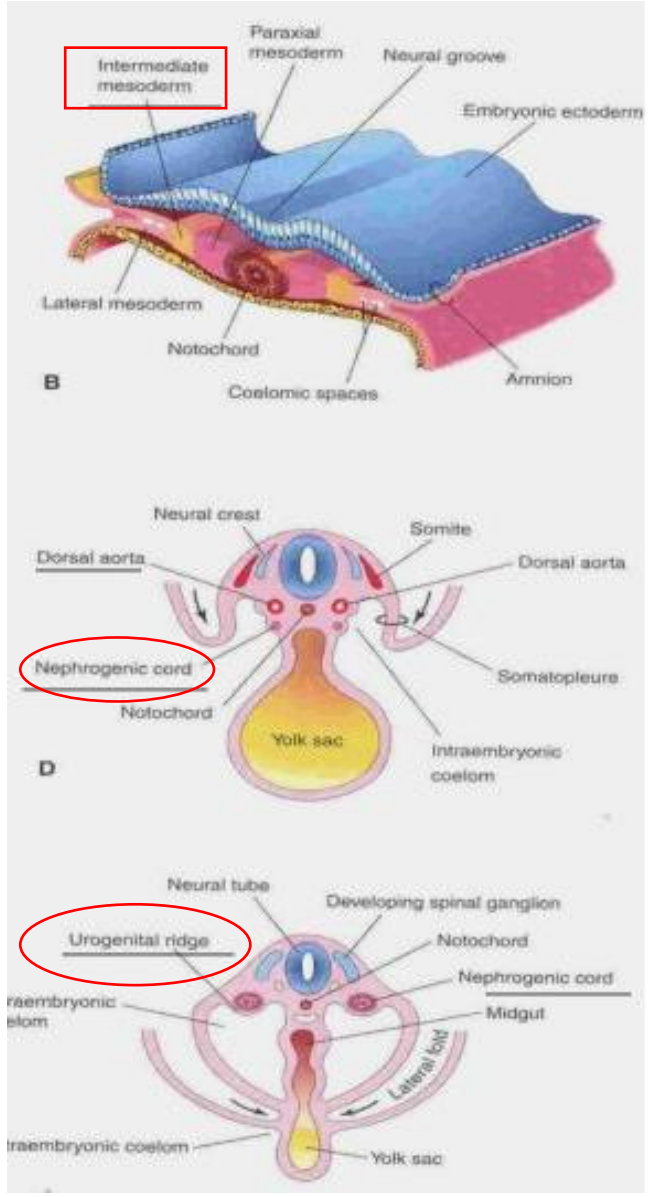
- gives rise to the urinary system

2. GONADAL RIDGE:

- gives rise to the genital system





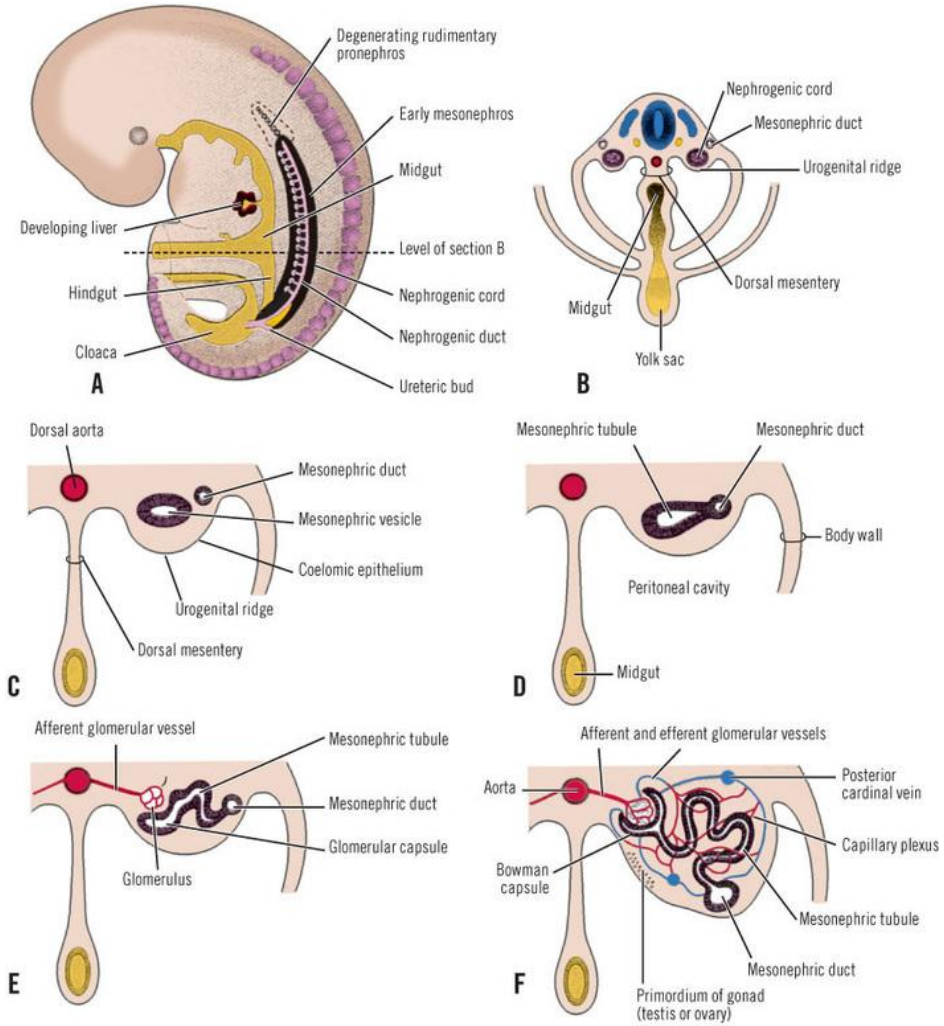


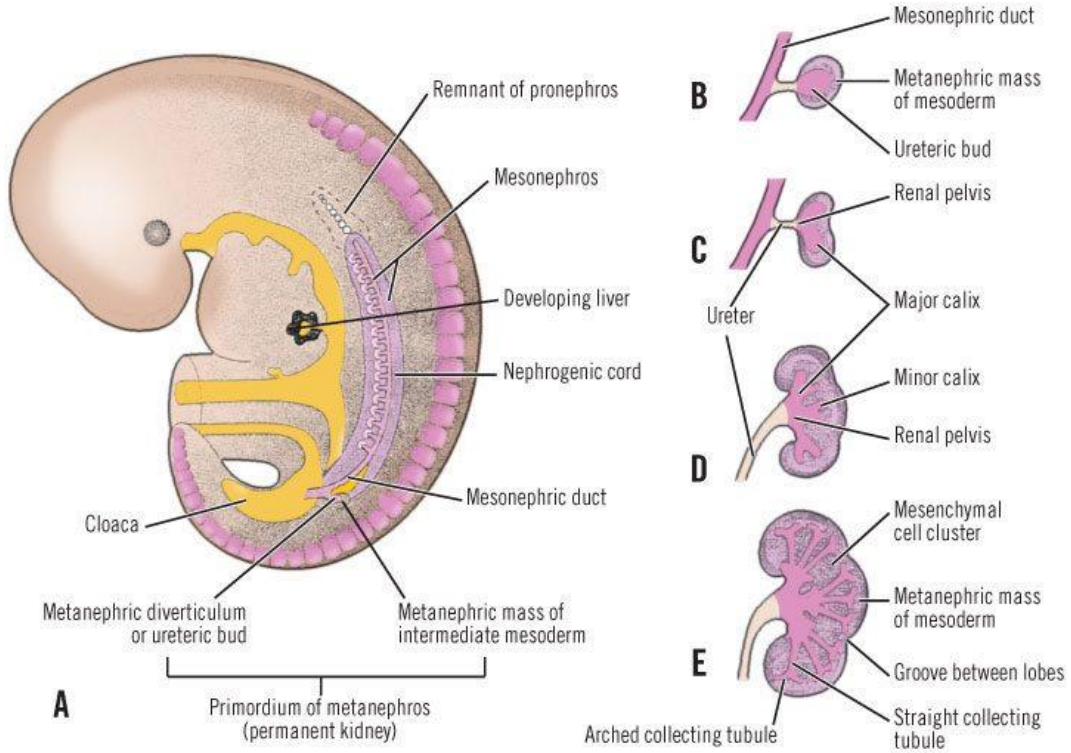
DEVELOPMENT OF URINARY SYSTEM (NEPHROGENESIS)

- **begins to develop before the genital system**

consists of the:

1. **kidney**
2. **ureter**
3. **urinary bladder**
4. **urethra**

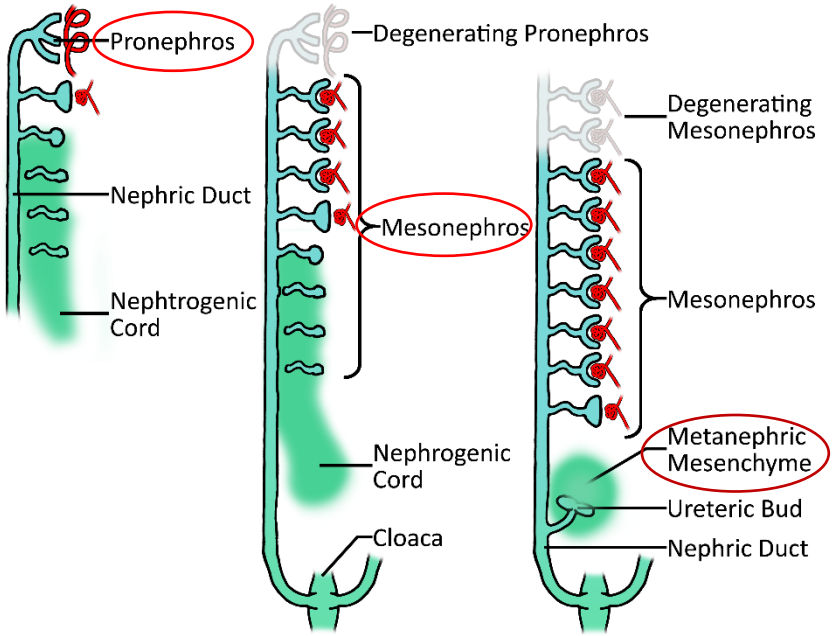


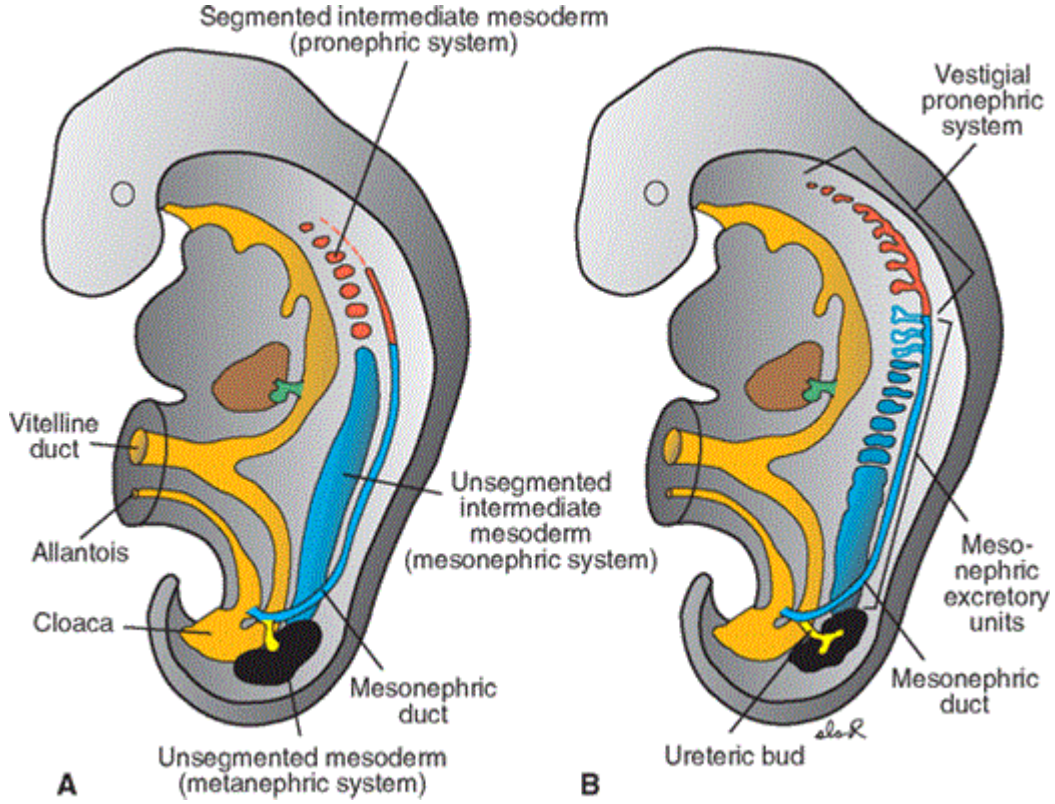


DEVELOPMENT OF KIDNEYS AND URETERS

- **three sets of kidneys are develop:**

1. **PRONEPHROS (first set)**
2. **MESONEPHROS (second set)**
3. **METANEPHROS (third set)**



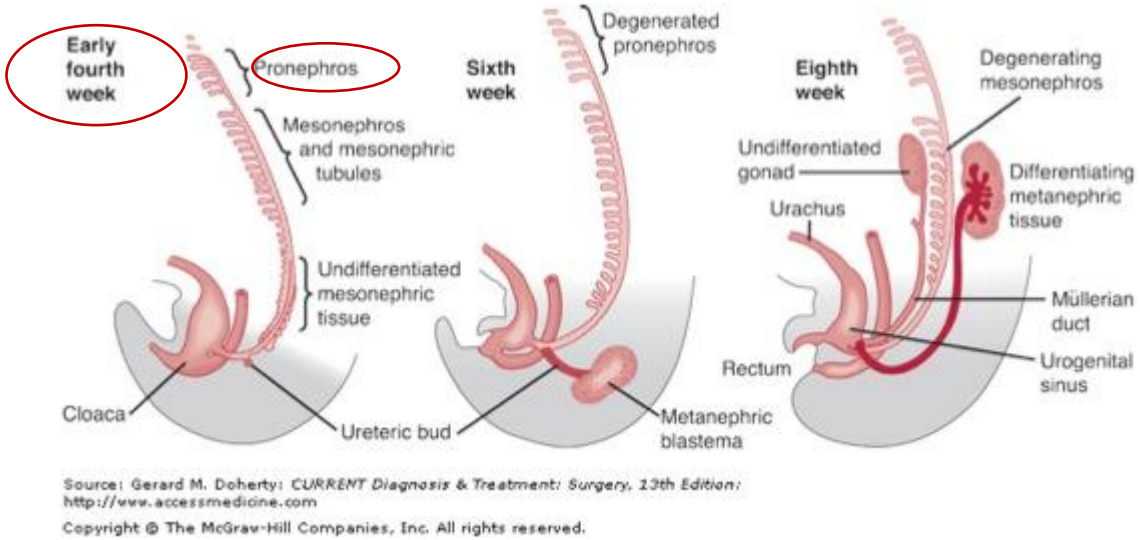


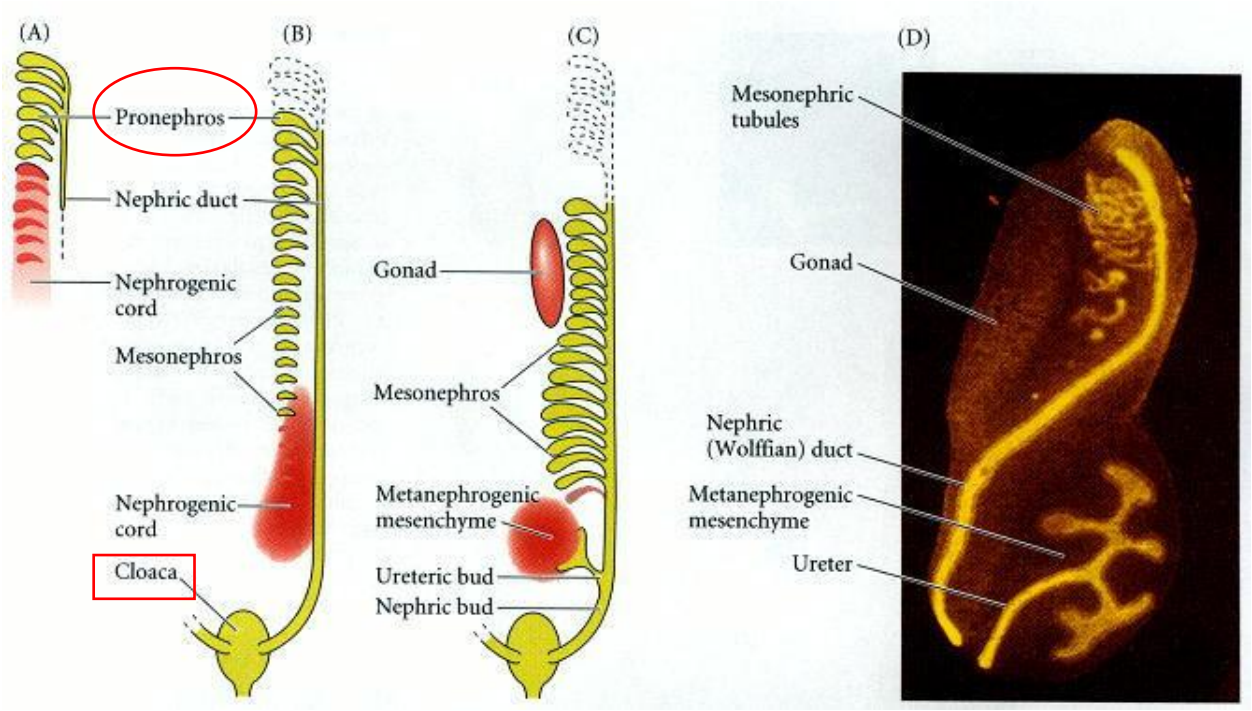
https://healtheappointments.com/chapter-16-urogenital-system-essays/

DEVELOPMENT OF KIDNEYS AND URETERS

1. **PRONEPHROS (first set):**

- **appear early in the 4th week**
- **a few cell clusters in the neck region**
- **the pronephric ducts run caudally – open into the cloaca**
- **rudimentary**
- **never has functions**



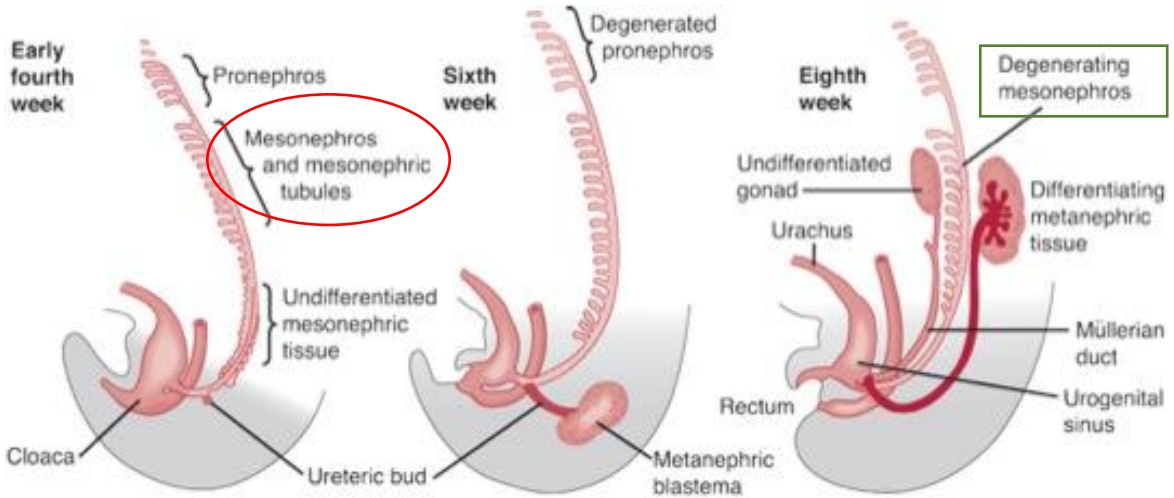


http://www.interactive-biology.com/3695/embryology-of-the-kidney/

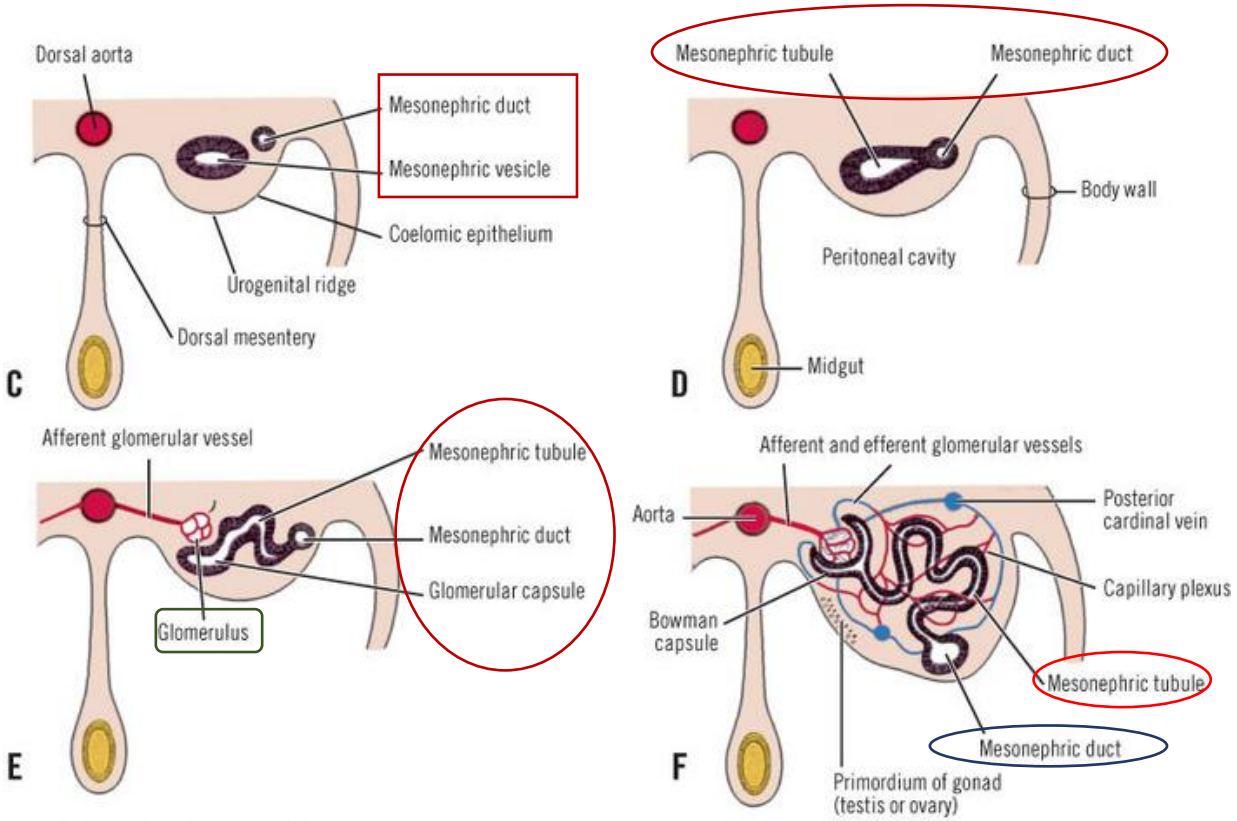
DEVELOPMENT OF KIDNEYS AND URETERS

2. MESONEPHROS (second set):

- **appear late in the 4th week caudal to the pronephros**
- **function as interim kidneys until the permanent kidneys develop**



Source: Gerard M. Doherty: *CURRENT Diagnosis & Treatment: Surgery, 13th Edition*: http://www.accessmedicine.com



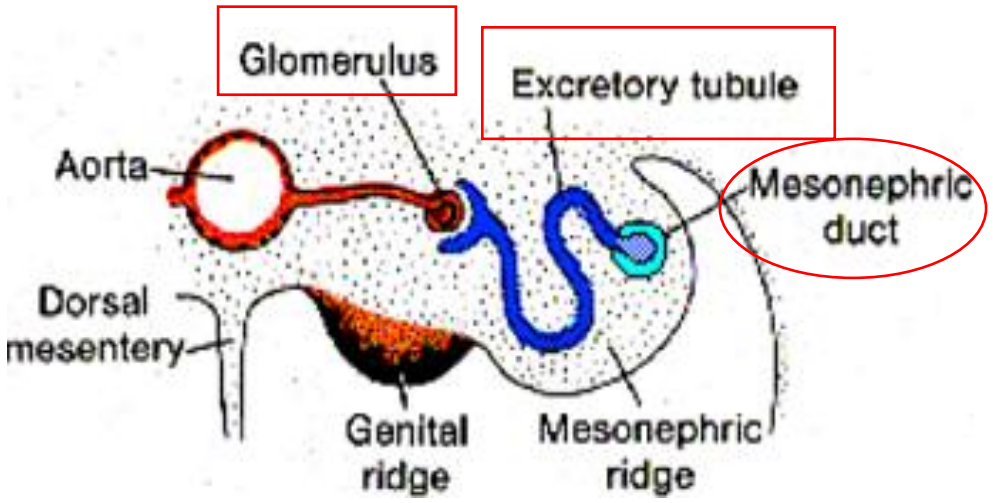
DEVELOPMENT OF KIDNEYS AND URETERS

2. MESONEPHROS (second set):

consist of:

1. **glomeruli**
2. **mesonephric tubules – open into the mesonephric ducts (originally the pronephric ducts)**
3. **mesonephric ducts open itno the cloaca**

- **mesonephros degenerate the end of the 1st trimester**
- **mesonephric ducts become the efferent ductules of the testes**



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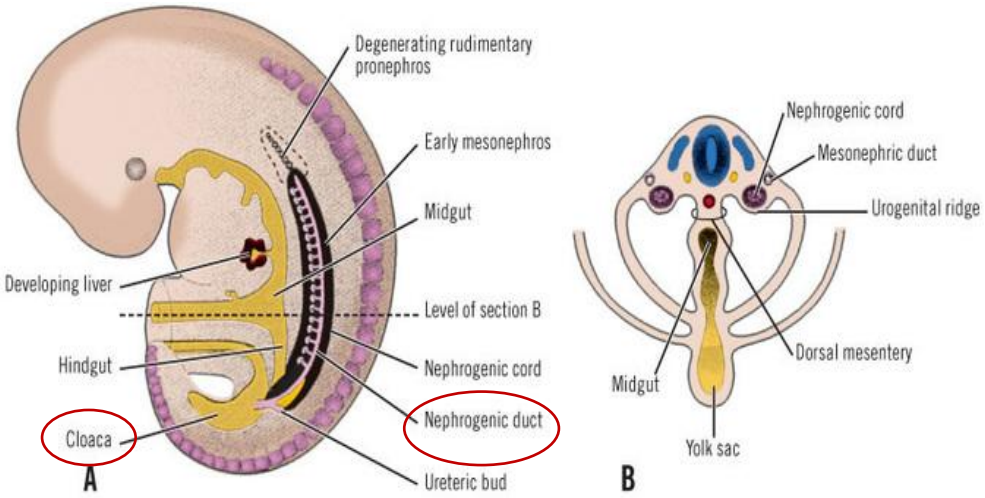
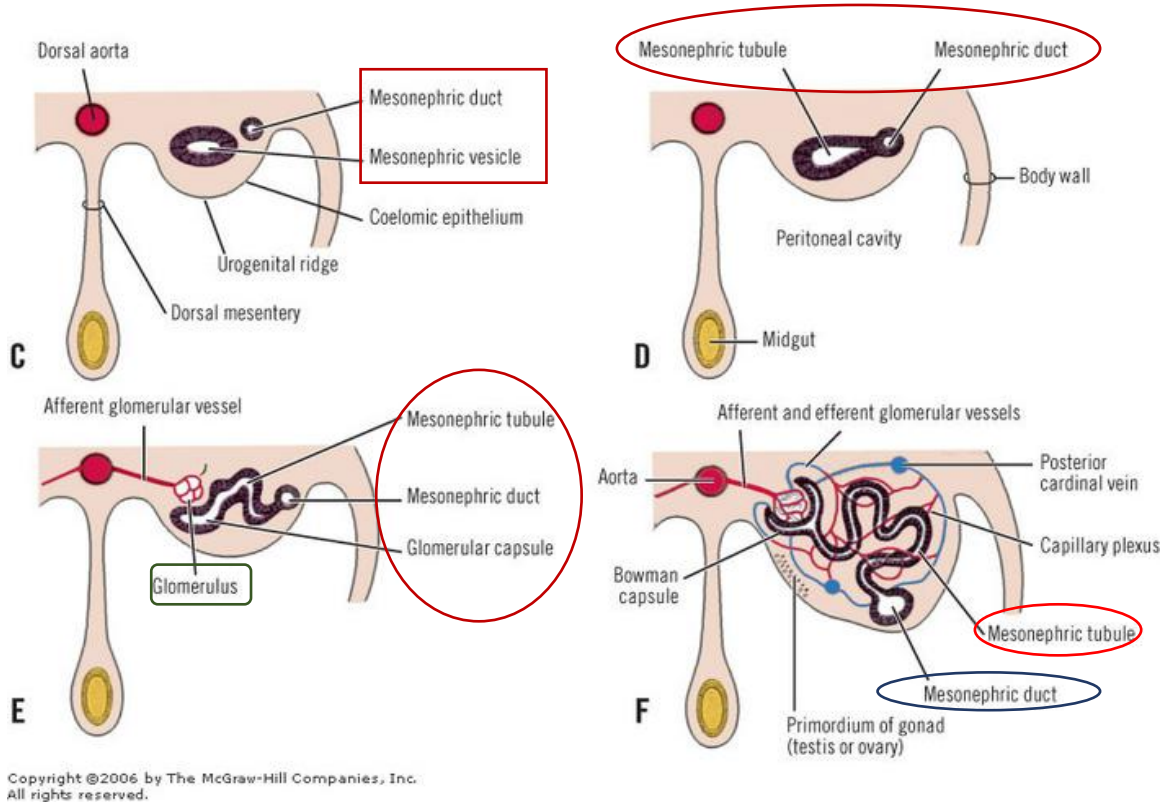
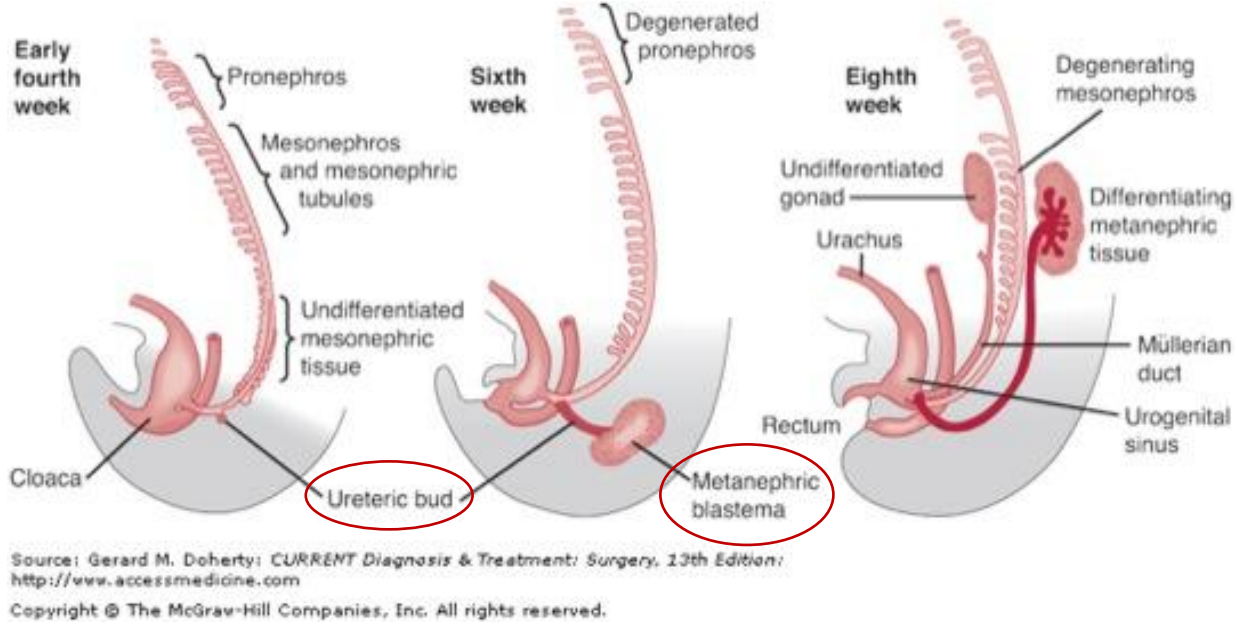


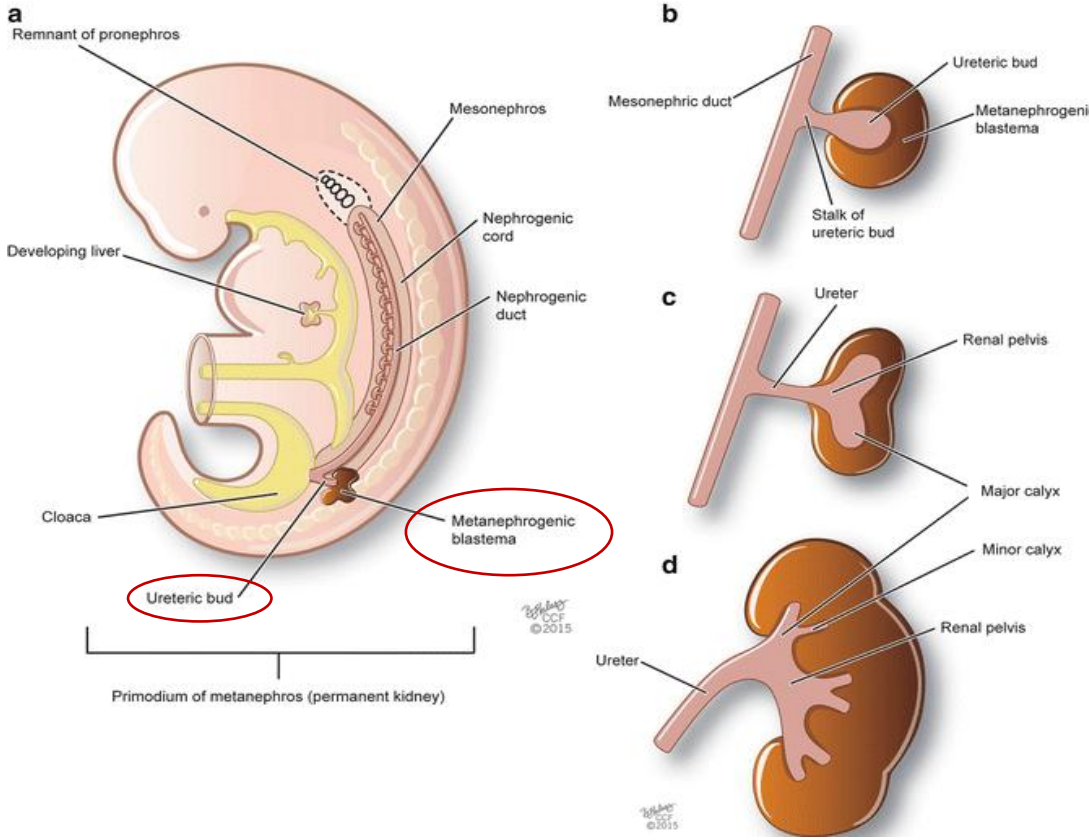


DEVELOPMENT OF KIDNEYS AND URETERS

3. METANEPHROS (third set):

- **primordia of the permanent kidneys**
- **begins to develop in the 5th week**
- **starts to function 4 week later**
- **urine formation continues through fetal life**
- **the urine is secreted into the amniotic cavity – mixed with the amniotic fluid**



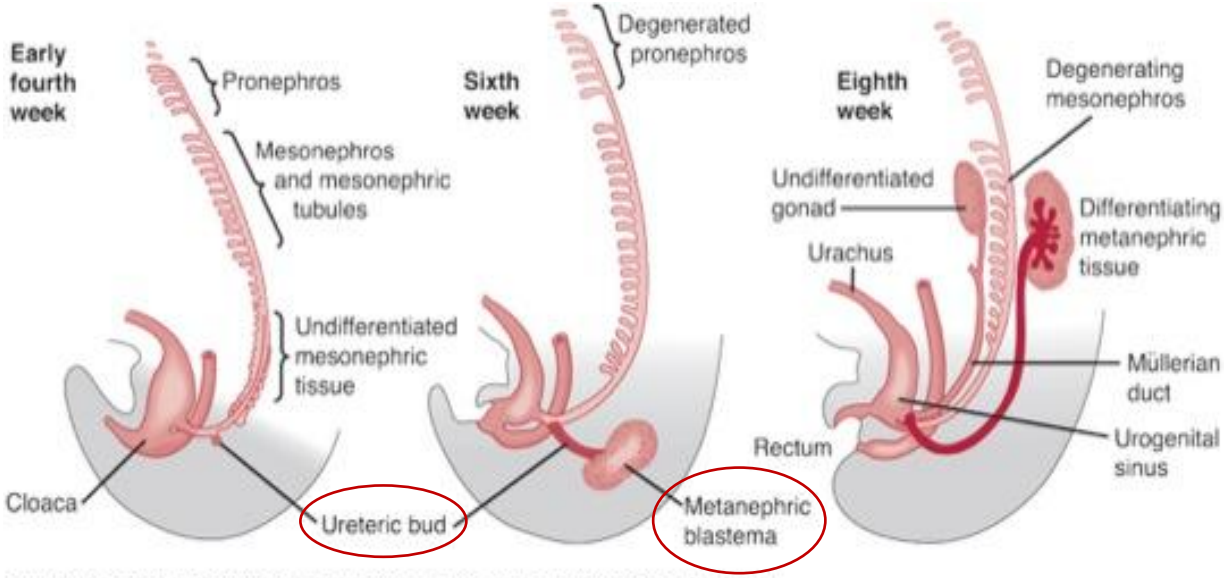


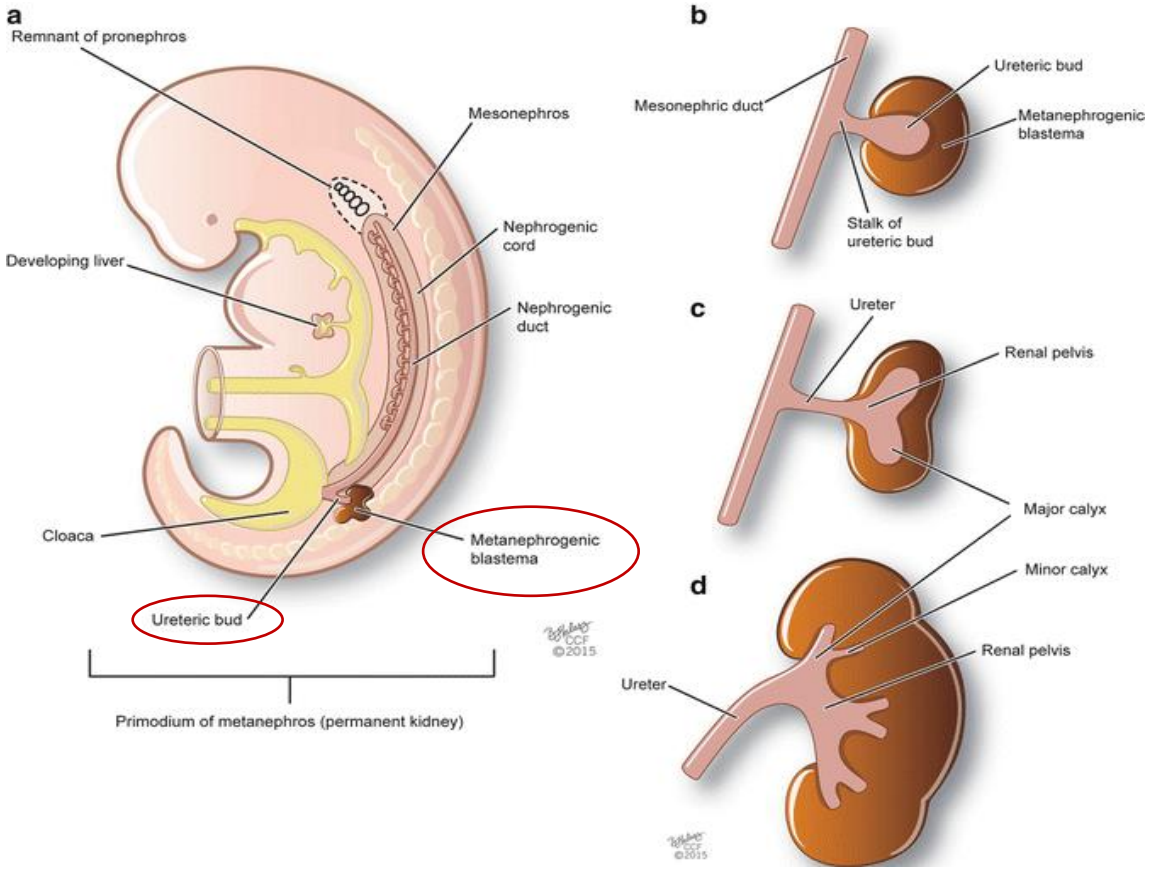
DEVELOPMENT OF KIDNEYS AND URETERS

3. METANEPHROS (third set):

THE PERMANENT KIDNEY develops from:

1. **the ureteric bud**
2. **the metanephric blastema**

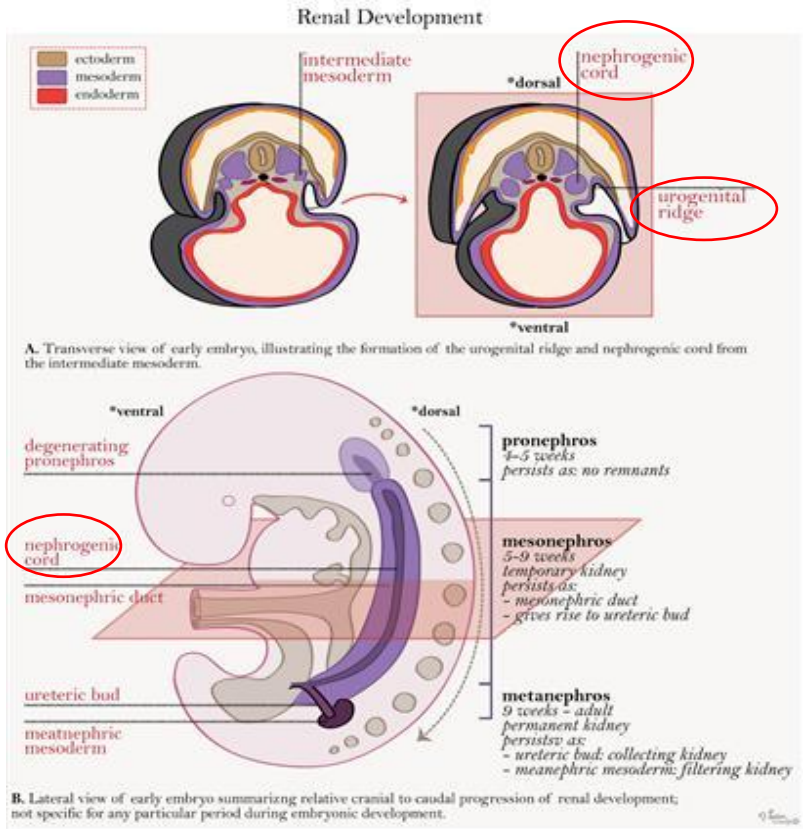


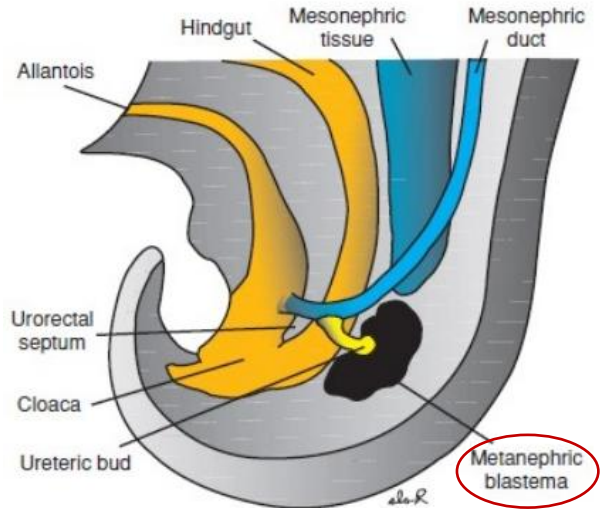


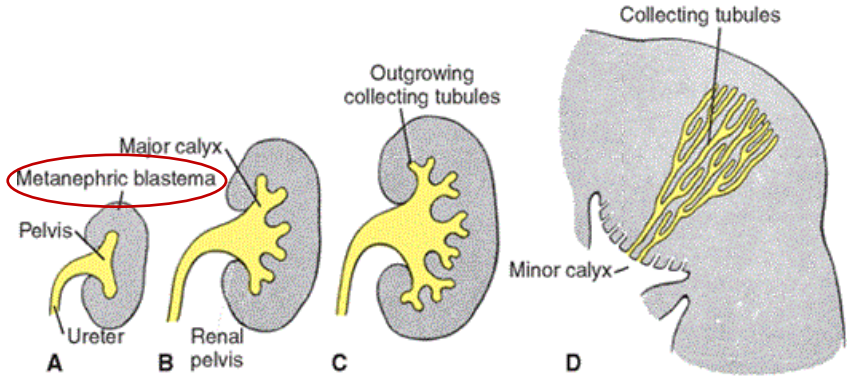
DEVELOPMENT OF KIDNEYS AND URETERS

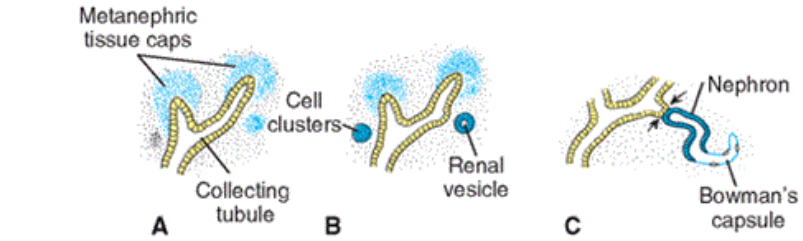
THE METANEPHRIC BLASTEMA:

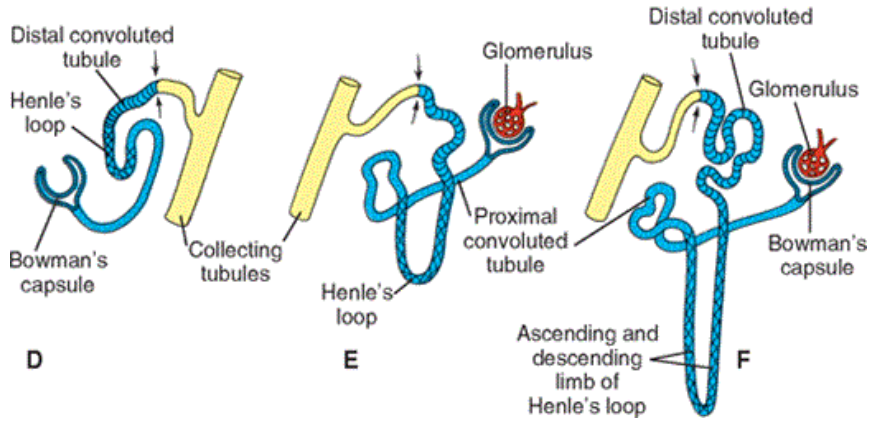
- **cellmass from the nephrogenic cord**
- **forms the nephron**











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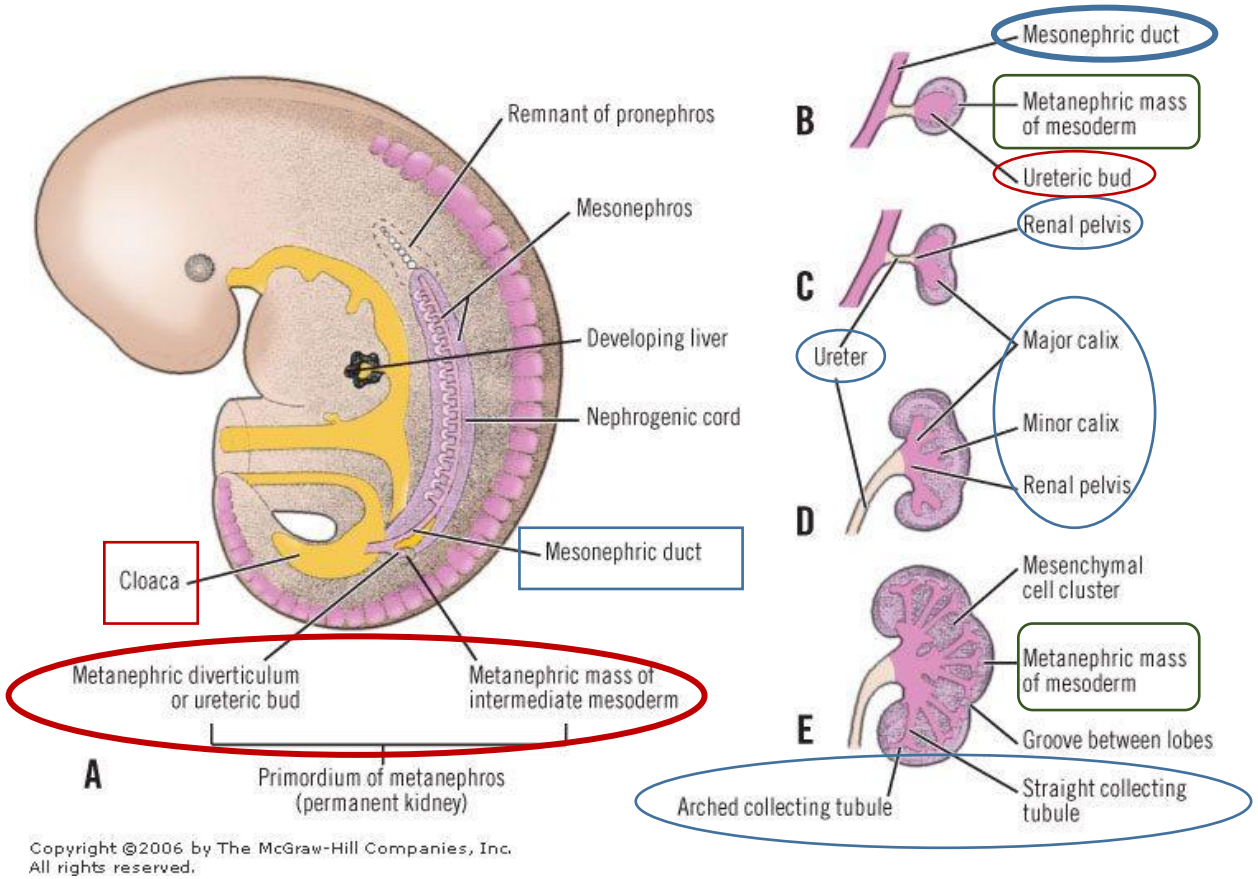
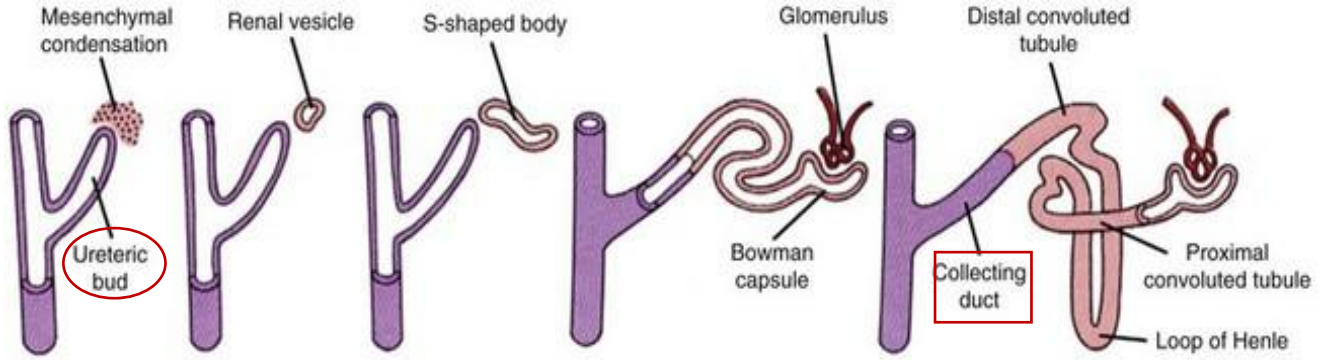
DEVELOPMENT OF KIDNEYS AND URETERS

THE URETERIC BUD primordium of the:

1. **ureter**
2. **renal pelvis**
3. **calices**
4. **collecting tubules**

- **an outgrowth from the mesonephric duct**
- **enter the cloaca**
- **the elongating bud penetrates the metanephrogenic blastema**





DEVELOPMENT OF KIDNEYS AND URETERS

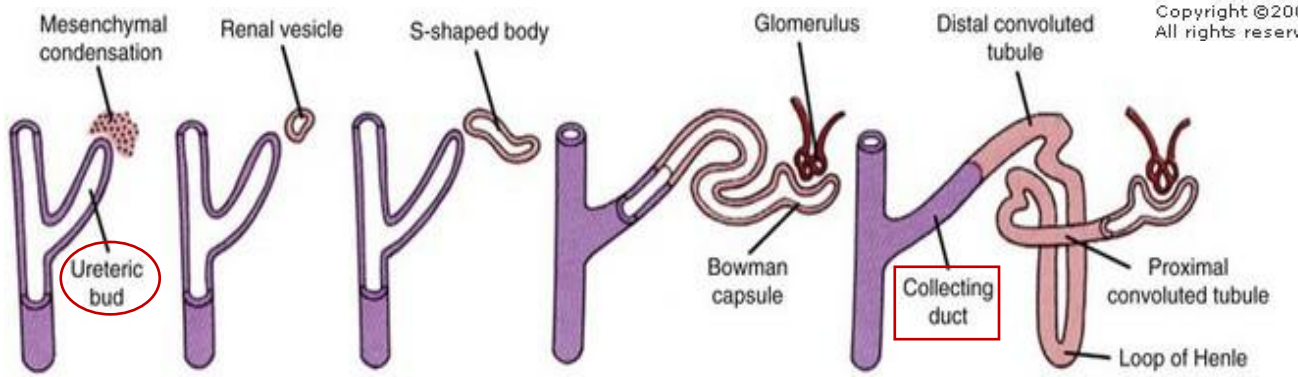
STALK OF THE URETERIC BUD:

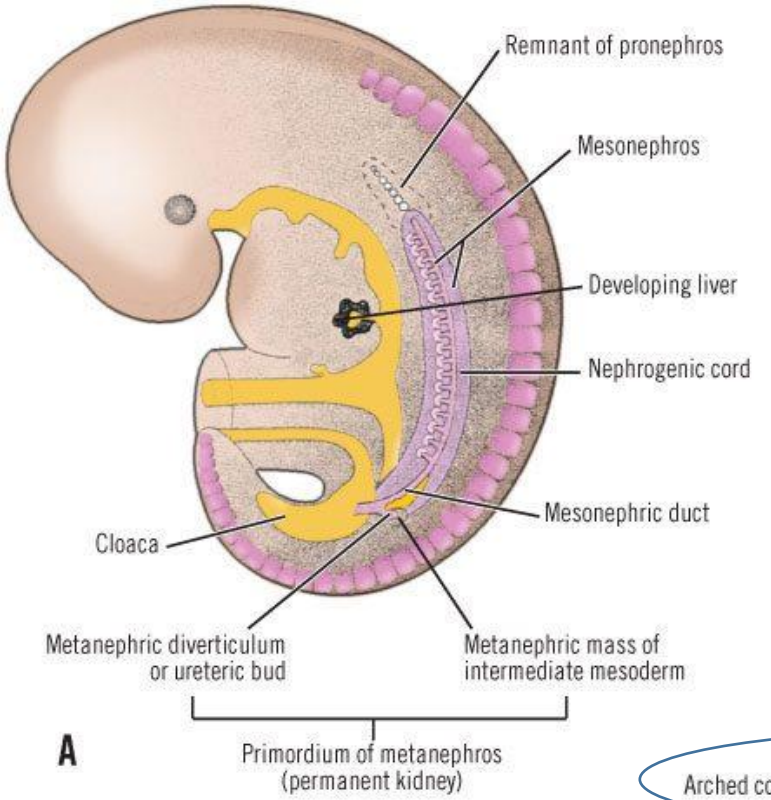
- **becomes the ureter**

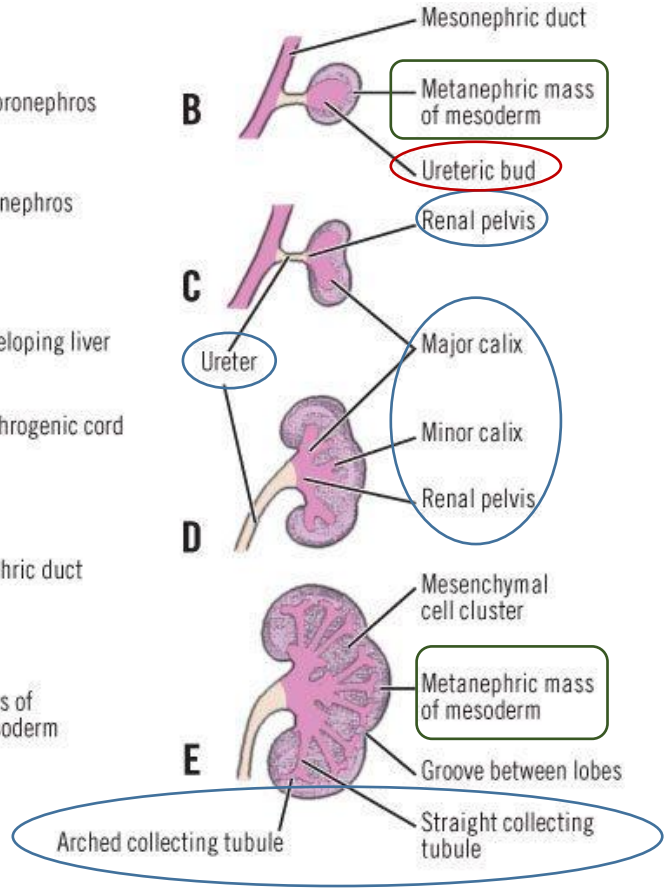
THE CRANIAL PART OF THE URETERIC BUD:

- **undergoes repetitive branching:**

- the branching form the collecting tubules







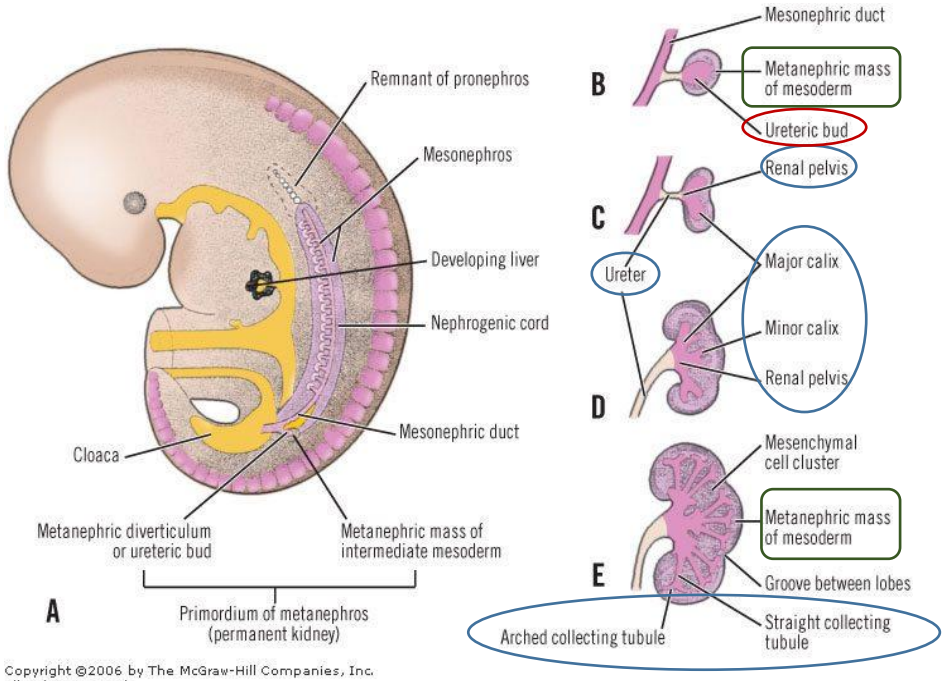
DEVELOPMENT OF KIDNEYS AND URETERS

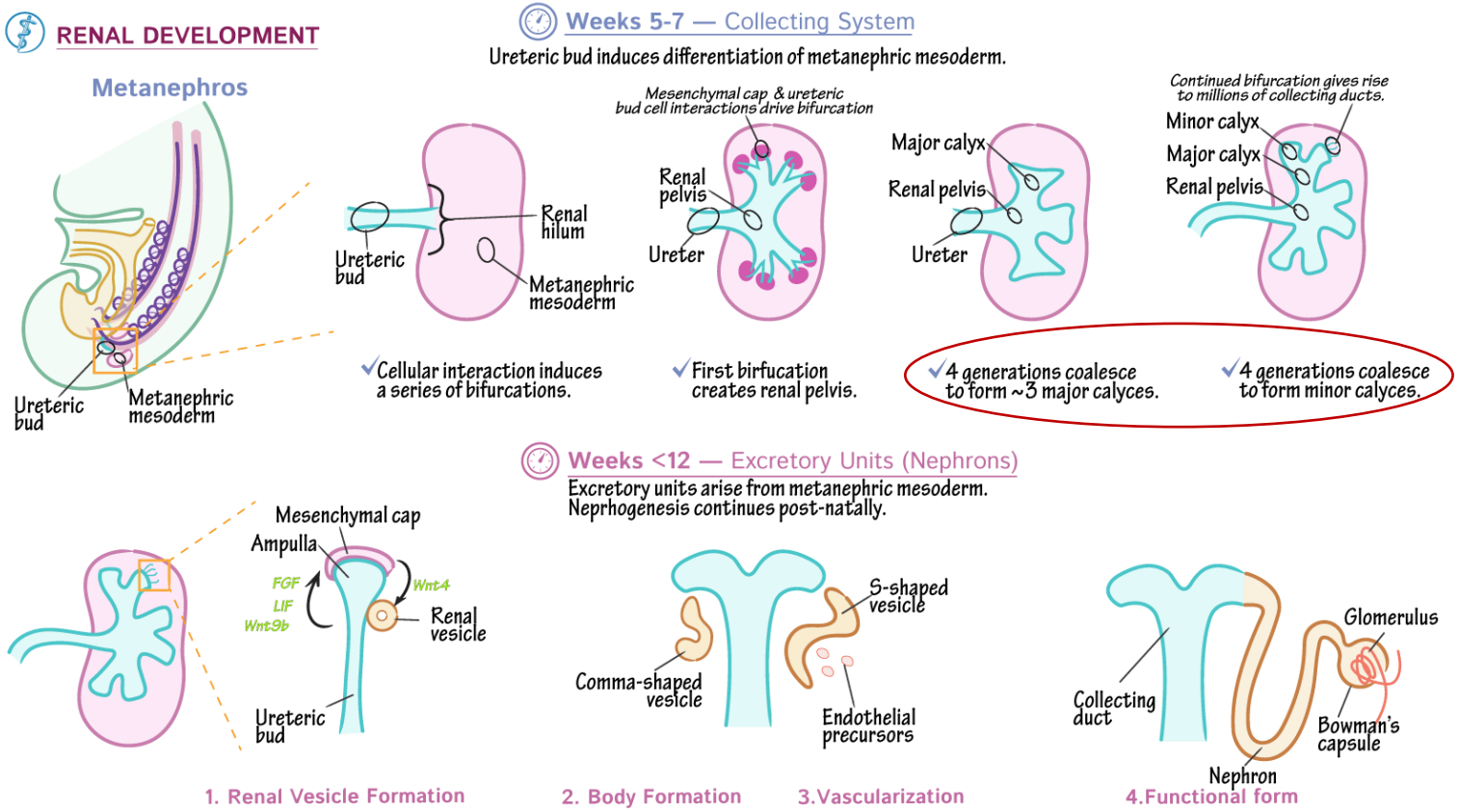
A. the first four generations of tubules:

1. **enlarge**
2. **form the MAJOR CALICES**

B. the second four generations coalesce to form:

1. the MINOR CALICES





https://www.drawittoknowit.com/course/renal-system/embryology/metanephros/1410/metanephros-development/subscribe

DEVELOPMENT OF KIDNEYS AND URETERS

1. RENAL TUBULES:

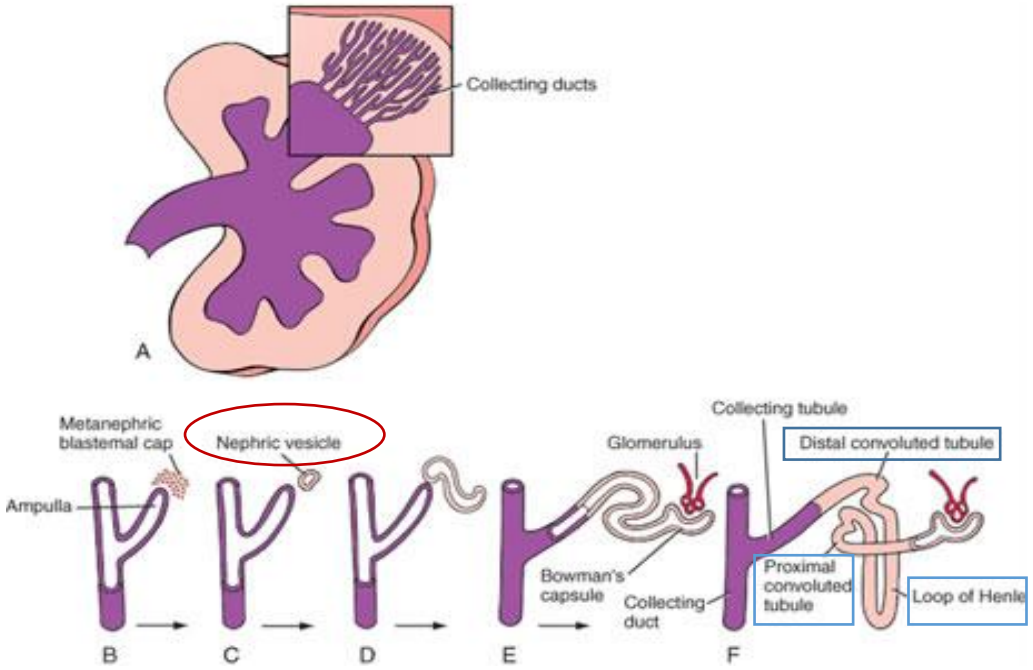
- the end of the arched collecting tubules induces clusters of mesenchymal cells in the metanephrogenic blastema – form small METANEPHRIC VESICLES

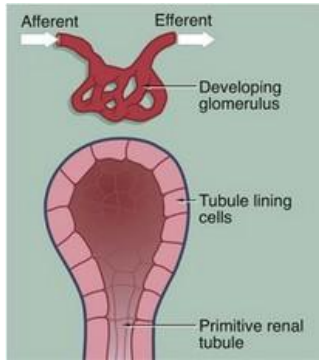
2. METANEPHRIC VESICLES:

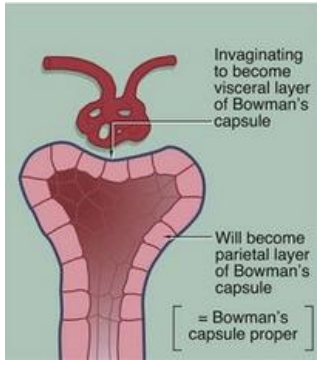
- elongate – become the renal tubules

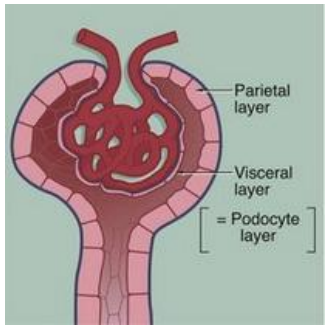
3. GLOMERULI:

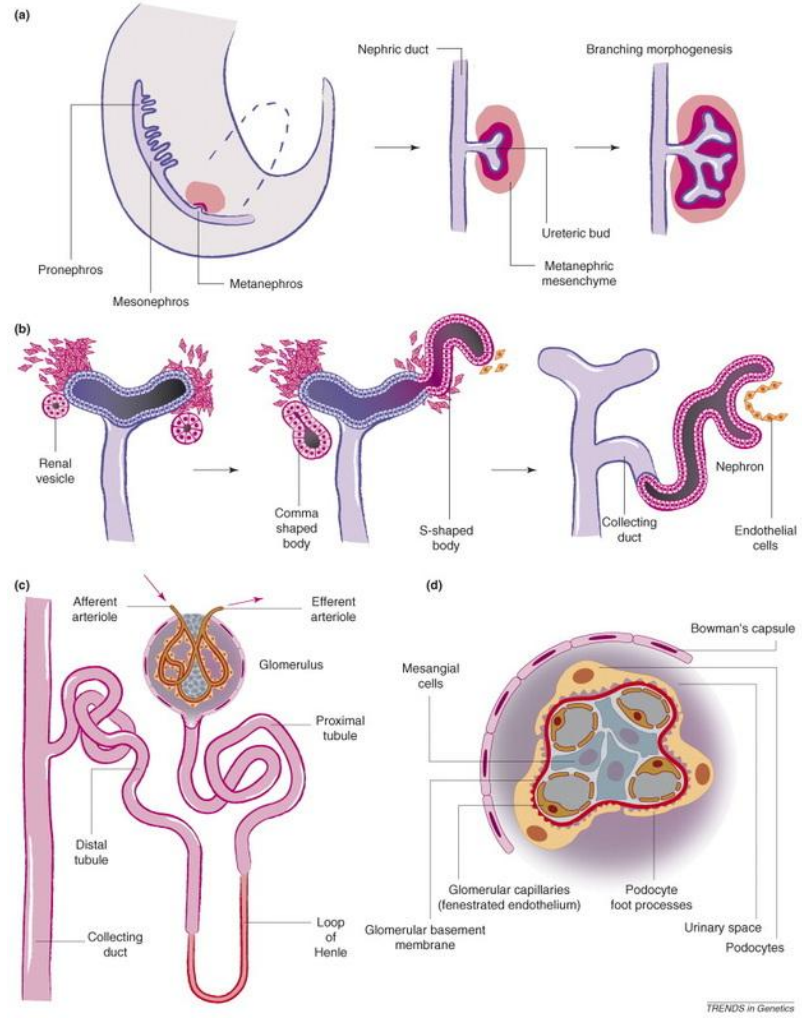
- the proximal end of the renal tubules are invaginated to form the glomeruli





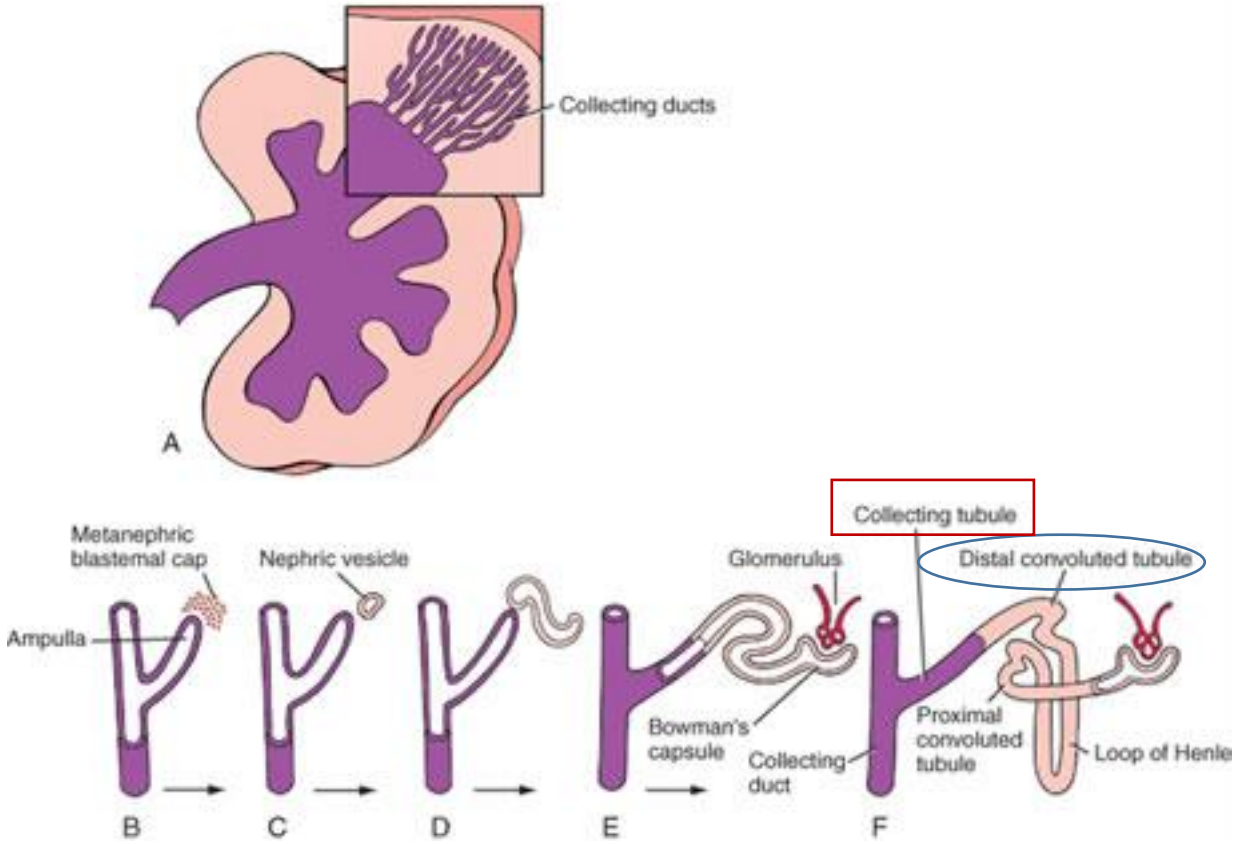


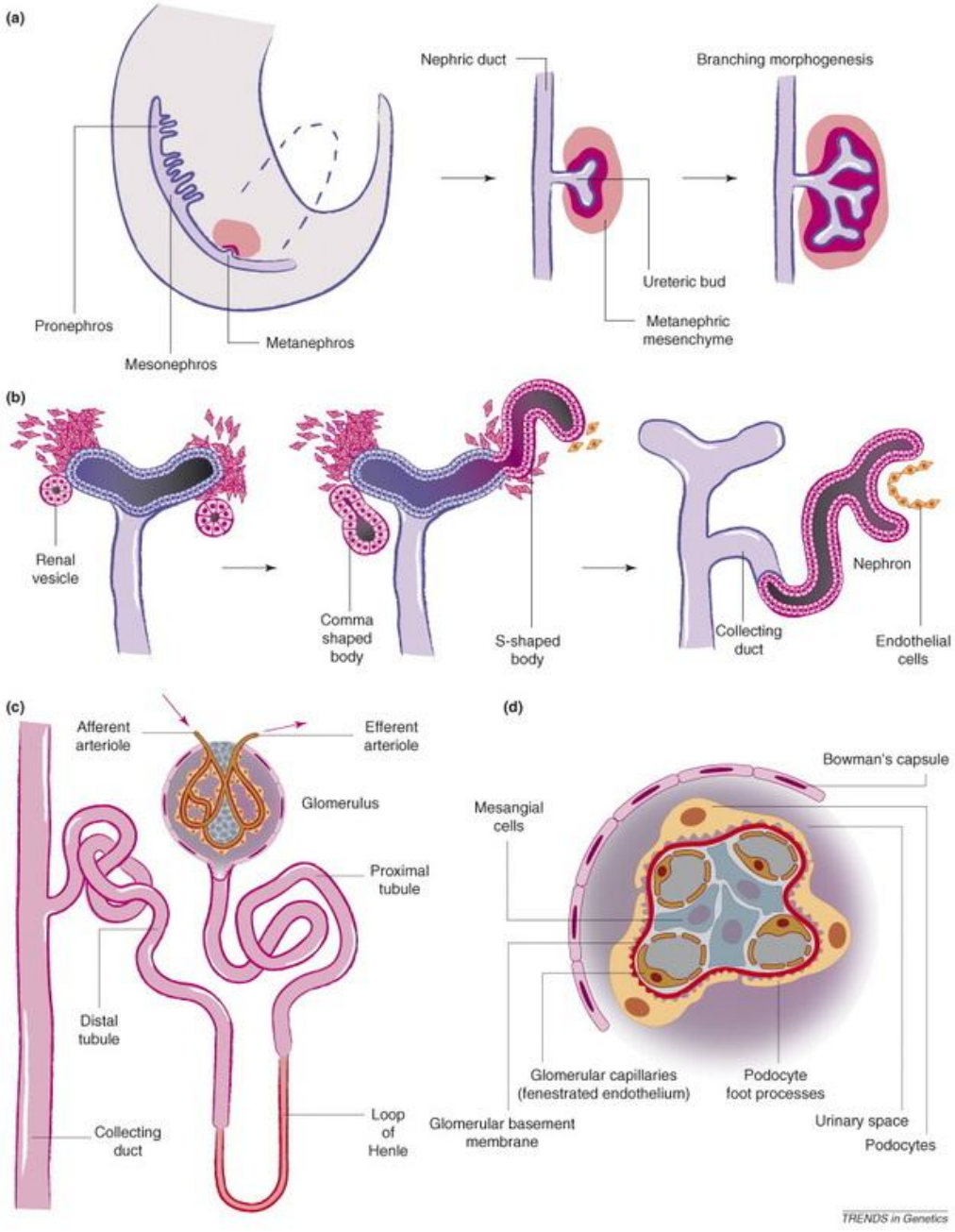




DEVELOPMENT OF KIDNEYS AND URETERS

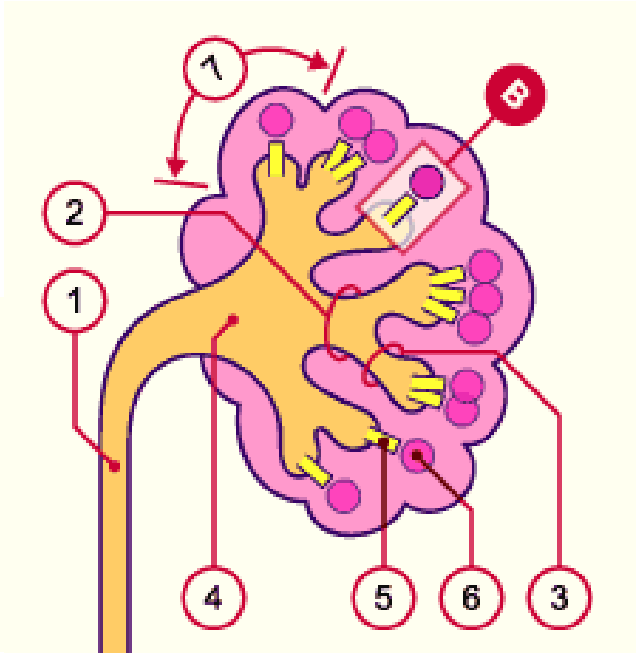
- each distal convoluted tubule contacts an arched collecting tubule
- the tubules become confluent – formation of uriniferous tubule



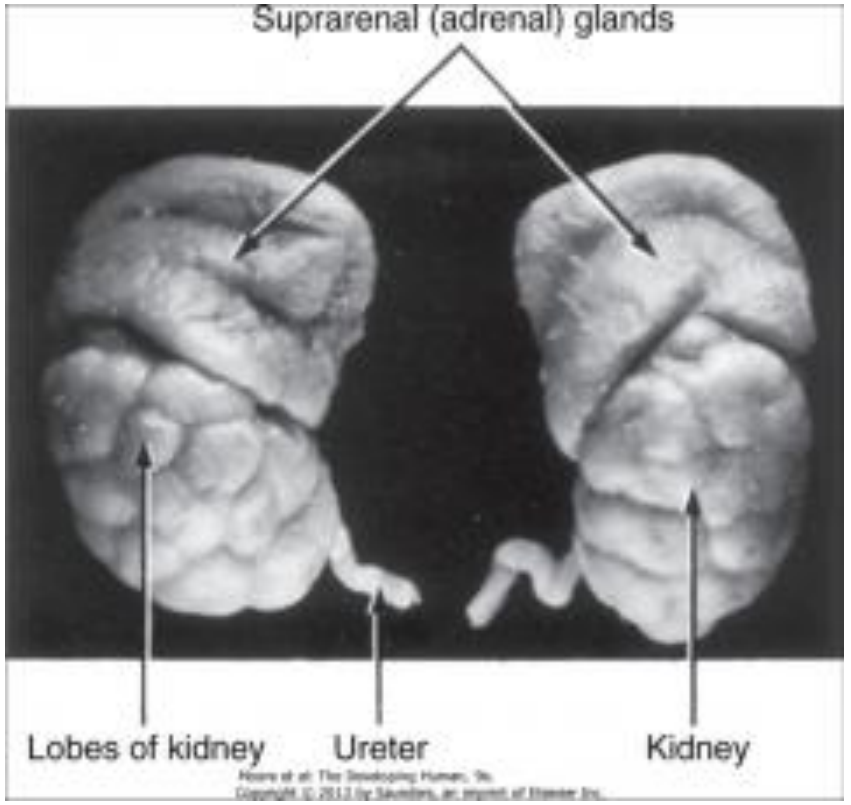


DEVELOPMENT OF KIDNEYS AND URETERS

- **the fetal kidneys are subdivided into lobes**
- **the lobulation disappears during infancy as the nephrons increase and grow**



1 Ureter
2 Major calix
3 Minor calix
4 Renal pelvis
5 Collecting duct
6 Metanephric vesicle
7 Kidney lobe



***Kidney at 28 weeks. Note the lobules; they define the locations of renal pyramids.**

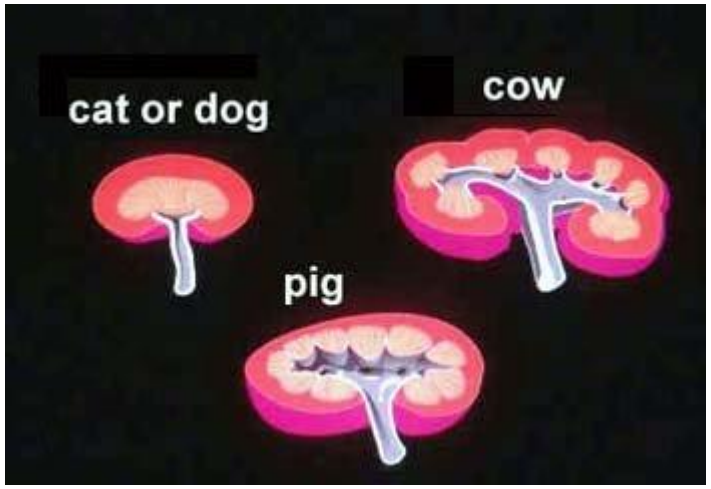
http://www.cram.com/flashcards/pathology-general-concepts-in-renal-pathology-3430072

DEVELOPMENT OF KIDNEYS AND URETERS

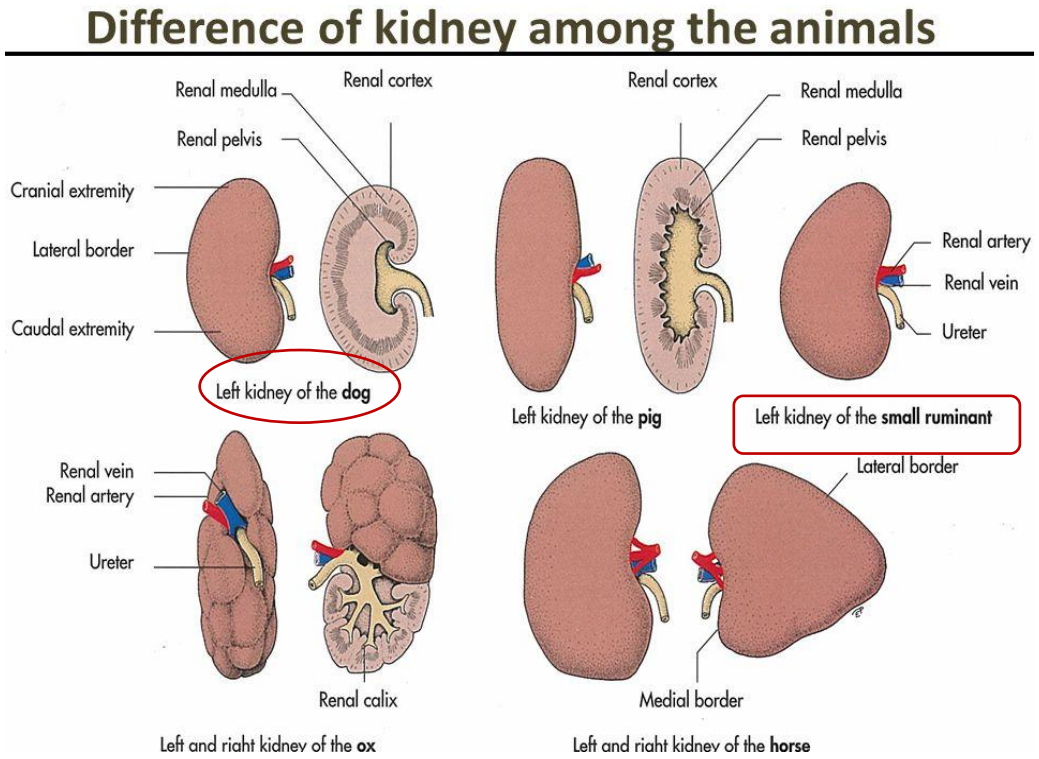
SPECIES DIFFERENCIES

Canine, Feline, and Ovine

- **kidneys relatively short and thick**
- **bean shape**
- **smooth outer surface**
- **the renal pelvis is large and irregular with recesses which are finger like processes**
- **have a single calyx and renal papilla (unipyramidal)**



http://vet.uga.edu/ivcvm/courses/vpat5215/urinary/nephritis/NEPH_4.htm

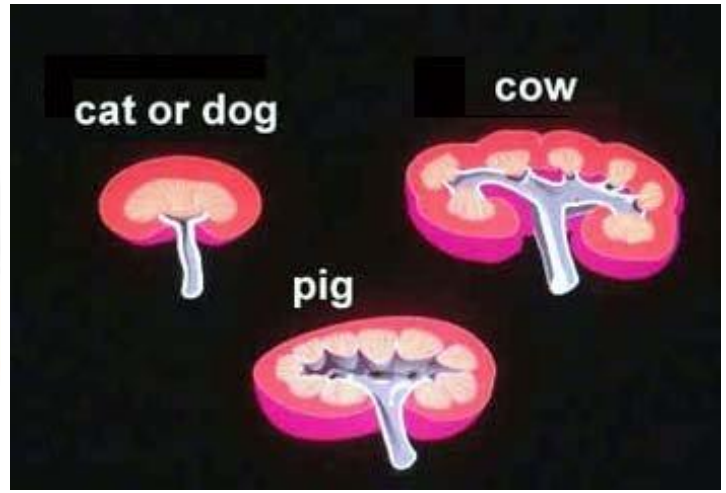


http://annahamilton.me/anatomy-of-kidney-in-horse.html

DEVELOPMENT OF KIDNEYS AND URETERS

SPECIES DIFFERENCIES

http://www.marsea.co.uk/meat/beef-kidneys



http://vet.uga.edu/ivcvm/courses/vpat5215/urinary/nephritis/NEPH_4.htm

Bovine

- **the kidneys do not lose their foetal lobulation**
- **the surface of each kidney is divided into approximately 12 lobules**
- **the cortex of the bovine kidney is continuous and the kidney is of multipyramidal type**
- **the bovine kidney has no renal pelvis but rather the ureters enters the kidney and divide into a cranial and caudal branch. These branches then subdivide and the papilla at the apex of the pyramids open and drain into these**
- **the right ureter leaves the kidney and passes along the roof of the abdomen to the pelvis in a fairly standard pattern**
- **the left ureter however moves across the dorsal surface of its kidney to return to the midline and follow a course as if the kidney was located on the left**

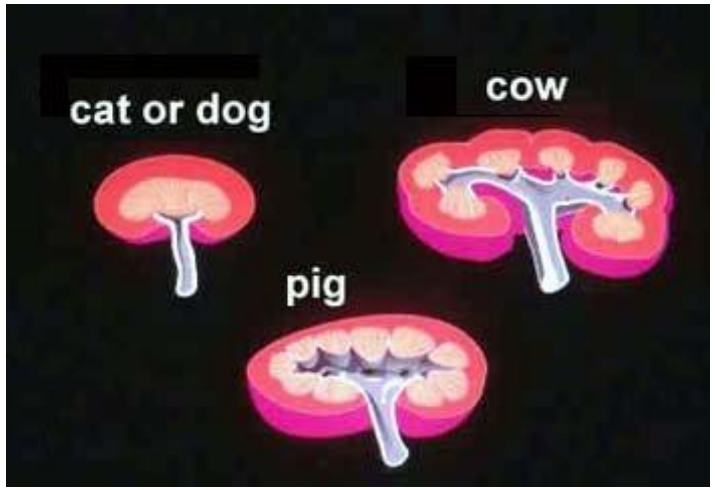
Fig. 9-20. Ureter of an ox with renal calices, corrosion cast.

DEVELOPMENT OF KIDNEYS AND URETERS

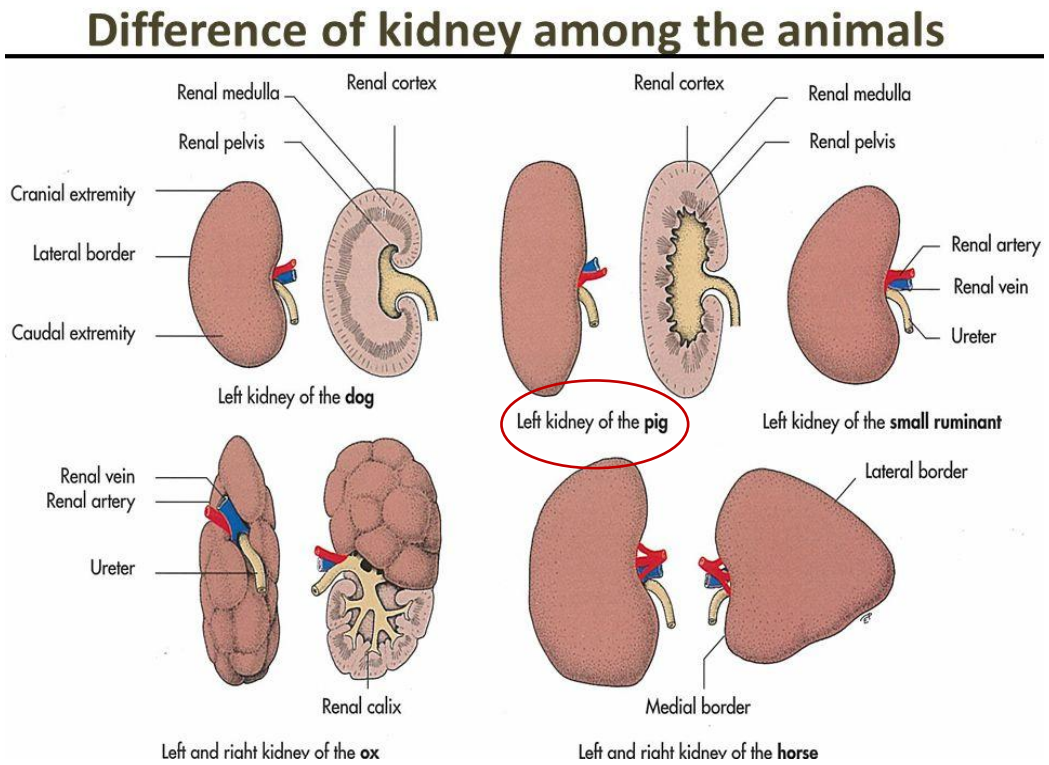
SPECIES DIFFERENCIES

Porcine

- the kidneys are dorsoventrally flattened
- the renal pelvis opens into quite a large space of two major calyces from which bud about 10 minor calyces - these attach to one renal papilla each
- the kidneys have a smooth surface



http://vet.uga.edu/ivcvm/courses/vpat5215/urinary/nephritis/NEPH_4.htm

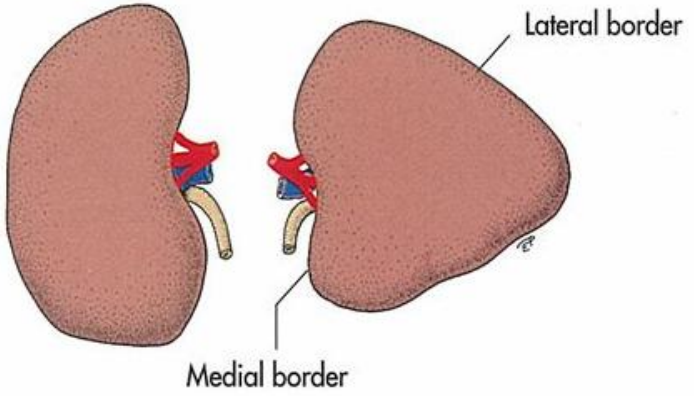


DEVELOPMENT OF KIDNEYS AND URETERS

SPECIES DIFFERENCIES

Equine

- the kidneys have very different shapes compared to the rest of the domestic species but they also each have a different shape
- the right kidney is heart shaped
- the left is described as pyramidal
- both are dorsoventrally flattened
- the kidneys are basically unipyramidal
- the external surface is not always smooth
- has a single renal papilla like the dog
- its renal pelvis is large and irregular with 2 recesses (finger like processes) the cells of its pelvis secret mucin giving the urine its cloudy appearance



Left and right kidney of the **horse**

Right kidney

https://slideplayer.com/slide/3898387/

Migration of the kidneys
Stage 15 (ca. 36 days)

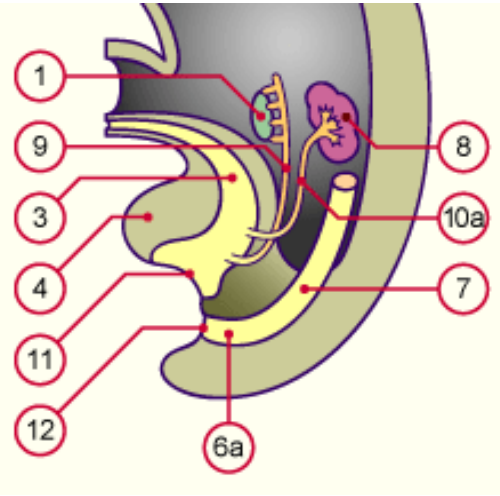
POSITIONAL CHANGES OF KIDNEYS

(ASCENT OF KIDNEY)

- the metanephric kidneys lie close to each other in the pelvis
- the abdomen and the pelvis grow and the kidneys:

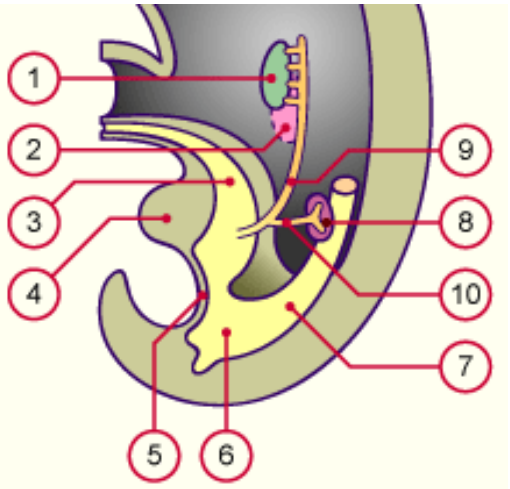
1. come to lie in the abdomen
2. move farther apart
3. the caudal part of the embryo grow away from the kidney
4. during the ascend of the kidneys they rotate medially
5. by the 9th week the kidneys come in contact with the suprarenal glands – reach their adult position

Migration of kidney, stage 23, ca. 53 day



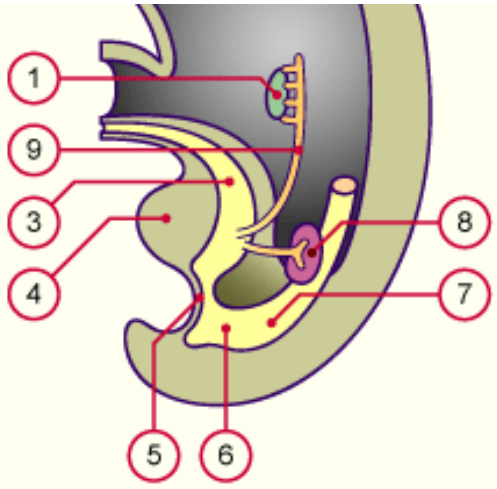
1 Gonad
3 Bladder being formed
4 Genital tubercle
6a Rectum
7 Posterior intestine
8 Metanephros
9 Mesonephric duct (Wolffian duct)
10a Ureter
11 Urogenital orifice
12 Anal orifice

Migration of kidney, stage 15, ca. 36 day



1 Gonad
2 Mesonephros
3 Allantois
4 Tuberculum genitale
5 Cloacal membrane
6 Cloaca
7 Posterior intestine
8 Metanephros
9 Mesonephric duct (Wolffian duct)
10 Ureter anlage

Migration of kidney, stage 18. ca. 44 day

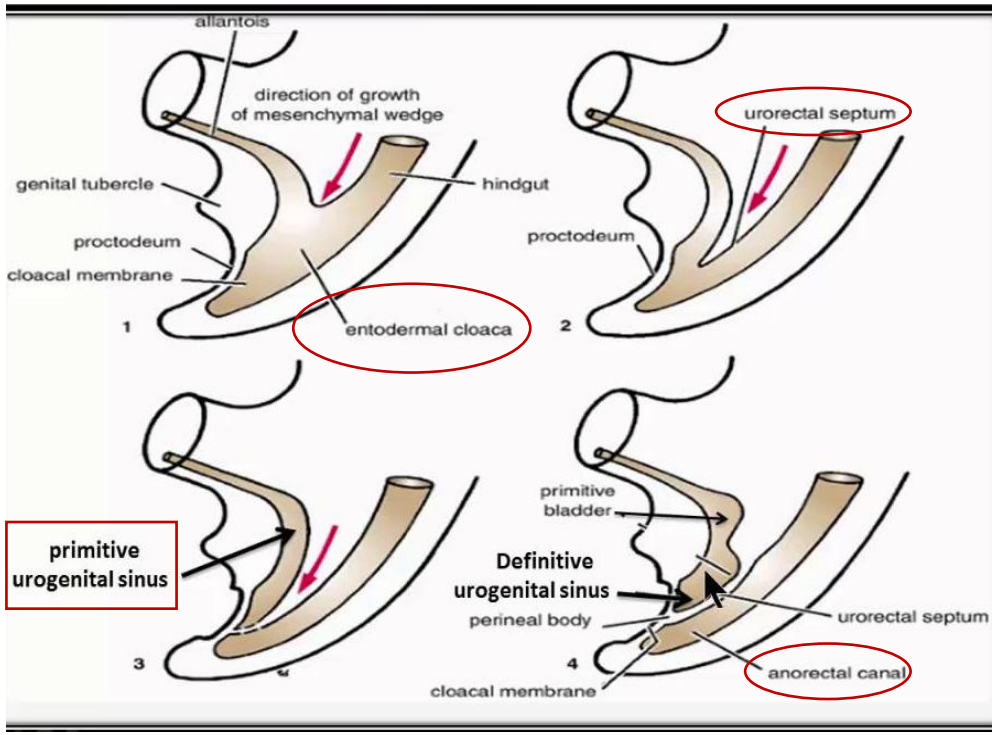


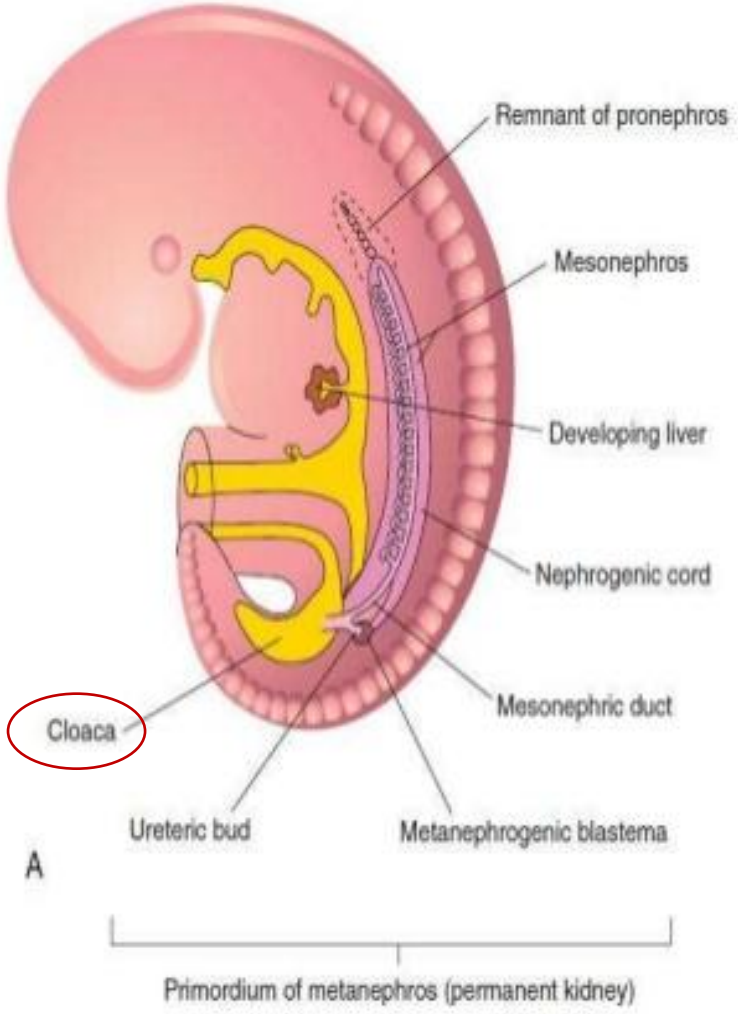
1 Gonad
3 Bladder being formed
4 Genital tubercle
5 Cloacal membrane
6 Rectum
7 Posterior intestine Metanephros
8 Metanephros
9 Mesonephric duct (Wolffian duct)

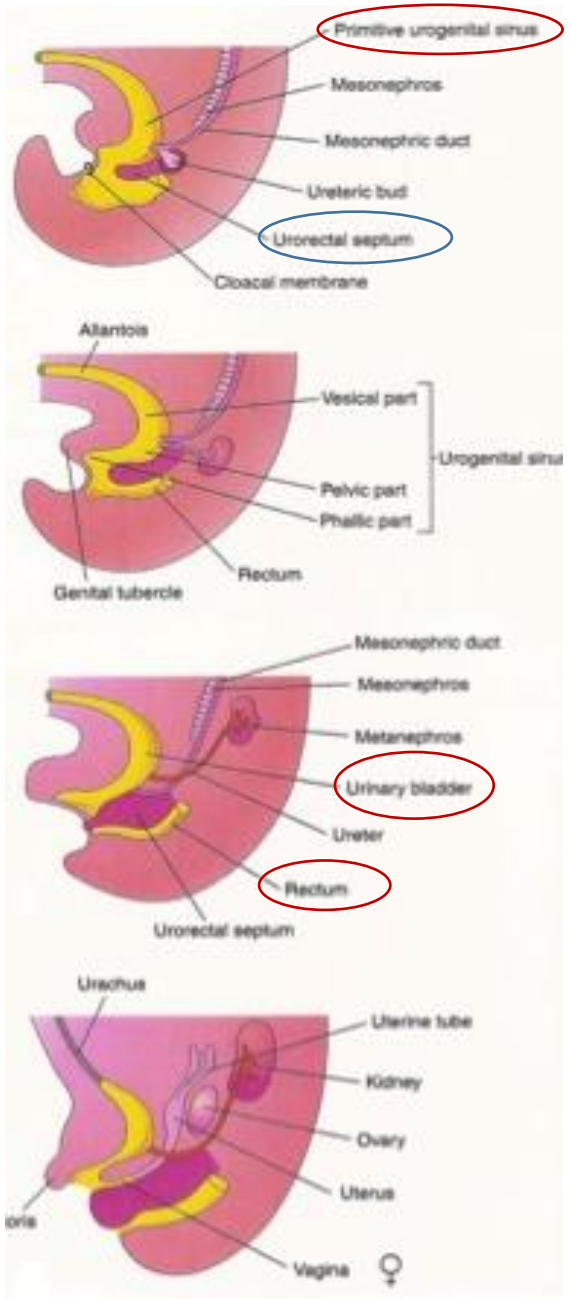
DEVELOPMENT OF URINARY BLADDER

division of the cloaca by the urorectal septum into:

1. **a dorsal rectum**
2. **a ventral urogenital sinus**







DEVELOPMENT OF URINARY BLADDER

UROGENITAL SINUS divided into:

1. A VESICAL PART (cranial):

- forms most of the bladder
- continuos with the allantois

2. PELVIC PART (middle):

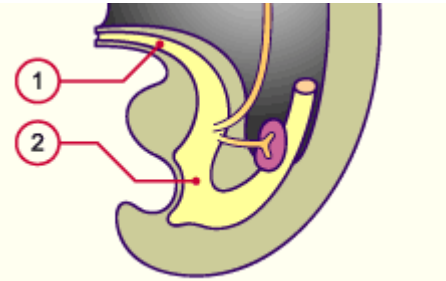
- becomes the urethra in the neck of the bladder
- the prostatic part of the urethra in male
- entire urethra in female

3. PHALLIC PART (caudal):

- grow toward the genital tubercle

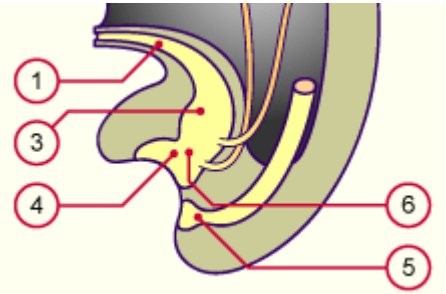
GENITAL TUBERCLE – primordium of the penis or the clitoris

Stage 13 ca. 32nd day



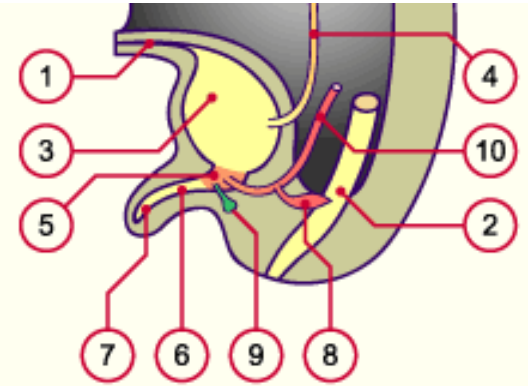
1 Allantois
2 Cloaca
3 Urinary bladder

Stage 23, ca. 56th day

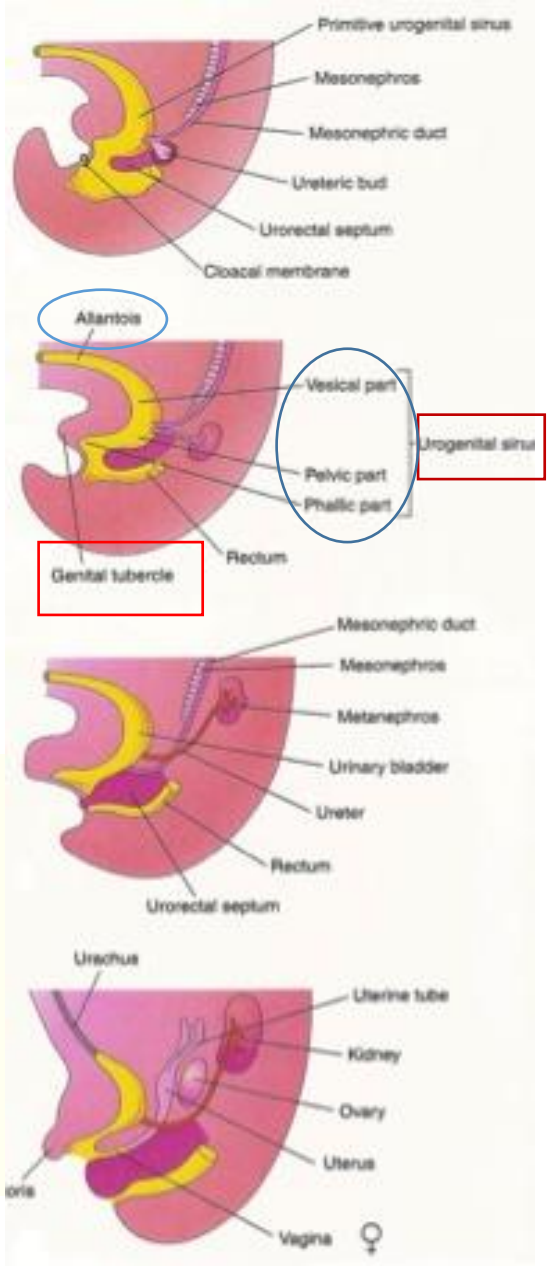


4. Phallic part of the definitive urogenital sinus
5. Rectum
6. Pelvic part of the definitive urogenital sinus

12th week



1 Urachus
2 Rectum
3 Urinary bladder
4 Ureter
5 Urethra, prostatic part (orange zone)
6 Membranous part of the urethra
7 Spongy part of the urethra
8 Seminal vesicle
9 Bulbourethral gland (Cowper's)
10 Deferent duct



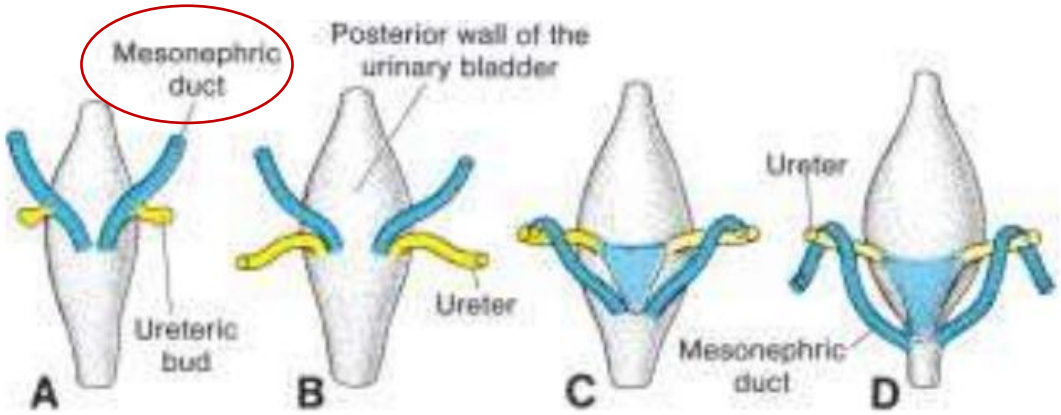
DEVELOPMENT OF URINARY BLADDER

TRIGONE OF THE BLADDER:

1. the bladder enlarges

2. distal part of the mesonephric ducts incorporated into the dorsal wall – formation the connective tissue in the trigone of the bladder

3. ureters open into the bladder

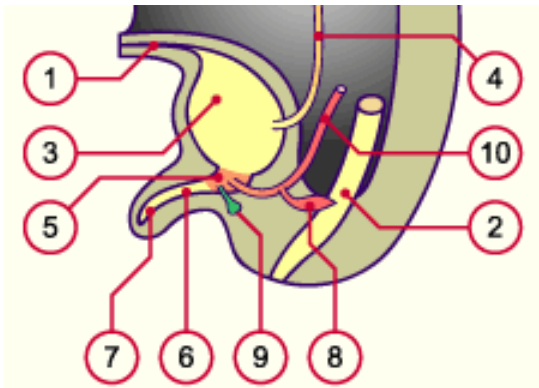


Dorsal views of the bladder showing the relation of the ureters and mesonephric ducts during development

(A) Initially the ureters are formed by an outgrowth of the mesonephric duct

(C and D)the trigone of the bladder formed by incorporation of the mesonephric ducts.

12th week



1 Urachus
2 Rectum
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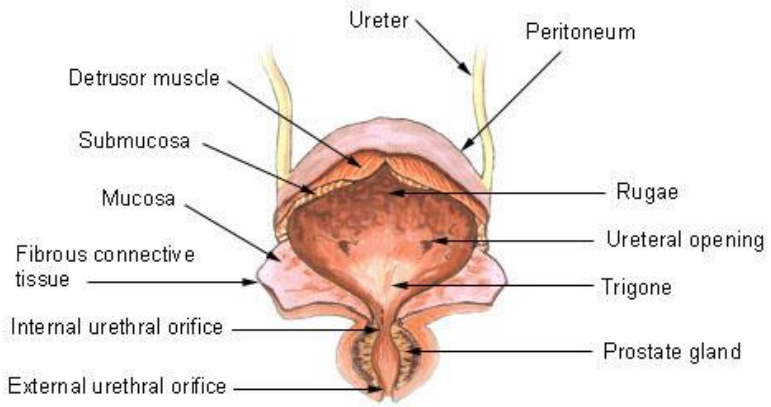
10 Deferent duct

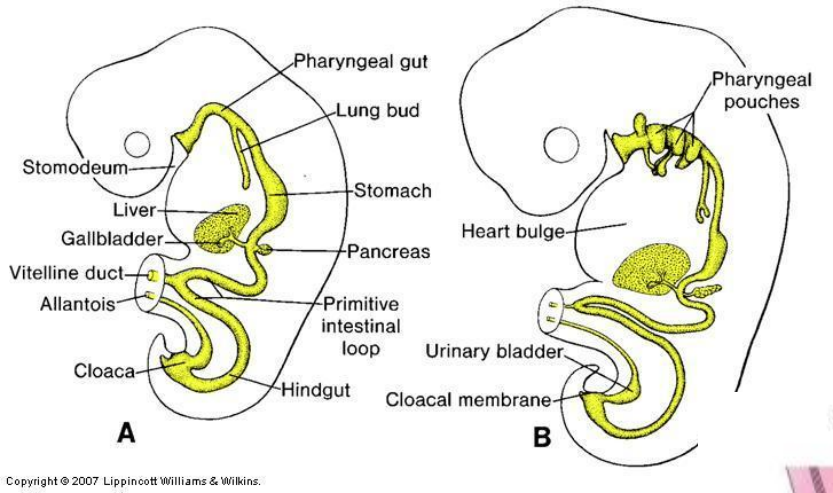
Urinary Bladder

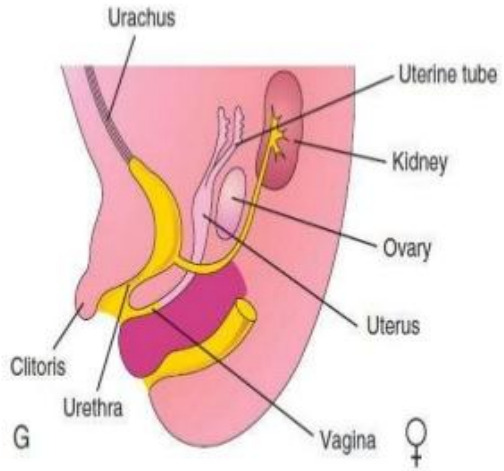


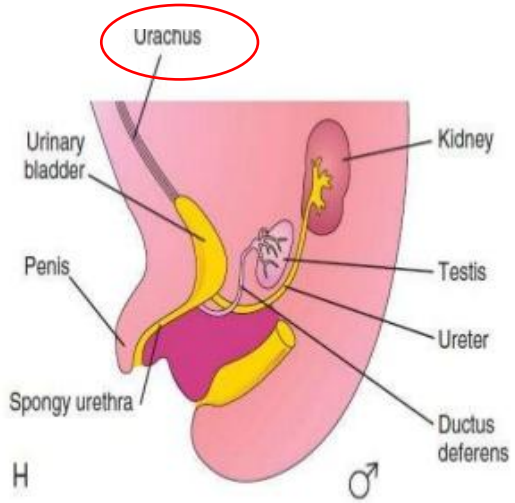
DEVELOPMENT OF URINARY BLADDER

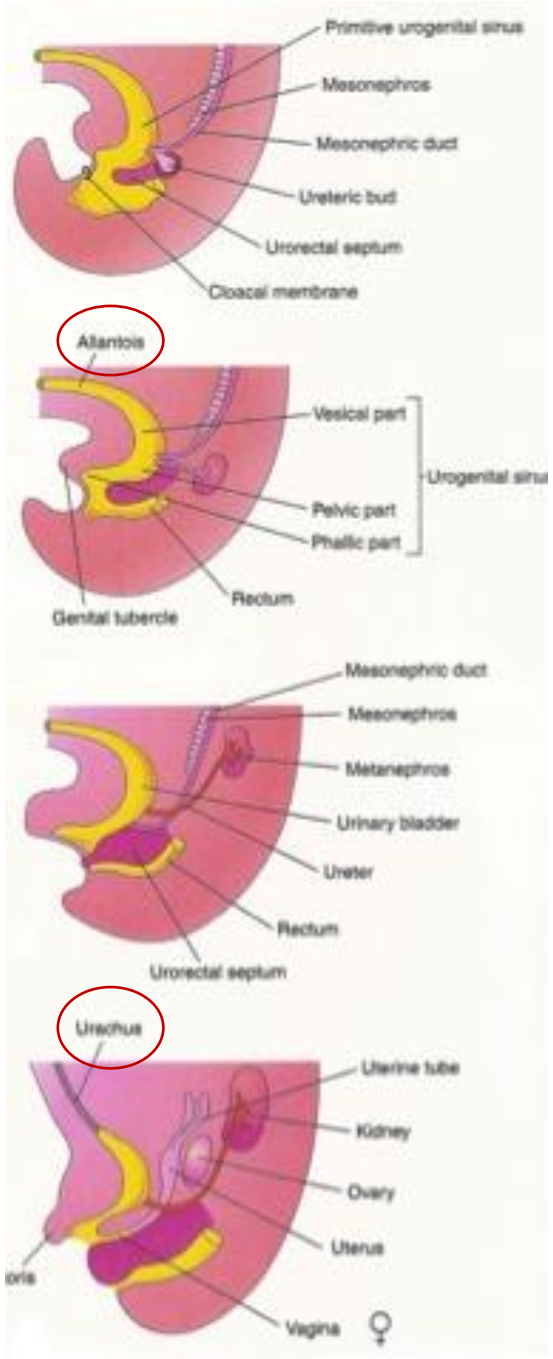
URACHUS:

- the allantois constricts and becomes thick, fibrous cord









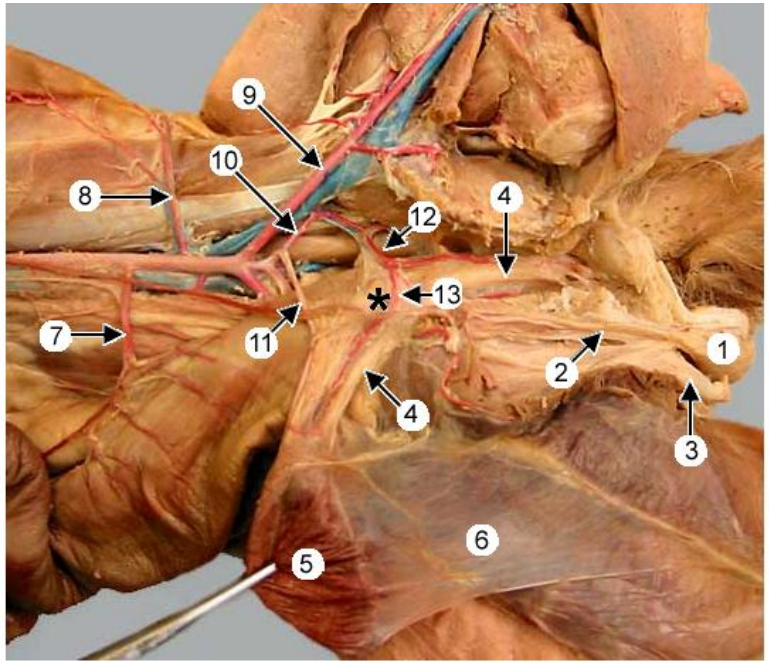
Initially the bladder is continuous with the allantois. The allantois soon constricts and becomes a thick fibrous cord, the urachus.

DEVELOPMENT OF URINARY BLADDER

URACHUS:

- the median umbilical ligament (urachal remnant) is a fibrous band in the umbilical region of the abdomen that contains the urachus (embryonic communication between the allantois and cloaca)

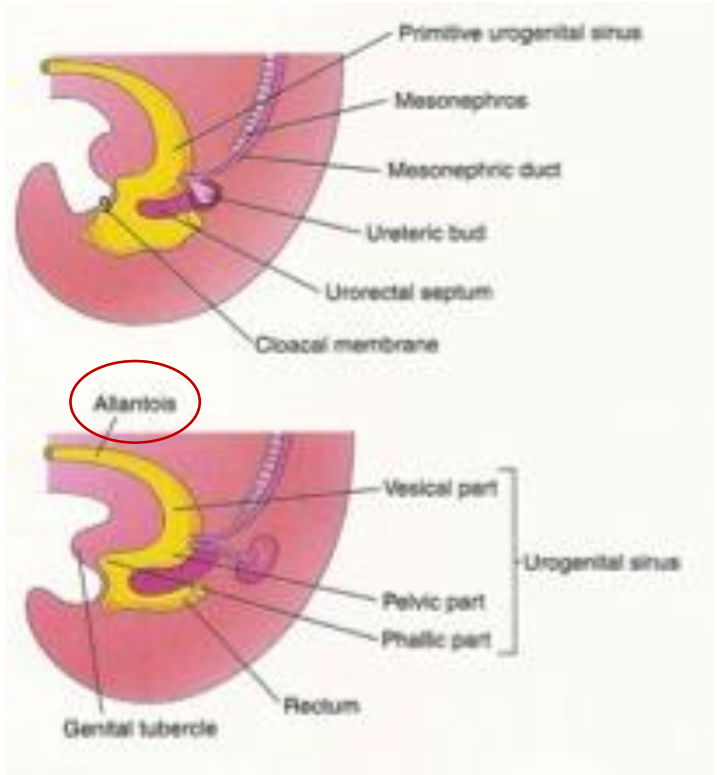
- ***the function of the median umbilical ligament, in the postnatal life, is to support the urinary bladder***

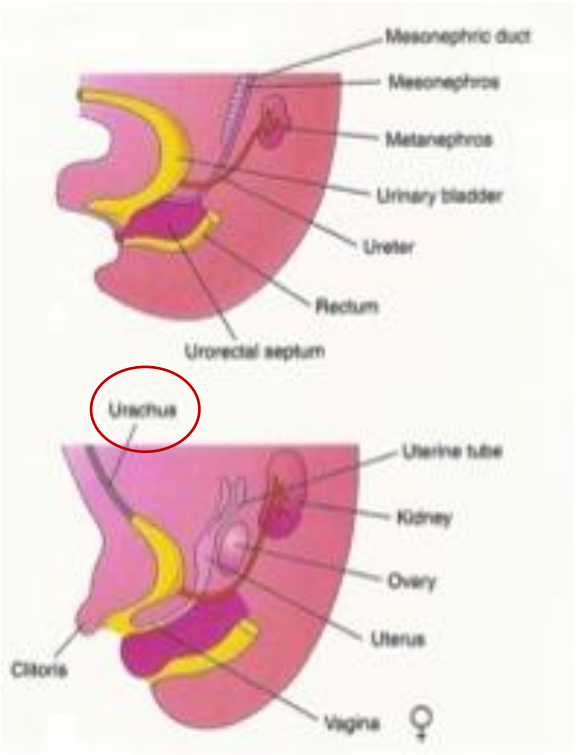


Male cat, **pelvic viscera** exposed by cutting the pelvic symphysis. Identify: testis (1), spermatic cord (2), penis (3), pelvic urethra (4), prostate (asterisk), urinary bladder (5), median ligament (6) of the urinary bladder running to the reflected abdominal floor.

Locate the following **arteries**: caudal mesenteric a. (7), deep circumflex iliac a. (8), external iliac a. (9), internal iliac a. (10), umbilical a. (11) continuing in the lateral ligament of the urinary bladder, internal pudendal a. (12), prostatic a. (13).

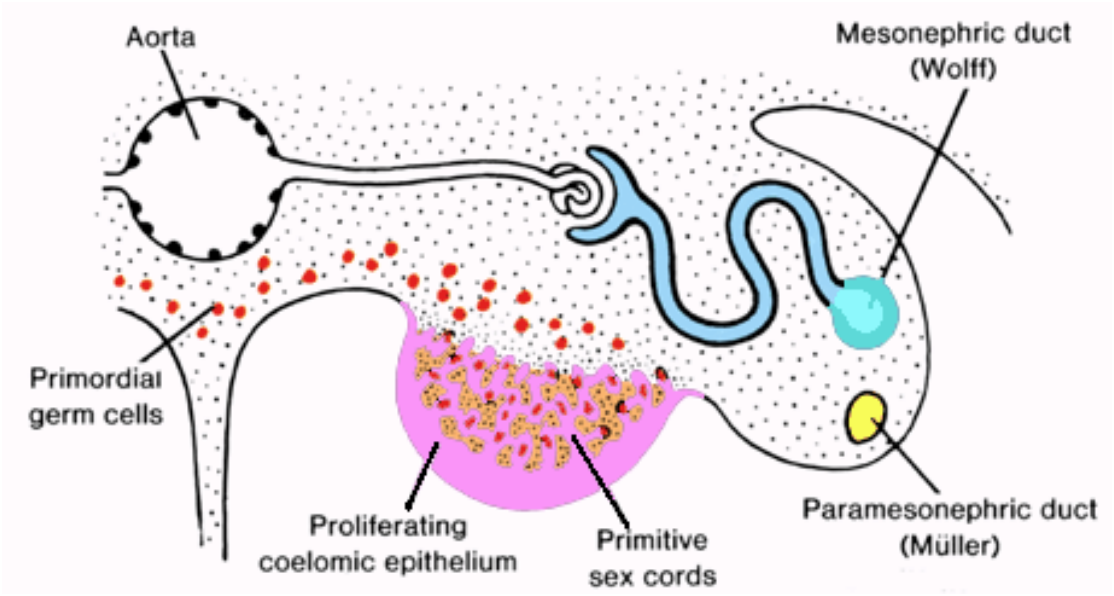
http://vanat.cvm.umn.edu/carnLabs/Lab19/Img19-1.html

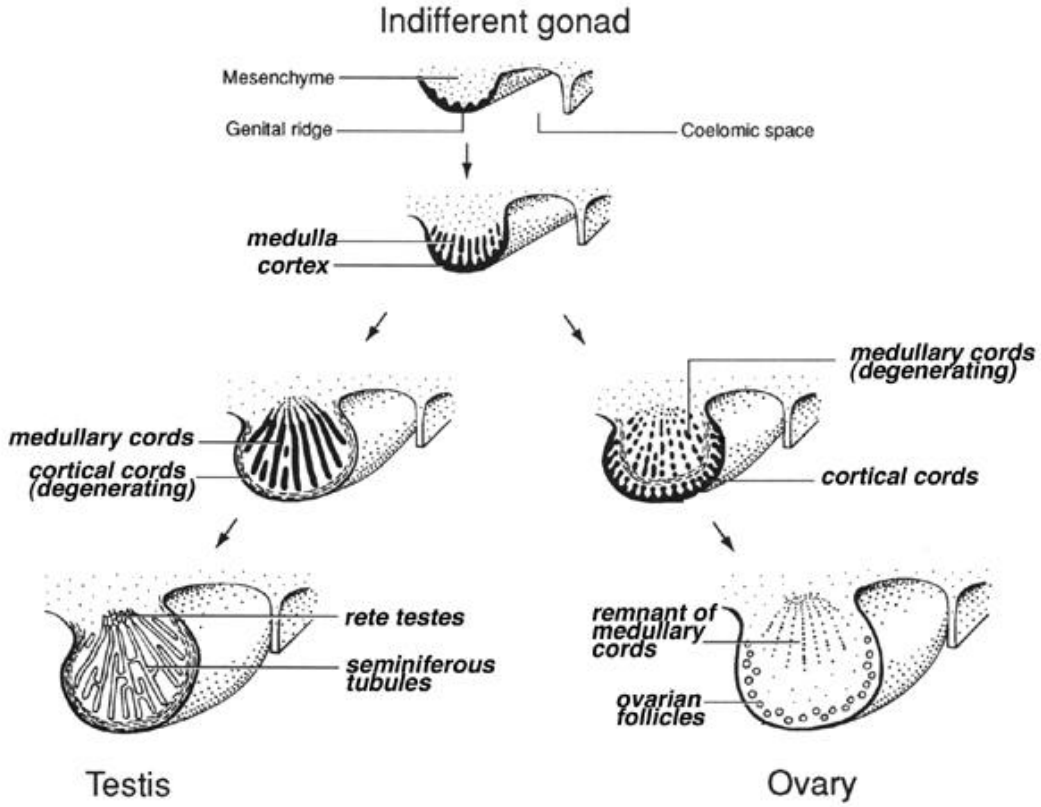




DEVELOPMENT OF GENITAL SYSTEM

- the early genital system in both sexes are similar
- the initial period of genital development is referred to as the indifferent state of sexual development
- before the 7th weeek – the gonads of two sexes are identical in appearance – called as INDIFFERENT GONADS

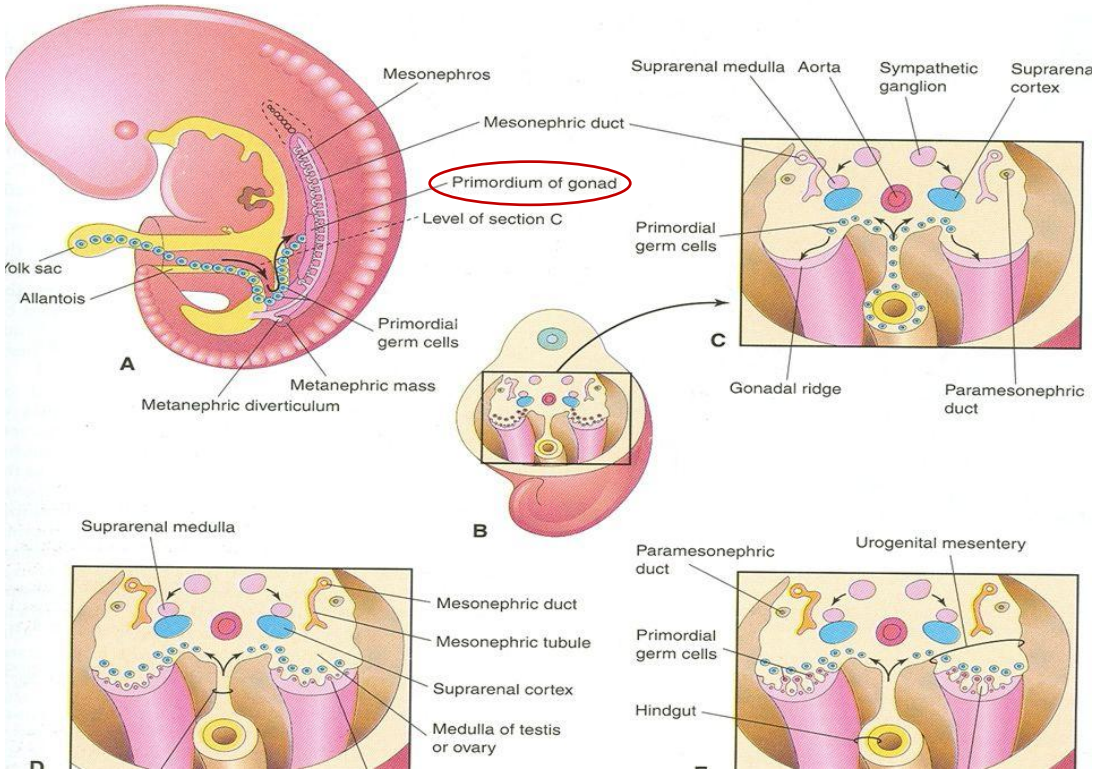


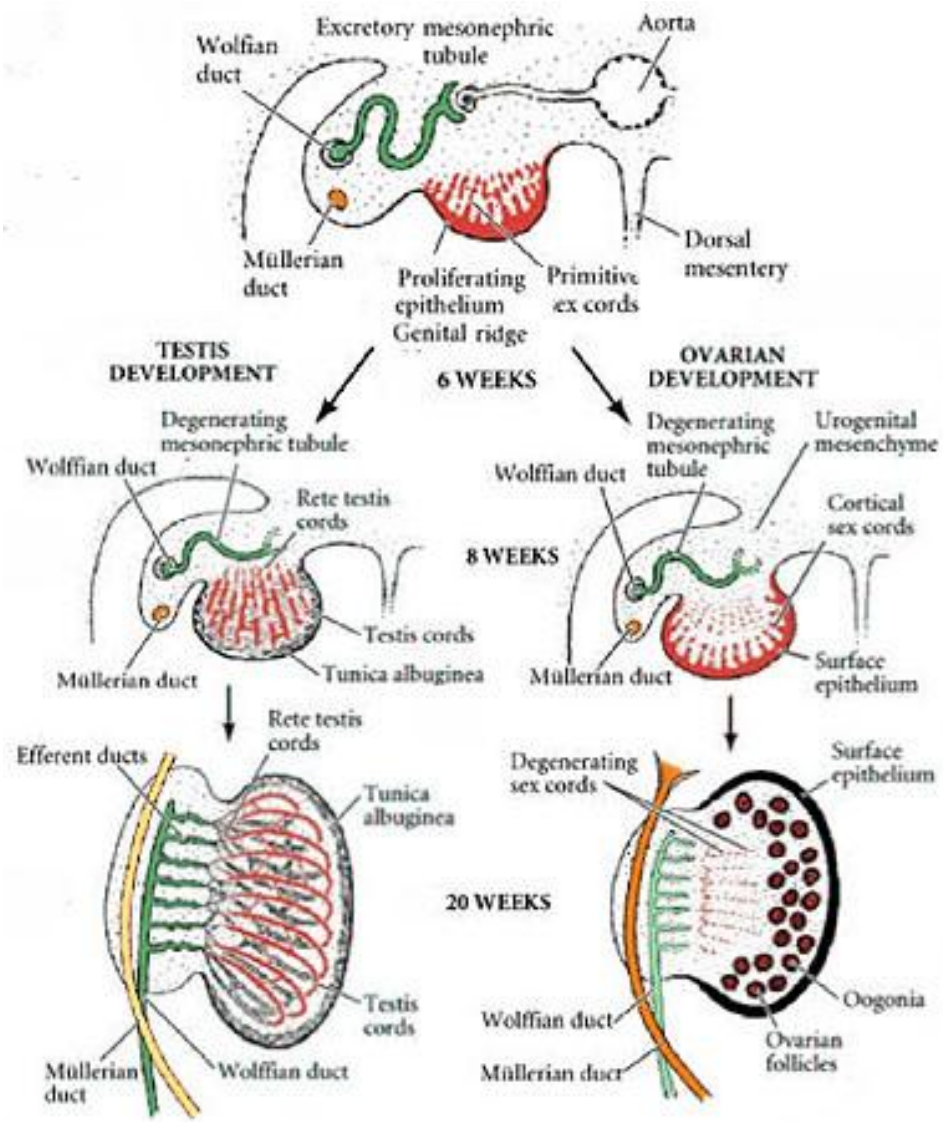


DEVELOPMENT OF GONADS (TESTES, OVARIES)

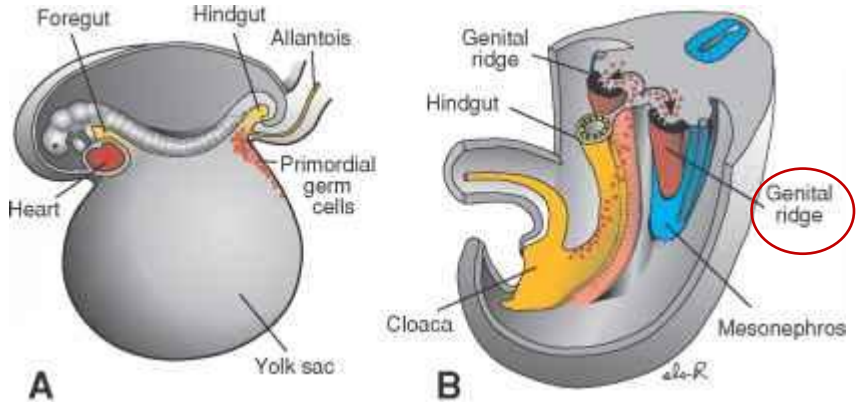
- **derived from three sources:**

1. **MESOTHELIUM (mesodermal epithelium) lining the posterior abdominal wall**
2. **UNDERLYING MESENCHYME**
3. **PRIMORDIAL GERM CELLS**





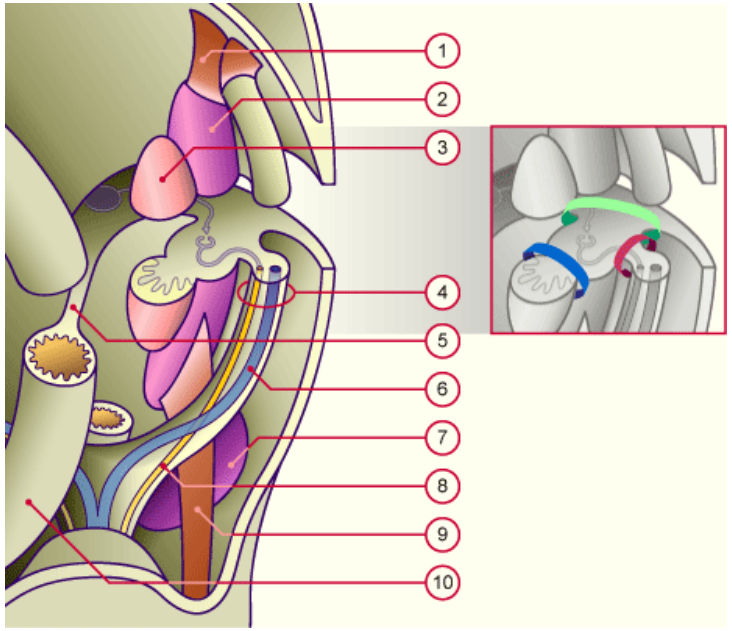
DEVELOPMENT OF GONADS (TESTES, OVARIES)



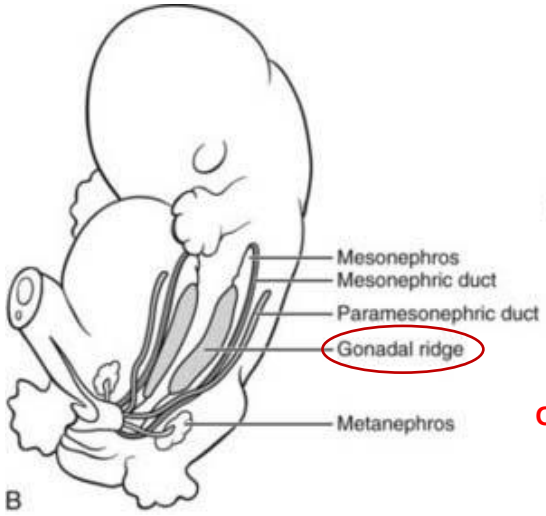
INDIFFERENT GONADS:

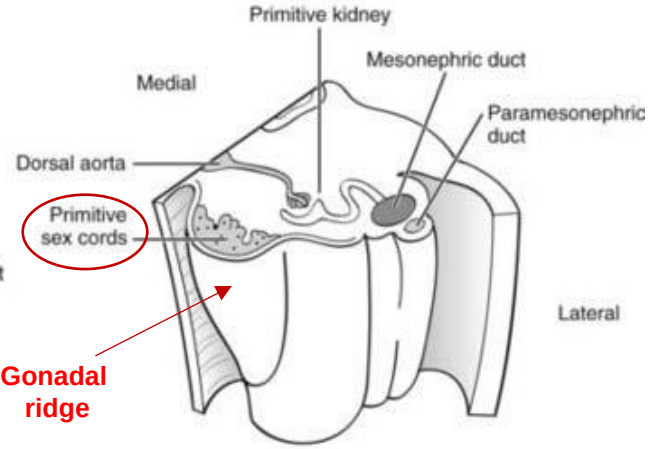
- **gonadal development begins during the 5th week**

1. **a thickened area of mesothelium develops on the medial side of the mesonephros**
2. **mesothelium proliferates**
3. **the underlaying mesenchyme produces a bulge on the medial side of the mesonephros – GONADAL (genital) RIDGE**
4. **finger – like epithelial cords (GONADAL CORDS, primitiv sex cords) grow into the underlaying mesenchyme**



1 Upper part of the gubernaculum
2 Mesonephros
3 Gonad
4 Urogenital cord
5 Dorsal mesentery
6 Paramesonephric duct (Müller)
7 Metanephros
8 Mesonephric duct (Wolff)
9 Lower part of the gubernaculum
10 Intestine





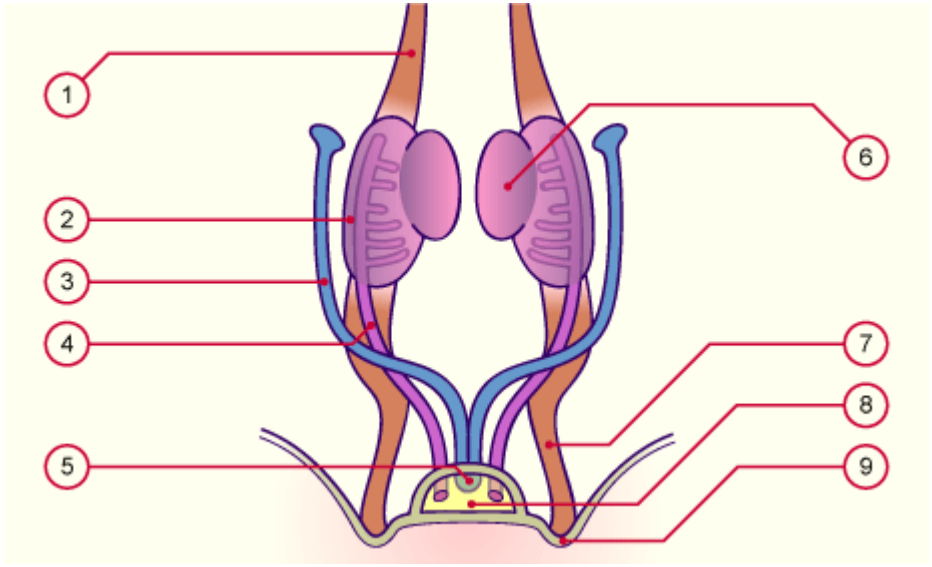
DEVELOPMENT OF GONADS (TESTES, OVARIES)

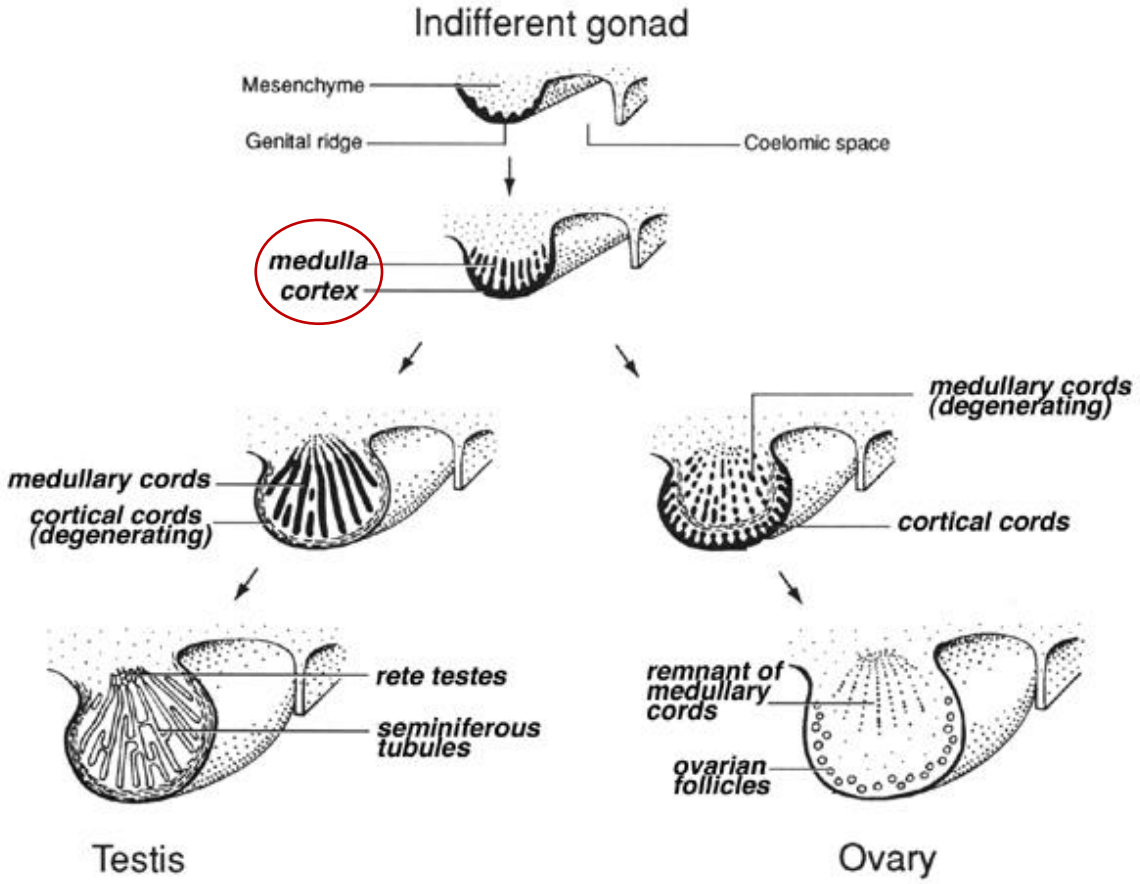
1. **THE INDIFFERENT GONADS now consist of:**

a) **an external cortex**

b) **an internal medulla**

ca. 6th week





1. Upper gubernaculum
2. Mesonephros
3. Paramesonephric duct (Müller)
4. Mesonephric duct (Wolf)
5. Sinual tubercule
6. **Indifferent gonad**
7. Lower gubernaculum
8. Urogenital sinus
9. Genital swelling (insertion of the lower gubernaculum)

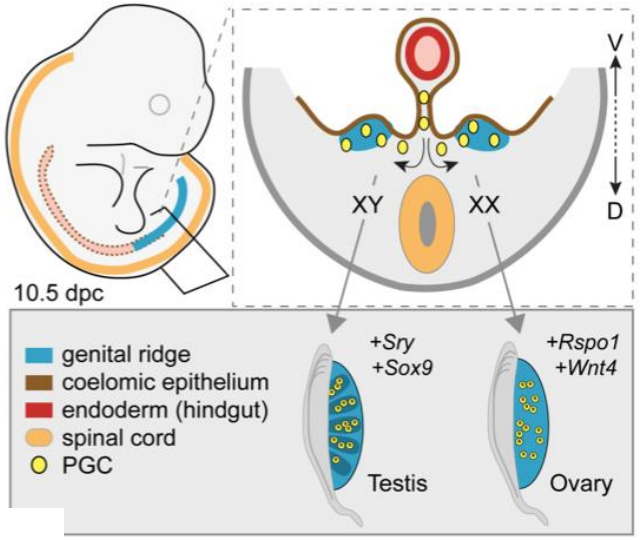
DEVELOPMENT OF GONADS (TESTES, OVARIES)

IN EMBRYO with XY sex chromosome complex:

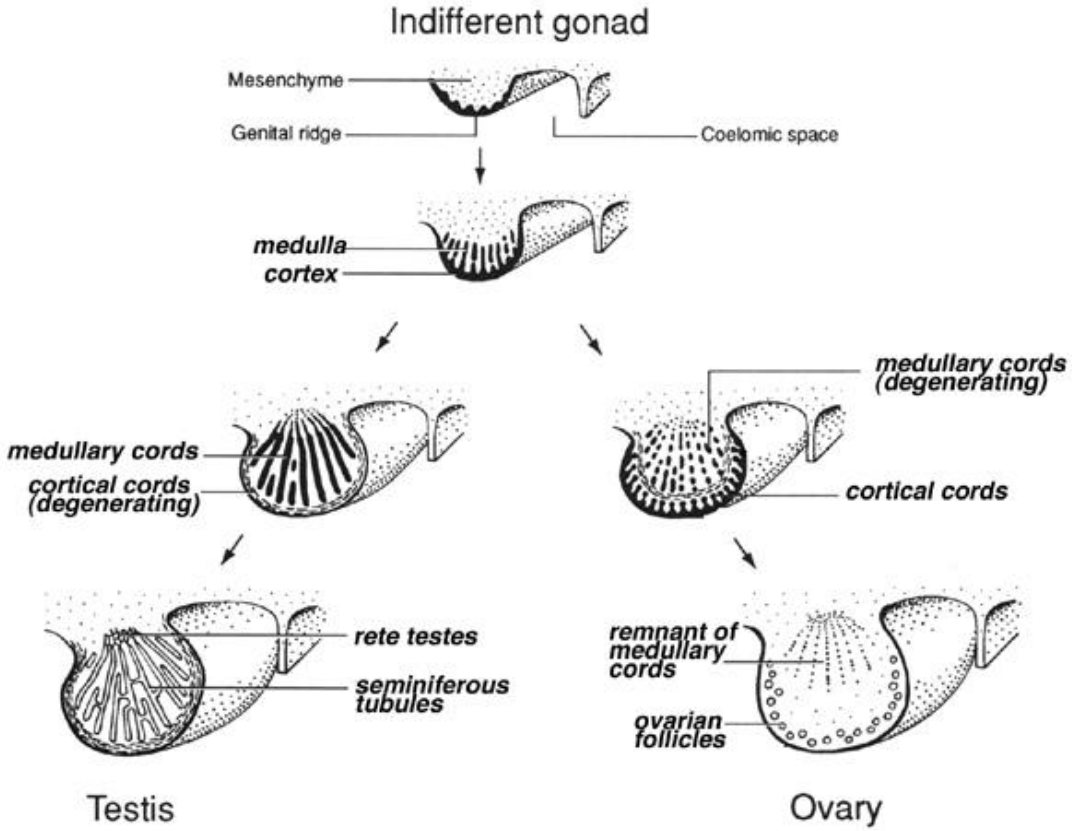
- **the medulla differentiates into a testis**
- **the cortex regresses, exept for vestigial remnants**

IN EMBRYO with XX sex chromosme complex:

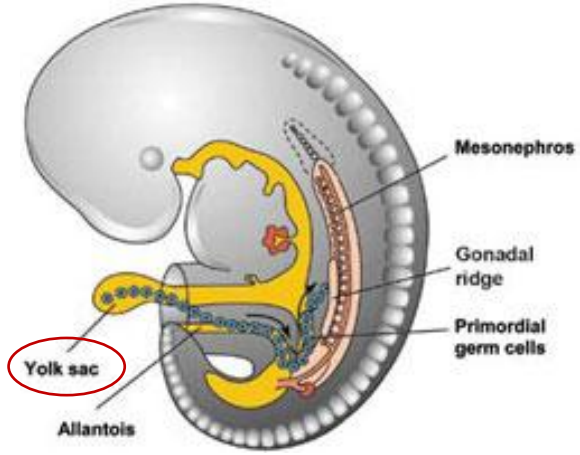
- **the cortex differentiates into ovary**
- **the medulla regresses**



http://dsdgenetics.org/index.php?id=25



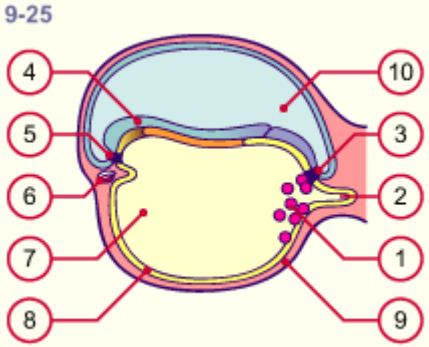
DEVELOPMENT OF GONADS (TESTES, OVARIES)



PRIMORDIAL GERM CELLS:

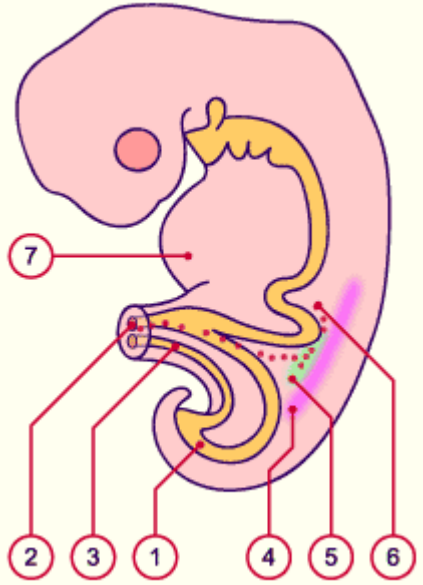
1. originate from the wall of the umbilical vesicle (yolk sac)
2. migrate along the dorsal mesentery of the gut to the gonadal ridge
3. during the 6th week these cells enter the underlying mesenchyme
4. these cells incorporated into the gonadal cords – differentiate into oocyte or sperms

Embryo in the 4th week

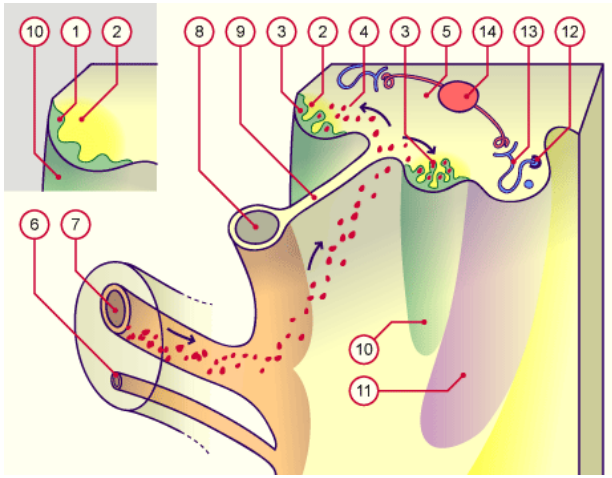


1 Primordial germ cells
2 Allantois
3 Rectum
4 Ectoderm
5 Foregut
6 Primordial heart
7 Secondary yolk sac
8 Endoderm (yellow)
9 Mesoderm (red)
10 Amniotic cavity

Embryo in the 5th week



1 Rectum
2 Vitelline
3 Allantois
4 Nephrogenic cord (pink)
5 Gonadal ridge (green)
6 Primordial germ cells (red dots)
7 Heart prominence



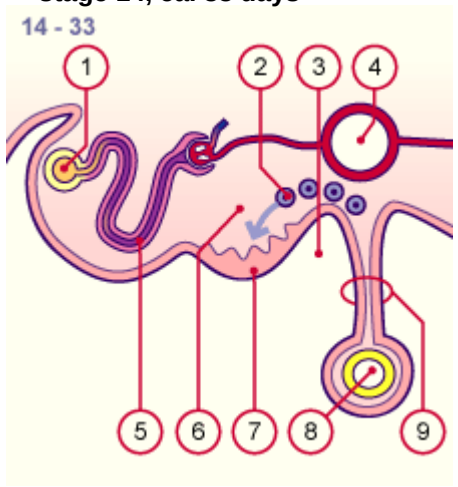
Poliferating coelomic epithelium
2. Thickening of the mesenchyma
3. Germinal cords
4. Primordial germ cells (red dots)
5. Mesenchyma
6. Allantois
7. Vitelline
8. Intestinal tube
9. Dorsal mesentery
10. Gonadal ridge
11. Nephrogenic cord
12. Mesonephric (Wolffian) duct
13. Mesonephric tubule
14. Aorta

Embryo in the 5th week
Indifferent gonads
Stage 14, ca. 33 days

DEVELOPMENT OF GONADS (TESTES, OVARIES)

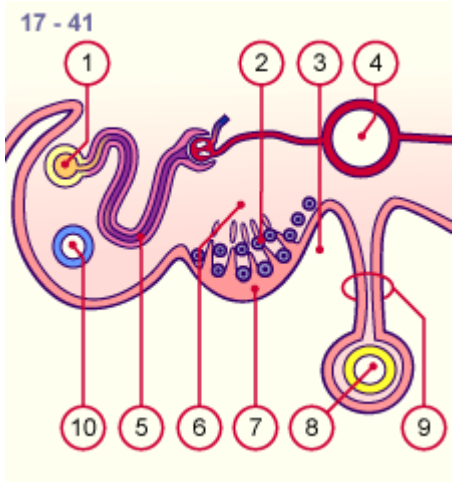
Indifferent gonads

Indifferent gonads, stage 14, ca. 33 days



1 Mesonephric duct (Wolff)
2 PGC
3 Peritoneal cavity
4 Aorta
5 Mesonephric tubule
6 Local coelomic mesenchyme
7 Thickened coelomic epithelium
8 Intestine
9 Mesentery

Indifferent gonads, stage 17, ca. 41 days



1 Mesonephric duct (Wolff)
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3 Peritoneal cavity
4 Aorta
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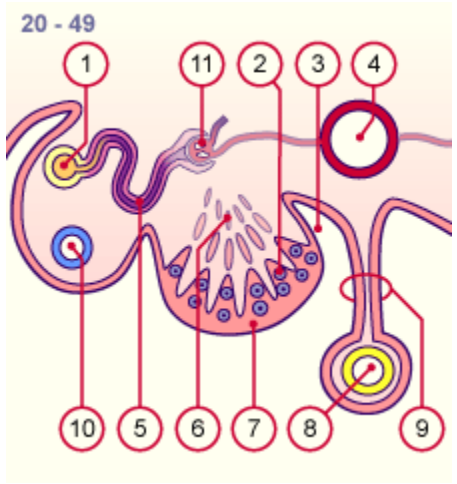
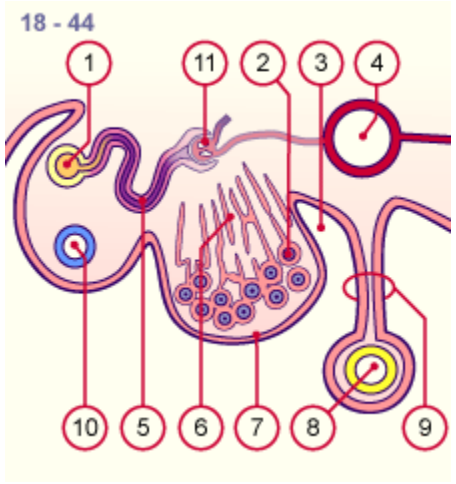
6 Local coelomic mesenchyme
7 Thickend coelomic epithelium
8 Intestine
9 Mesentery
10 Anlage of the paramesonephric duct (Müller)

Early development in the female stage 18, ca. 49 - 51 days



1 Mesonephric duct (Wolff)
2 PGC
3 Peritoneal cavity
4 Aorta
5 Mesonephric tubule
6 Degenerated gonadal cords
7 Thickened coelomic epithelium
8 Intestine
9 Mesentery
10 Anlage of the paramesonephric duct (Müller)
11 Atrophying mesonephric nephron

Early development in a male stage 18, ca. 44 - 49 days



1 Mesonephric duct (Wolff)
2 PGC
3 Peritoneal cavity
4 Aorta
5 Mesonephric tubule
6 Gonadal cords
7 Coelomic epithelium
8 Intestine
9 Mesentery
10 Anlage of the paramesonephric duct (Müller)
11 Mesonephric nephron

DEVELOPMENT OF TESTES

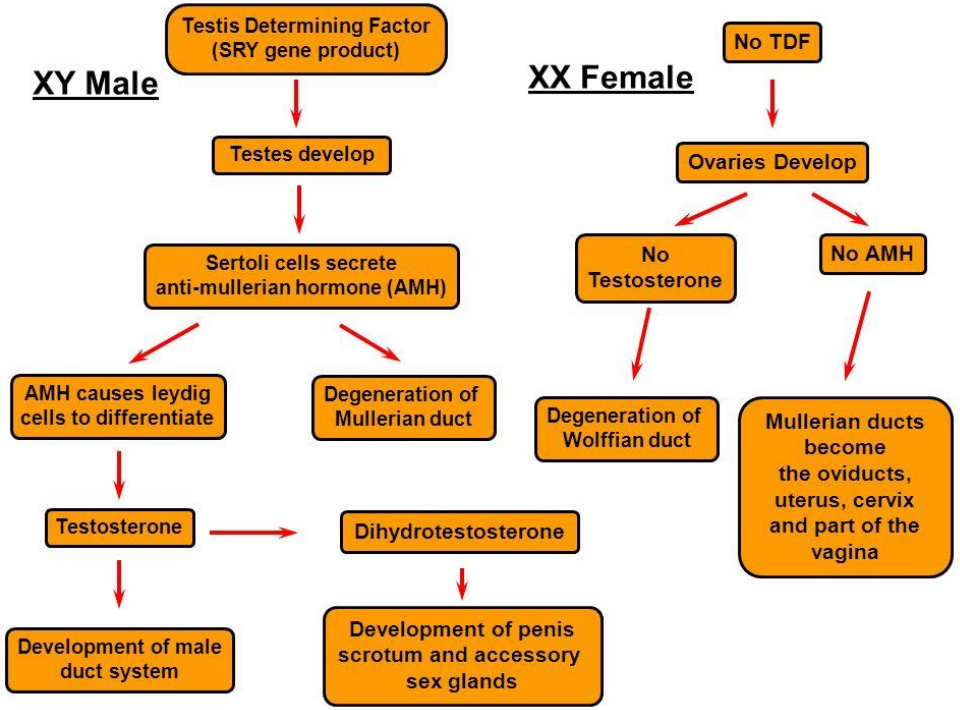
Genes induce the development of testes:

SRY gene:

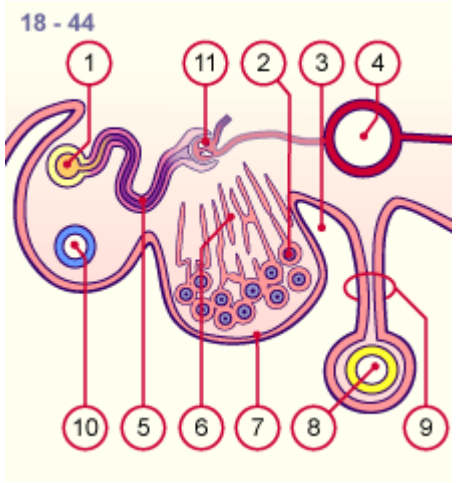
- **on the sort arm of Y chromosome**
- **for the Testis – Determining Factor (TDF):**

TDF:

1. **directs the development of indifferent gonads into a testis**
2. **induces the condensation of gonadal cords**

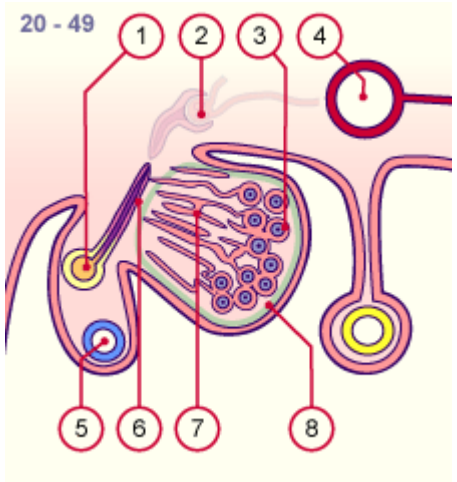


Early differentiation (male)
stage 18, ca. 7 weeks



1 Mesonephric duct (Wolff)
2 PGC
3 Peritoneal cavity
4 Aorta
5 Mesonephric tubule
6 Gonadal cords
7 Coelomic epithelium
8 Intestine
9 Mesentery
10 Anlage of the paramesonephric duct (Müller)
11 Mesonephric nephron

http://slideplayer.com/slide/8302661/



Early differentiation (male)
stage 20, ca. 8 weeks

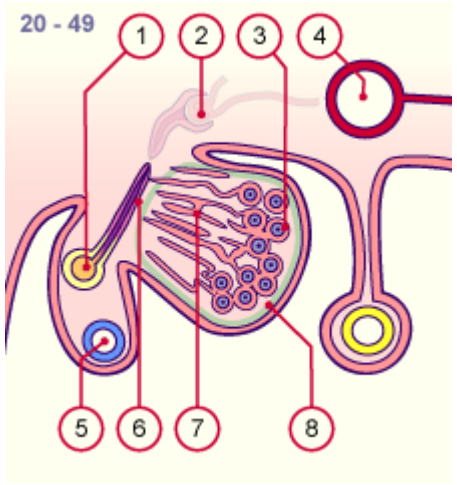
1 Mesonephric duct (Wolff)
2 Mesonephric nephron (atrophying)
3 Testicular cords surround the PGC
4 Aorta
5 Paramesonephric duct (Müller)
6 Mesonephric tubule
7 Testicular cords that grow into the medulla
8 Tunica albuginea

DEVELOPMENT OF TESTES

3. the condensed gonadal cord extend into the medulla of the indifferent gonad

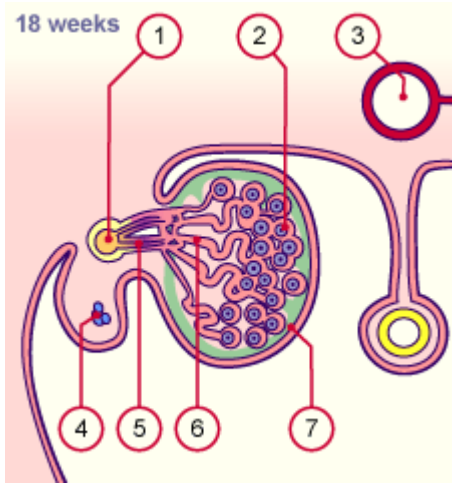
4. within the medulla the gonadal cord branch and anastomose to form the RETE TESTIS

Early differentiation (male)
stage 20, ca. 8 weeks



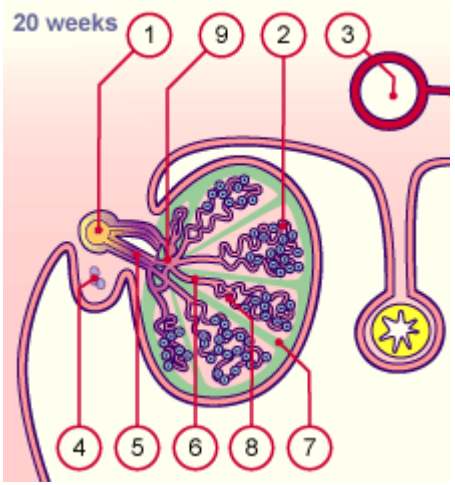
1 Mesonephric duct (Wolff)
2 Mesonephric nephron (atrophying)
3 Testicular cords surround the PGC
4 Aorta
5 Paramesonephric duct (Müller)
6 Mesonephric tubule
7 Testicular cords that grow into the medulla
8 Tunica albuginea

Late differentiation (male)
ca. 18 weeks



1 Mesonephric duct (Wolff)
2 Testicular cords, surround the PGC
3 Aorta
4 Paramesonephric duct (Müller) (atrophying)
5 Mesonephric tubule (later efferent ductules)
6 Testicular cords
7 Tunica albuginea

Late differentiation (male)
ca. 20 weeks



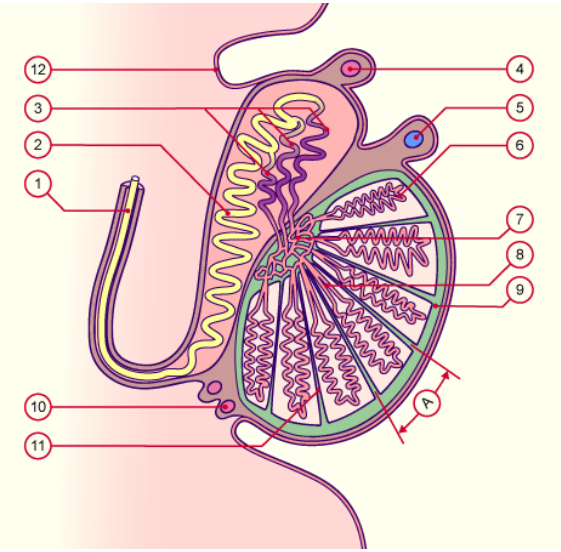
1 Mesonephric duct (Wolff)
2 PGC surrounded by supporting cells (Sertoli)
3 Aorta
4 Paramesonephric duct (derivative)
5 Efferent ductules
6 Straight seminiferous tubule
7 Tunica albuginea
8 Convoluted seminiferous tubule
9 Rete testis (testicular network)

DEVELOPMENT OF TESTES

5. the connection of the seminiferous cords with the surface epithelium is lost during the development of the tunica albuginea

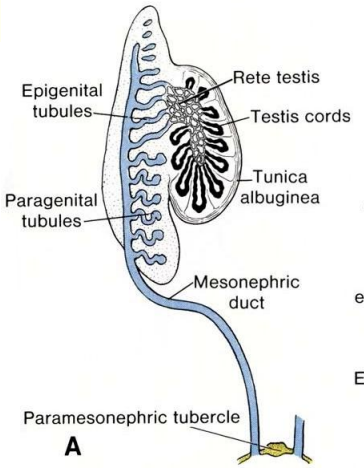
6. the seminiferous cords develop into the seminiferous tubules, the straight tubules (tubuli recti) and the rete testis

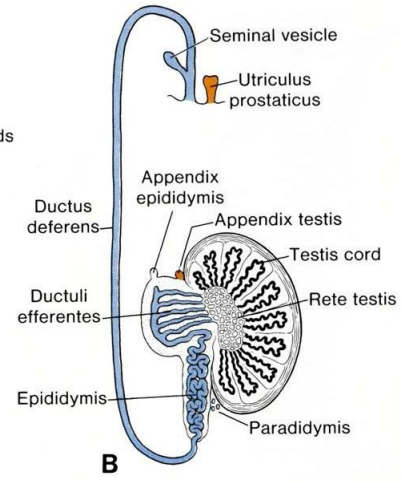
Detailed diagram of the differentiated testis in the 4th month

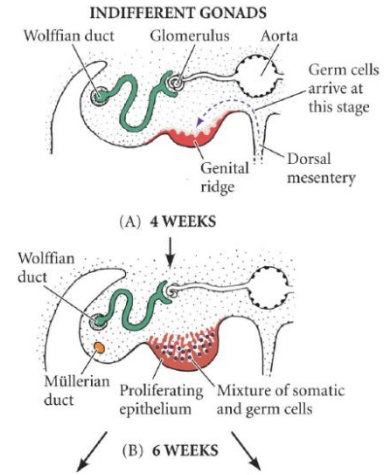


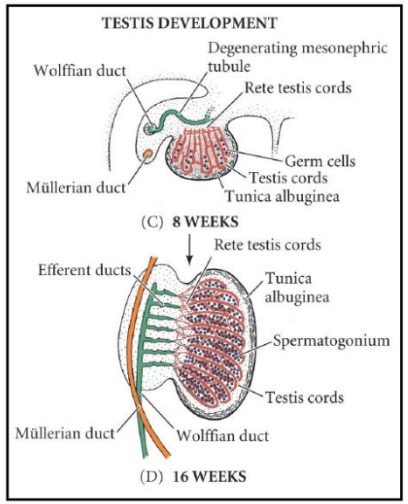
1 Deferent duct (Wolff)
2 Epididymis
3 Efferent ductules
4 Appendix epididymidis
5 Appendix testis
6 Convoluted seminiferous tubules
7 Rete testis

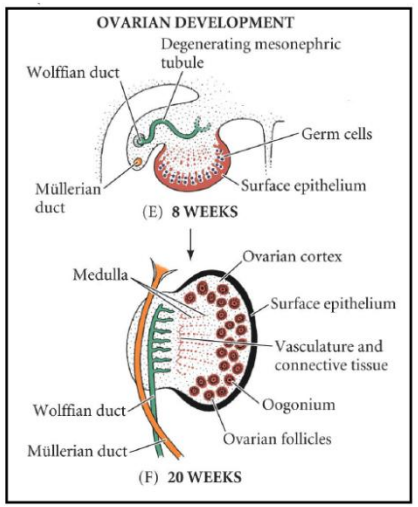
8 Straight seminiferous tubules
9 Tunica albuginea
10 Paradidymis
11 Interlobular septum
12 Mesothelium
A Lobule







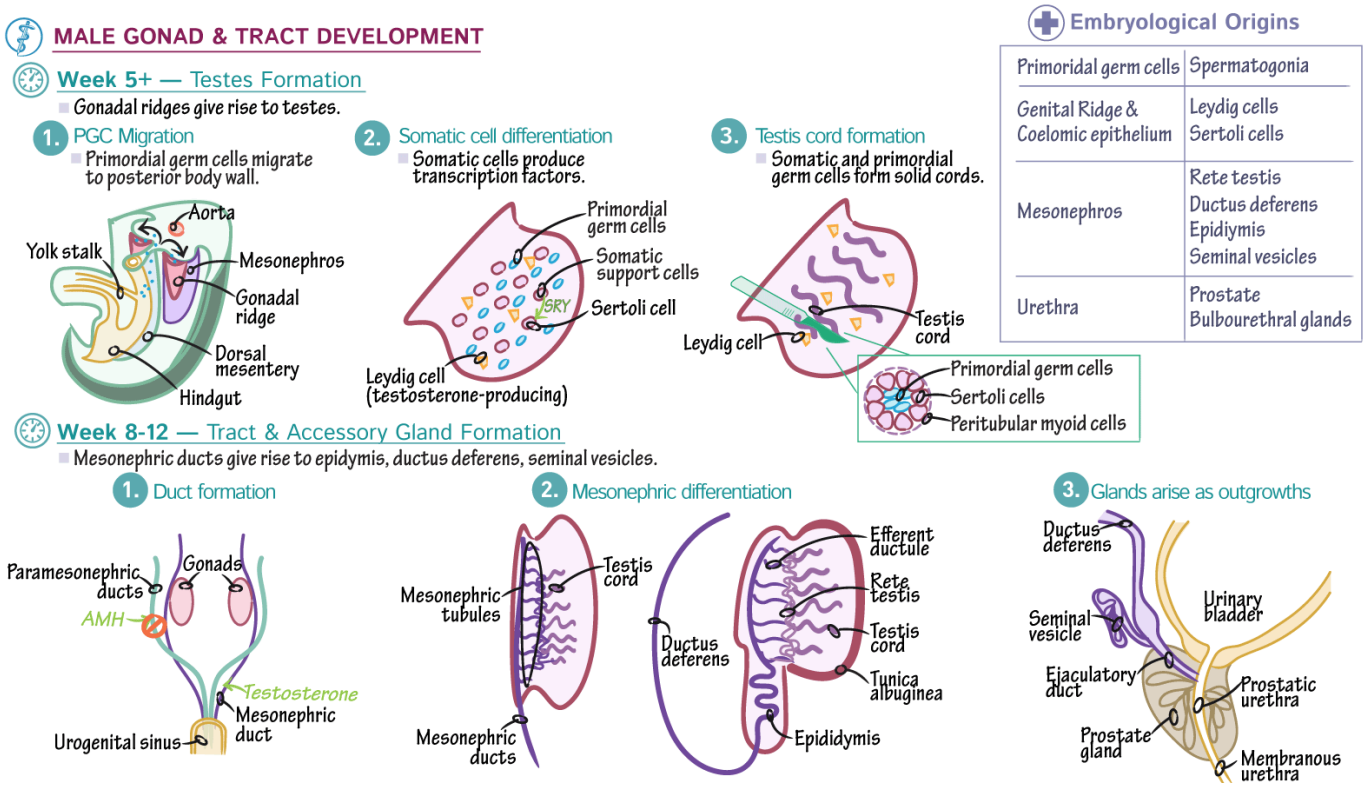




DEVELOPMENT OF TESTES

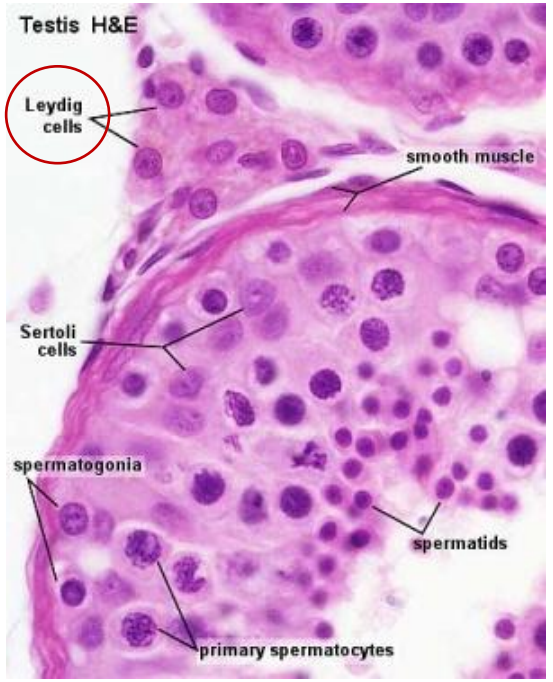
7. the seminiferous tubules separated by mesenchyme – formation of the interstitial cells (Leydig)

8. by 8th week the Leydig – cells secrete androgenic hormones – induces the masculine differentation of the mesonephric ducts and the external genitalia



Embryological Origins

Primoridal germ cells	Spermatogonia
Genital Ridge & Coelomic epithelium	Leydig cells Sertoli cells
Mesonephros	Rete testis Ductus deferens Epidiymis Seminal vesicles
Urethra	Prostate Bulbourethral glands



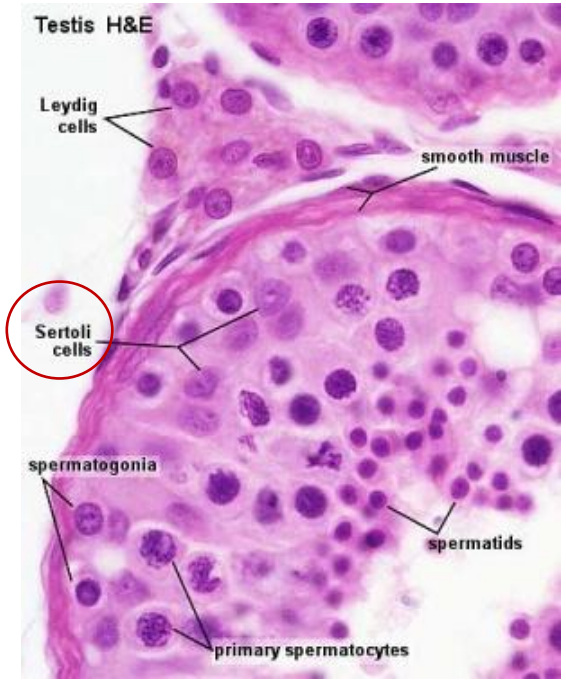
https://embryology.med.unsw.edu.au/embryology/index.php/Testis_Development

DEVELOPMENT OF TESTES

9. the fetal testes produce the Müllerian – Inhibiting Substance (MIS or Antimüllerian Hormone)

MIS:

- **produced by the Sertoli cells**
- **suppresses the development of the paramesonephric ducts – which form the uterus and the uterine tubes**



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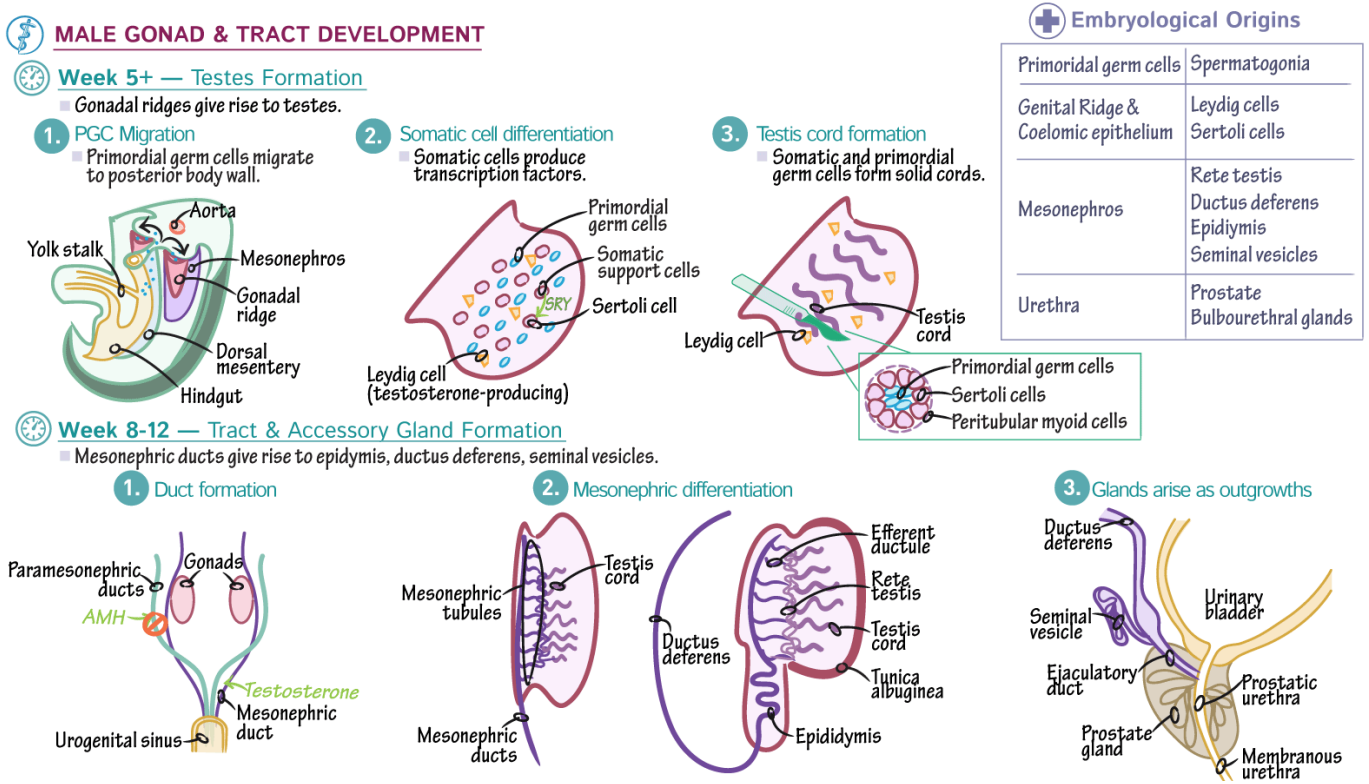
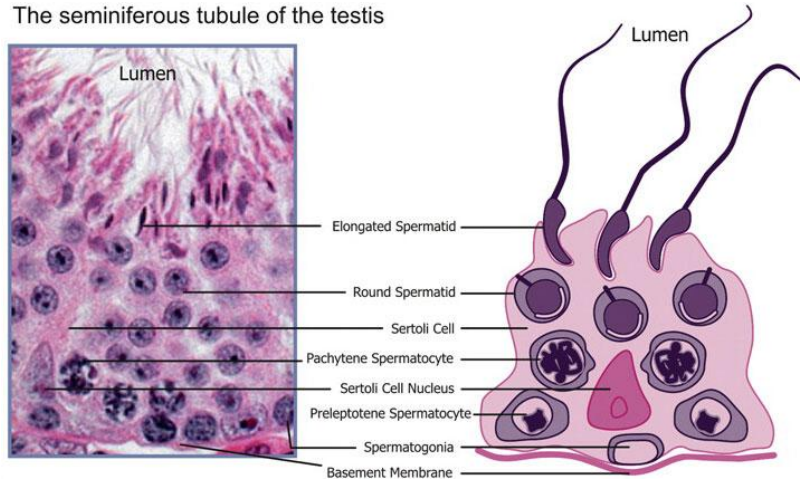
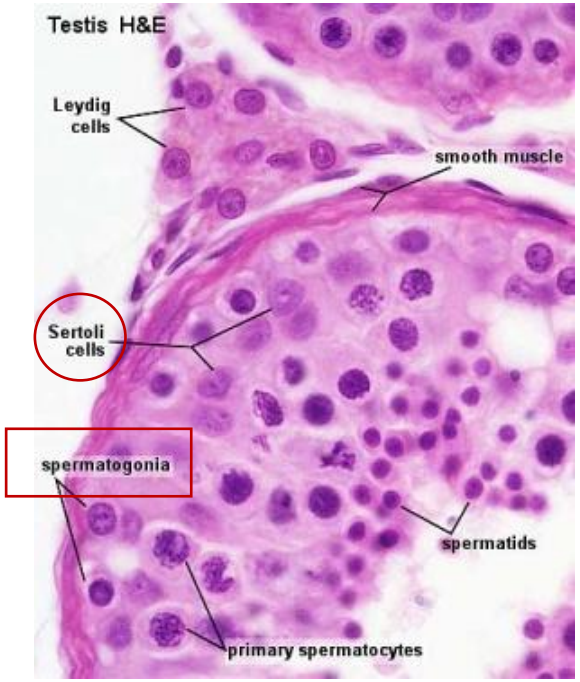


DEVELOPMENT OF TESTES



THE WALL OF THE SEMINIFEROUS TUBULES composed of:

1. **SERTOLI CELLS – derived from the surface epithelium of testes**
2. **SPERMATOGONIA – primordial sperms derived from the primordial germ cells**



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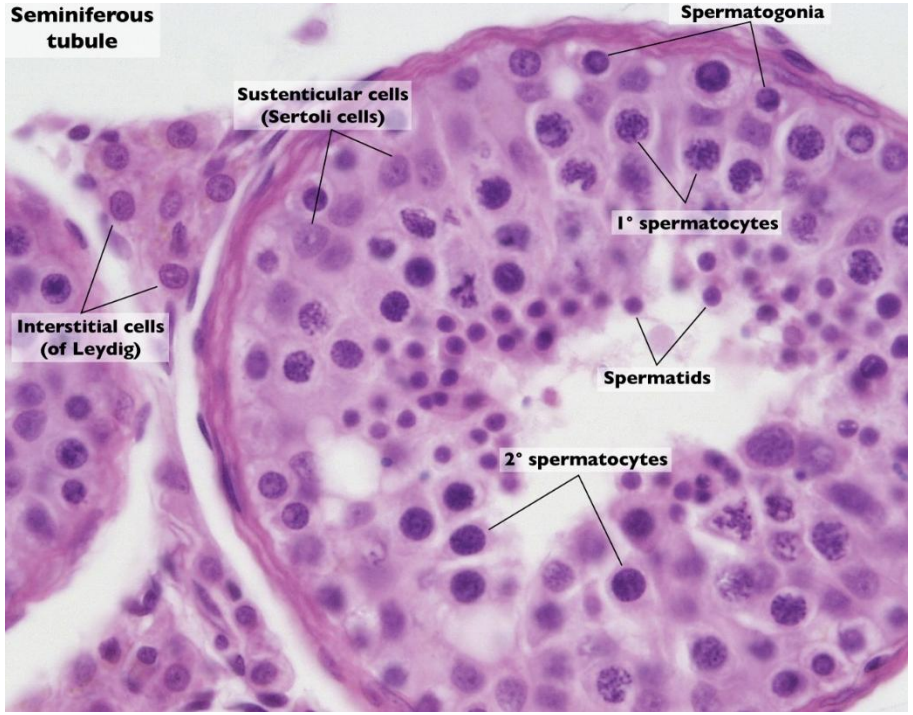
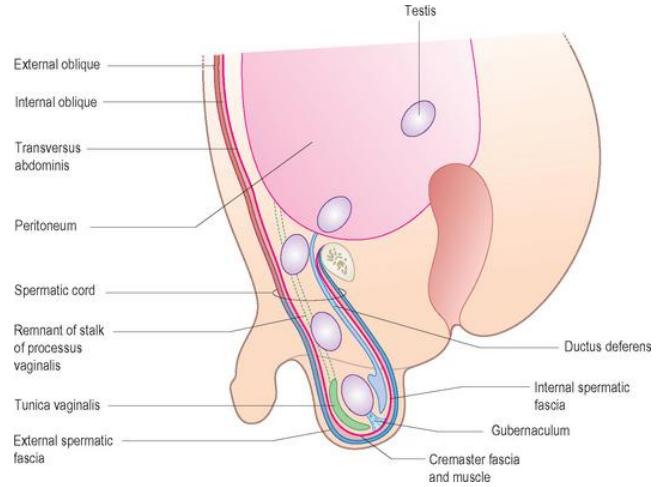
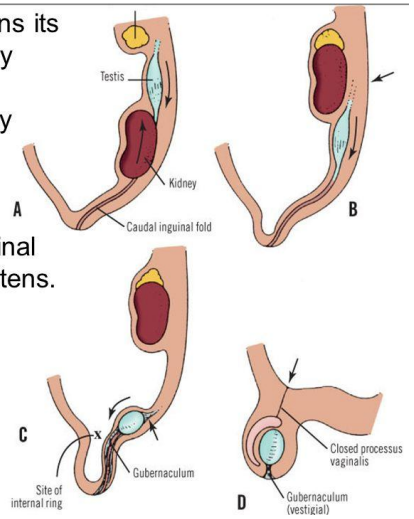


https://hu.pinterest.com/pin/148829962662861074/

DESCENT OF TESTIS

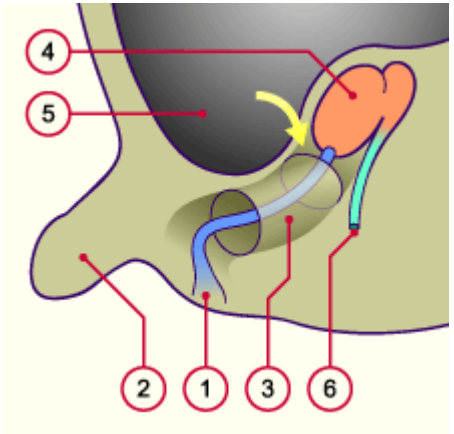
- **by 26 week the testes have descended retroperitoneally from the posterior abdominal wall to the deep inguinal rings, then into the scrotum**
- **the fetal pelvis enlarges**
- **the trunk of the embryo elongates**
- **It takes 2 to 3 days**
- **the testis carries the ductus deferent and vessels**
- **GUBERBNACULUM TESTIS – guide the testis during the descent**





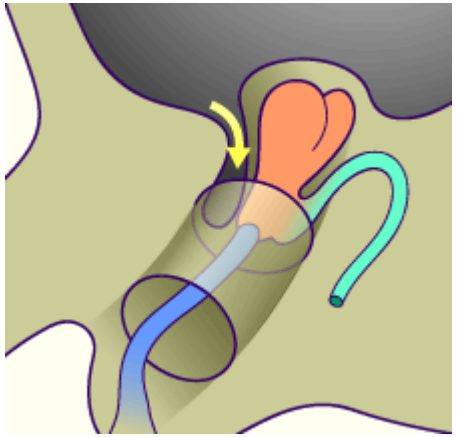
A, 5th week Testis begins its primary descent; kidney ascends.
B, 8th-9th weeks. Kidney reaches adult position.
C, 7th month, Testis at internal inguinal ring; gubernaculum (in inguinal fold) thickens and shortens.
D, Postnatal life.

Descent of the testis ca. 2 months



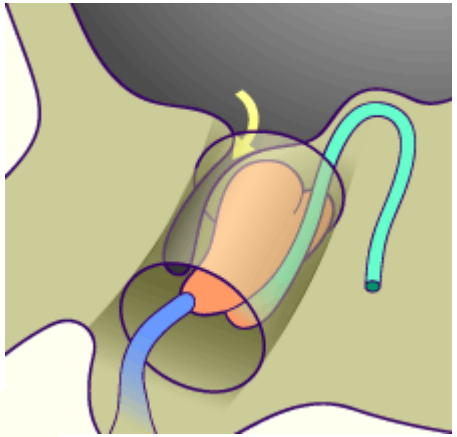
The yellow arrow shows the location of the protrusion of the peritoneum and the beginning of the testicular descent into the inguinal canal.

Descent of the testis ca. 3 months



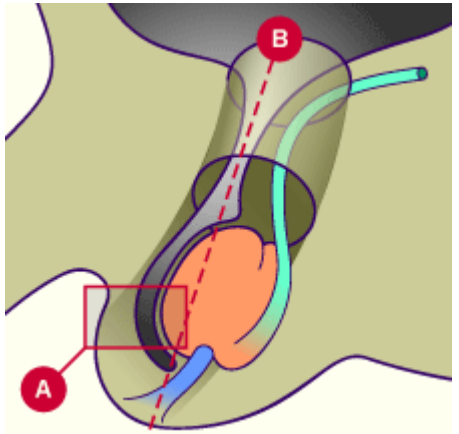
the beginning of the formation of the vaginal process is visible. It enters with the testis into the inguinal canal. Shown in blue is the gubernaculum that becomes increasingly shorter.

Descent of the testis ca. 7 months



The vaginal process lengthens while the gubernaculum shortens, thereby drawing the testis, the deferent duct and its vessels on both sides downwards.

Descent of the testis ca. 9 months



the testes reach the scrotum. The vaginal process forms now a serous bilaminar structure on the front side of the testis.

1 Gubernaculum testis
2 Penis
3 Inguinal canal

4 Testis
5 Peritoneal cavity
6 Deferent duct

DESCENT OF TESTIS

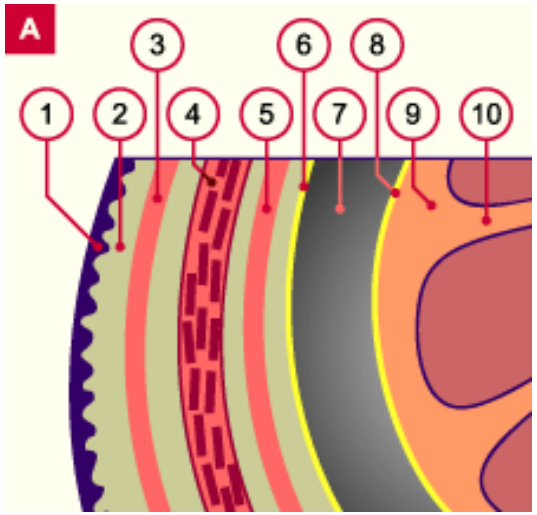
- during the descends the testis and the ductus deferens are ensheated by the fascial extension of the abdominal wall

1. the extension of the transversalis fascia becomes the internal spermatic fascia

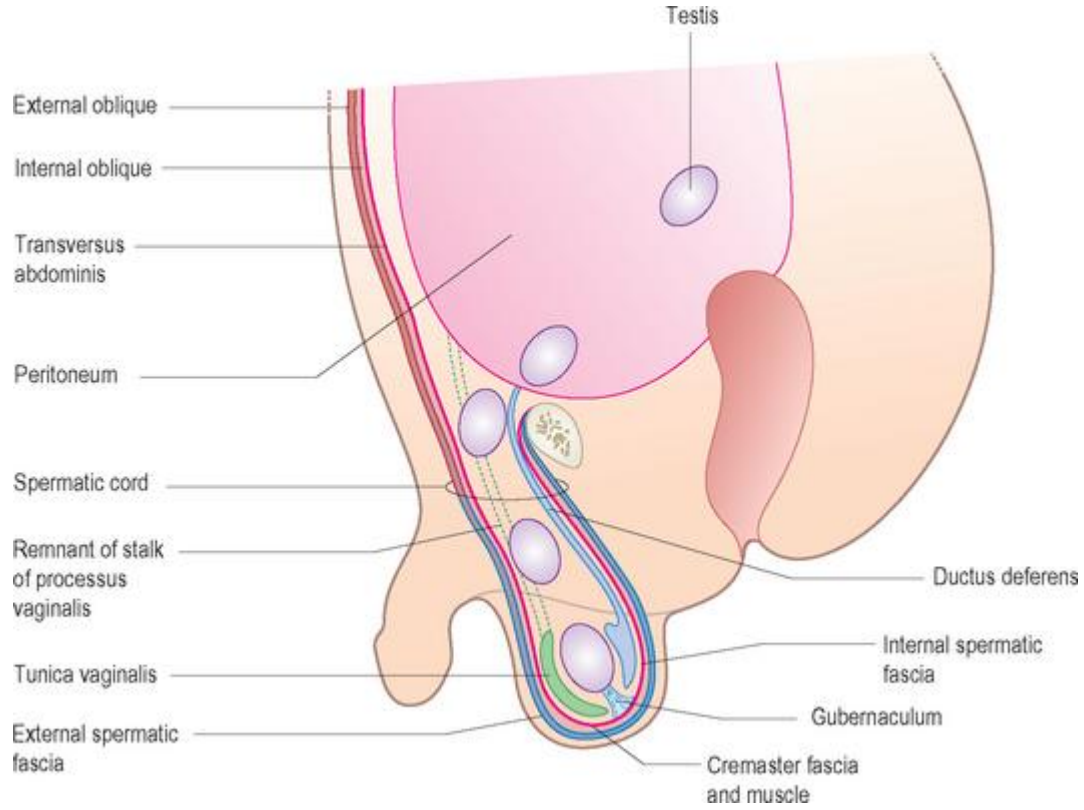
2. the extension of the internal obligue muscle and its fascia become the cremasteric muscle and cremasteric fascia

3. the extension of external obligue aponeurosis becomes the external spermatic fascia

Section through the scrotum at the time of birth according



1. Epidermis
2. Dermis (tunica dartos)
3. External spermatic fascia
4. Musculus cremaster
5. Internal spermatic fascia
6. Parietal lamina of the tunica vaginalis
7. Virtual cavity between the two layers of the tunica vaginalis
8. Visceral lamina of the tunica vaginalis
9. Tunica albuginea
10. Interlobular septum of the testis



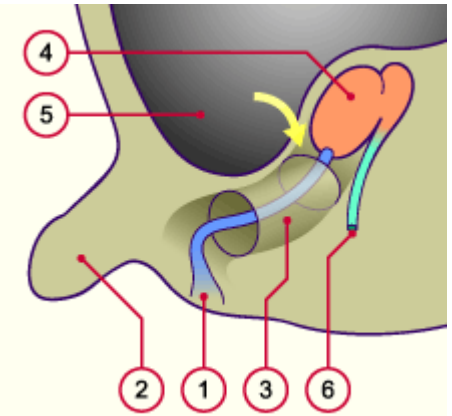
DESCENT OF TESTIS

- within the scrotum the testis projects into the distal end of the processus vaginalis

PROCESSUS VAGINALIS TESTIS:

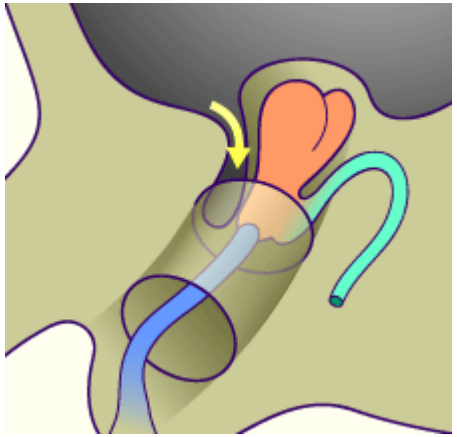
- during perinatal period obliterates
- isolates the tunica vaginalis testis – peritoneal sac releated to the testis

Descent of the testis
ca. 2 months



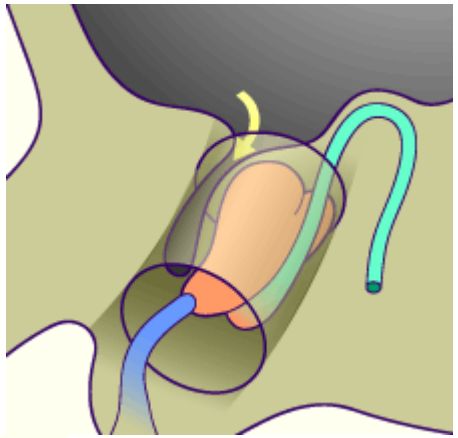
The yellow arrow shows the location of the protrusion of the peritoneum and the beginning of the testicular descent
into the inguinal canal.

Descent of the testis
ca. 3 months



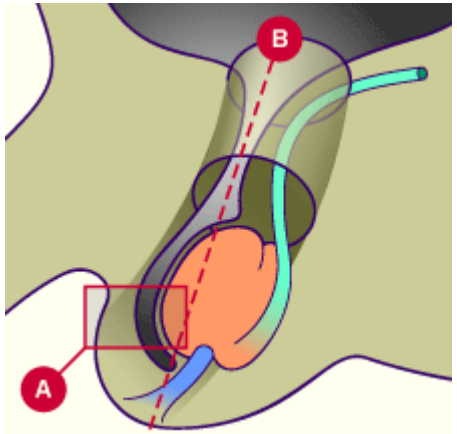
The beginning of the formation of the vaginal process is visible.
It enters with the testis into the inguinal canal.
Shown in blue is the gubernaculum that becomes
increasingly shorter.

Descent of the testis
ca. 7 months



The vaginal process lengthens while the gubernaculum shortens, thereby drawing the testis, the deferent duct and its vessels on both sides downwards.

Descent of the testis
ca. 9 months



The testes reach the scrotum.
The vaginal process forms now a serous bilaminar structure on the front side of the testis.

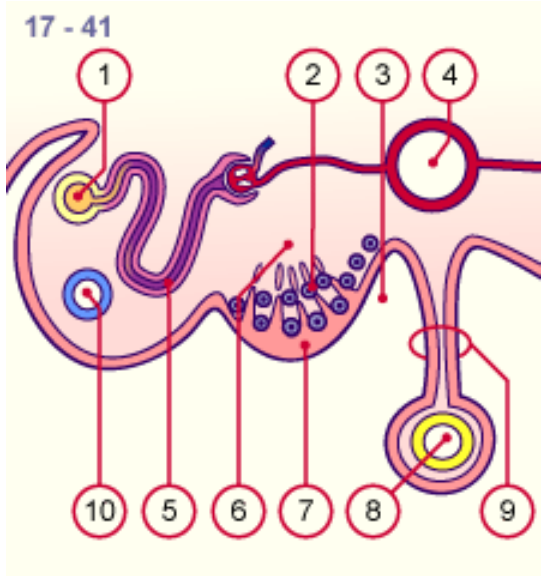
1 Gubernaculum testis
2 Penis
3 Inguinal canal

4 Testis
5 Peritoneal cavity
6 Deferent duct

DEVELOPMENT OF OVARIES

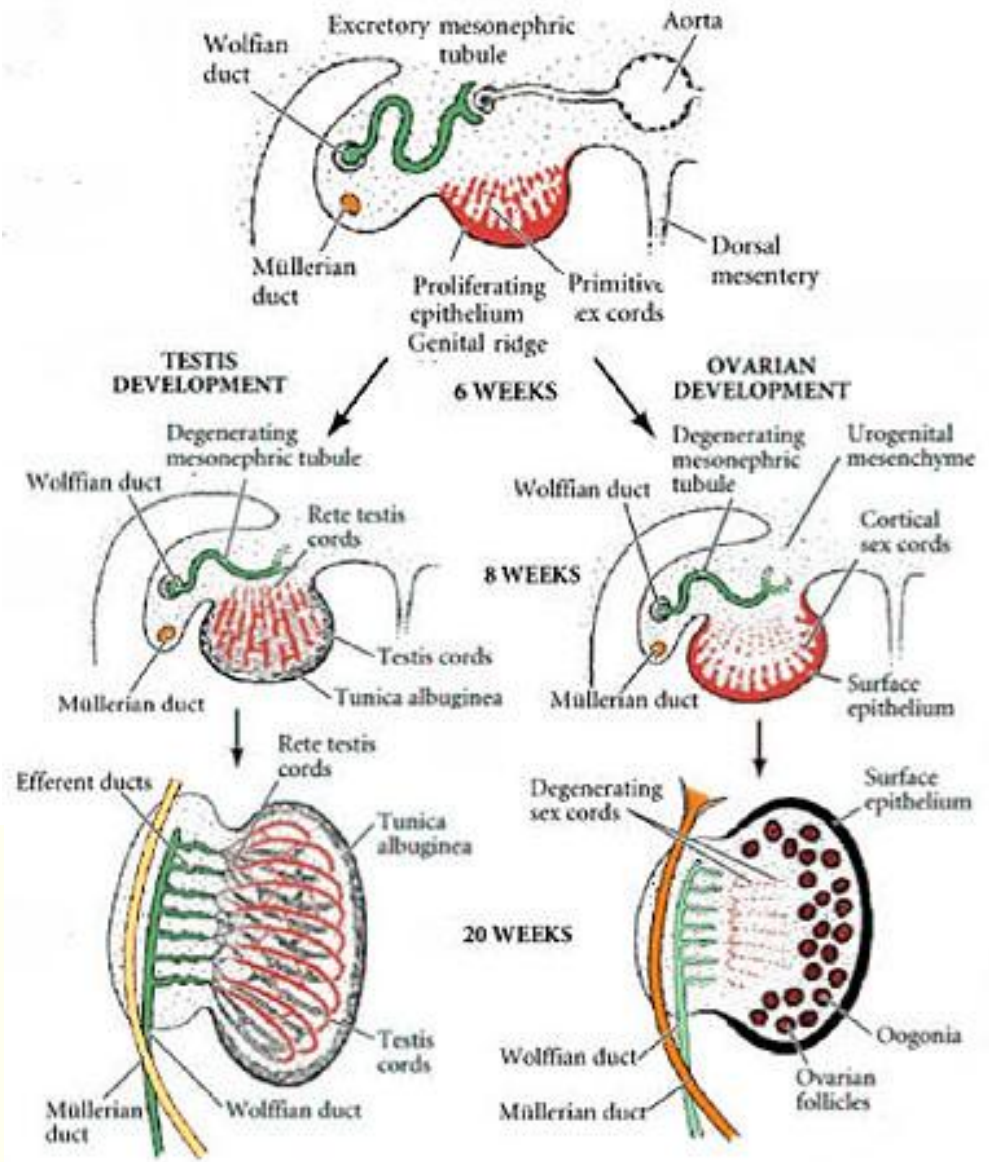
- the X chromosmes have genes for ovarian development
- the ovary is not identifiable till the 10th week of gestation

1. gonadal cords extend into the medulla of the ovary – form the rudimentary rete ovarii
2. cortical cords extend from the surface epithelium of the developing ovary into the underlying mesenchyme
3. the cortical cords increase in size – primordial germ cells are incorporated into them

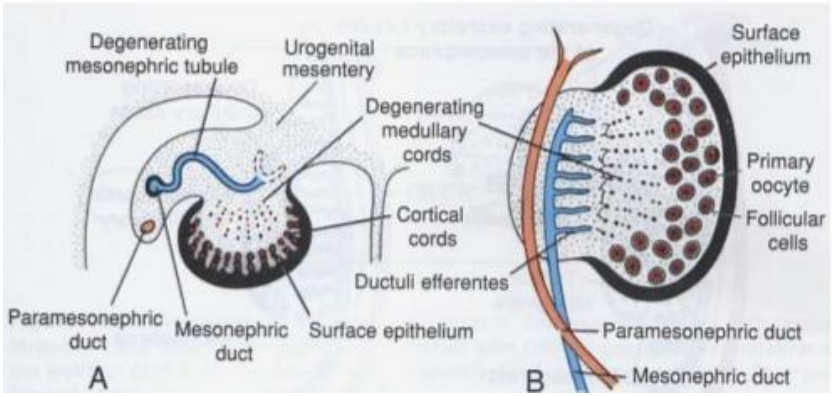


Indifferent gonads
stage 17, ca. 41 days

1	Mesonephric duct (Wolff)
2	PGC
3	Peritoneal cavity
4	Aorta
5	Mesonephric tubule
6	Local coelom mesenchyma
7	Thickened coelomic epithelium
8	Intestine
9	Mesentery
10	Anlage of the paramesonephric duct (Müller)



DEVELOPMENT OF OVARIES



at 16 week:

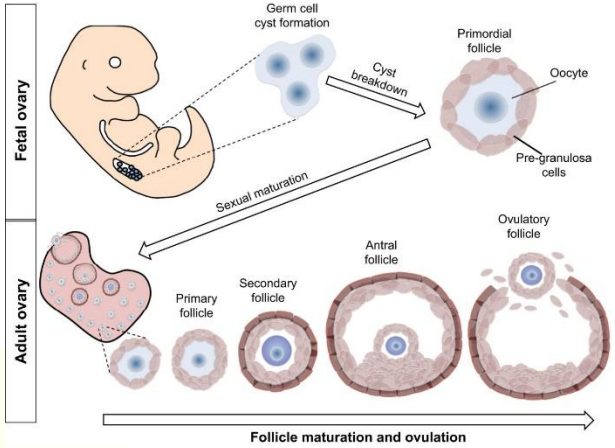
4. the cortical cords begin to break up into isolated cell clusters – PRIMORDIAL FOLLICLES

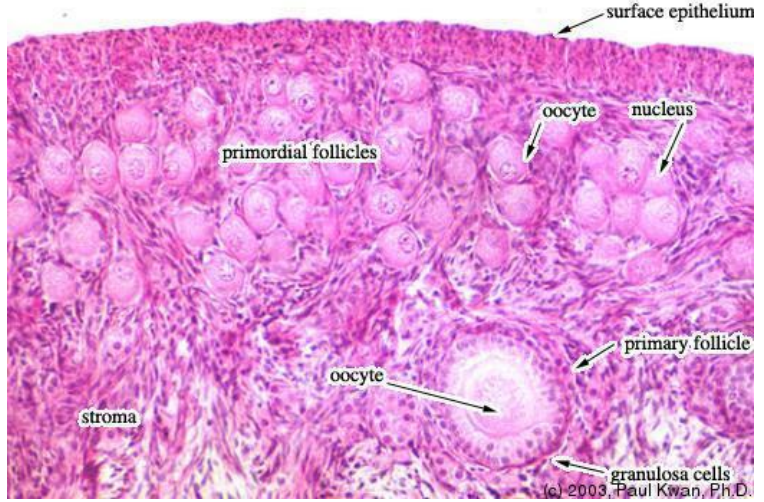
EACH PRIMODIAL FOLLICLES consists of:

a) an oogonium – derived from the primordial germ cells

b) a single layer of follicular cells – derived from the surface epithelium

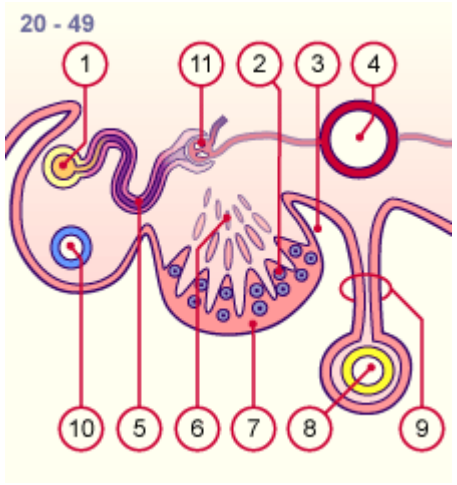
- **no oogonia form from postnatally**



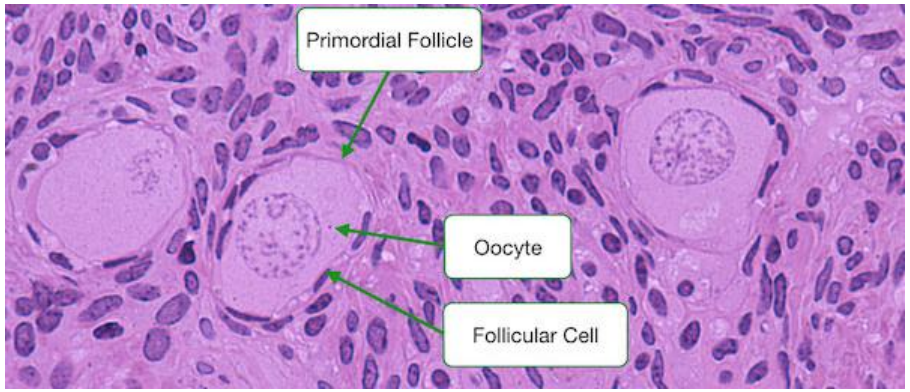


http://ocw.tufts.edu/Content/4/coursehome/221179/221181

Early differentiation (female)
stage 20, ca. 49 days

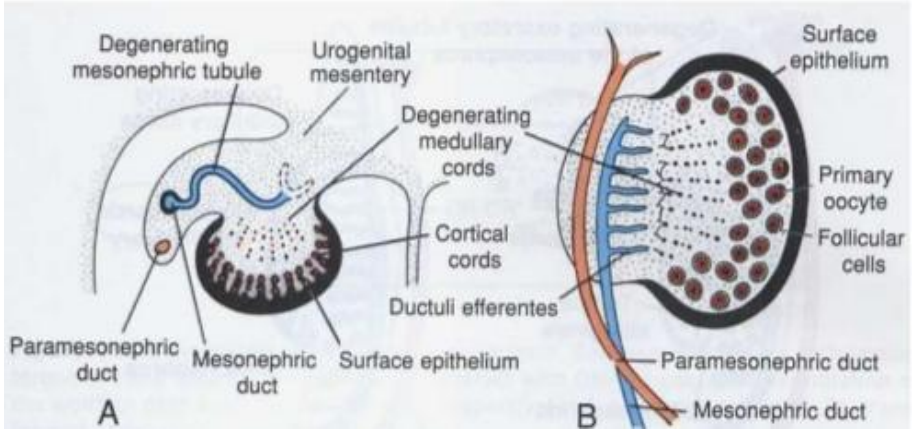


1 Mesonephric duct (Wolff)
2 PGC
3 Peritoneal cavity
4 Aorta
5 Mesonephric tubule
6 Degenerated gonadal cords
7 Thickened coelomic epithelium
8 Intestine
9 Mesentery
10 Anlage of the paramesonephric duct (Müller)
11 Atrophy of the mesonephric nephron



http://medcell.med.yale.edu/histology/ovary_follicle.php

DEVELOPMENT OF OVARIES

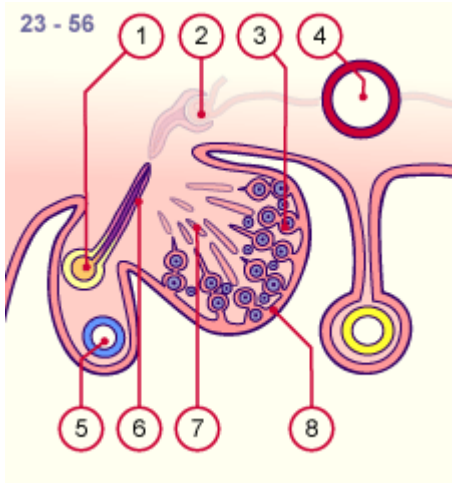


at 16 week:

5. the surface epithelium becomes separated from the follicles in the cortex by TUNICA ALBUGINEA

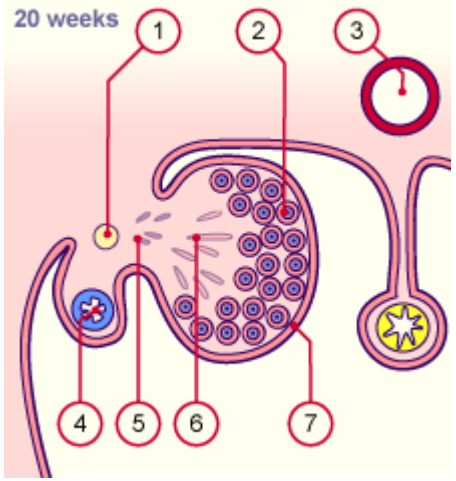
6. the ovary separates from the mesonephros – suspended by the mesovarium

Early differentiation (female)
stage 23, ca. 56 days

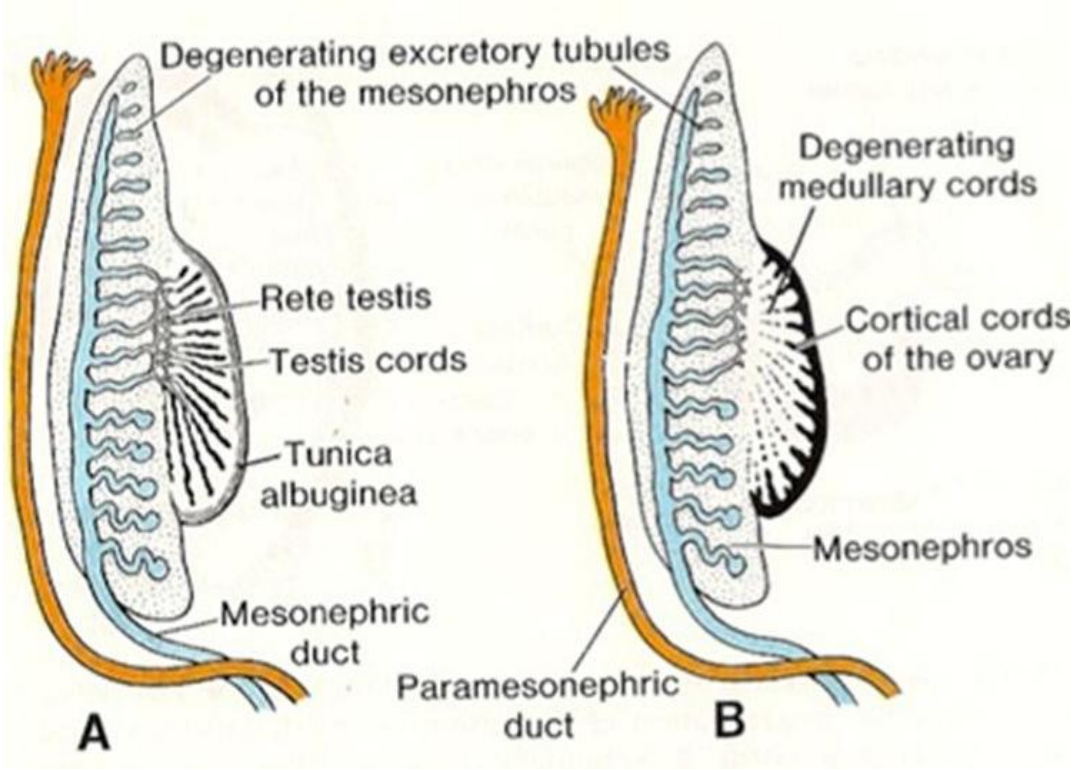


1	Mesonephric duct (Wolff)
2	Mesonephric nephron atrophying
3	Oogonia in the ovarian cortex
4	Aorta
5	Paramesonephric duct (Müller)
6	Mesonephric tubules atrophying
7	Degenerated gonadal cords
8	Thickened coelomic epithelium in contact with the gonadal cords

Further differentiation (female)
ca. 20 weeks

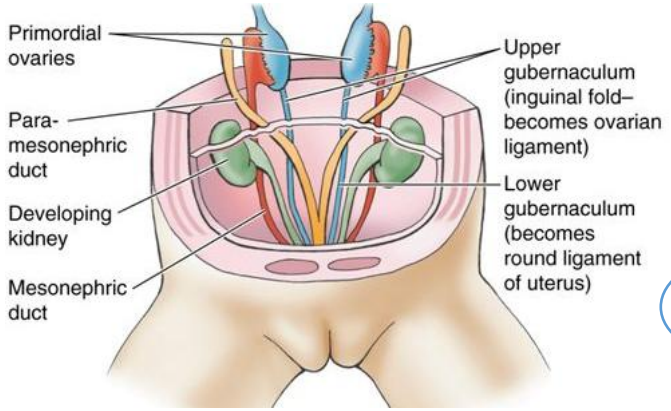


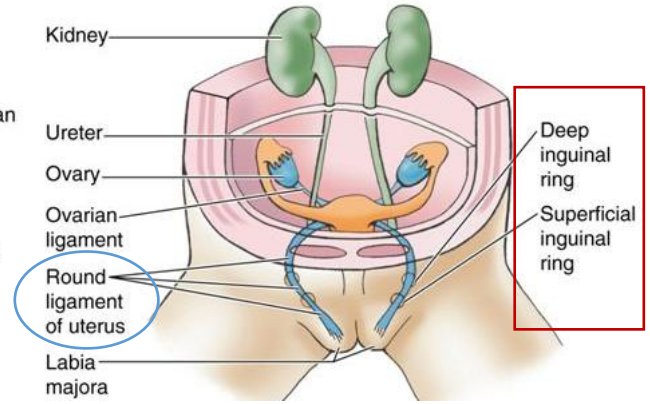
1	Mesonephric duct (Wolff) atrophying
2	Primordial follicle in the ovarian cortex
3	Aorta
4	Paramesonephric duct (Müller)
5	Mesonephric tubules atrophying
6	Degenerated gonadal cords
7	Mesothelium of the ovary



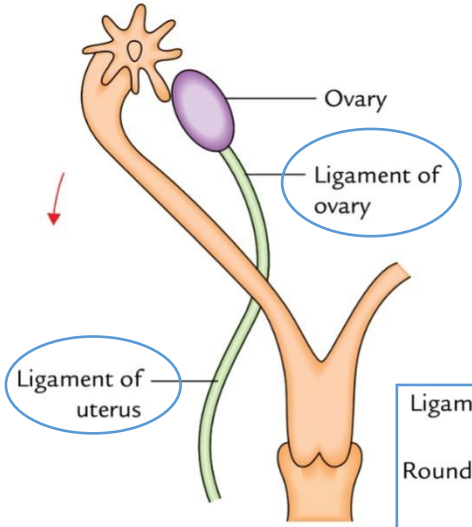
DESCENT OF OVARIES

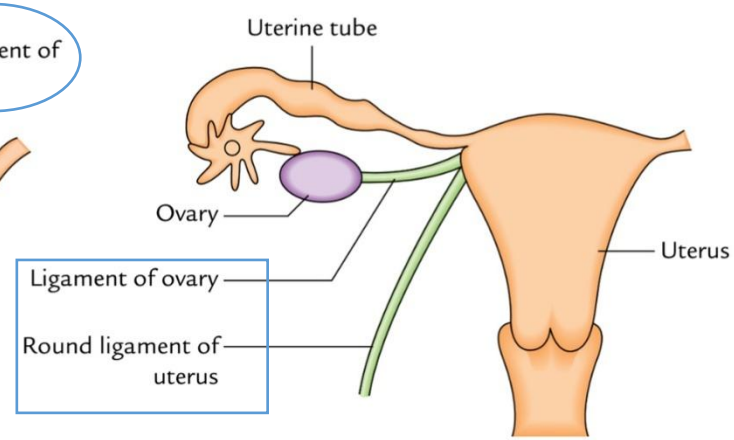
- descend from the posterior wall of the abdominal wall of the pelvis
- Gubernaculum attached to the uterus near the attachment of the uterine tube
- the cranial part of the gubernaculum becomes the ovarian ligament
- the caudal part of the gubernaculum becomes the round ligament of the uterus
- the round ligaments of the uterus pass through the inguinal canal – terminate in the labia





http://slideplayer.com/slide/10823178/





https://www.earthslab.com/anatomy/ovaries/

DEVELOPMENT OF GENITAL DUCTS

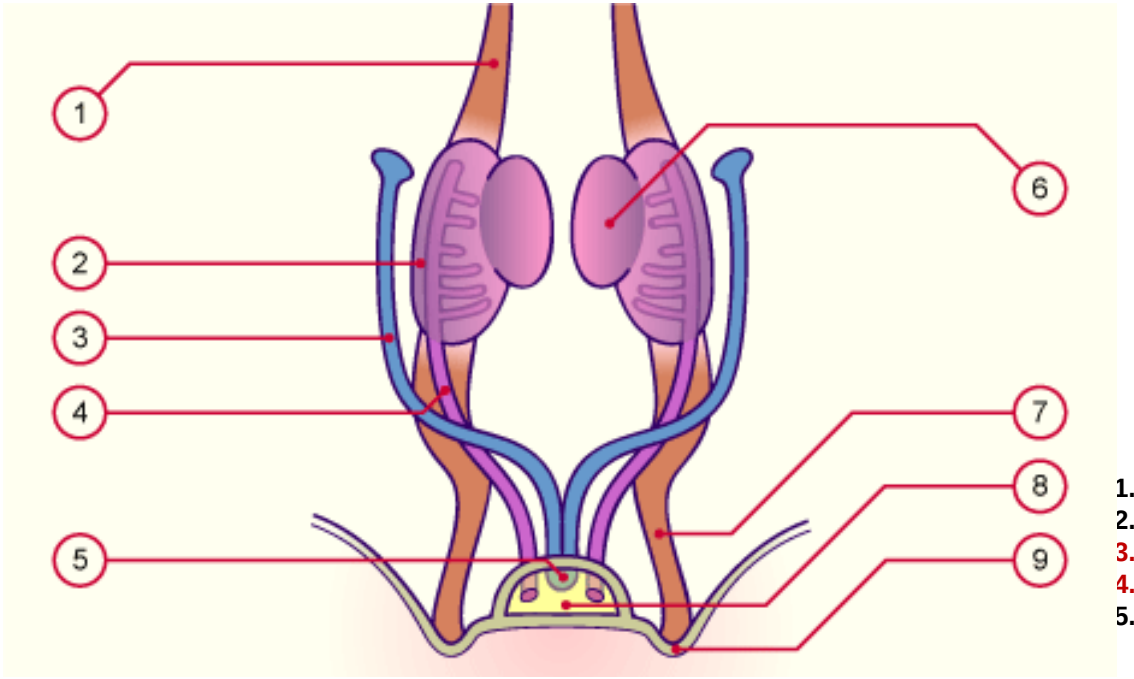
both male and female have two pairs of genital tract:

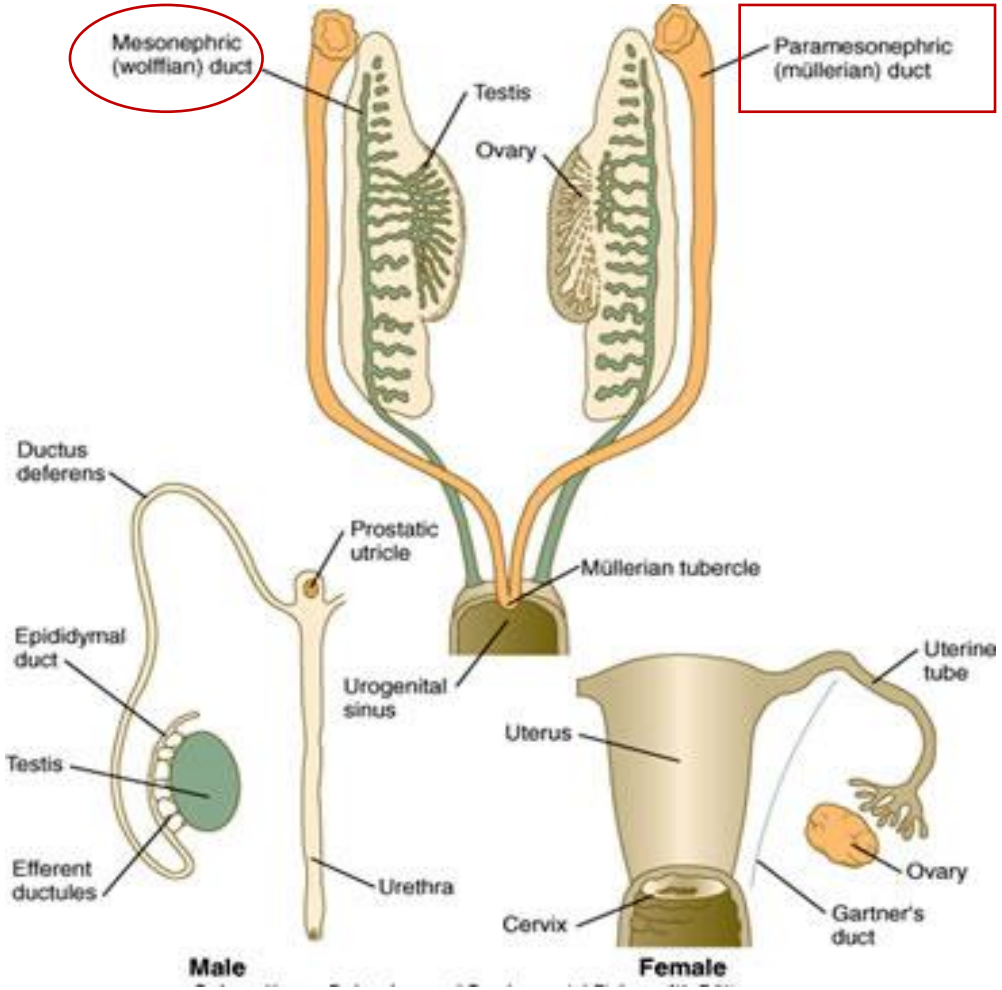
1. MESONEPHRIC DUCTS (WOLFFIAN DUCTS):

- play role int the development of the male reproductice system

2. PARAMESONEPHRIC DUCTS (MÜLLERIAN DUCTS):

- play role in the development of the female reproductive system





ca. 6th week

1. **Upper gubernaculum**
2. **Mesonephros**
3. **Paramesonephric duct (Müller)**
4. **Mesonephric duct (Wolf)**
5. **Sinual tubercule**
6. **Indifferent gonad**
7. **Lower gubernaculum**
8. **Urogenital sinus**
9. **Genital swelling (insertion of the lower gubernaculum)**

DEVELOPMENT OF MALE GENITAL DUCTS

the fetal testes produce:

a) Testosterone

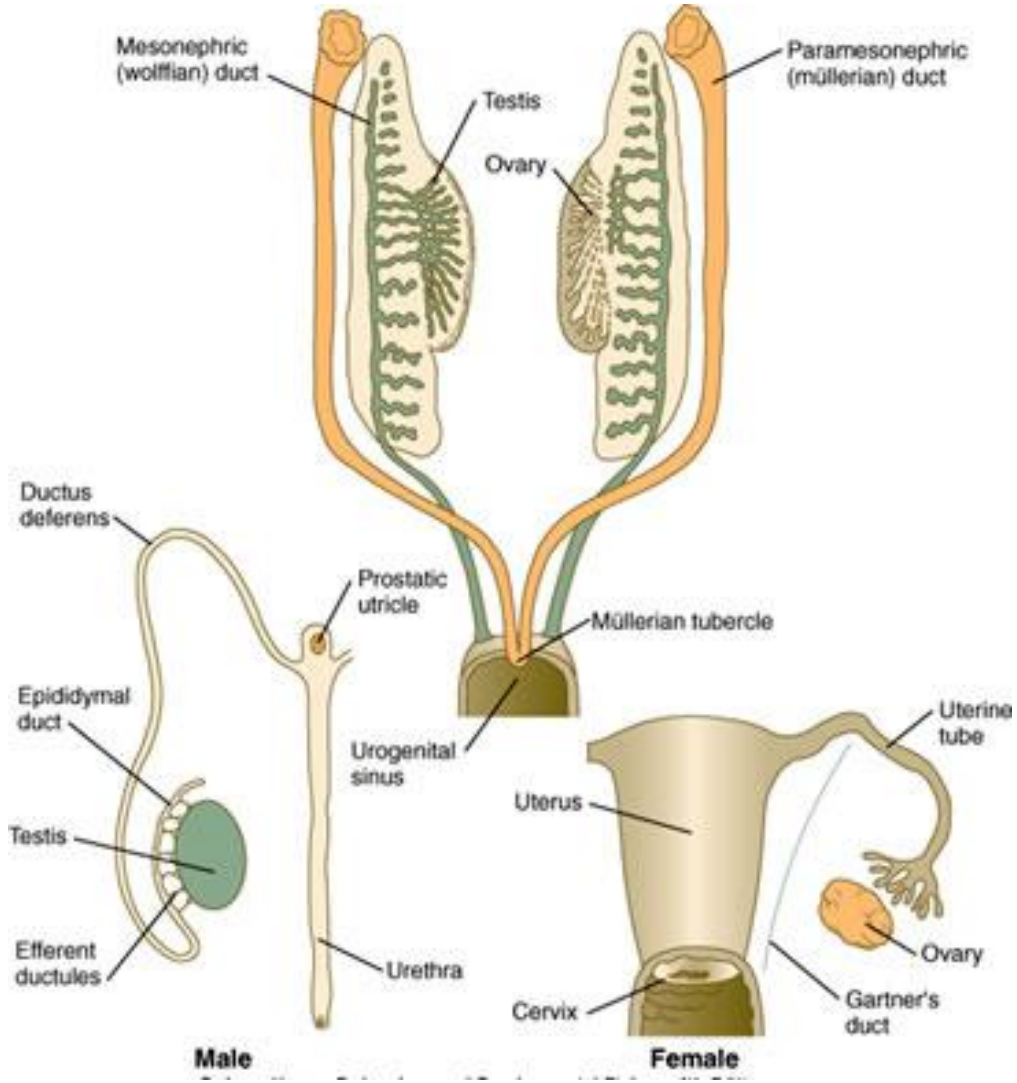
b) MIS

TESTOSTERONE:

- **stimulates the mesonephric ducts to form male genital ducts**

MIS:

- **causes the paramesonephric ducts to disappear**



DEVELOPMENT OF MALE GENITAL DUCTS

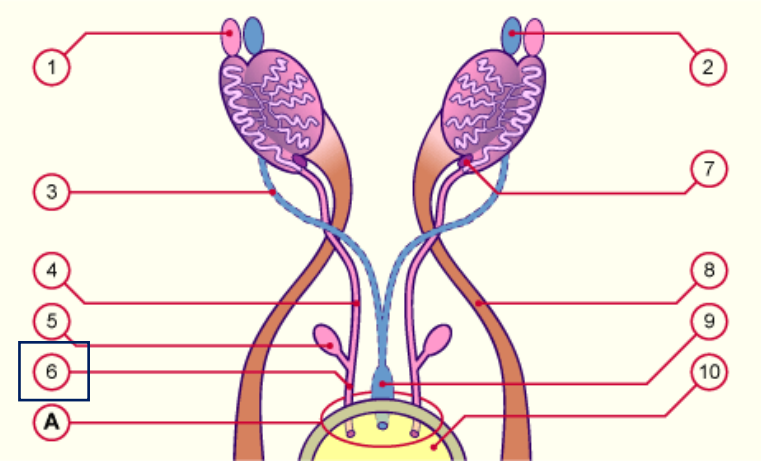
a) some mesonephric tubules persist – transformed into efferent ductules – these ductules open into the mesonephric duct

b) the mesonephric duct transformed into the duct of epididymis

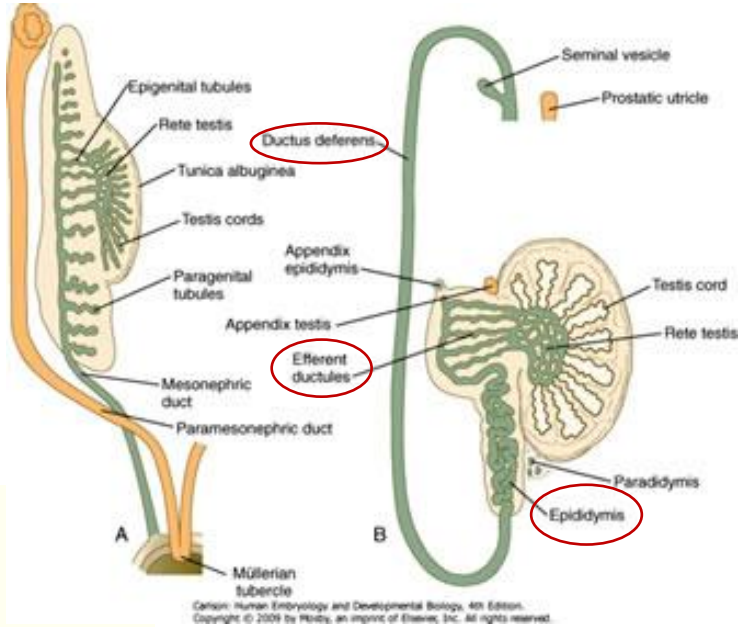
c) distal to the epididymis the mesonephric duct becomes ductus deferens

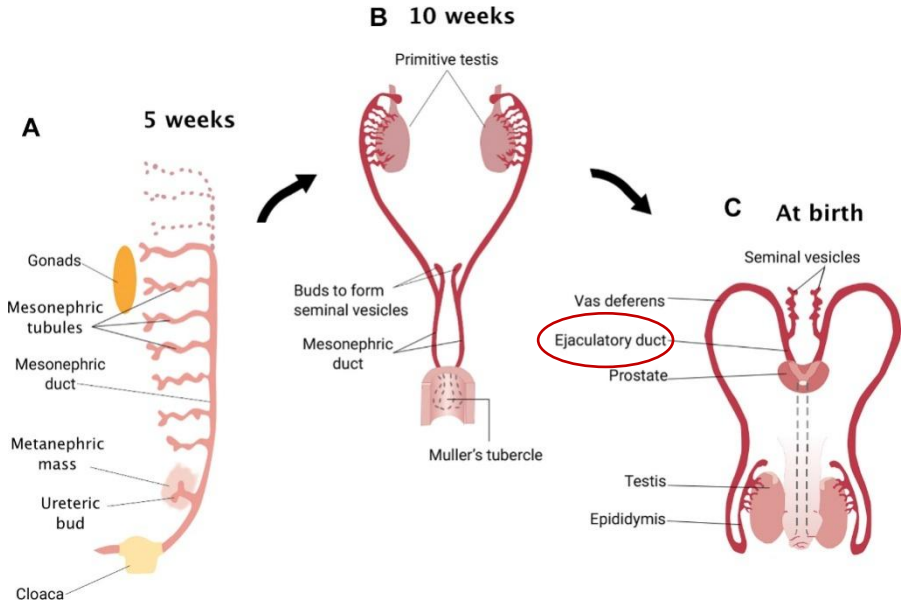
d) ejaculatory duct - the part of the mesonephric duct between the ductus epididymidis and the urethra

Differentiated canal system of the male sex organs, ca. 3rd month



1 Epididymal appendage
2 Testicular appendage
3 Atrophying paramesonephric duct (Müller)
4 Deferent duct
5 Seminal vesicle
6 Ejaculatory duct
7 Paradidymis
8 Gubernaculum
9 Prostatic utricule
10 View of the dorsal side of the urogenital sinus (=> prostatic utricule)
A Seminal colliculus



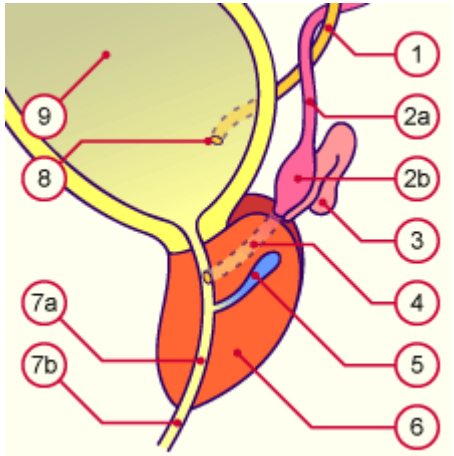


DEVELOPMENT OF MALE GENITAL DUCTS

SEMINAL GLAND:

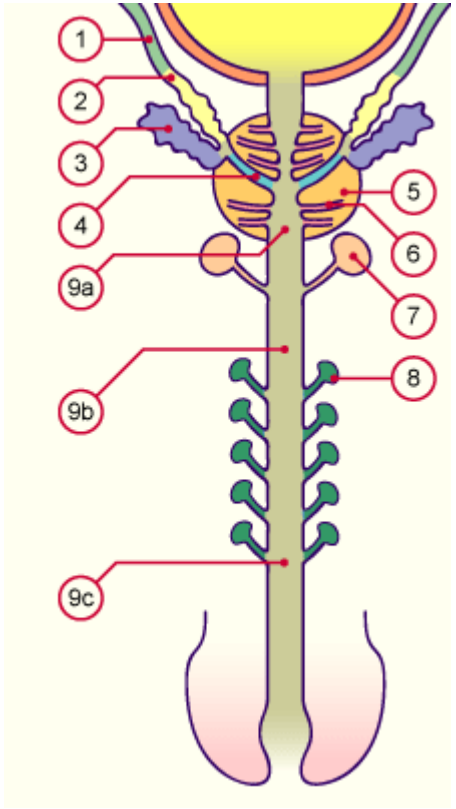
- **a lateral outgrowth from the caudal end of the mesonephric duct**
- **its secretion nourish the sperms**

Differentiation of the internal sex canals in the 4th month



1 Ureter
2a Deferent duct
2b Ampulla of the deferent duct
3 Seminal vesicle
4 Ejaculatory duct
5 Prostatic utricle
6 Prostate
7a Prostatic part of the urethra
7b Diaphragmatic part of the urethra
8 Ureter opening in the urinary bladder
9 Urinary bladder

Male urethra with accessory glands



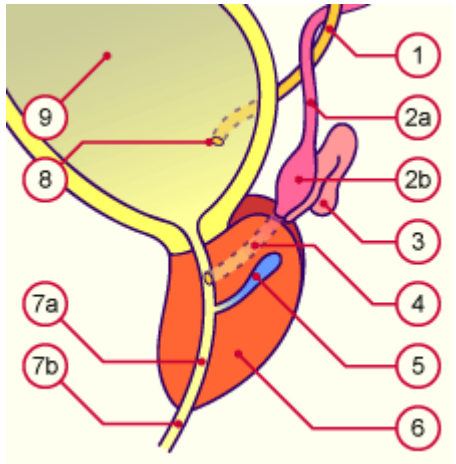
1 Deferent duct
2 Ampulla of the deferent duct
3 Seminal vesicle
4 Ejaculatory duct
5 Prostate
6 Outflow canals of the prostate
7 Bulbourethral gland (Cowper's)
8 Urethral gland (Littre's)
9a Prostatic part of the urethra
9b Membranous part of the urethra
9c Spongy part of the urethra

DEVELOPMENT OF MALE GENITAL DUCTS

PROSTATE:

- **multiple endodermal outgrowth from the prostatic part of the urethra**
- **grow into the surrounding mesenchyme**
- **its secretaion – part of the fluid of the ejaculate**

Differentiation of the internal sex canals in the 4th month



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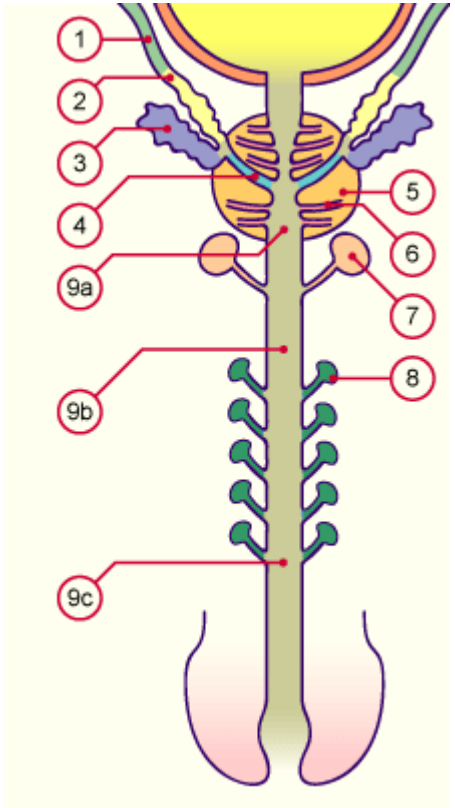
Male urethra with accessory glands



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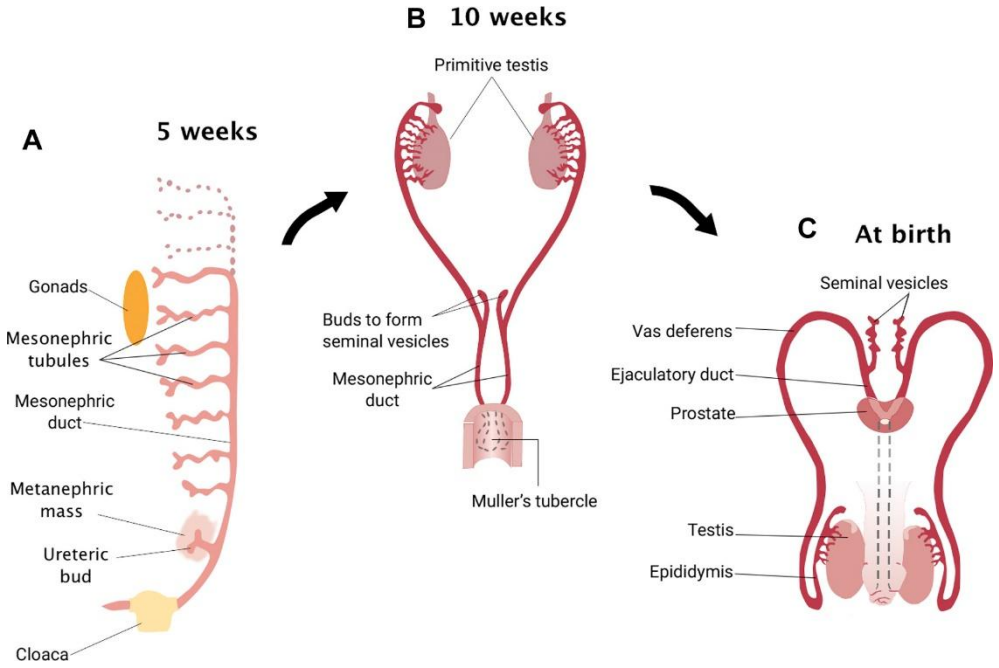


DEVELOPMENT OF MALE GENITAL DUCTS

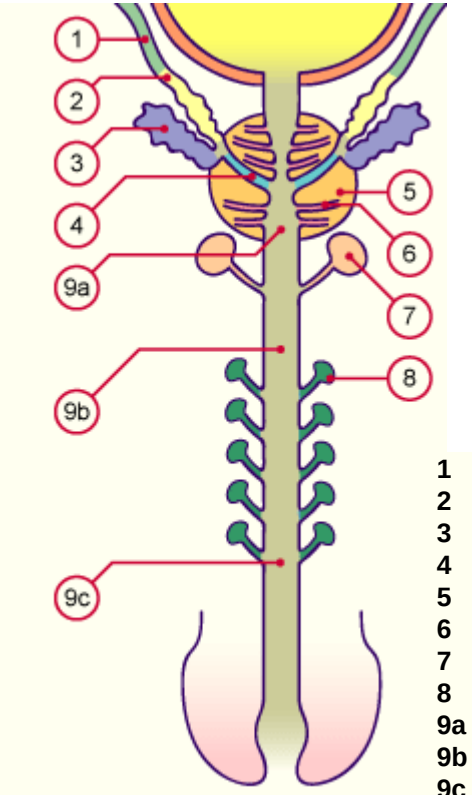
- **BULBOURETHRAL GLAND (Cowper):**

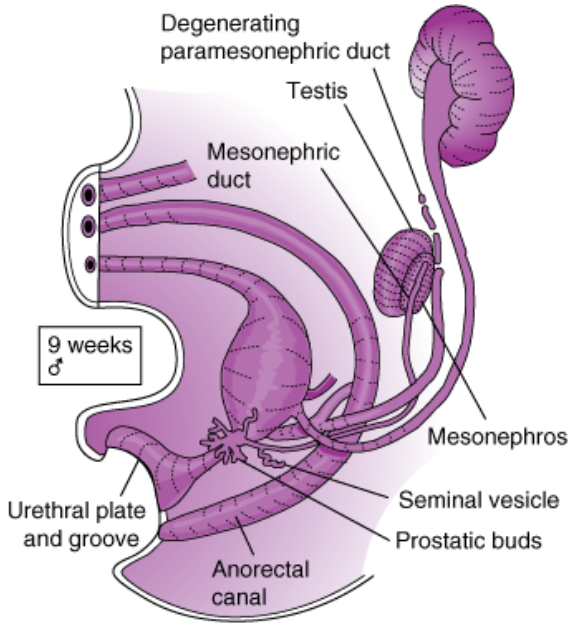
  pea – size

- **develop from the spongy part of the urethra**

- **its secret – part of the ejaculation**

Male urethra with accessory glands





Source: DeCherney AH, Nathan L, Laufer N, Roman AS: *CURRENT Diagnosis & Treatment: Obstetrics & Gynecology*, 11th Edition: www.accessmedicine.com

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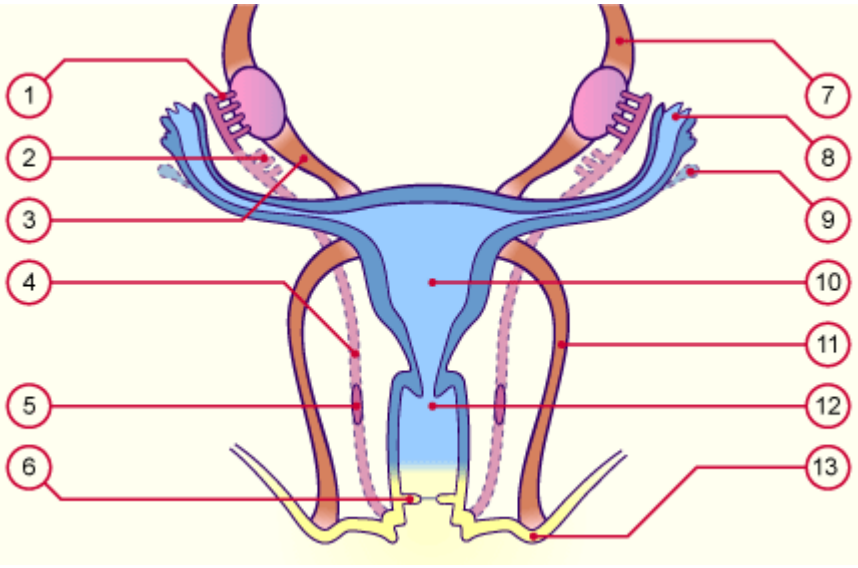
DEVELOPMENT OF FEMALE GENITAL DUCTS AND GLANDS

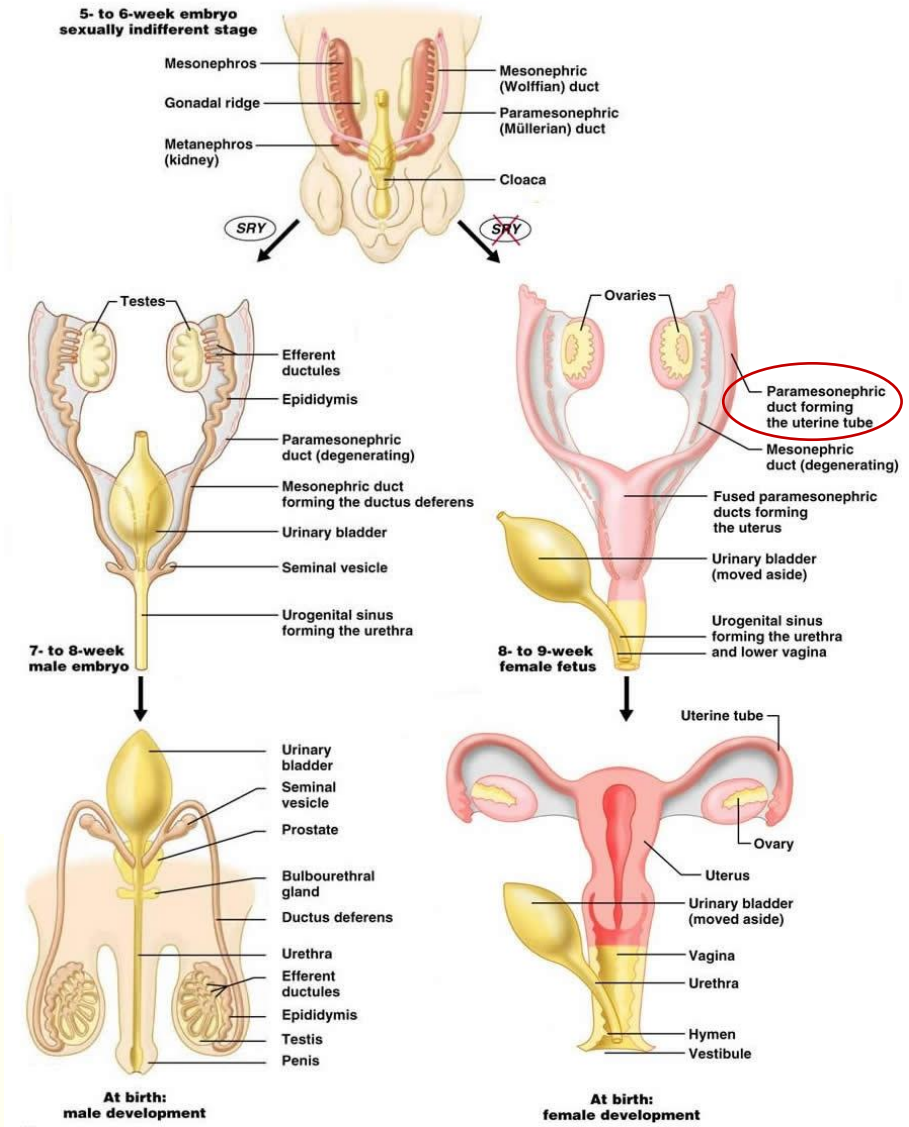
in female embryo:

- **the mesonephric ducts regress because of lack of testosterone**
- **the paramesonephric ducts develop because of the lack of MIS**

Differentiated female sex organs, ca. 4th month



1 Epoöphoron
2 Paroöphoron
3 Ovarian ligament
4 Atrophied mesonephric duct (Wolff)
5 Cysts of Gartner
6 Hymen
7 Suspensory ligament of ovary
8 Fallopian tube (ampulla)
9 Vesicular appendage (Morgani)
10 Uterus
11 Round ligament of uterus
12 Vagina
13 Insertion of the round ligament of uterus at the genital swelling



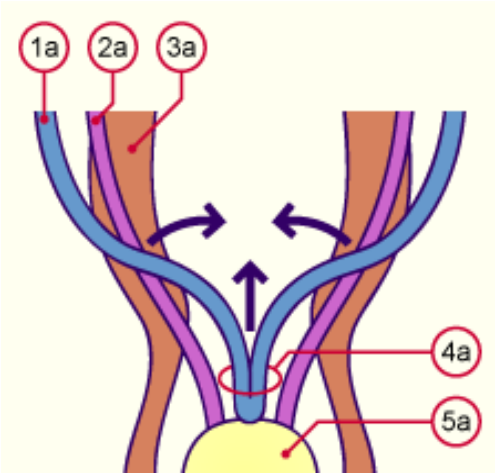
DEVELOPMENT OF FEMALE GENITAL DUCTS AND GLANDS

THE PARAMESONEPHRIC DUCTS:

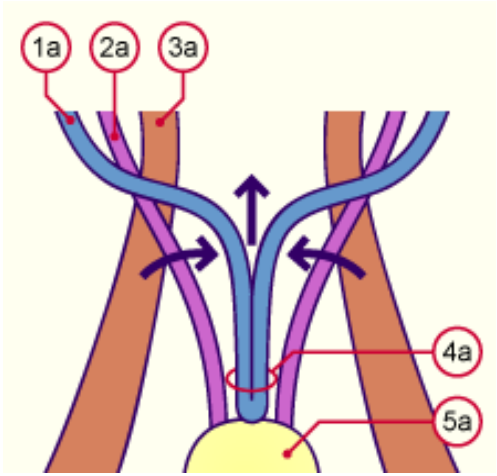
1. THE UTERINE TUBES:

- **develop from the unfused cranial parts of the paramesonephric ducts**

Formation of the uterus, 7th – 8th weeks

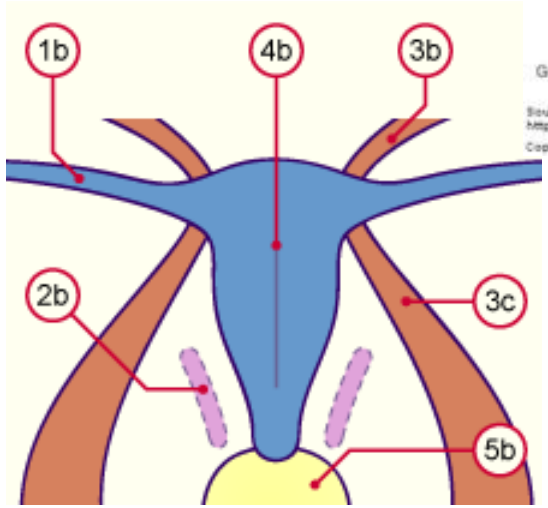


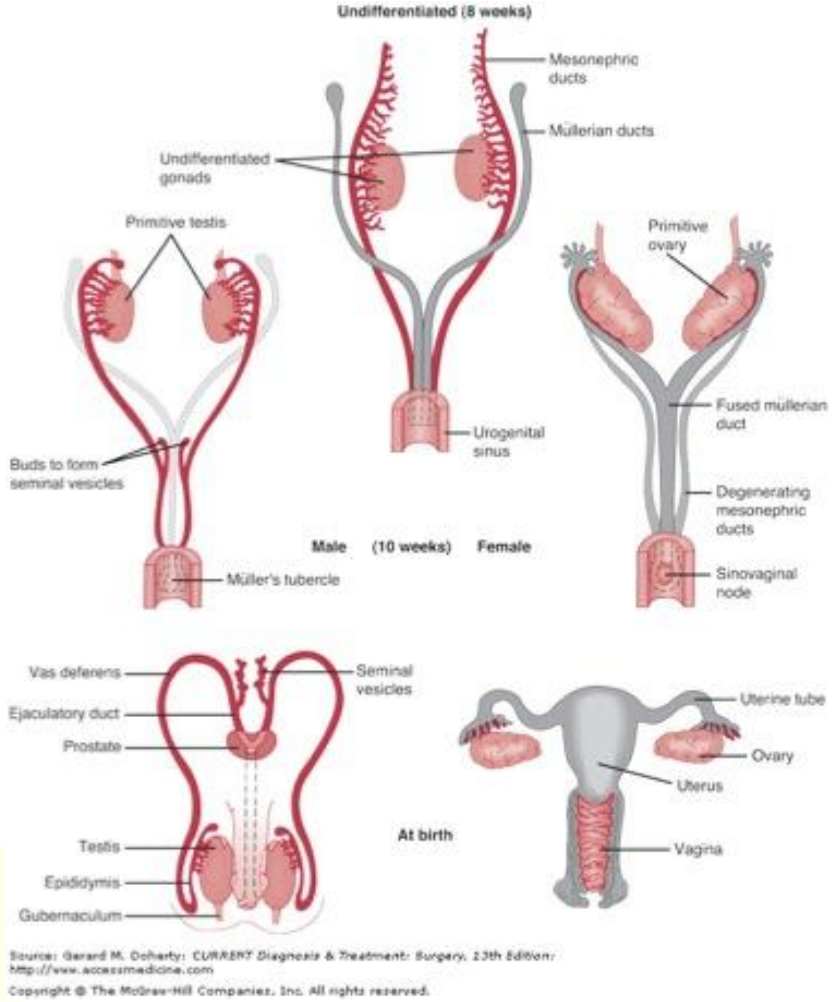
Formation of the uterus after 8 weeks



1a Paramesonephric duct (Müller)
2a Mesonephric duct (Wolff)
3a Lower gubernaculum
4a Utero-vaginal canal
5a Urogenital sinus

Formation of the uterus ca. 3rd month





1b Fallopian tube
2b Atrophied mesonephric duct (Wolff)
3b Ovarian ligament
3c Round ligament of uterus
4b Uterus
5b Vagina

DEVELOPMENT OF FEMALE GENITAL DUCTS AND GLANDS

THE PARAMESONEPHRIC DUCTS:

2. UTEROVAGINAL PRIMORDIUM:

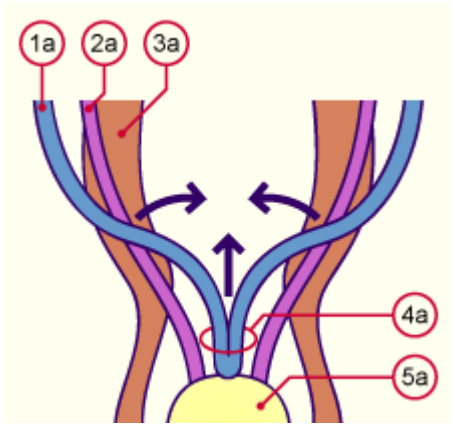
- **develops from the caudal, fused portion of the paramesonephric ducts**

gives rise to:

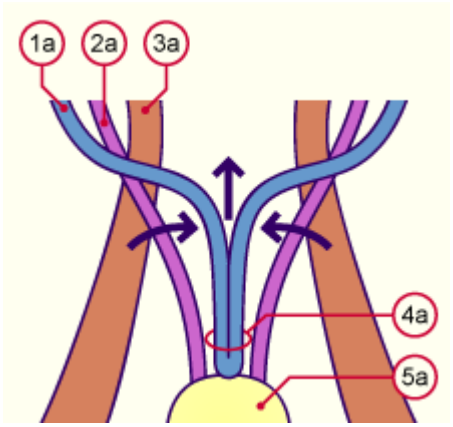
a) the uterus

b) the proximal portion of the vagina

Formation of the uterus, 7th – 8th weeks



Formation of the uterus after 8 weeks



1a Paramesonephric duct (Müller)
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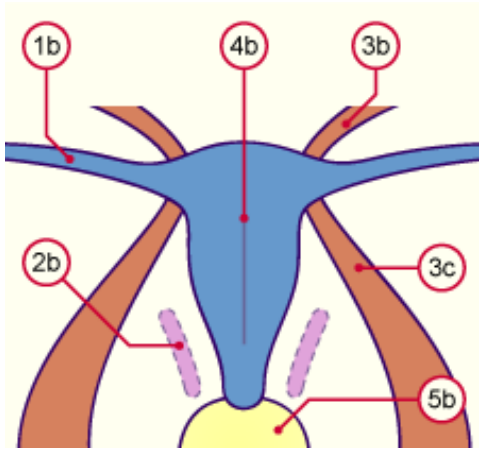
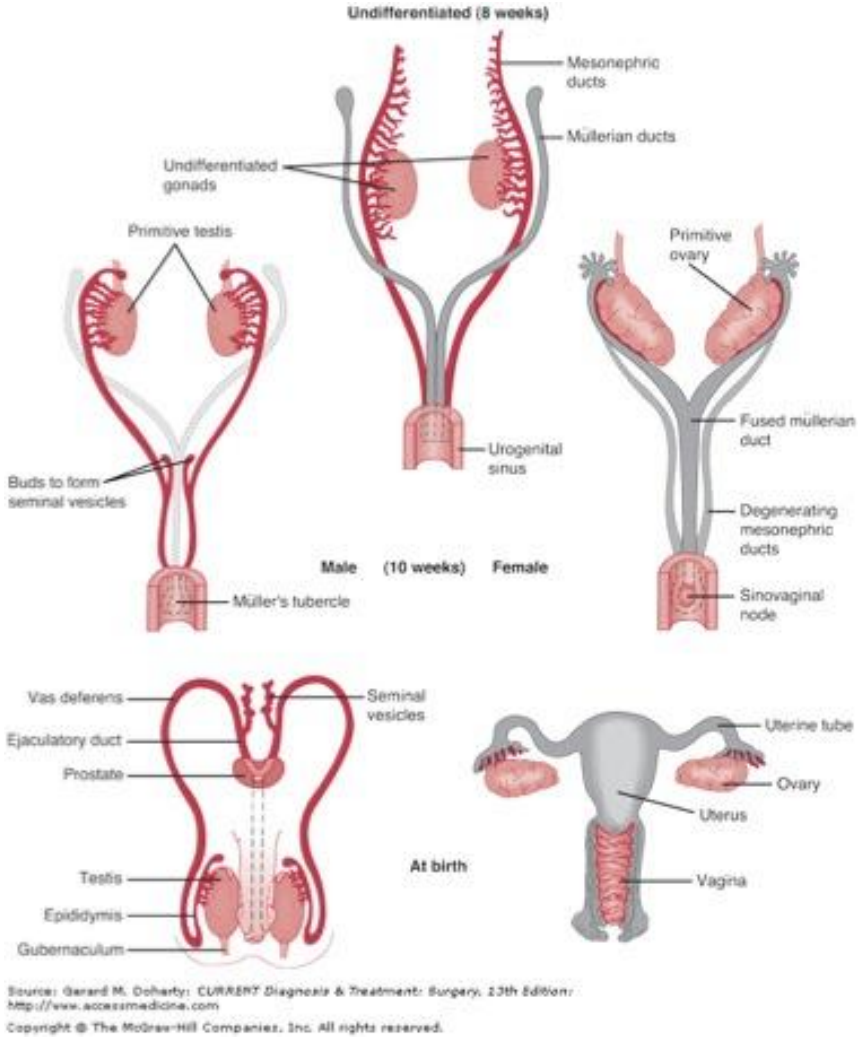
Formation of the uterus ca. 3rd month





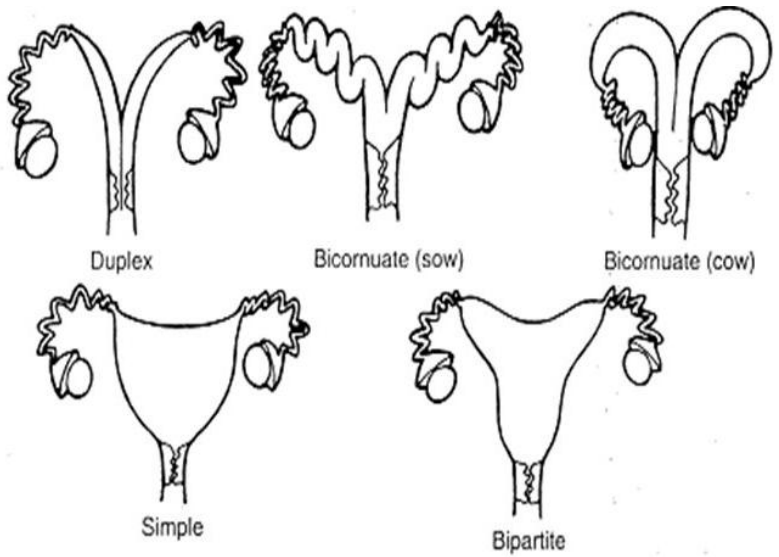
1b Fallopian tube
2b Atrophied mesonephric duct (Wolff)
3b Ovarian ligament
3c Round ligament of uterus
4b Uterus
5b Vagina

DEVELOPMENT OF FEMALE GENITAL DUCTS AND GLANDS

SPECIES DIFFERENCE

in mammals, the four main forms of the uterus are:

1. **duplex**
2. **bipartite**
3. **bicornuate**
4. **simplex**



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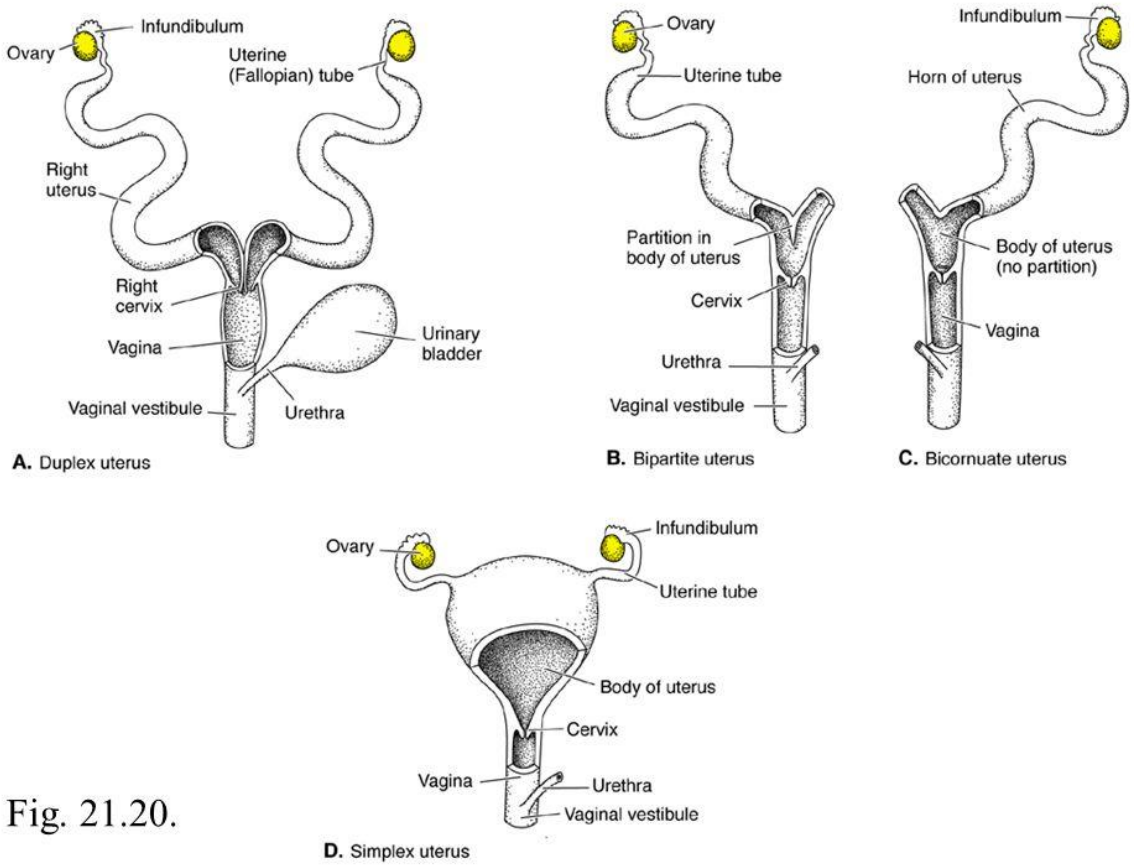

Fig. 21.20.

http://slideplayer.com/slide/4603349/

DEVELOPMENT OF FEMALE GENITAL DUCTS AND GLANDS

SPECIES DIFFERENCE

UTERUS DUPLEX:

- there are two wholly separate uteri, with one fallopian tube each

found in:

1. **marsupials (such as kangaroos, opossums)**
2. **rodents (mice, rats, guinea pigs)**
3. **lagomorpha (rabbits and hares)**

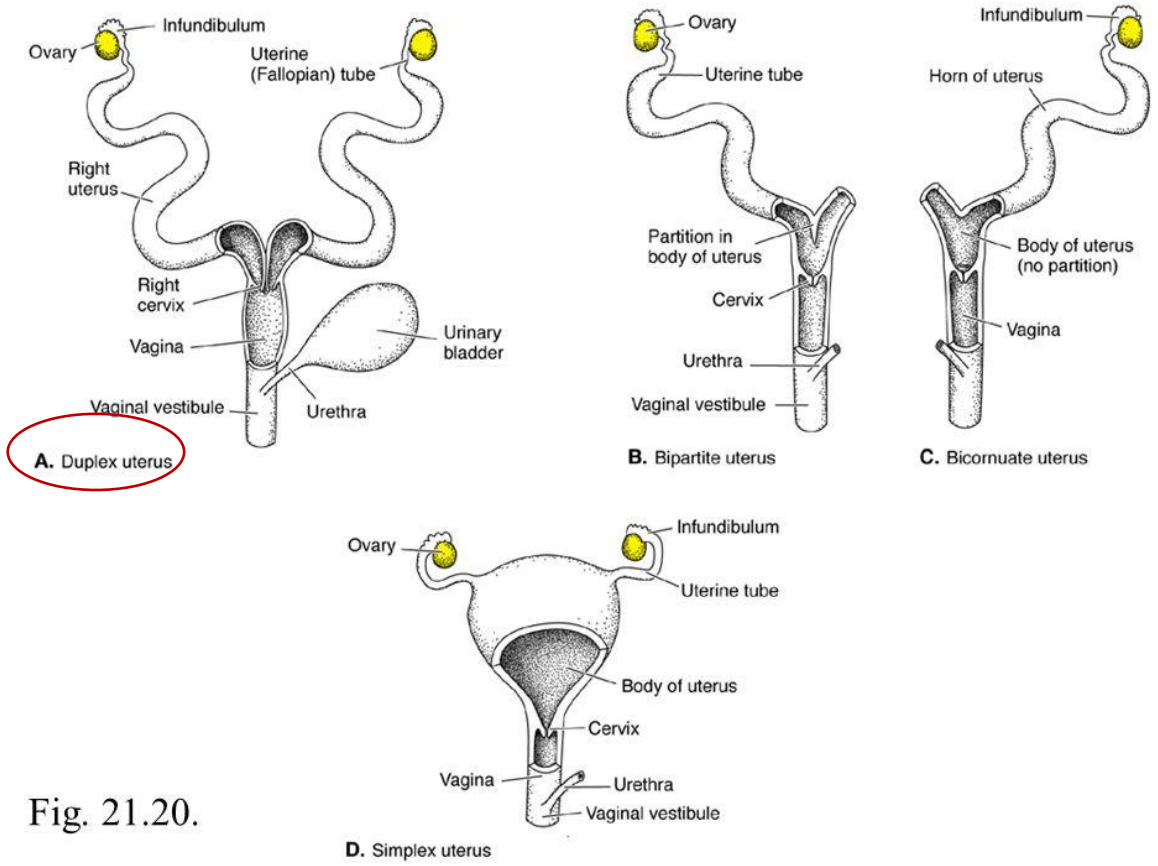

Fig. 21.20.

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DEVELOPMENT OF FEMALE GENITAL DUCTS AND GLANDS

SPECIES DIFFERENCE

Bipartite uterus

- **the two uteri are separated for most of their length, but share a single cervix**

found in:

1. **ruminants**
2. **cats**
3. **horses**

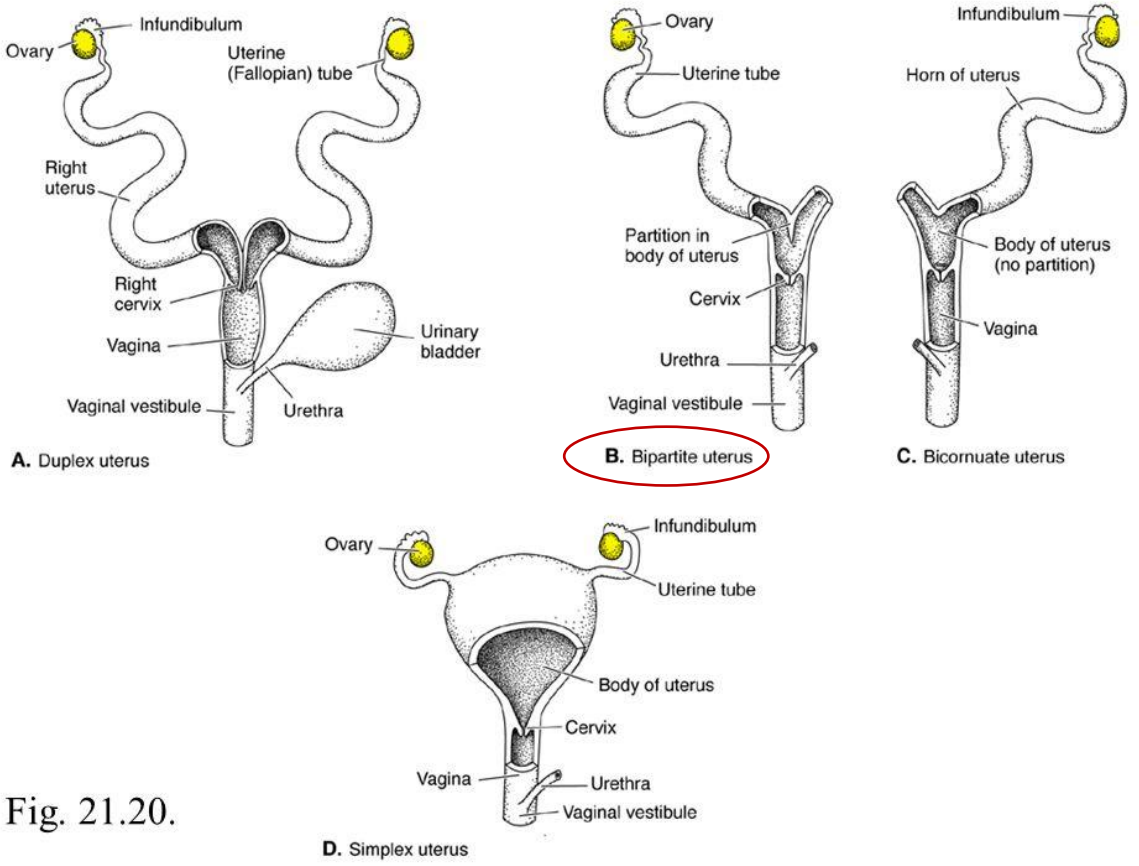

Fig. 21.20.

http://slideplayer.com/slide/4603349/

DEVELOPMENT OF FEMALE GENITAL DUCTS AND GLANDS

SPECIES DIFFERENCE

Bicornuate uterus

- the upper parts of the uterus remain separate

- the lower parts are fused into a single structure

found in:

1. **dogs**
2. **pigs**
3. **elephants**
4. **whales**
5. **dolphins**

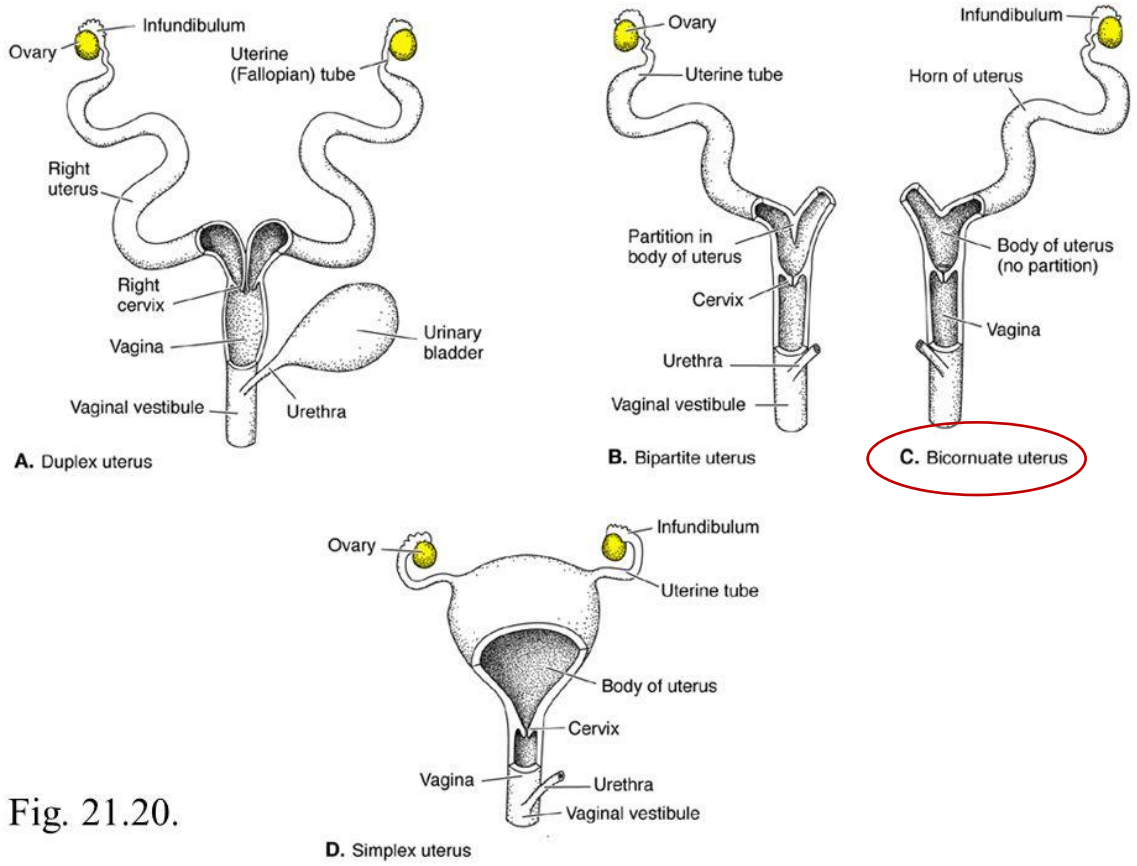

Fig. 21.20.

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DEVELOPMENT OF FEMALE GENITAL DUCTS AND GLANDS

SPECIES DIFFERENCE

Simplex

- the entire uterus is fused into a single organ

found in:

1. **higher primates - humans and chimpanzees**

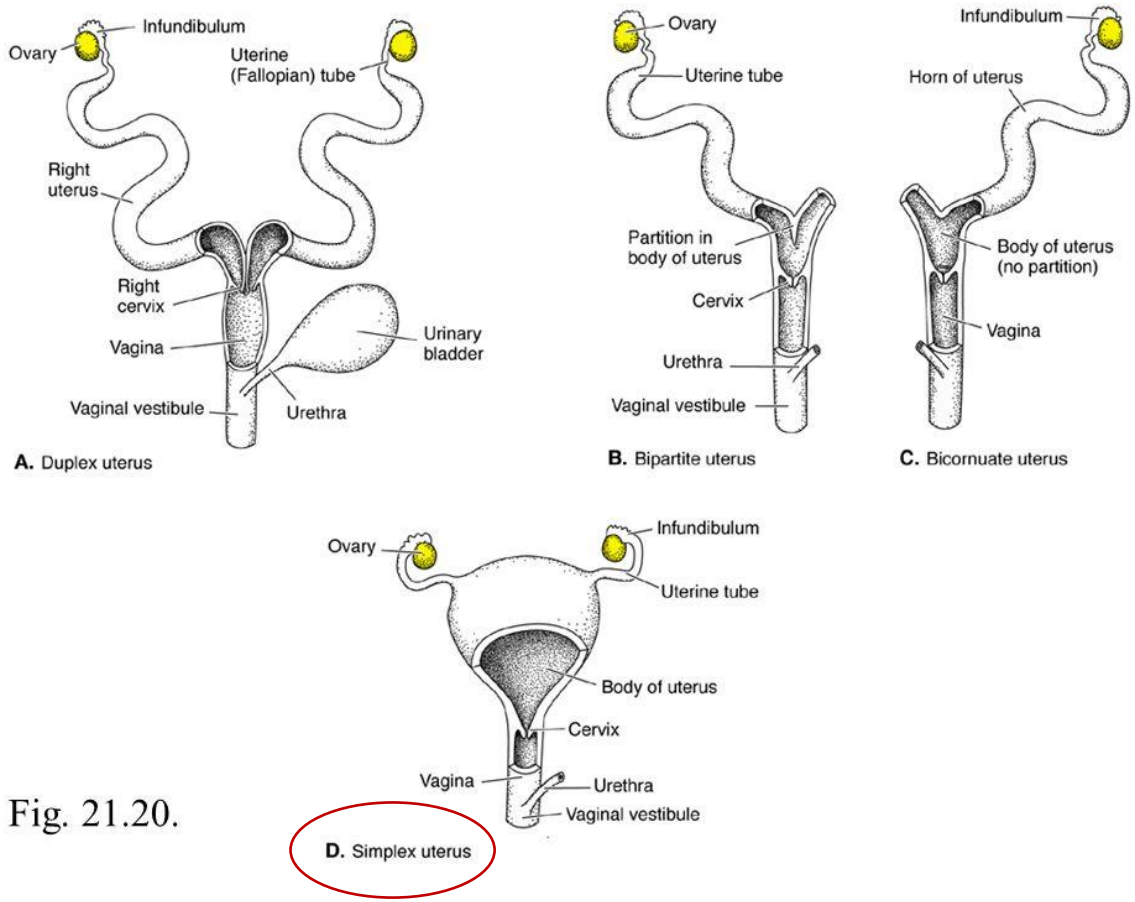


Fig. 21.20.

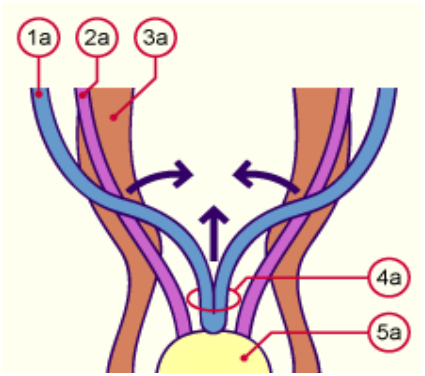
http://slideplayer.com/slide/4603349/

DEVELOPMENT OF FEMALE GENITAL DUCTS AND GLANDS

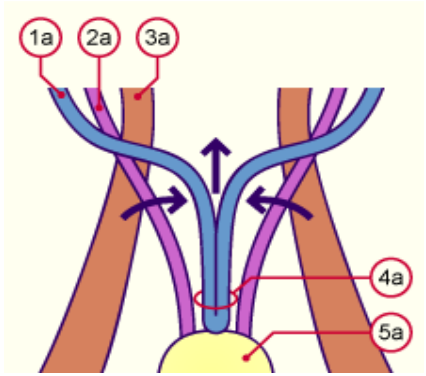
FUSION OF THE PARAMESONEPHRIC DUCTS brings together:

- **two peritoneal folds together – to form the BROAD LIGAMENT (ligamentum latum uteri)**
- **two peritoneal compartments – the rectouterine pouch and the vesicouterine pouch**

Formation of the uterus, 7th – 8th weeks

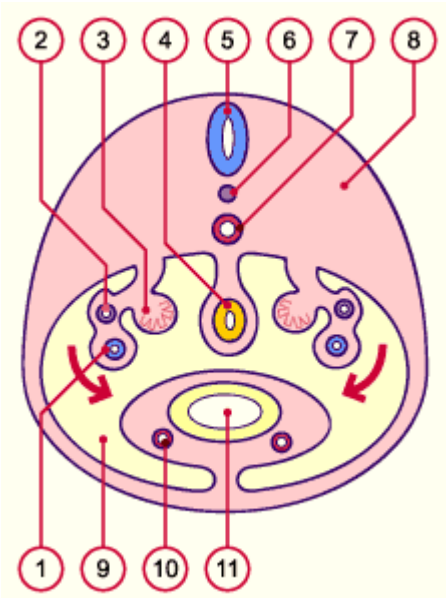


Formation of the uterus after 8 weeks

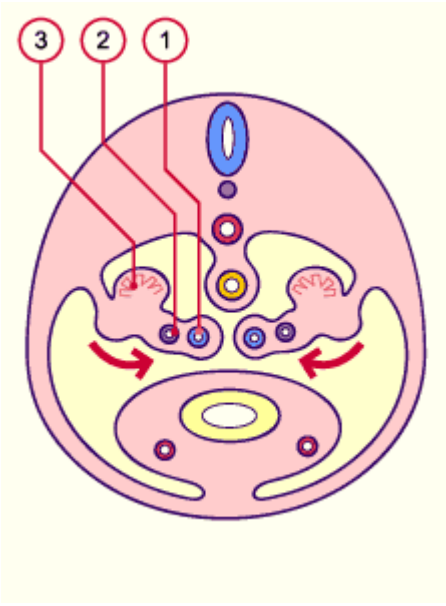


1a Paramesonephric duct (Müller)
2a Mesonephric duct (Wolff)
3a Lower gubernaculum
4a Utero-vaginal canal
5a Urogenital sinus

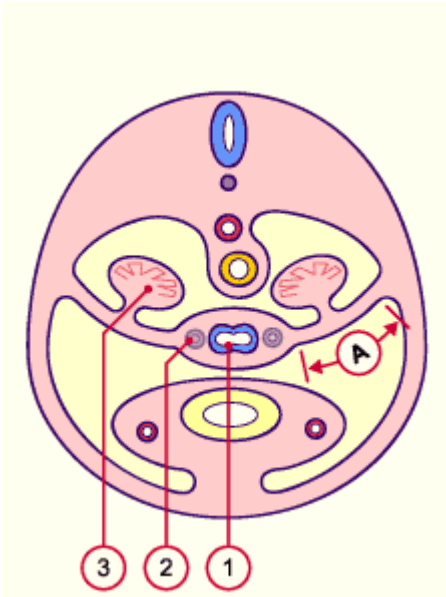
Formation of the broad ligament of uterus, ca. 8 weeks



Formation of the broad ligament of uterus, ca. end of the 8th week



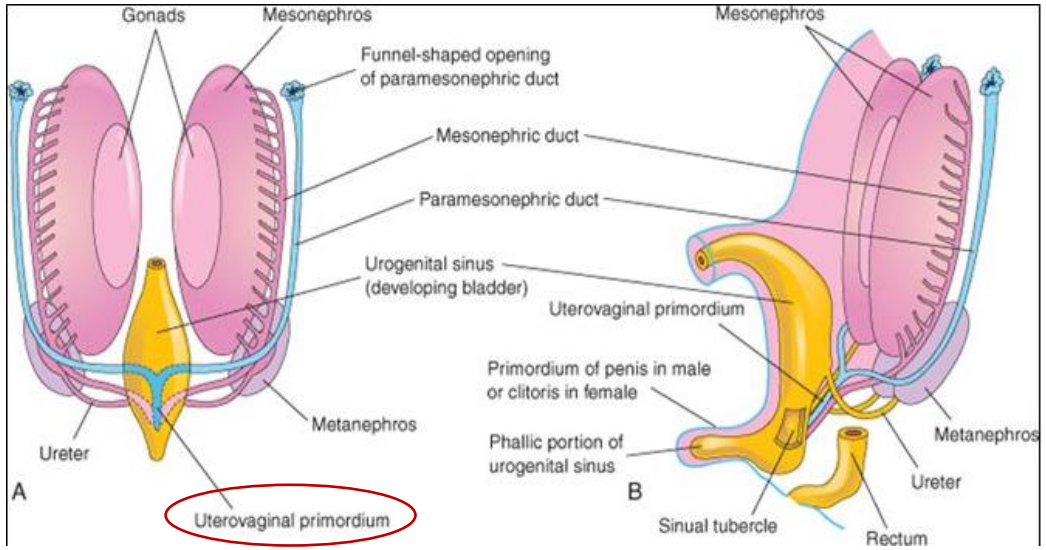
Formation of the broad ligament of uterus, ca. 10 weeks



1 Paramesonephric duct (Müller)
2 Mesonephric duct (Wolff)
3 Ovary
4 Intestine
5 Neural tube
6 Notochord
7 Aorta
8 Mesenchyma
9 Coelomic cavity
10 Umbilical artery
11 Urinary bladder
A Broad ligament or mesometrium

DEVELOPMENT OF VAGINA

- the vaginal epithelium derived from the endoderm of the urogenital sinus
- the fibromuscular wall of the vagina derived from the surrounding mesemchyme

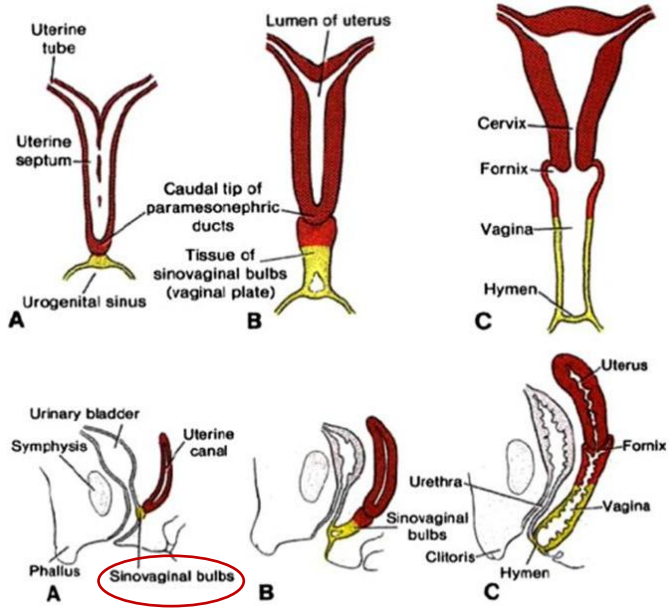


SINUS TUBERCULE:

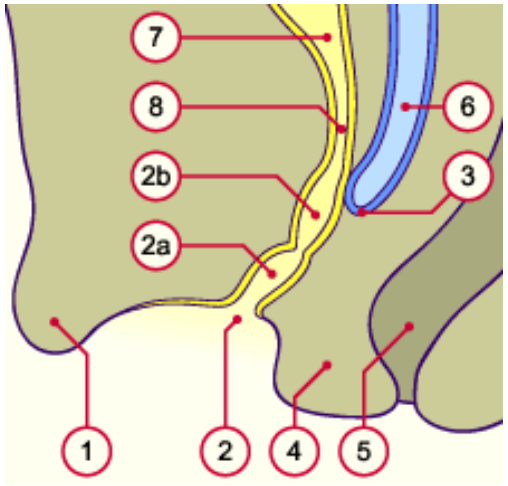
- contact of the uterovaginal primordium with the urogenital sinus
- formation of paired SINOVAGINAL BULBS (endodermal outgrowth)

SINOVAGINAL BULBS:

- extend from the urogenital sinus to the caudal end of the uterovaginal primordium – they fuse together – formation of the VAGINAL PLATE



Female sex organs
ca. 7th week



1 Genital tubercle
2 Vestibule
2a Urovaginal sinus: pelvic part
2b Urovaginal sinus: phallic part
3 Vaginal plate

4 Perineum
5 Rectum
6 Utero-vaginal canal
7 Urinary bladder
8 Urethra

The utero-vaginal canal comes up against the urogenital sinus and forms the sinu-vaginal eminence.

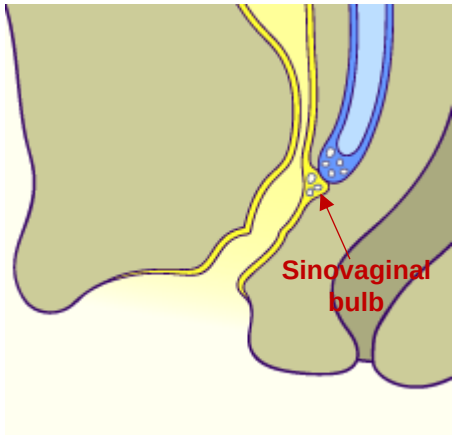
DEVELOPMENT OF VAGINA

VAGINAL PLATE:

- **its central cells break down – formation of the lumen of the vagina**
- **its peripheral cells – form the vaginal epithelium**
- **the lumen of the vagina is separated from the cavity of the urogenital sinus by the HYMEN**

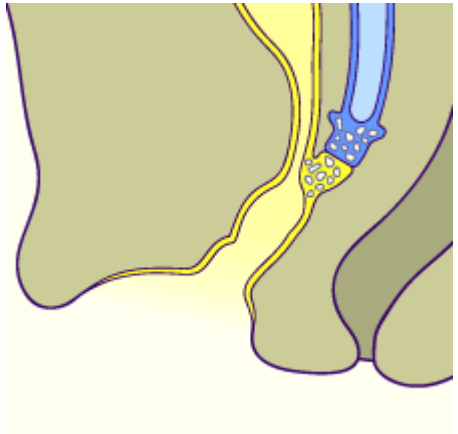
HYMEN: invaganation of the postreior wall of the urogenital sinus

Female sex organs
ca. 12th week



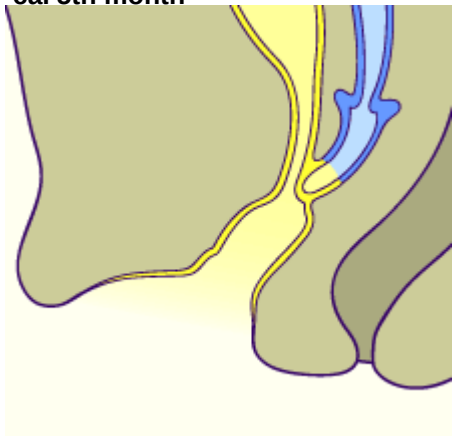
This sinu-vaginal eminence becomes thicker due to epithelial proliferation. This also leads to a epithelial proliferation in the SUG epithelium. Together they form the vaginal plate.

Female sex organs
ca. 3rd month



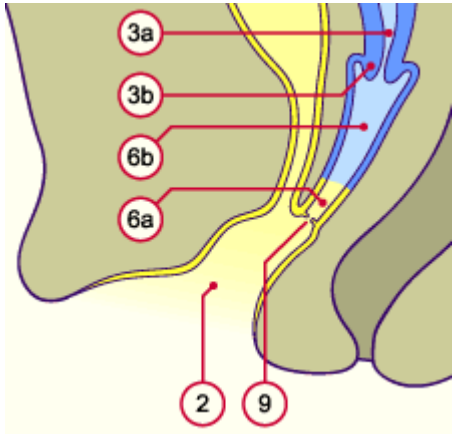
The canalization of the vaginal plate begins in the 3rd month.

Female sex organs
ca. 5th month



In the 5th month the vaginal canal is completely canalized, but the lumen is separated from the SUG by the hymen.

Female sex organs
ca. 9th month



Normally, the hymen tears open at the time of birth. The uterus and the vagina then have a connection to the vaginal vestibule.

2 Vaginal vestibule
3a Uterine cavity
3b Uterine cervix (neck)
6a Vagina: The lower fourth out of endoderm
6b Vagina: The upper 3/4 out of mesoderm
9 Hymen

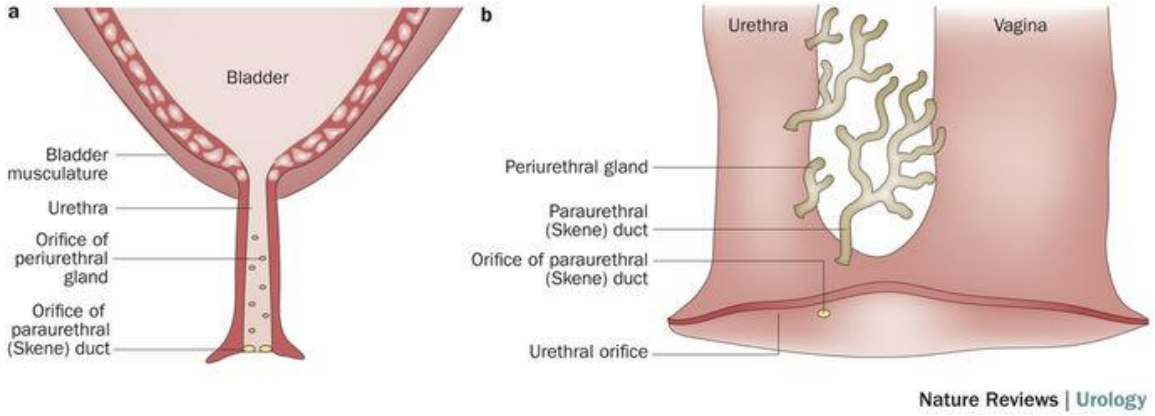
DEVELOPMENT OF FEMALE AUXILIARY GENITAL GLAND

URETHRAL and PARAURETHRAL GLANDS:

- **buds grow from the urethra into the surrounding mesenchyme**
- **mucus secretaion**

GREATER VESTIBULAR GLANDS of BARTHOLIN:

- **outgrowth of the urigenital sinus in the lower third of the labia**
- **mucus secretaion**

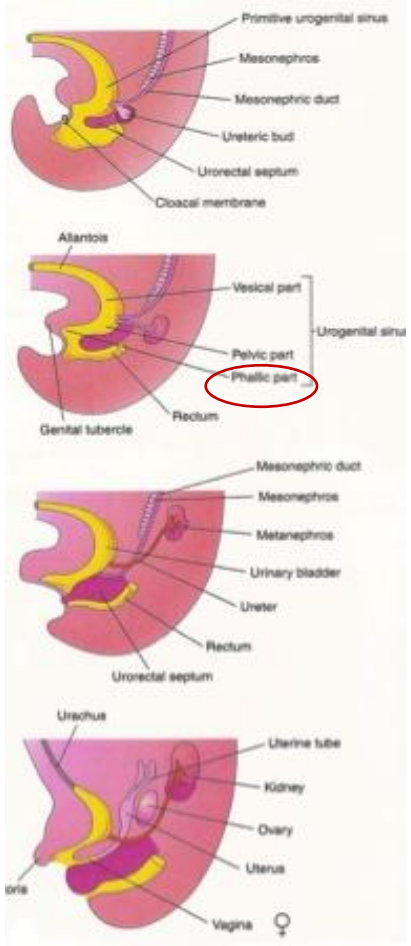


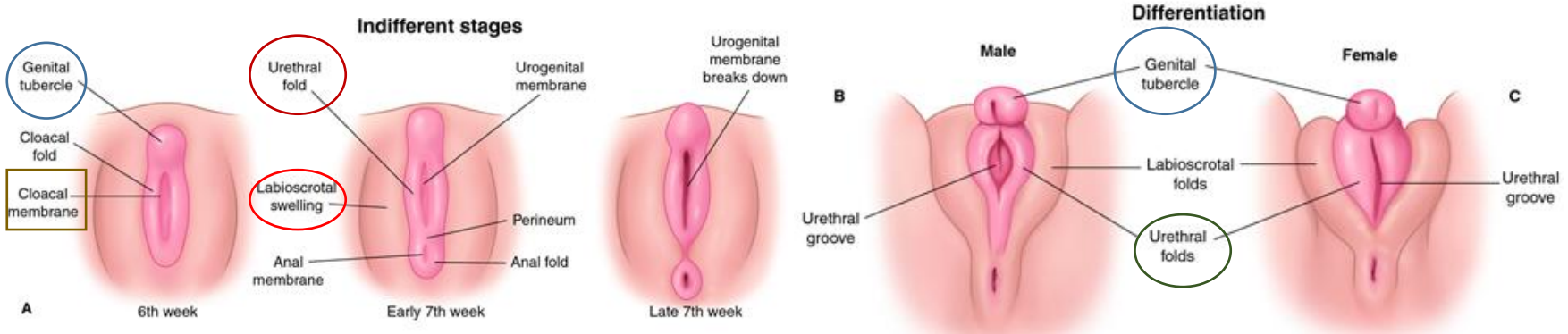
https://www.nature.com/articles/nrurol.2015.230

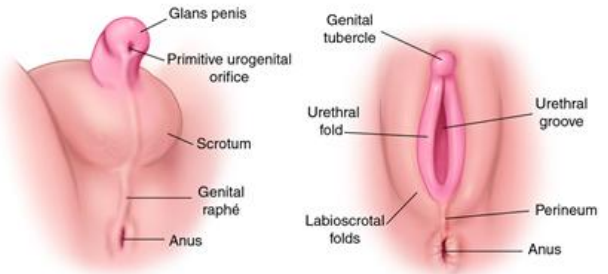
DEVELOPMENT OF EXTERNAL GENITALIA

- **from the 4th week to the early part of the 7th week the external genitalia are sexually undifferentiated**
- **distinguisching sexual characteristics appear during the 9th week**
- **the external genitalia not fully differentiated until the 12th week**

1. **early in the 4th week the proliferating mesenchyme produces a GENITAL TUBERCLE in both sexes at the cranial end of the cloaca membrane**
2. **LABIOSACROTAL SWELLING and URIOGENITAL FOLDS develop on each side of the cloacal membrane**







DEVELOPMENT OF EXTERNAL GENITALIA

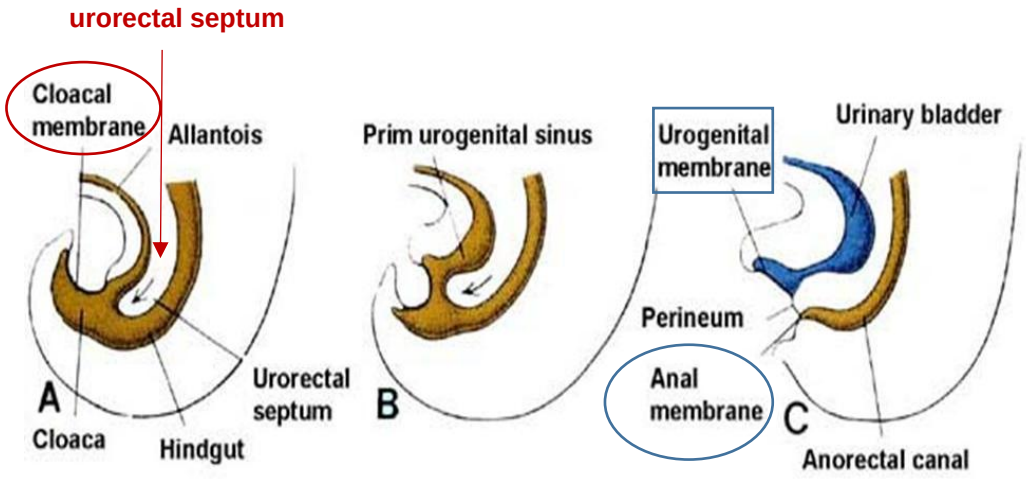
3. GENITAL TUBERCLE elongates to form the PRIMORDIAL PHALLUS

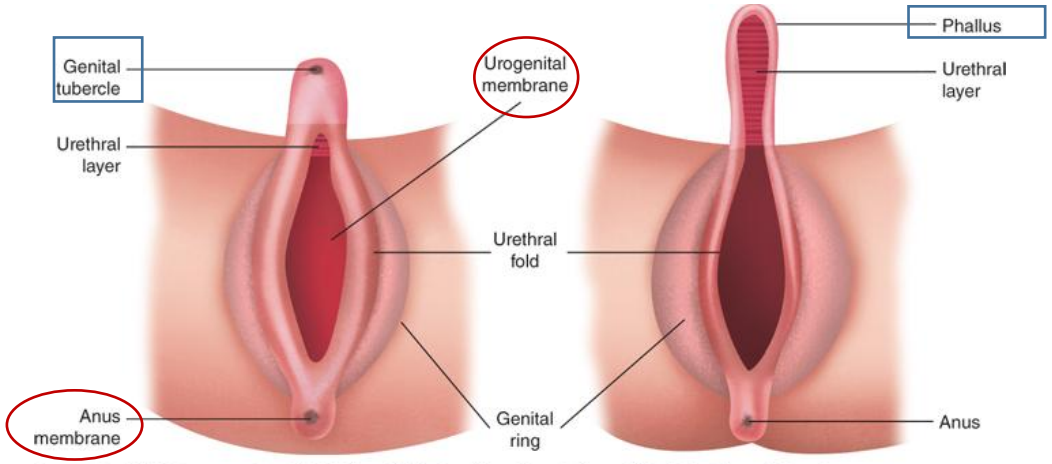
4. the urorectal septum fuses with the cloacal membrane (at the end of the 6th week)

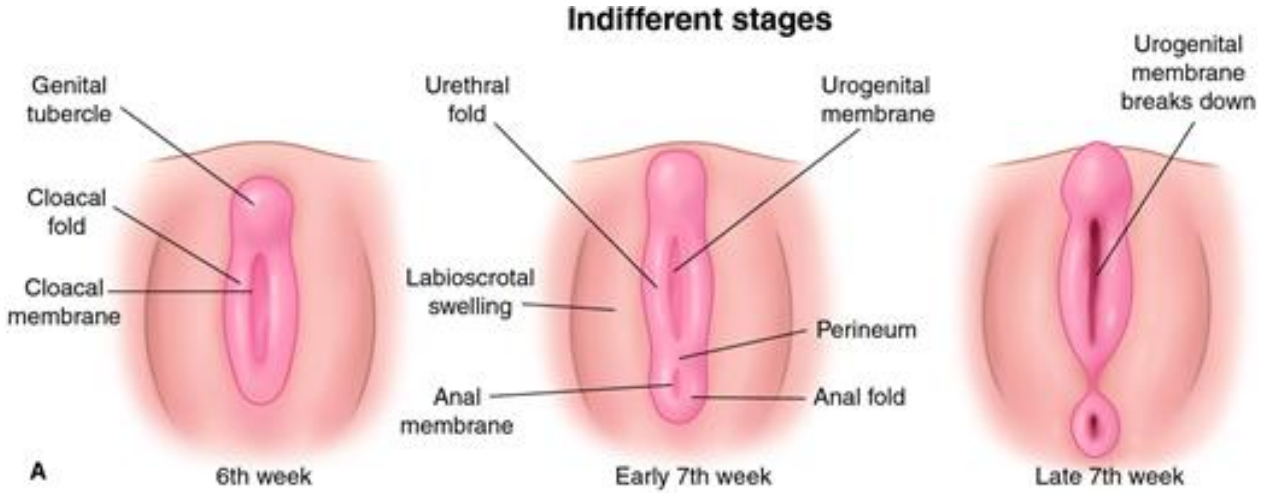
5. the urorectal septum devides the cloacal membrane into:

a. a dorsal anal membrane

b. a ventral urogenital membrane



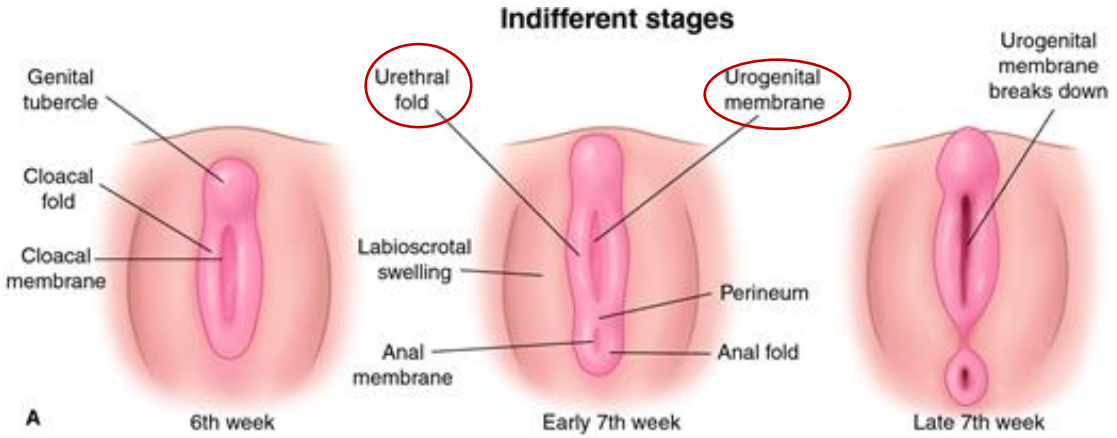


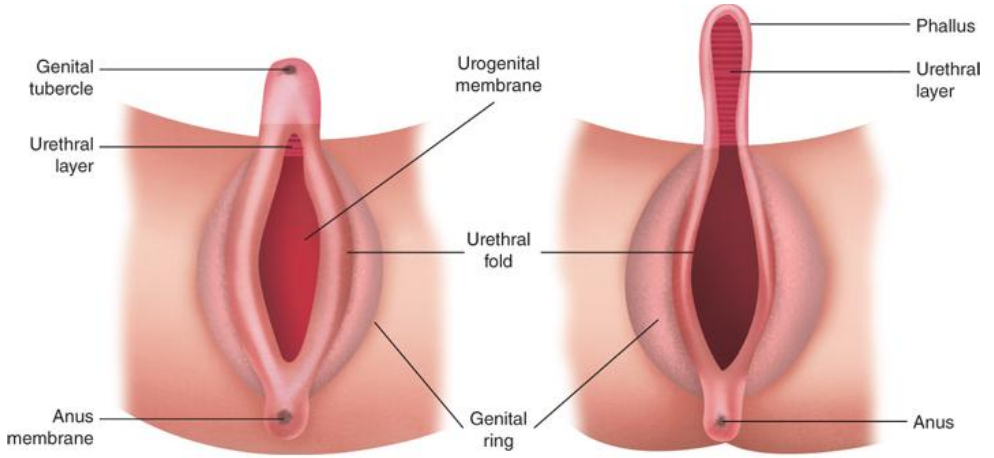


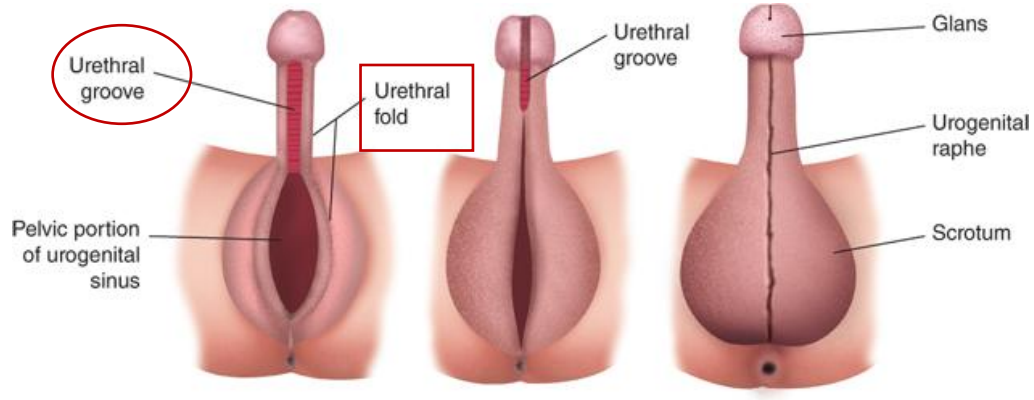
DEVELOPMENT OF EXTERNAL GENITALIA

UROGENITAL MEMBRANE:

- **the urethral membrane lies in the floor of the median cleft**
- **the urethral groove bound by the urogenital folds**



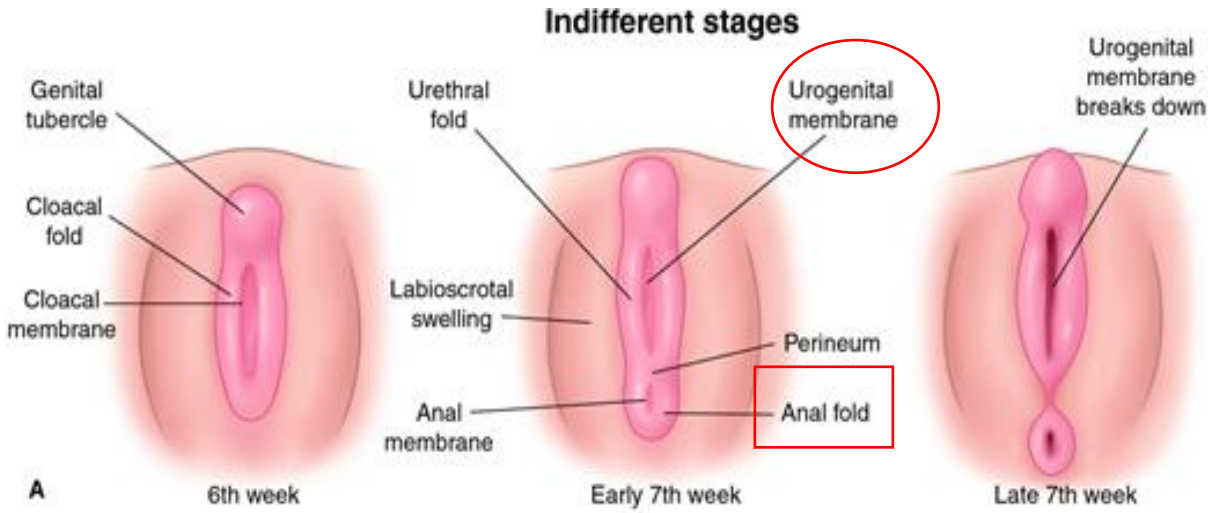


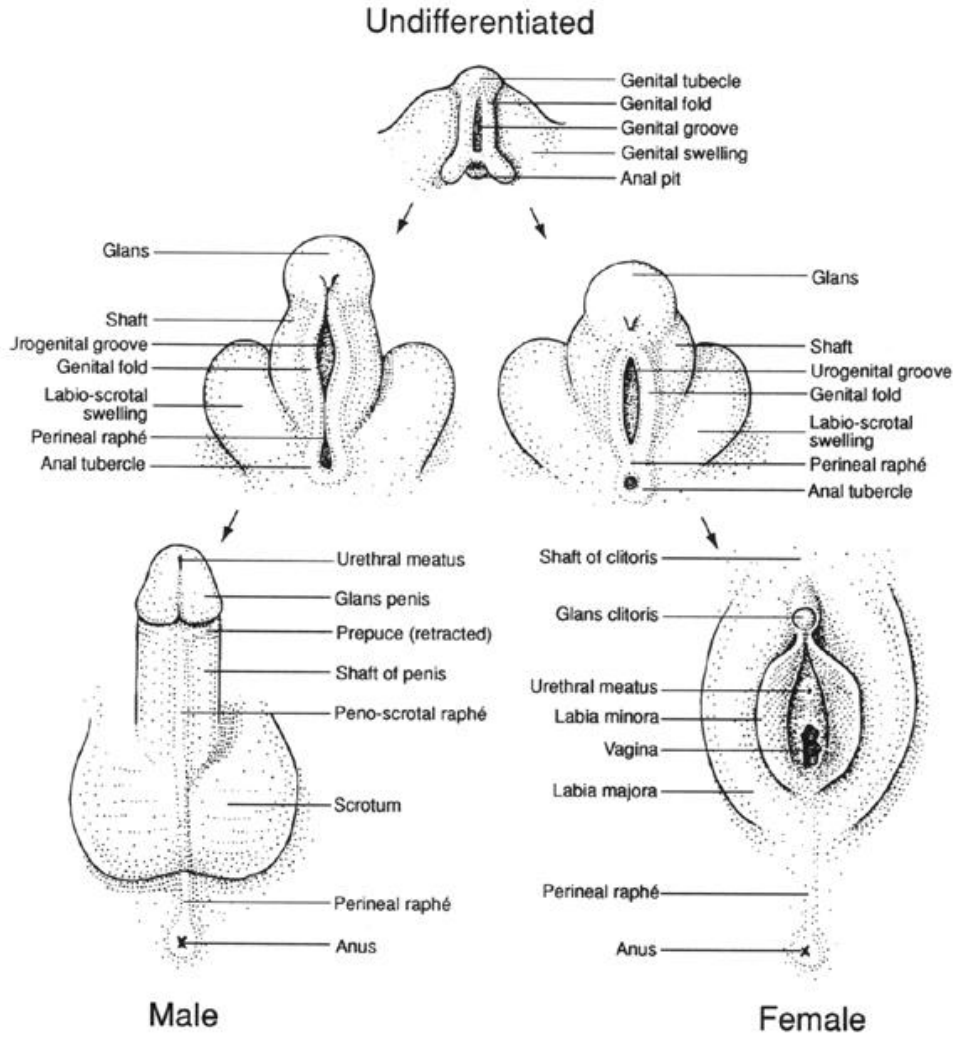


DEVELOPMENT OF EXTERNAL GENITALIA

- **the anal and the urogeintal membrane ruptures approx. 1 week later to form:**

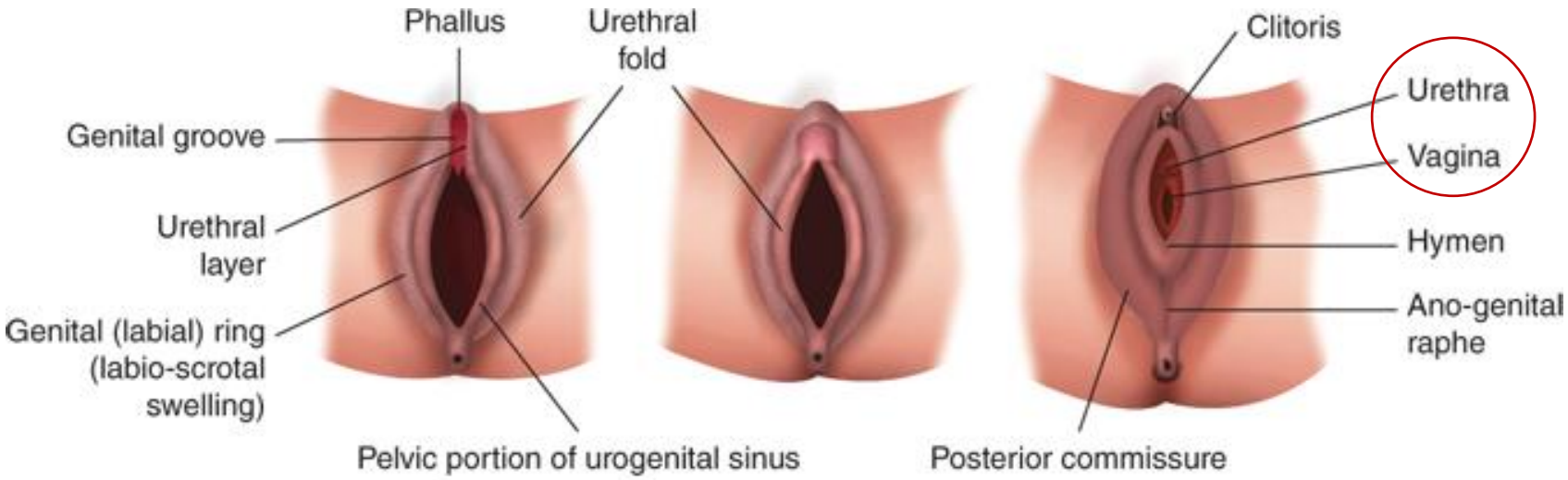
1. **the anus**
2. **the urogenital orifice**





DEVELOPMENT OF EXTERNAL GENITALIA

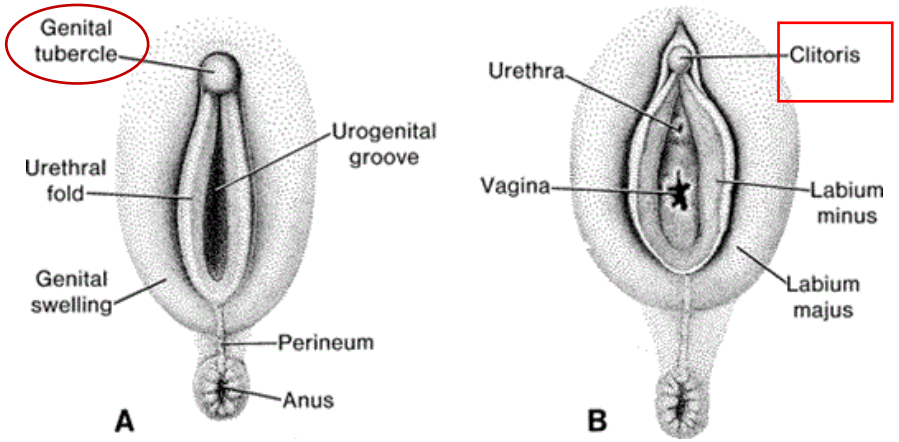
- **in female fetus the urethra and the vagina open into the vestibule of the vagina**

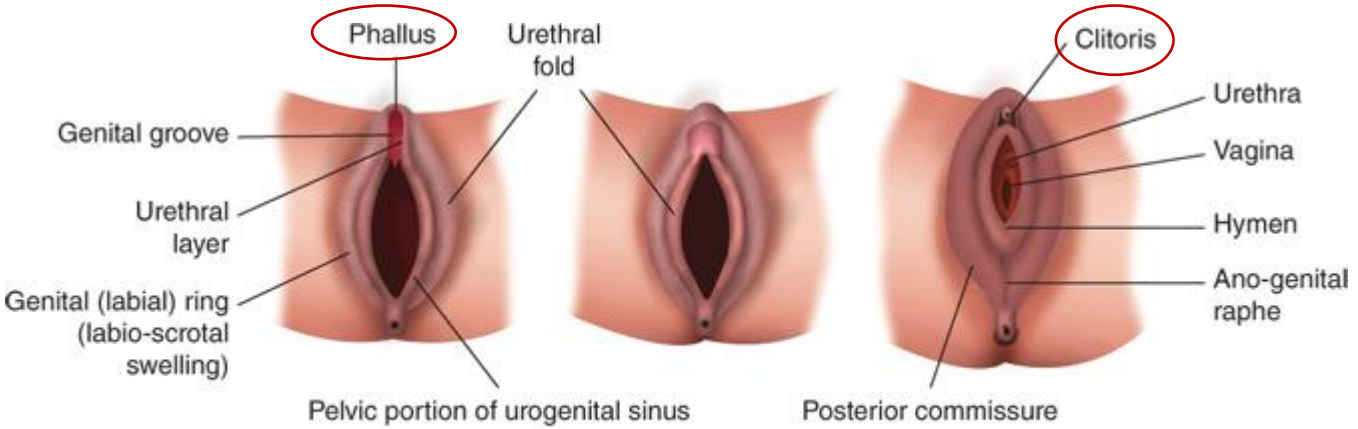


Source: David K. Stevenson, Ronald S. Cohen, Philip Sunshine: Neonatology: Clinical Practice and Procedures
www.accesspediatrics.com

DEVELOPMENT OF FEMALE EXTERNAL GENITALIA

- **growth of the primordial phallus decreases – becomes the CLITORIS**



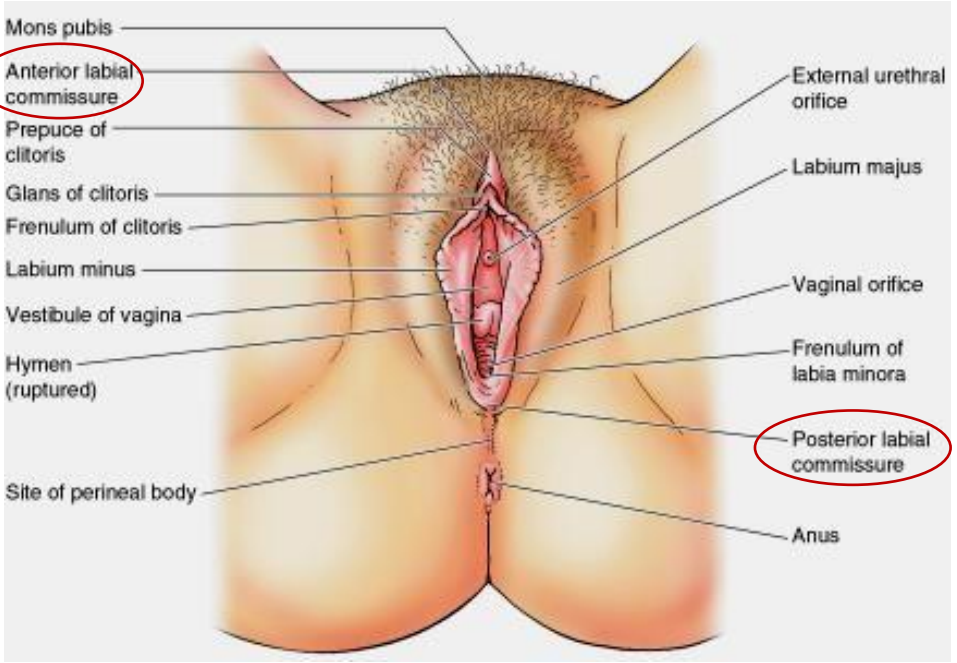


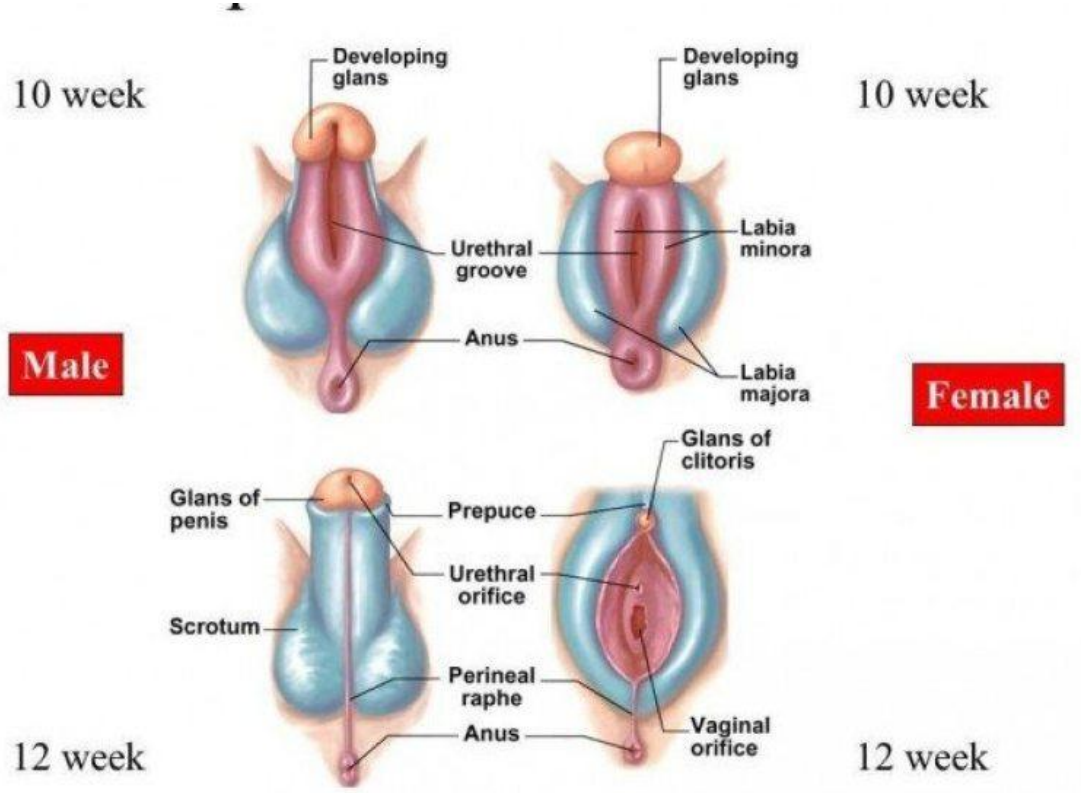
Source: David K. Stevenson, Ronald S. Cohen, Philip Sunshine: Neonatology: Clinical Practice and Procedures
www.accesspediatrics.com

DEVELOPMENT OF FEMALE EXTERNAL GENITALIA

LABIOSCROTAL FOLDS:

- **fuse posteriorly to form the posterior labial commissure**
- **fuse anteriorly to form the anterior labial commissure and the mons pubis**
- **most of the labioscrotal folds remain unfused – form the labia**

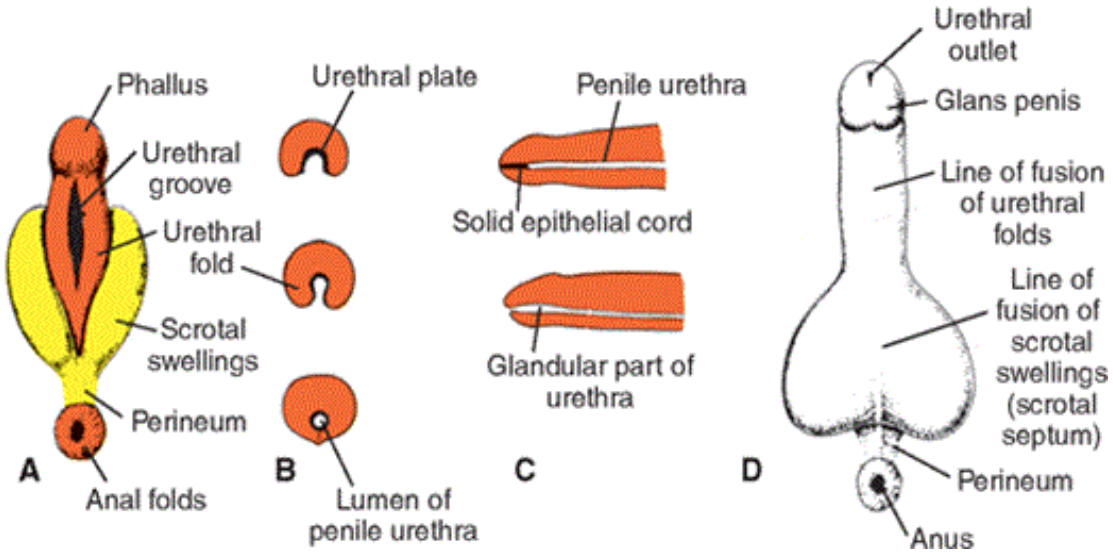


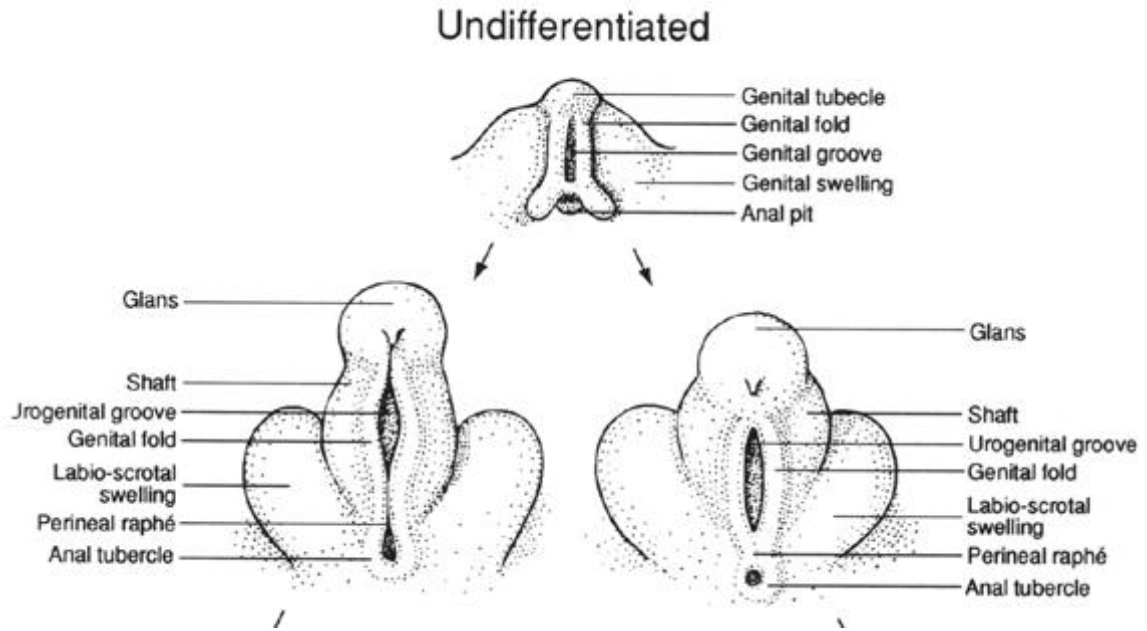


DEVELOPMENT OF MALE EXTERNAL GENITALIA

- **masculinization of the indifferent genitalia induced by dihydrotestosterone**

1. **the primordial phallus enlarges, elongates to become the penis**
2. **the urogenital folds form the lateral wall of the urethral groove on the ventral surface of the penis**
3. **the urethral groove is lined by the urethral plate (proliferation of endoderm)**
4. **the urethral plate extends from the phallic portion of the urogenital sinus**
5. **the urethral folds fuse with each other – formation of spongy urethra**





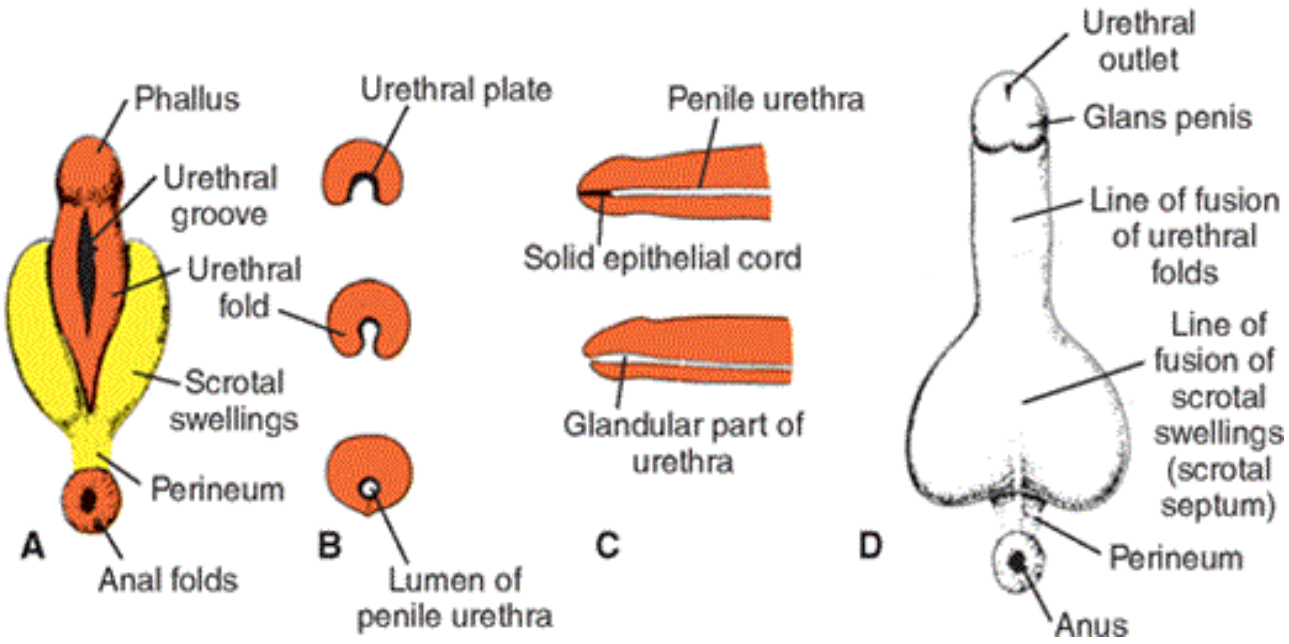
DEVELOPMENT OF MALE EXTERNAL GENITALIA

6. the surface ectoderm fuses in the medina plane of the penis – formation of penile raphe

7. at the tip of the glans penis – ectodermal ingrowth – form an ectodermal cord – extends toward and meet the spongy urethra

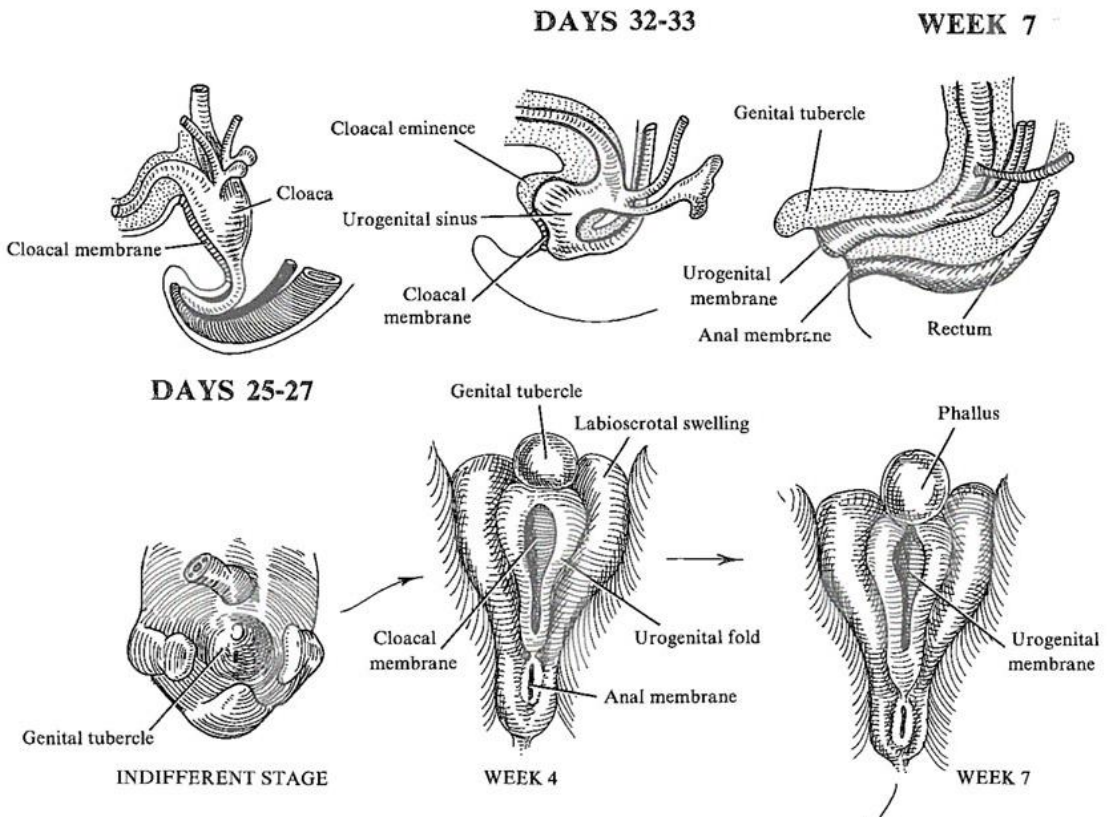
8. the ectodermal cord canalizes – join to the previously formed spongy urethra

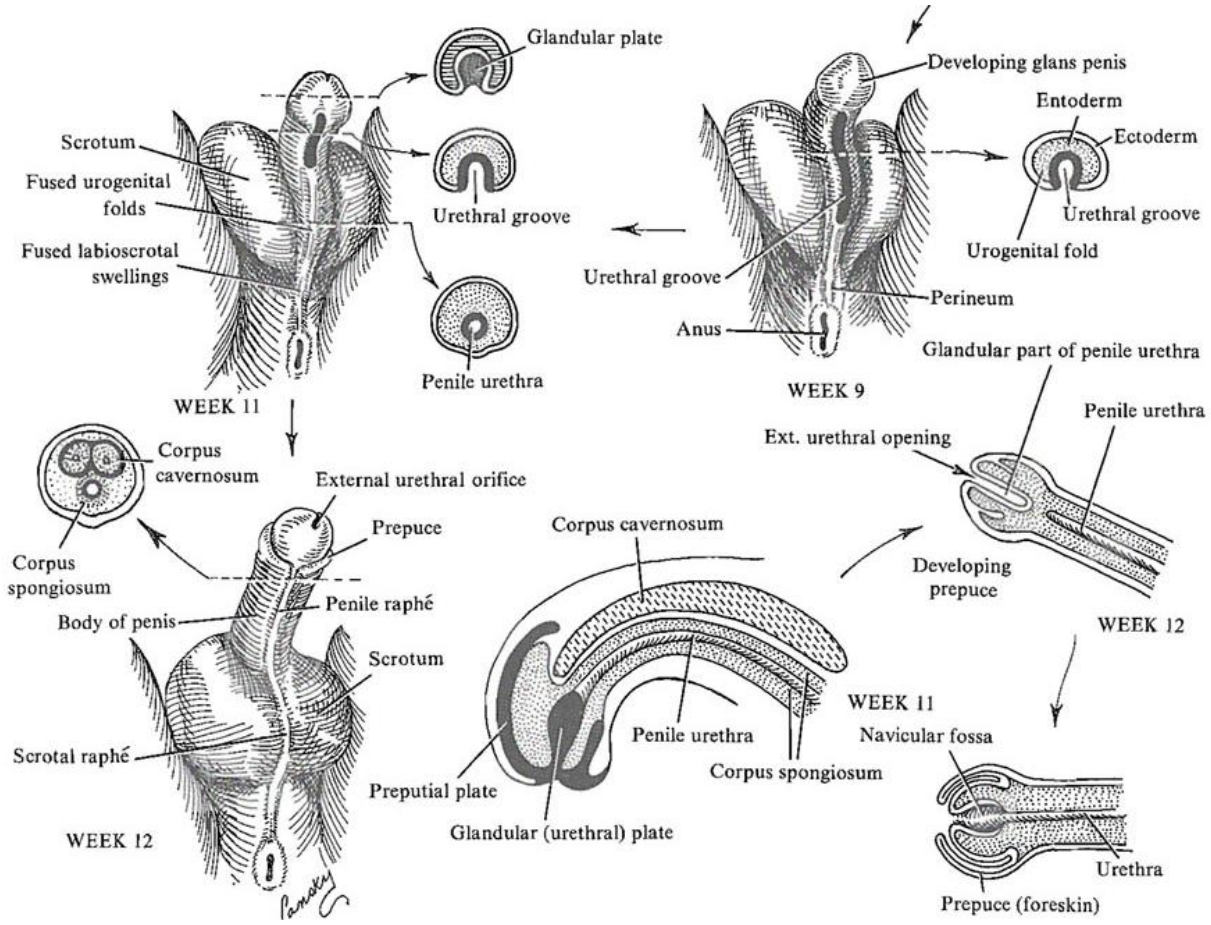
9. during the 12th week – circular ingrowth of ectoderm occurs at the periphery of glans penis – this break down – formation of prepuce (foreskin)



DEVELOPMENT OF MALE EXTERNAL GENITALIA

- **corpora spongiosa and cavernosa penis formed by the mesenchyme in the phallus**



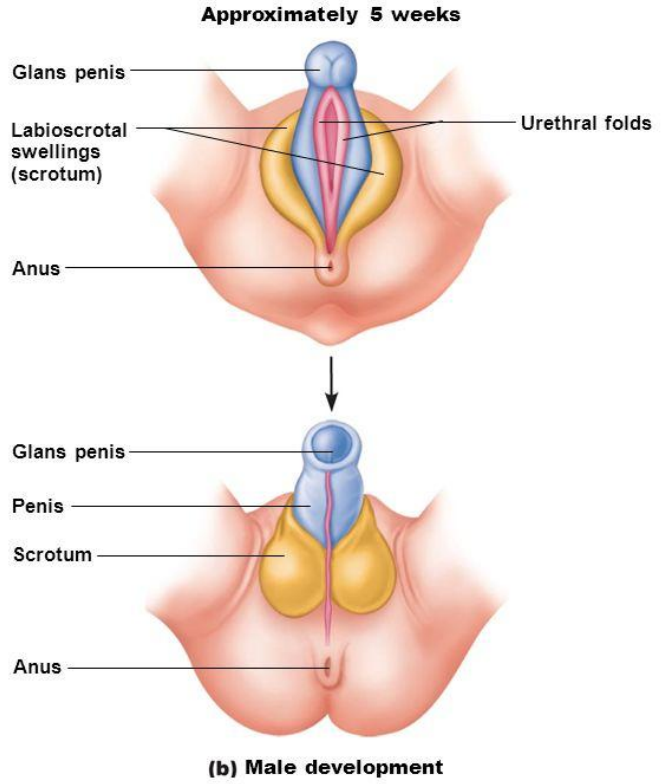


DEVELOPMENT OF MALE EXTERNAL GENITALIA

LABIOSCROTAL SWELLING:

- **grow toward each other - fuse to form the scrotum**
- **the line of fusion of these folds – SCROTAL RAPHE**

Figure 27.24b Development of homologous structures of the external genitalia in both sexes.



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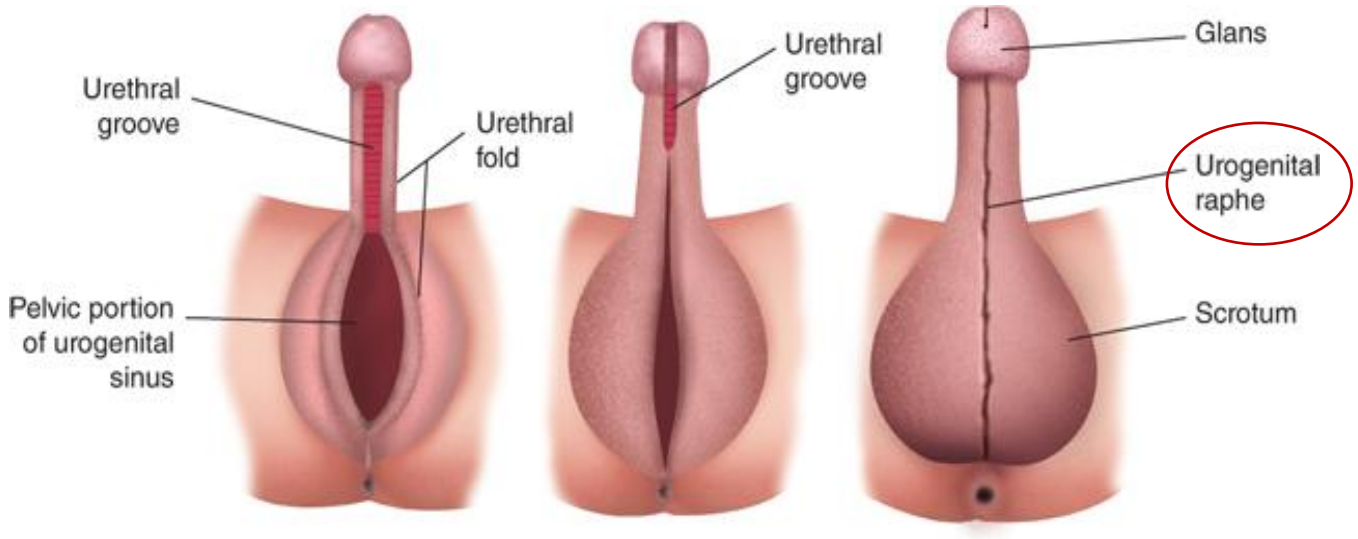

Source: David K. Stevenson, Ronald S. Cohen, Philip Sunshine: Neonatology: Clinical Practice and Procedures
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FOR

YOUR ATTENTION!

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