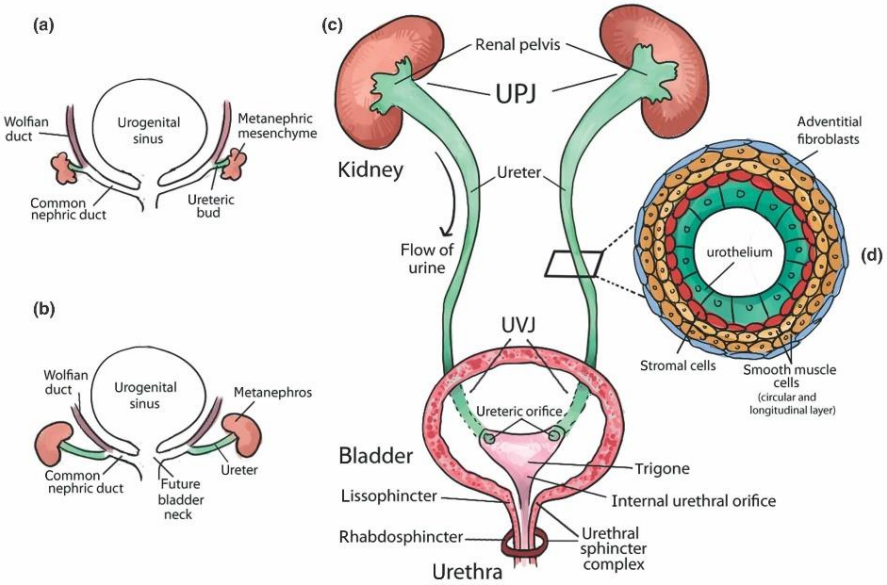
Kazan Federal (Volga Region) University
Institute of Fundamental Medicine and Biology
Department of Morphology and General Pathology

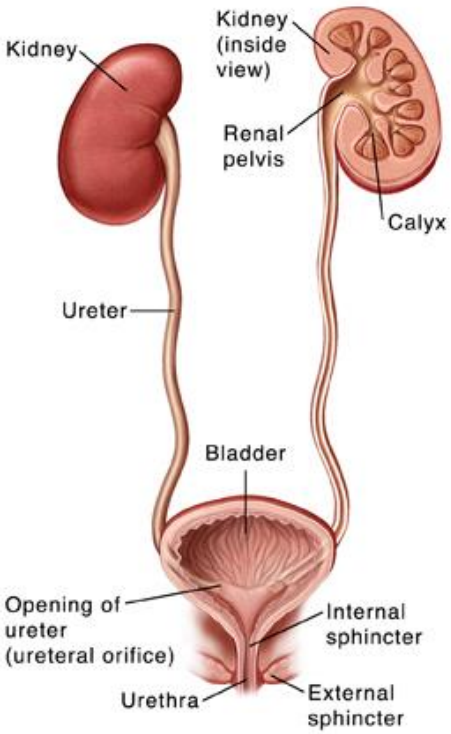
Lecture 3

Urinary system. Development



Zaikina Elvira Ildarovna,
MD, PhD, Senior lecturer

Urogenital apparatus



Urinary system organs

(*organa urinaria*)

-Kidney – produce urine

-Ureter

-Urinary bladder

-Male and female urethras

Genital system organs

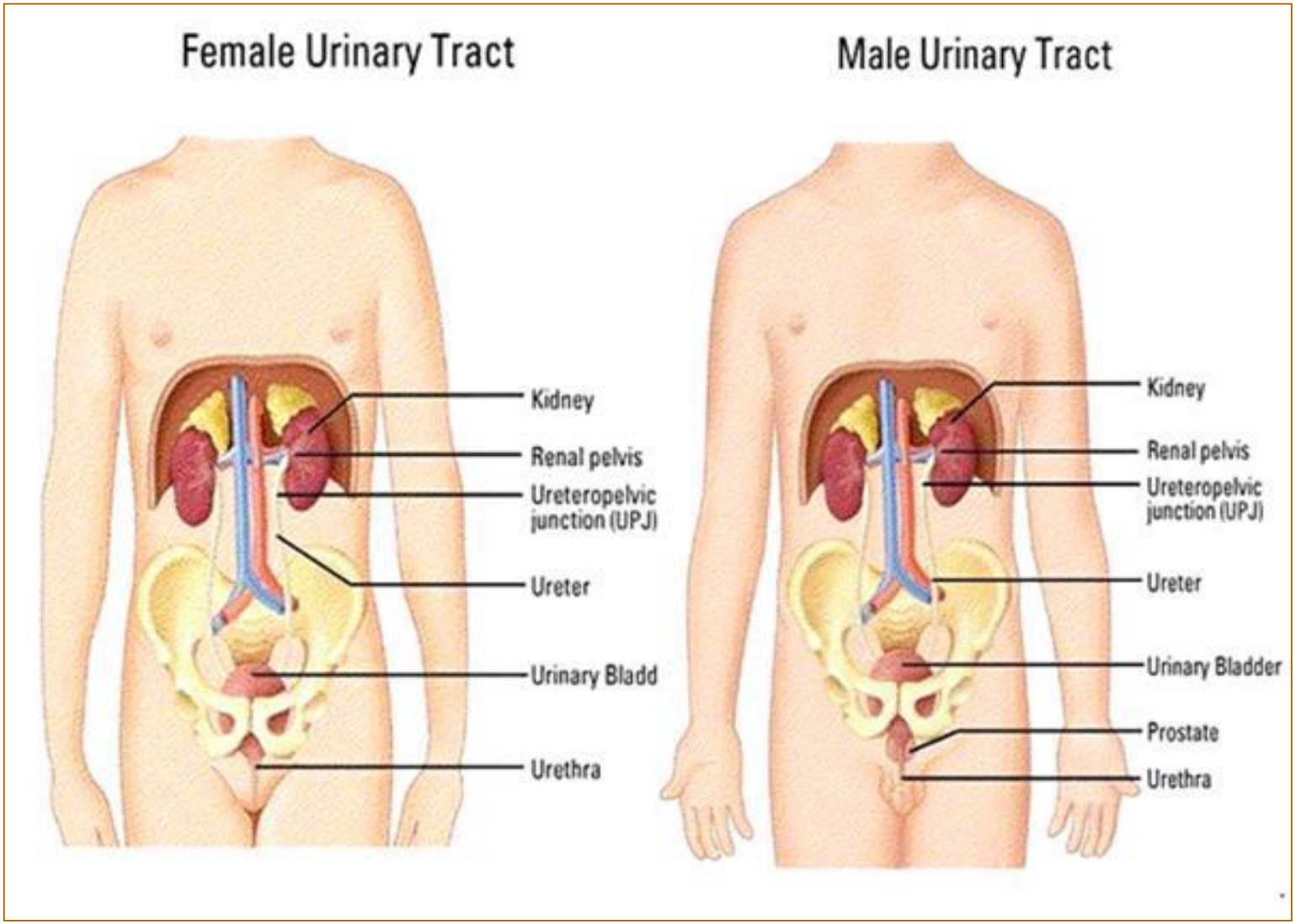
(*organa genitalia*)

Organs:

- internal and external male and female genital organs

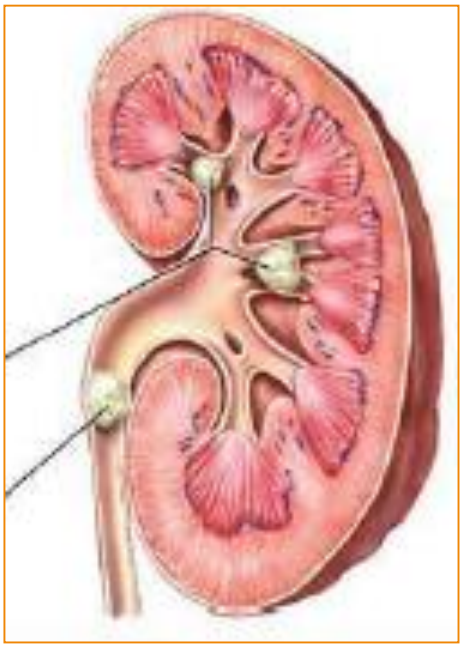
transport and excrete urine

Urinary system
(systema urinaria)

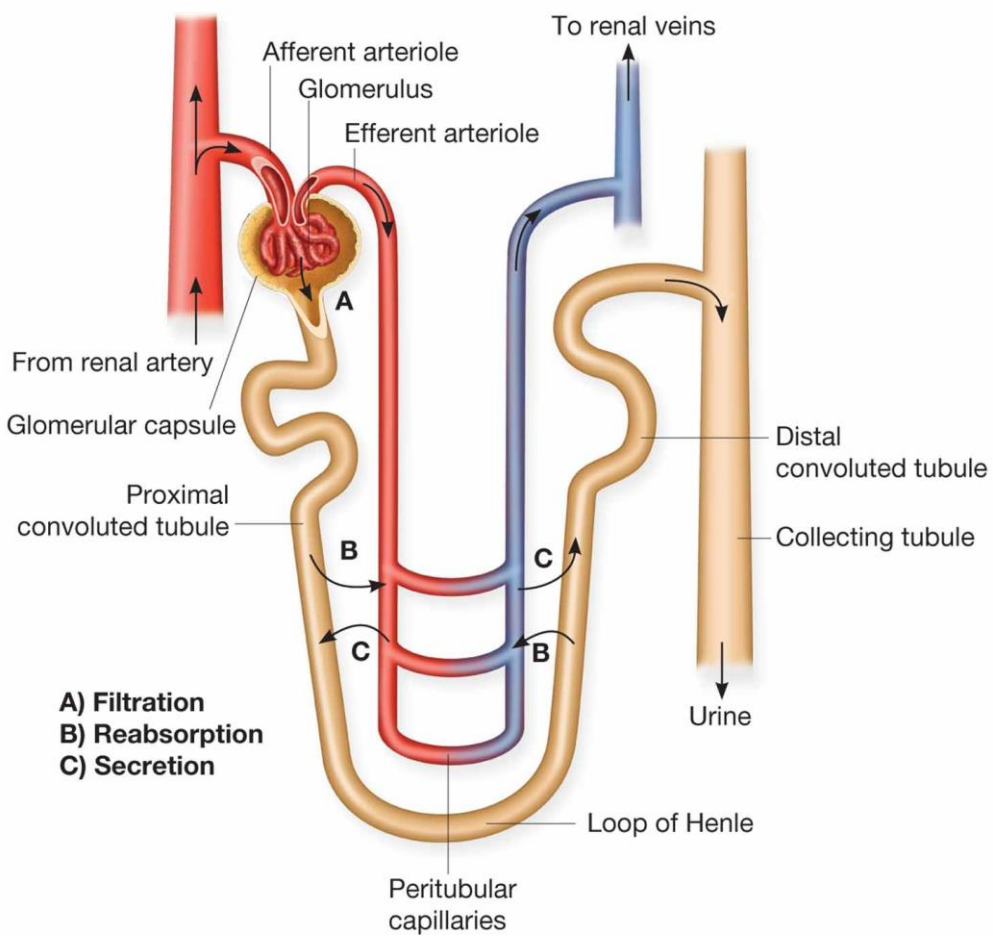


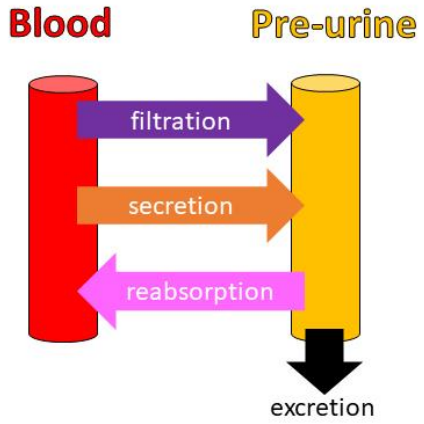
Functions of the kidney

- **1. Excretion with the urine:**
  - water-soluble metabolic products
  - xenobiotiks
- **2. Participate in the regulation:**
  - blood pressure and circulatory dynamics
  - water-salt and acid-base balance
  - osmotic presure
- **3. Synthesis of bioactive substances:**
  - Erythropoietin
  - Renin
  - Prostaglandins
- **4. Enzymatic conversion (hydroxylation) and activation of vitamin D**



Uropoiesis (formation of the urine)



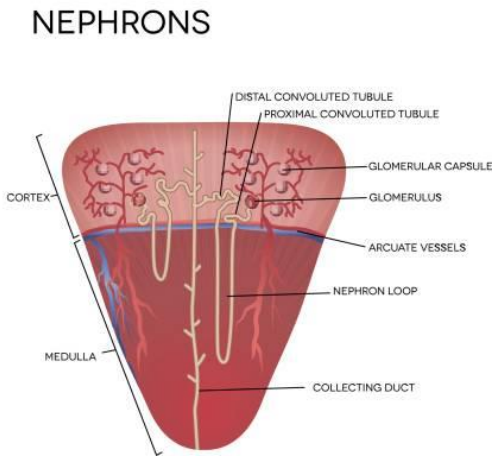


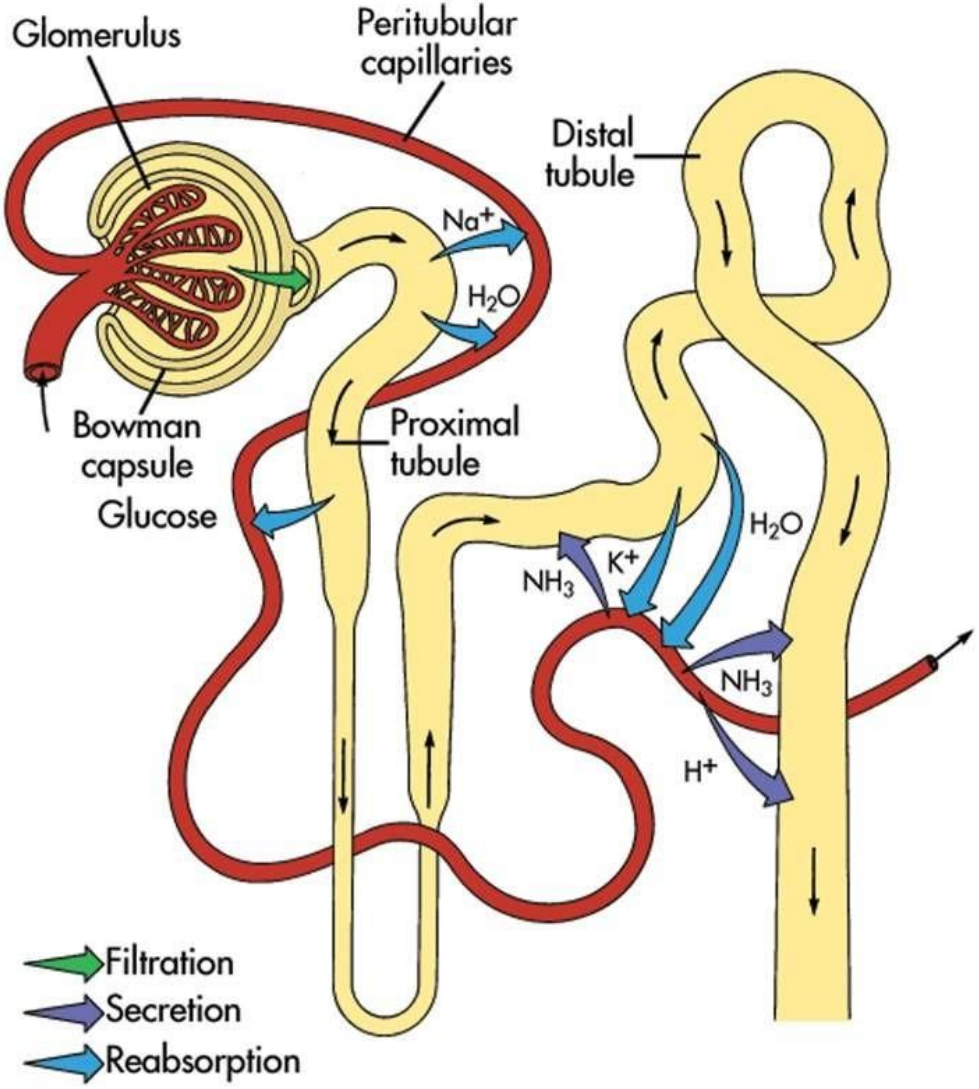
Urine is formed from blood

3 main stages:

1) **Filtration** of blood in glomerulus
2) **Reabsorption** of substances and water in tubules and collecting ducts
3) **Secretion** of substances from blood into proximal and distal tubules

Nephron – morphological and functional unite of the kidney



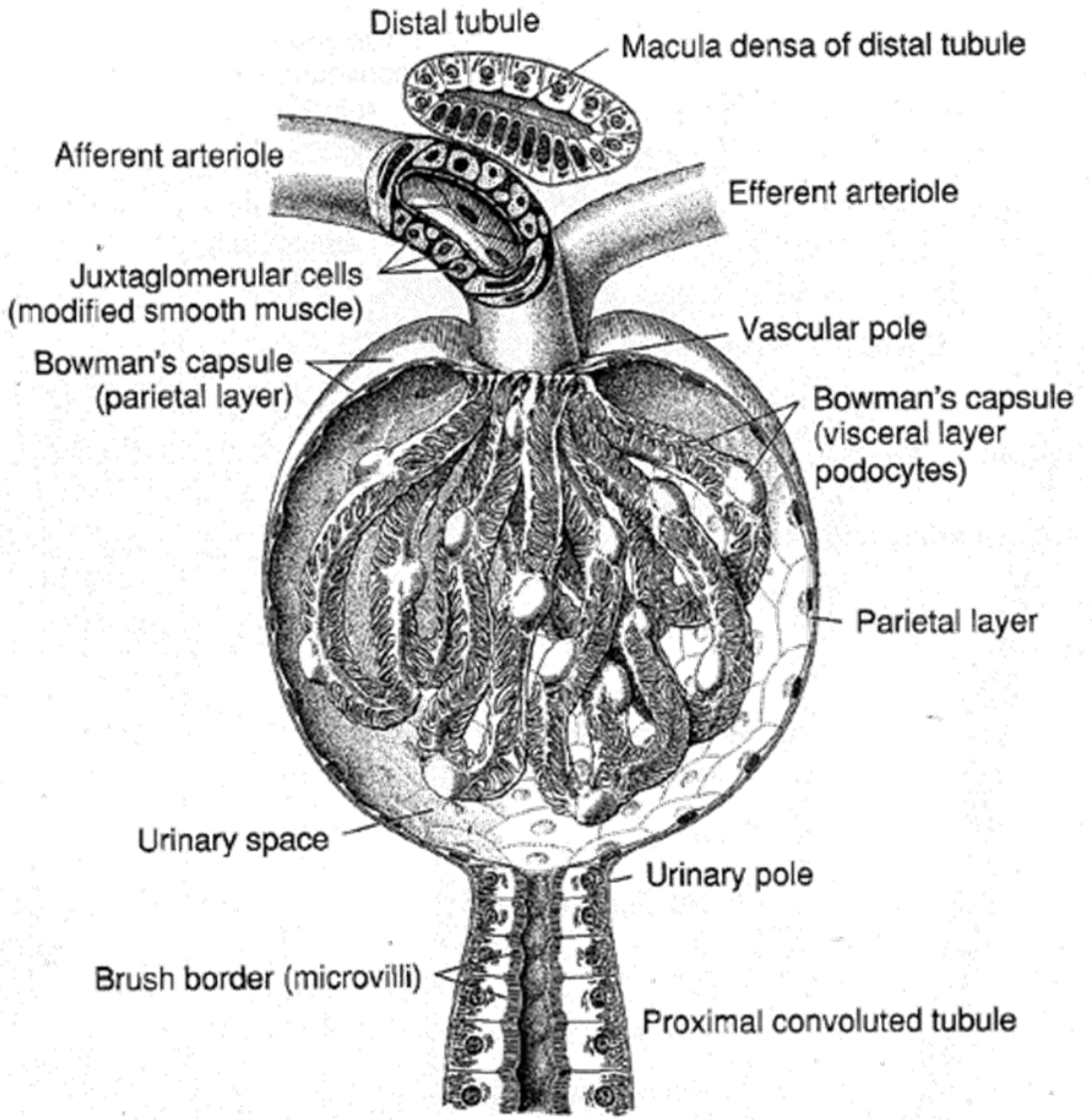


(From Thibodeau GA, Patton KT: *Anatomy & physiology,* ed 5, St Louis, 2003, Mosby.)

In glomerulus

- different diameter of afferent and efferent arterioles creates pressure between them and provides filtration

- Bowman`s capsule is a an extended blind end of the tubule



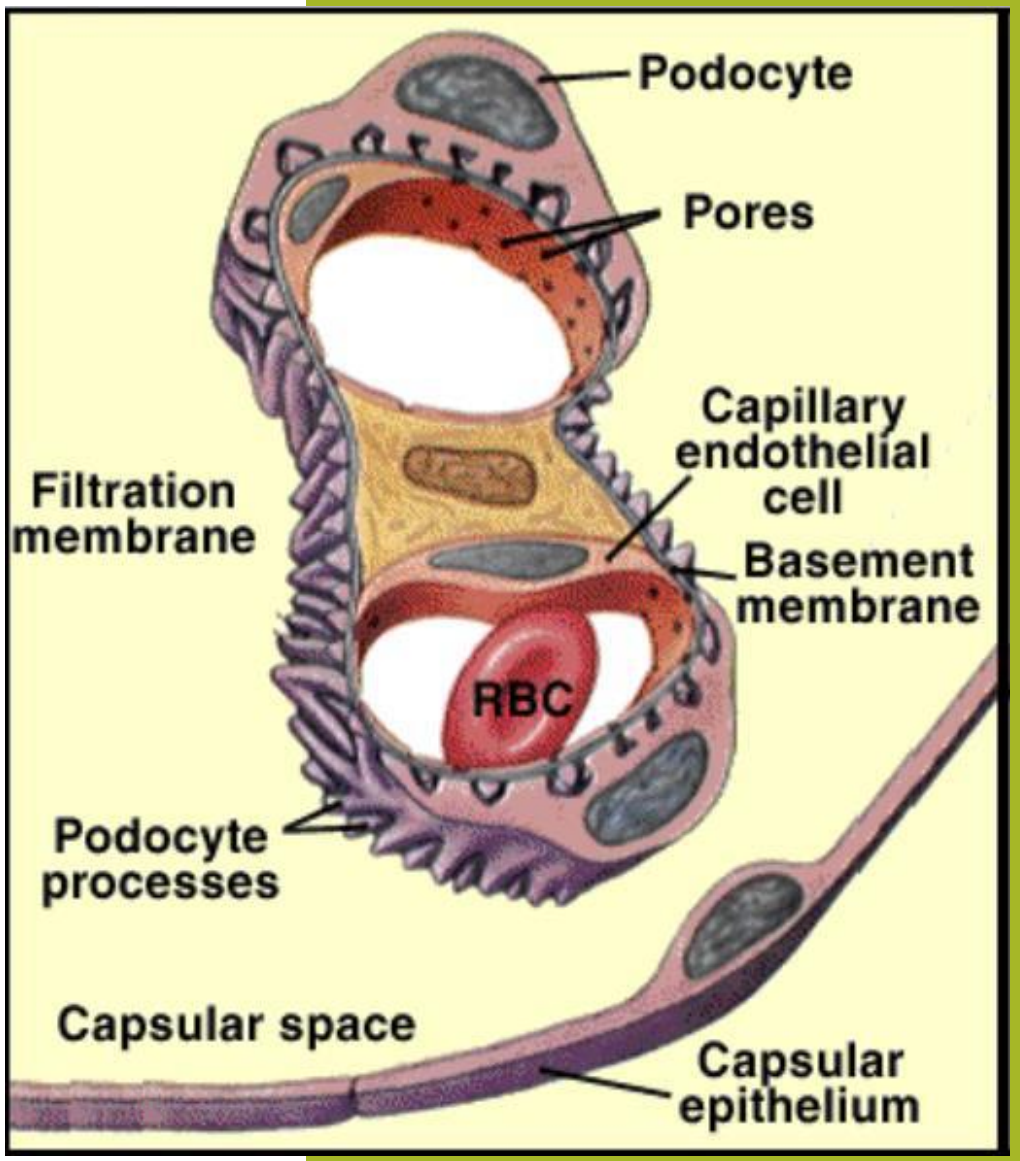
- endothelium of the glomerulus is fenestrated (with pores):

- - basal memebrane
- - podocytes (with pores)

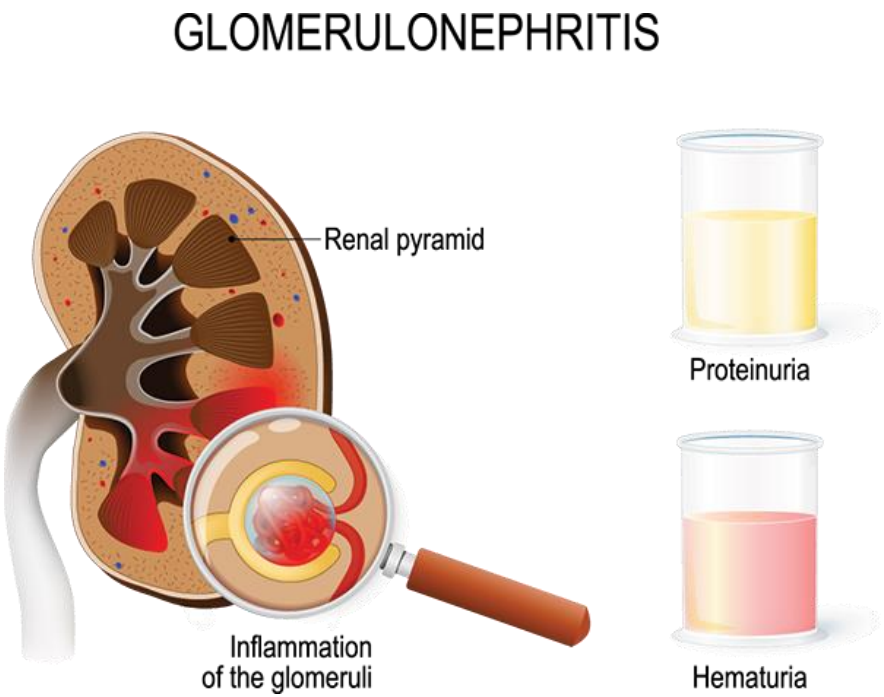
Result of filtration – **primary urine**, 170 L per day

Primary urine – is an ultrafiltrate of blood:

- - water
- - salts
- - glucose
- - small proteins (less than 30kDa)
- - other small water-soluble substances

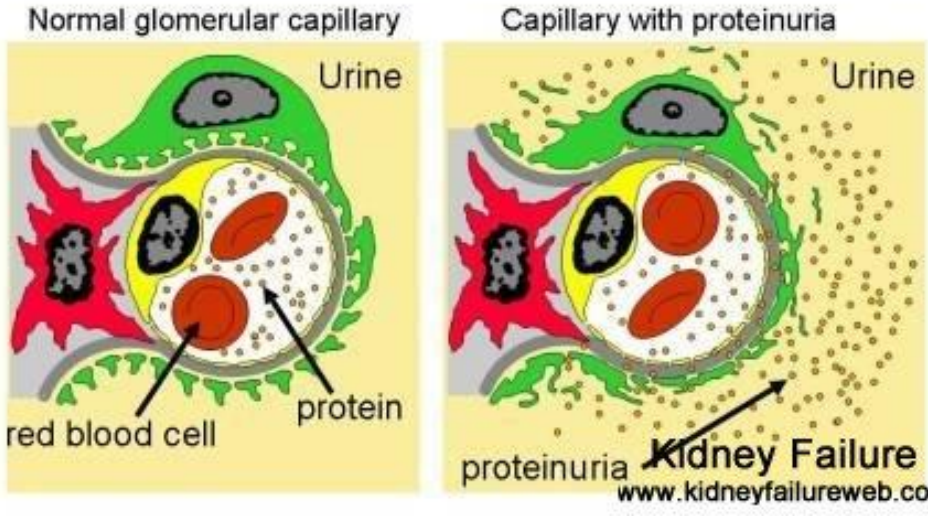


Glomerular filtration rate is destroyed



- by **glomerulonephritis** - in urine appear:
  - Proteins – *proteinuria*
  - Erythrocytes – *hematuria*

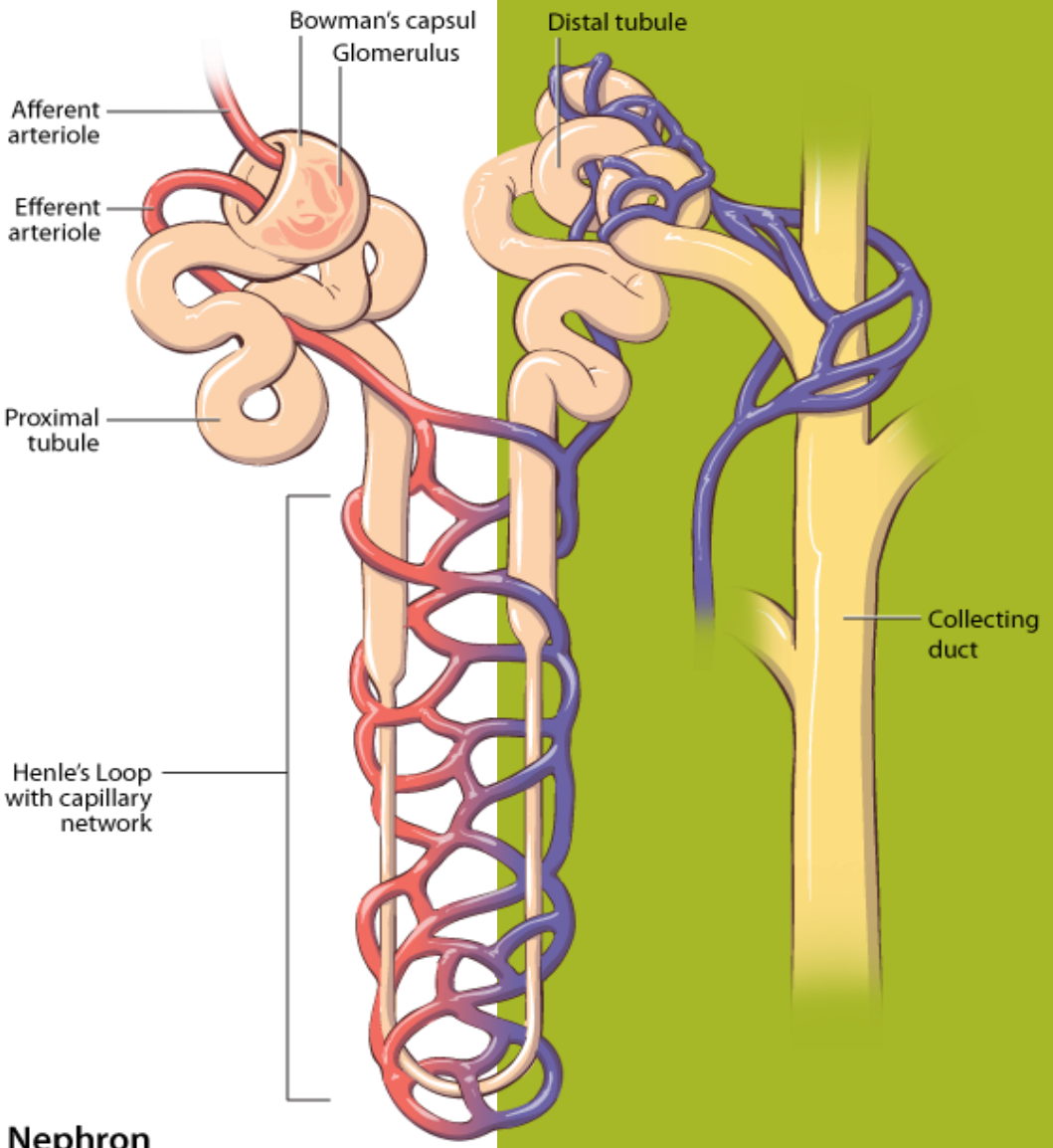
- by **decreased systolic blood pressure**:
  - less then 80mm Hg – *olyguria*
  - less then 60mm Hg – *anuria*



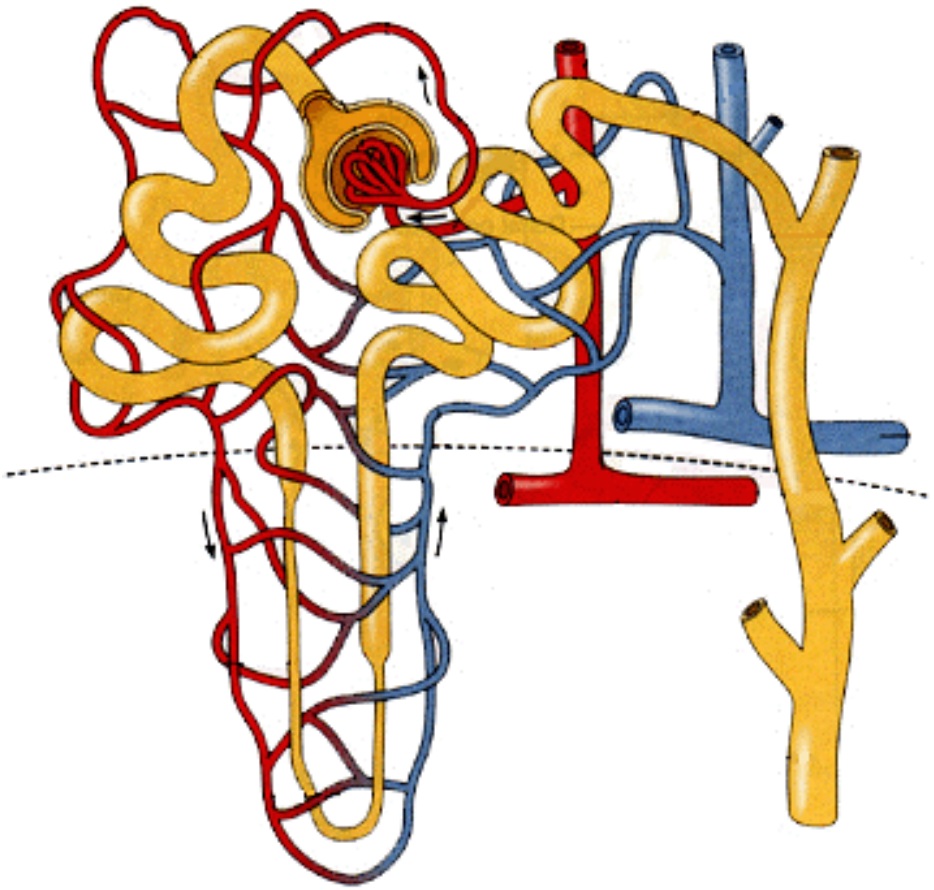
In proximal (85%) and distal tubules and Henle`s loop

- reabsorption of water, salts, glucose, amino acids, proteins and other components into blood (secondary capillary network of vas efference)

- H2O follows Na+



Where is it all reabsorbed?
– into **secondary capillary network**

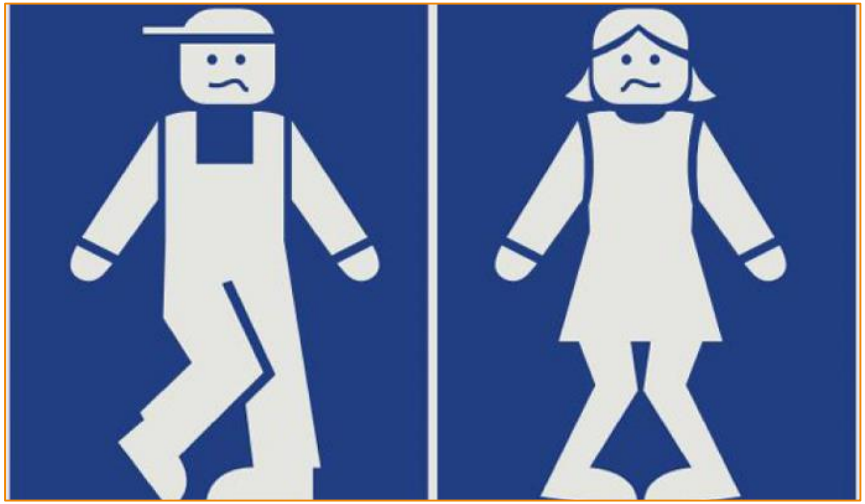


Rete mirabile*= *arteriole *(afferent)*- ***capillary*** *(glomerulus)*-***arteriole*** *(efferent)*-***peritubular capillary*** *(secondary network)*-***venule***

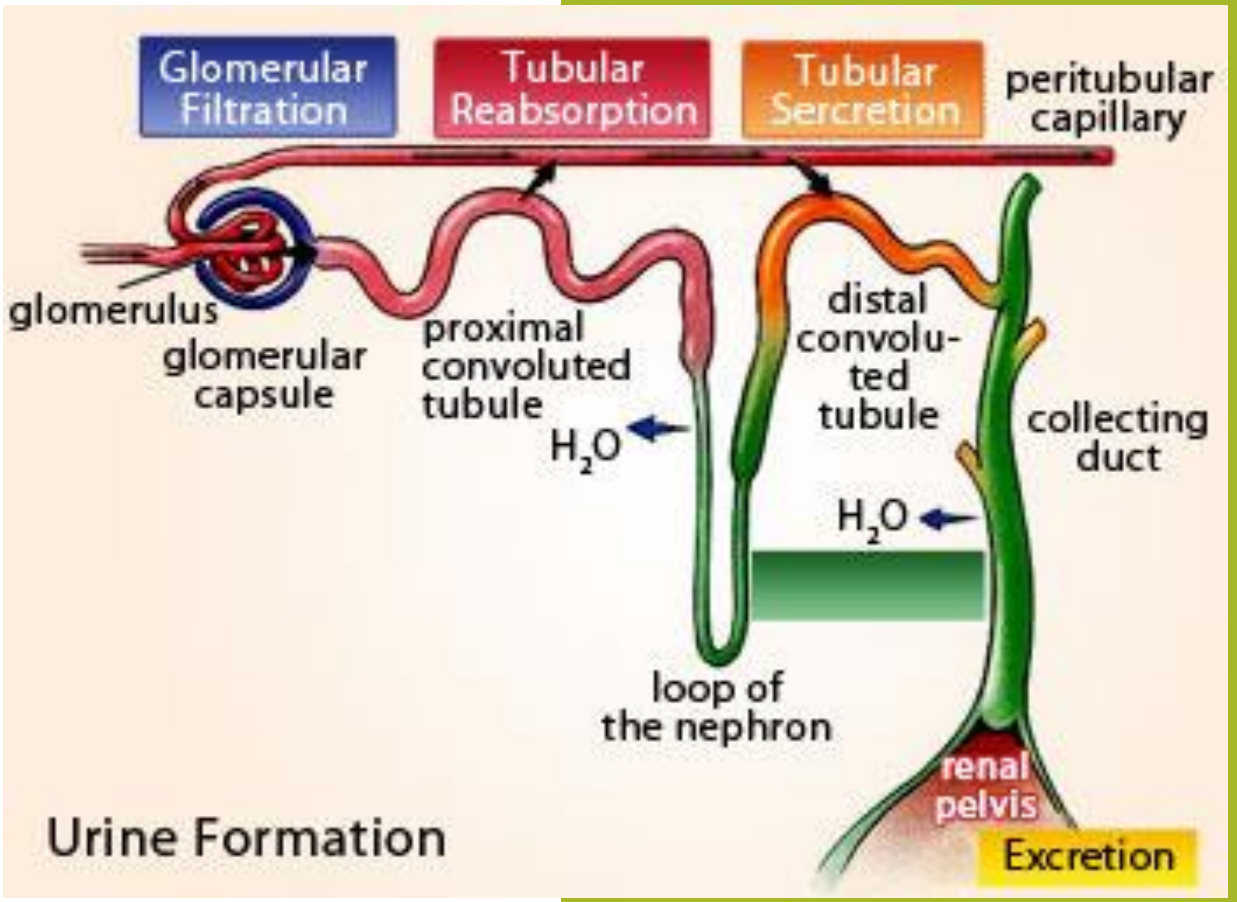
Reabsorption is destroyed

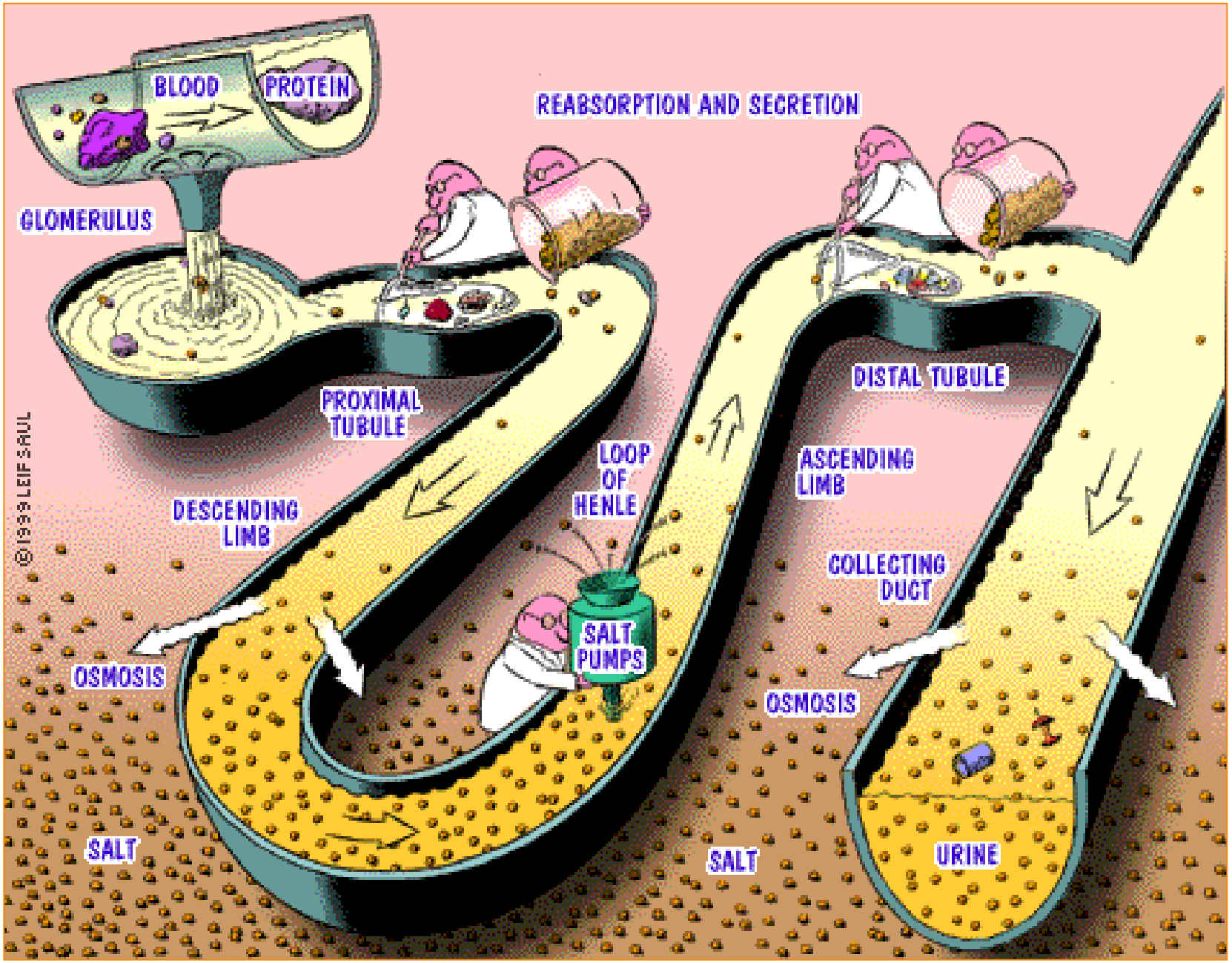
- lesion of tubules and collecting ducts (pyelonephritis, interstitial nephritis, congenital pathology of the tubules)

- Urine:
- contain not reabsorbed substances (small proteins)
- increased volume (*polyuria*) and low concentration (low urine specific gravity - *hypostenuria*)

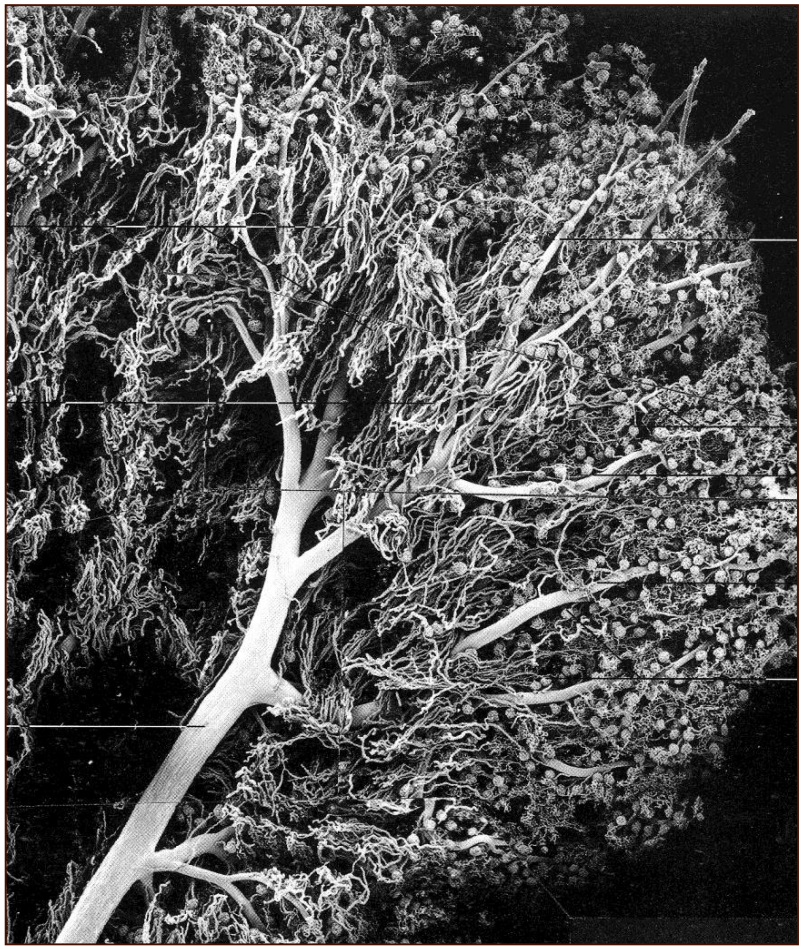


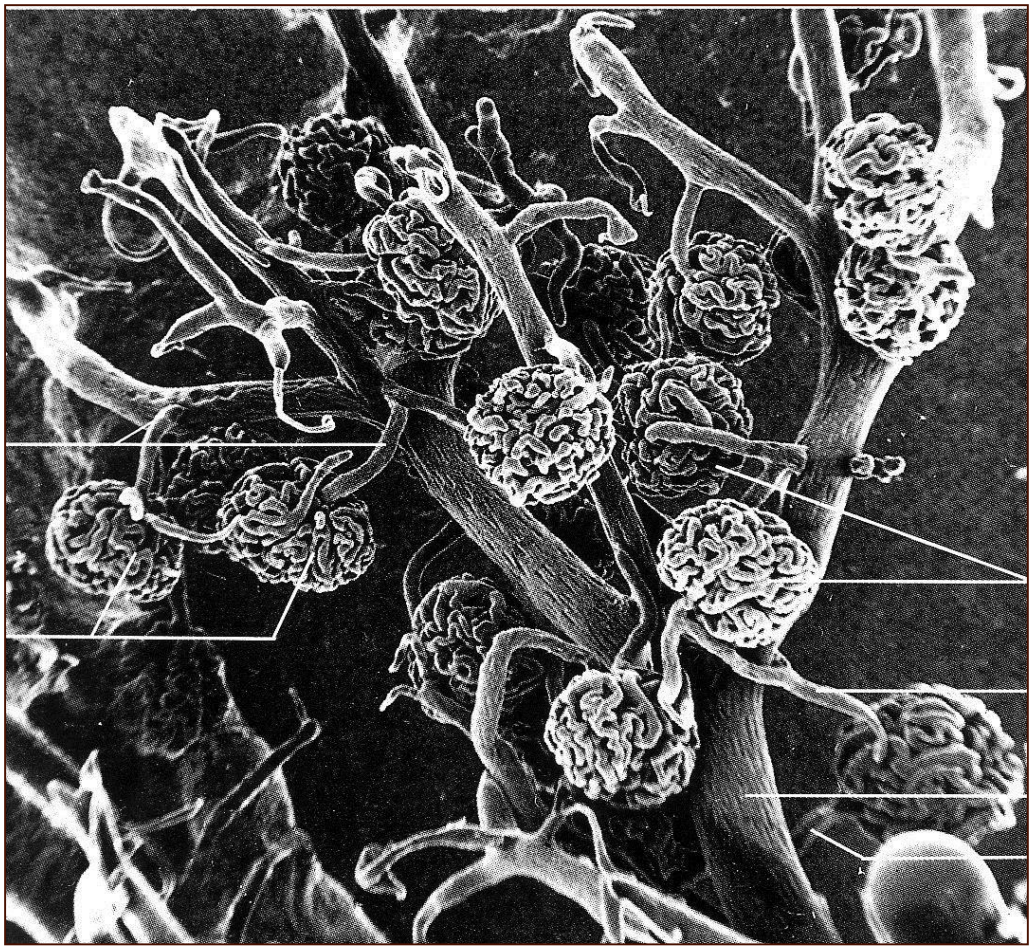
- Some substances (bilirubin, potassium ions, hydrogen, creatinine, histamine, xenobiotic and others) are excreted into the tubules by secretion

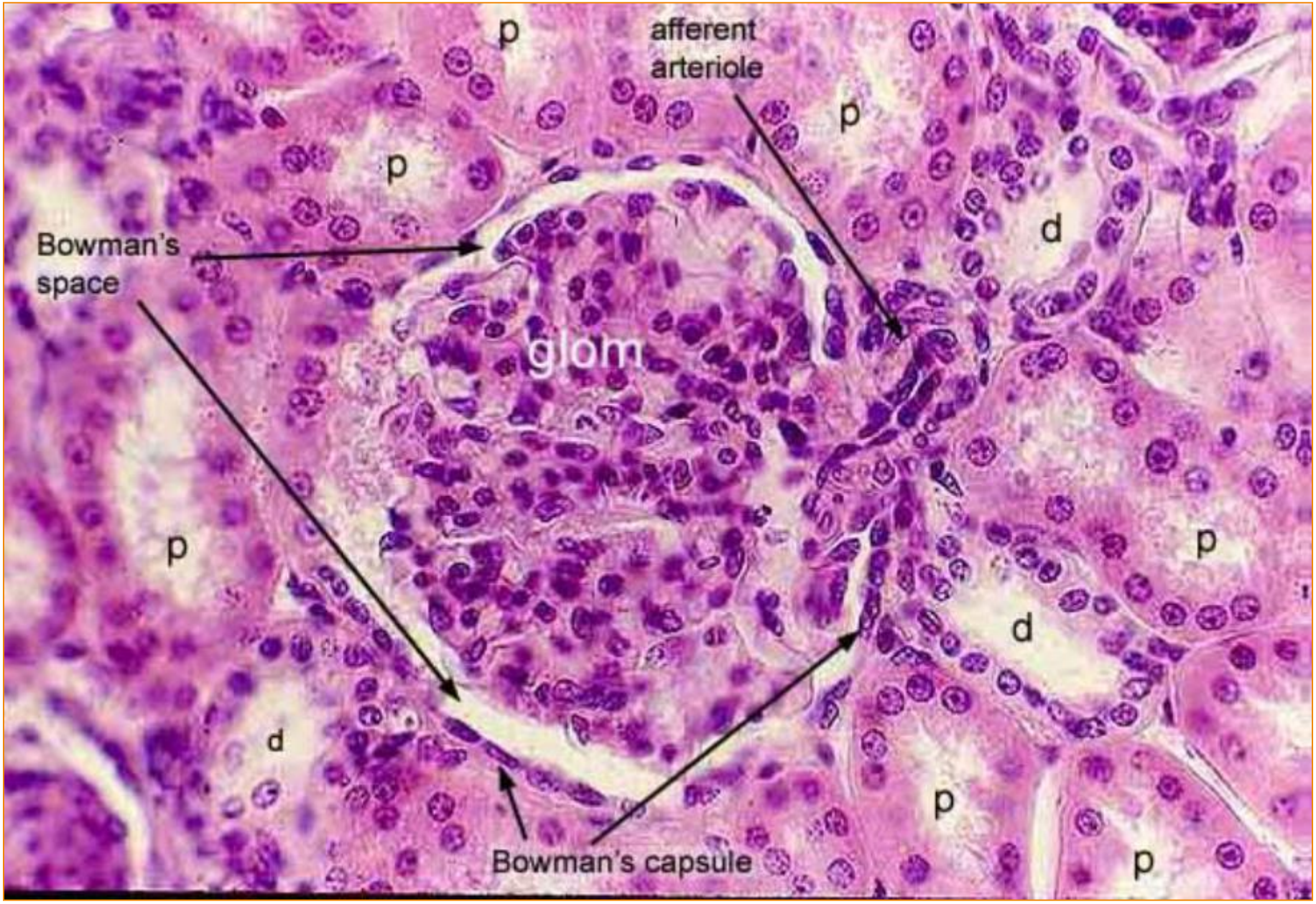



BLOOD
PROTEIN
REABSORPTION AND SECRETION
GLOMERULUS
PROXIMAL TUBULE
DISTAL TUBULE
LOOP OF HENLE
ASCENDING LIMB
DESCENDING LIMB
COLLECTING DUCT
SALT PUMPS
OSMOSIS
OSMOSIS
SALT
SALT
URINE
©1999 LEIF SAUL

Nephron






p
afferent
arteriole
p
p
d
Bowman's
space
glom
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Bowman's capsule
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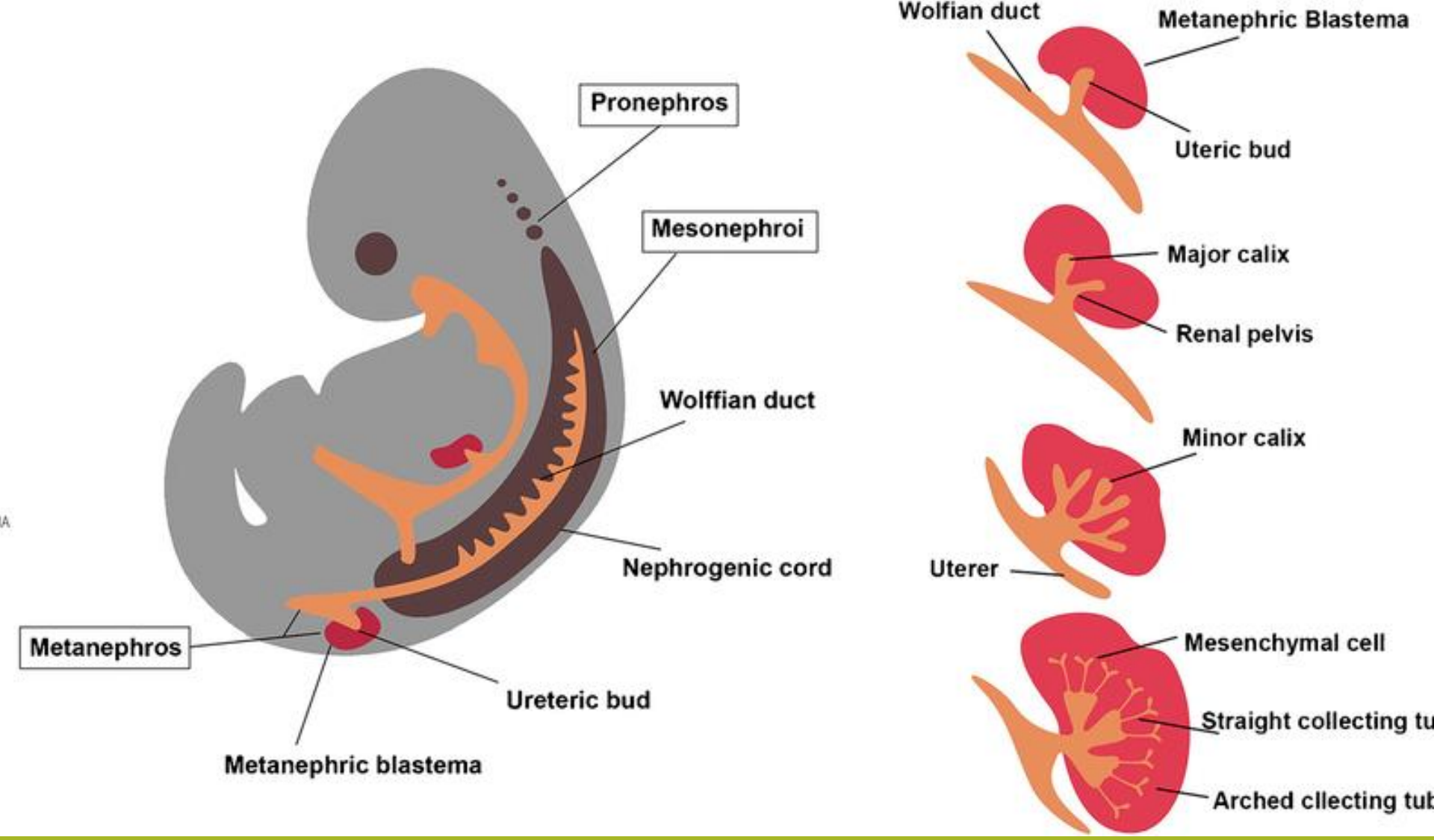
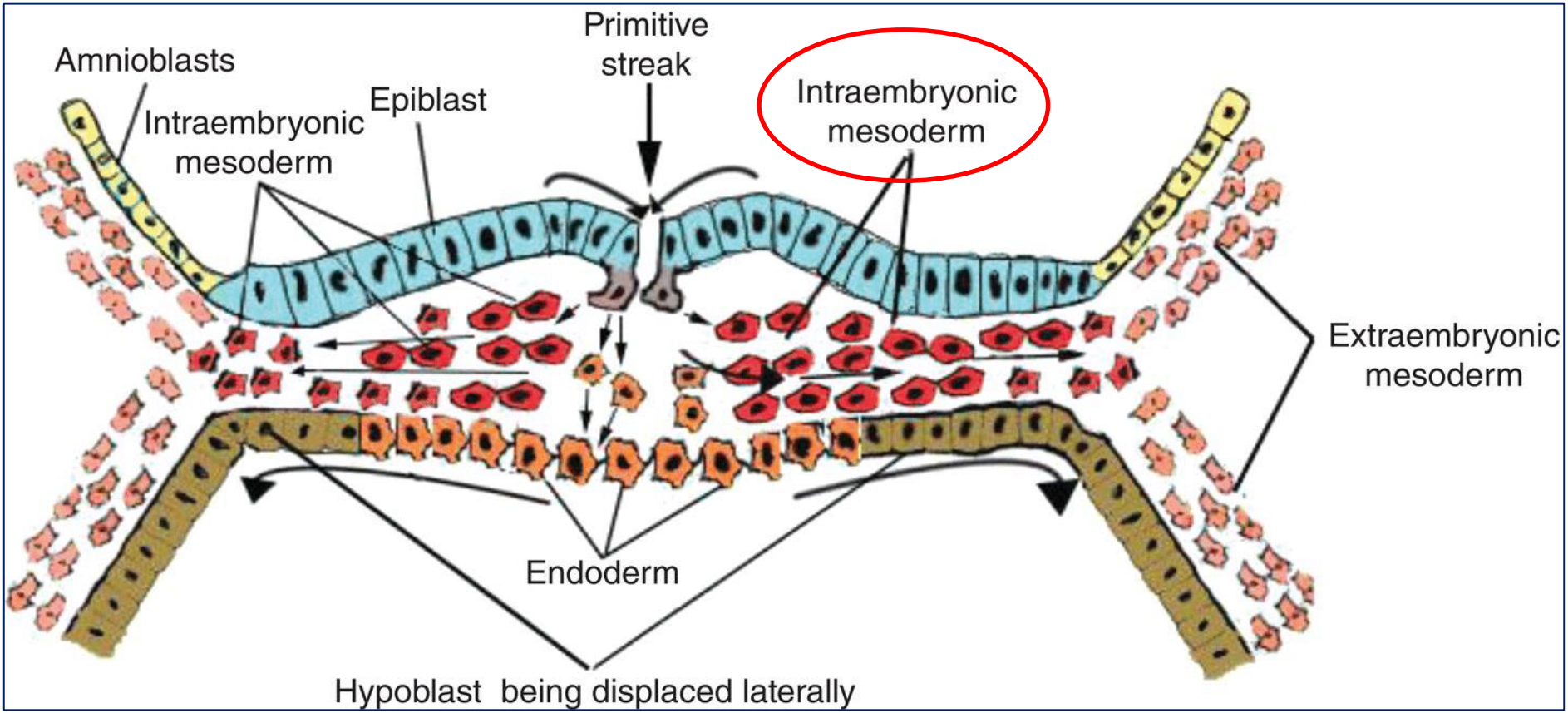
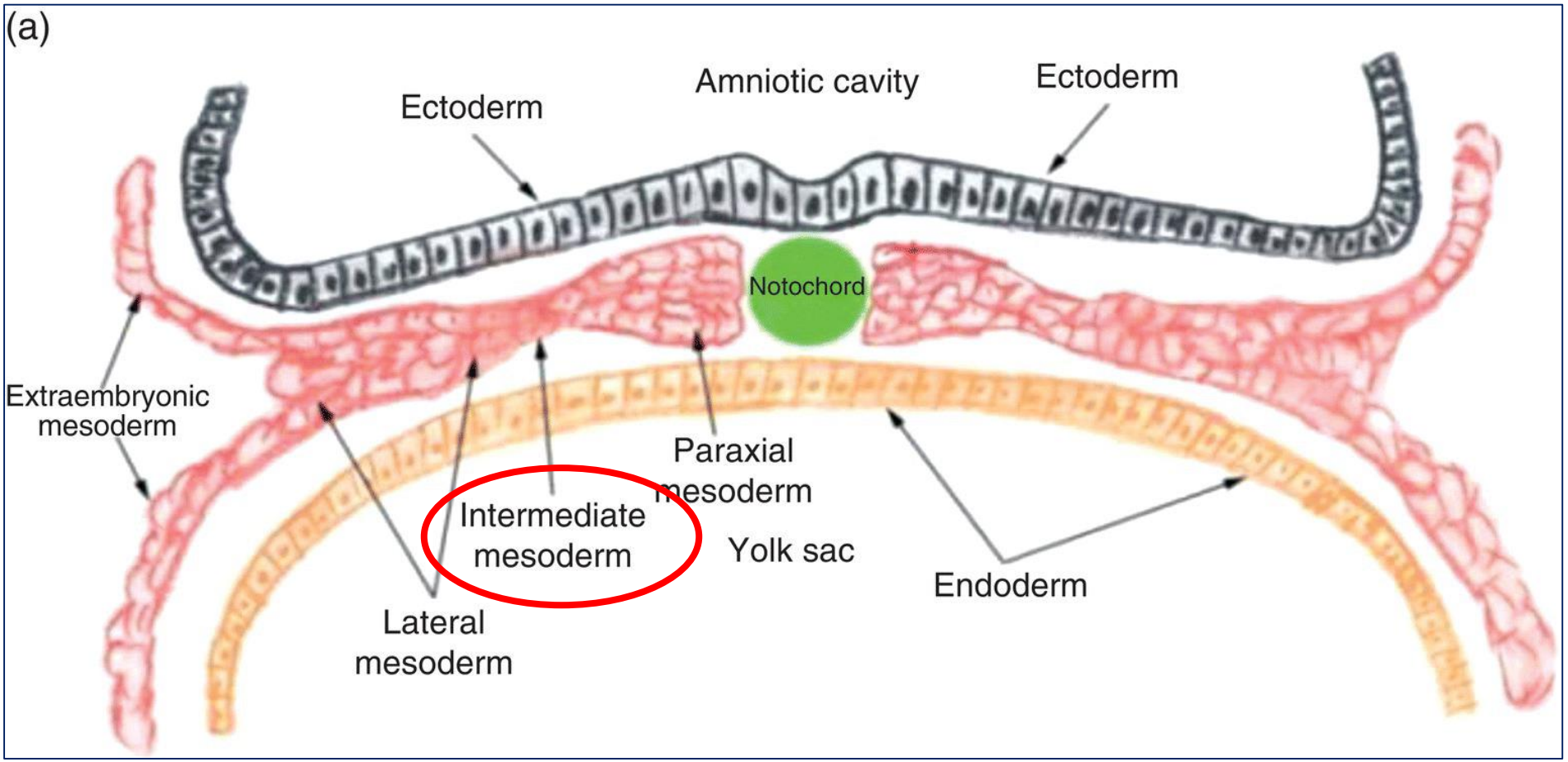


Development of Urinary System

Development of the kidney



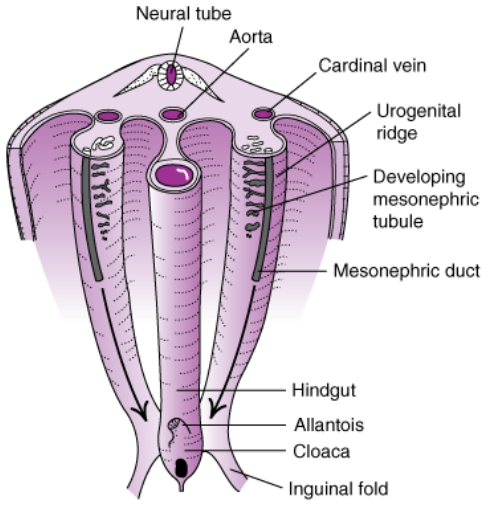


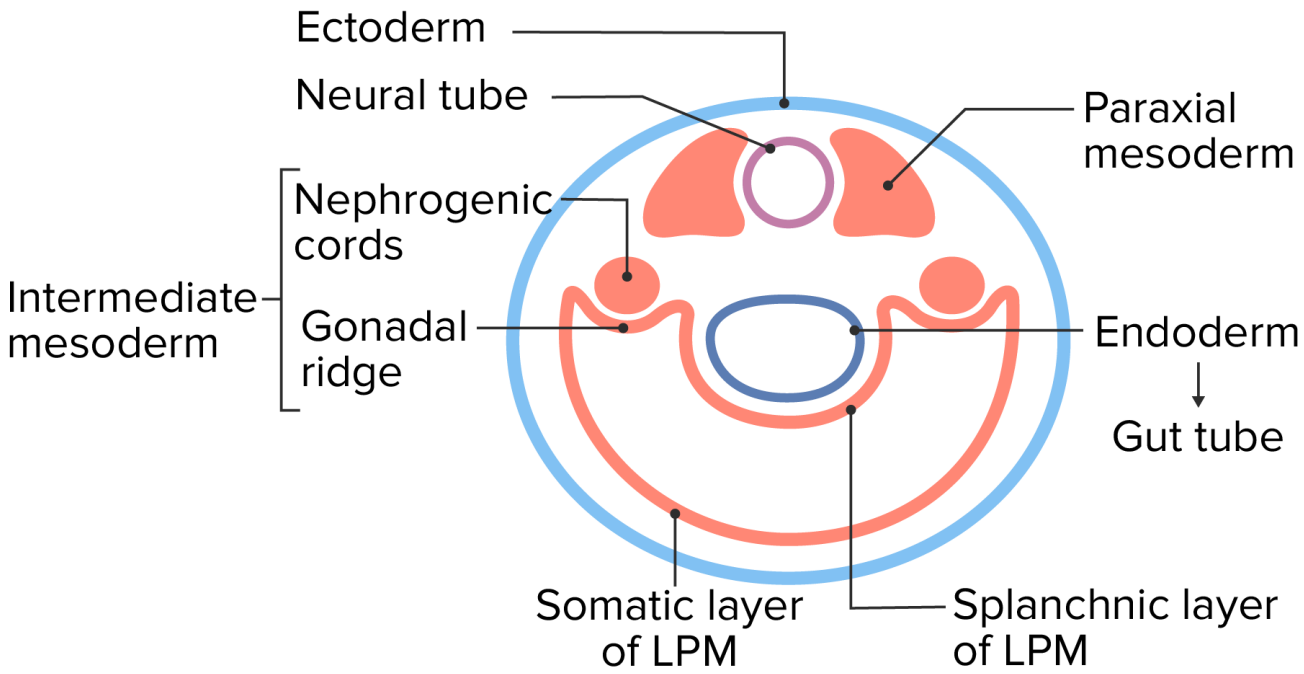
Intraembryonic mesoderm plates:

- *Paraxial (dorsal) mesoderm* – axial skeleton (somites)
- *Intermediate mesoderm* – urogenital apparatus
- *Lateral mesoderm (somatic and splanchnic)* – appendicular skeleton and internal organs

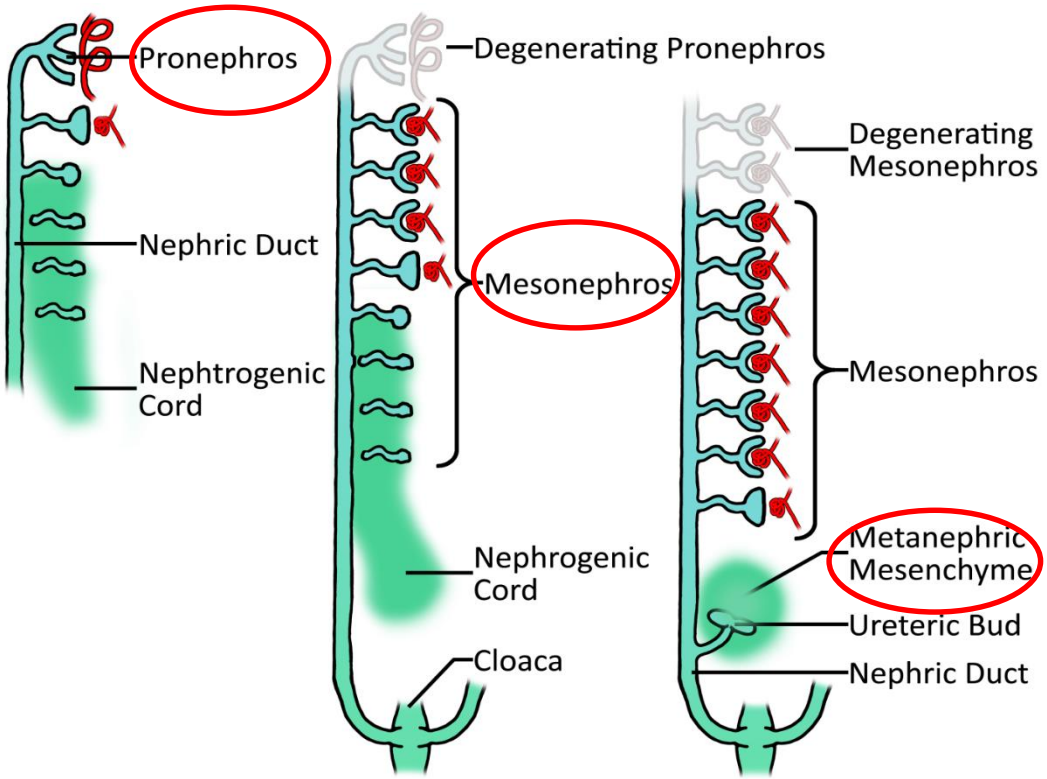
Urogenital ridge and nephrogenic cord formation

- The intermediate mesoderm forms a longitudinal elevation along the dorsal body wall – the urogenital ridge.
- Part of the urogenital ridge forms the nephrogenic cord – give rise to the urinary system





LPM = lateral plate mesoderm

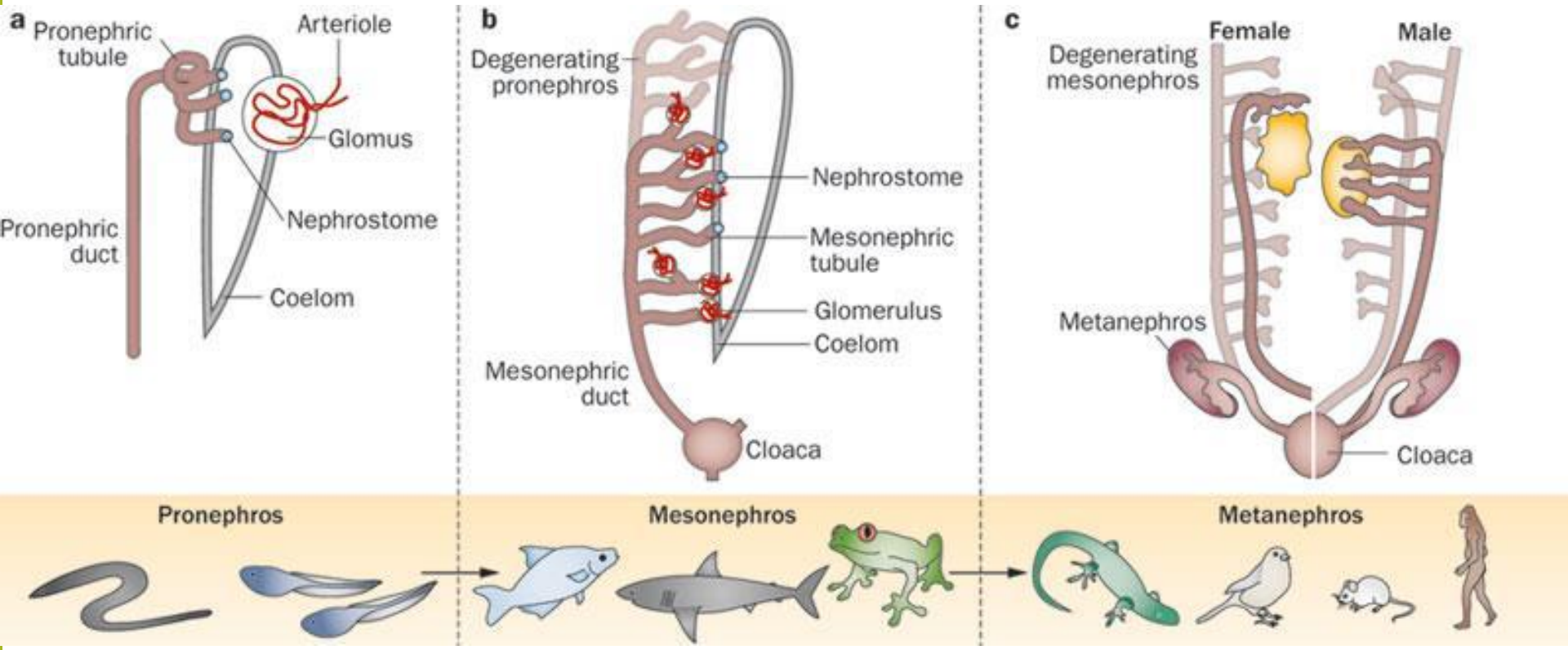


1) ***Pronephros*** (forekidney)

2) **Mesonephros** (primary kidney)

3) **Metanephros** (hind kidney)

- form in cranial to caudal sequence

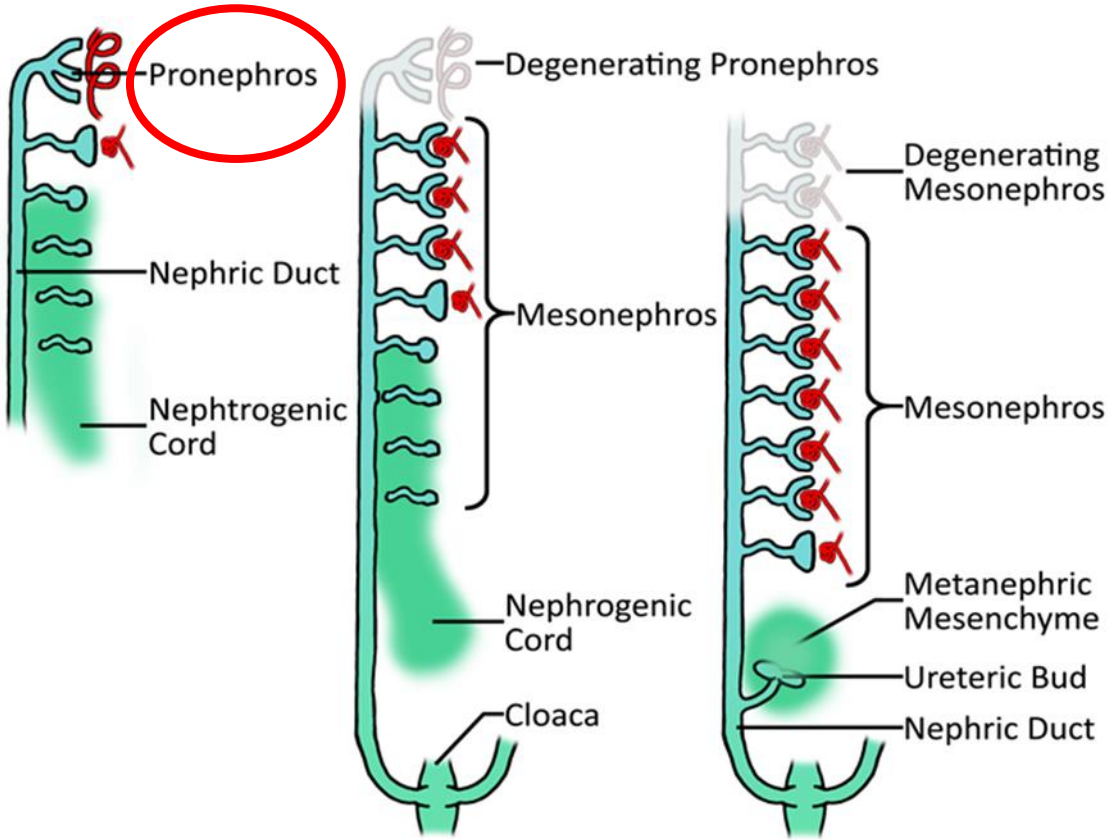


- Ancient fish
- Amphibian larvae

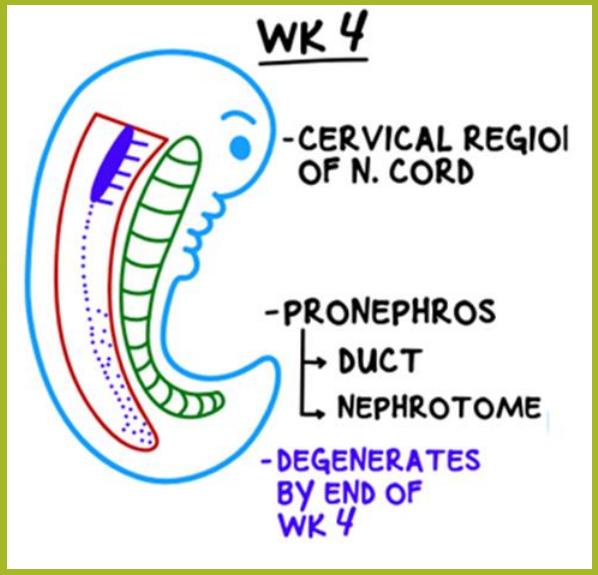
- Fishes
- Amphibia

- Mammals
- Human

Pronephros



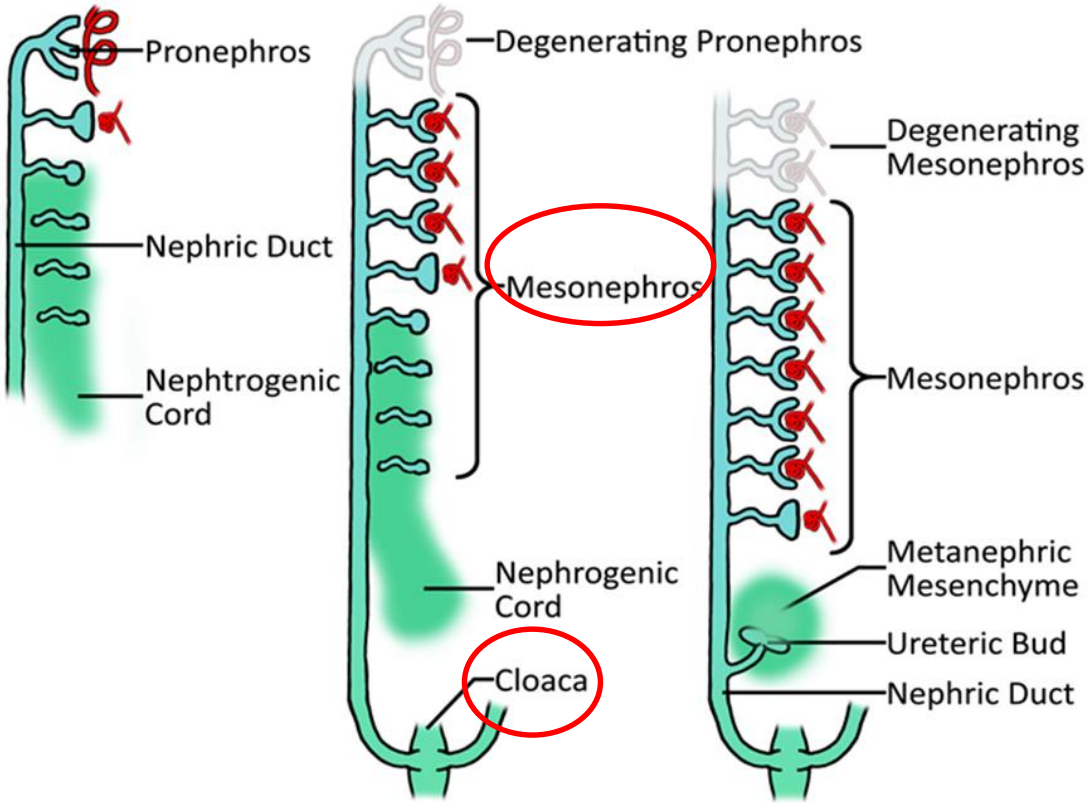
- **Pronephros starts digressing** and degenerate by the end of week 4. The purpose is unknown.
- ✓ It could be important because it helps providing a structure that the next part from the nephrogenic cord derives



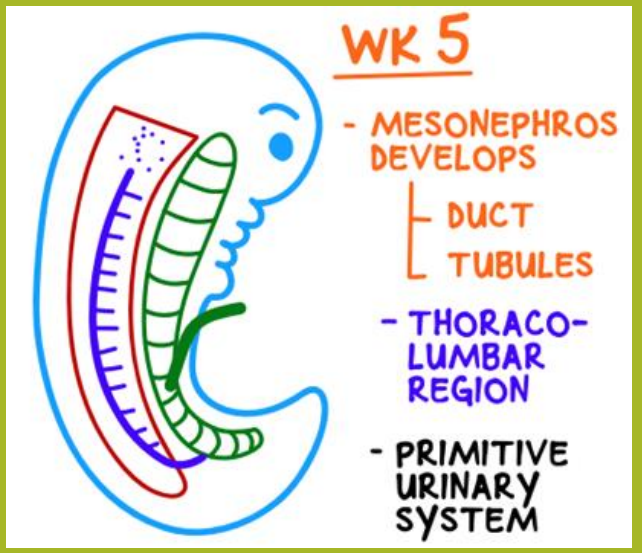
- -**Pronephros** develops in the Cervical region of the nephrogenic cord.
- Pronephros is made out of 2 parts:
  - Duct
  - Little tubules that form in front of it called **nephrotome**
- several glomuses, not connected with pronephric tubules
- no organized glomerules

Mesonephros

(Wolffian body)



- Mesonephros is going to become **primitive urinary system**
  Mesonephric duct is **connected with cloaca** → cloaca become bladder and the urethra

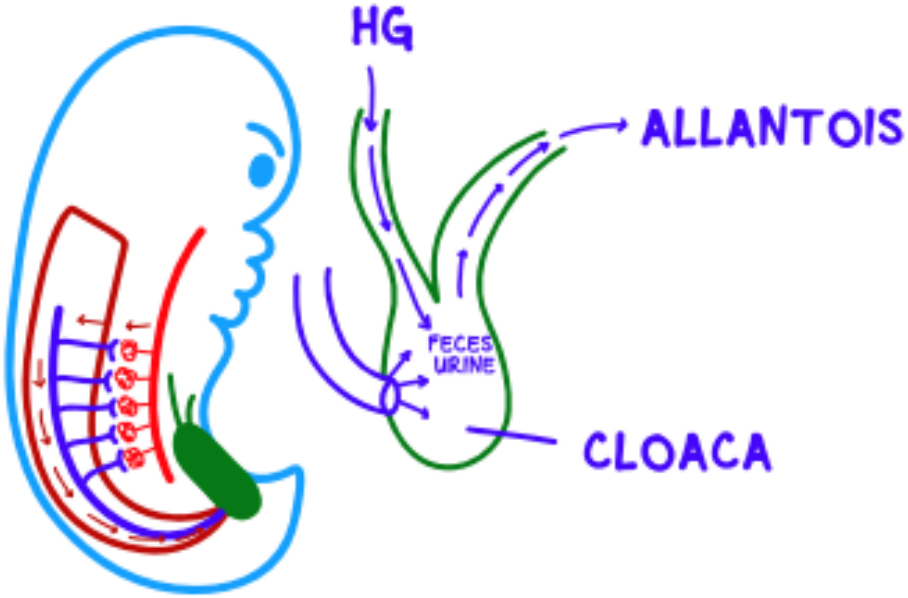


- **Mesonephros** develops at the week 5
- Extends from the **thoracic region** to the **lumbar region** and connects with the cloaca

- Mesonephros components
  - Mesonephric duct
  - Mesonephric tubules (comes off mesonephric duct)

Mesonephros and cloaca

Mesonephros → mesonephric duct connecting to the cloaca



Primitive urinary system makes urine from about week 5 → week 10

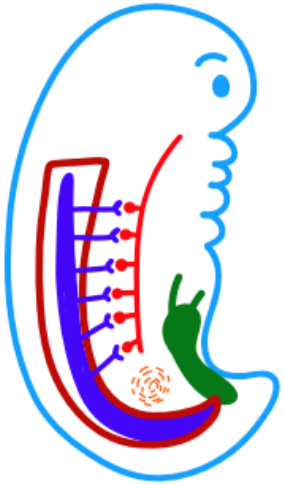
- Mesonephric duct is connected with cloaca → cloaca become bladder and the urethra
- Kidney and ureter will connect to the bladder and urethra

<u>Cloaca has two things</u>

- Mesonephric duct is dumping primitive urine → to the cloaca
- **Hindgut** is making poop → to the cloaca
- Draining these two structures to the **allantois**

Metanephros

Forms in pelvic region



PRIMITIVE URINARY SYSTEM
- WK 5 → WK 10
- MESONEPHROS

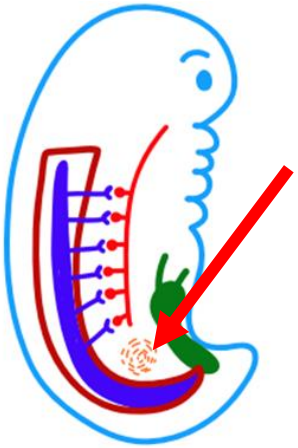
METANEPHRIC MESODERM
- BLASTEMA
- PELVIC REGION

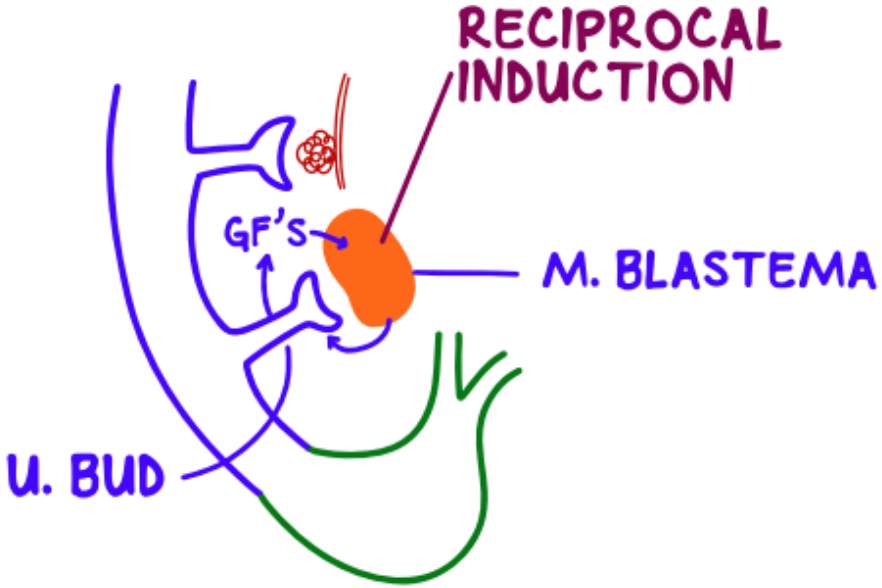
- Primitive urinary system makes urine from about week 5 → week 10
- In the pelvic region, some **intermediate mesoderm** starts of condensing in front of mesonephric duct →

Metanephric mesoderm / metanephric blastema

Metanephros

(1) Metanephric blastema





Mesenteric blastema starts releasing growth factors and stimulate the **mesonephric duct**

- It will make a little bud → **ureteric bud**
- Ureteric bud will eventually make ureter (collecting system).

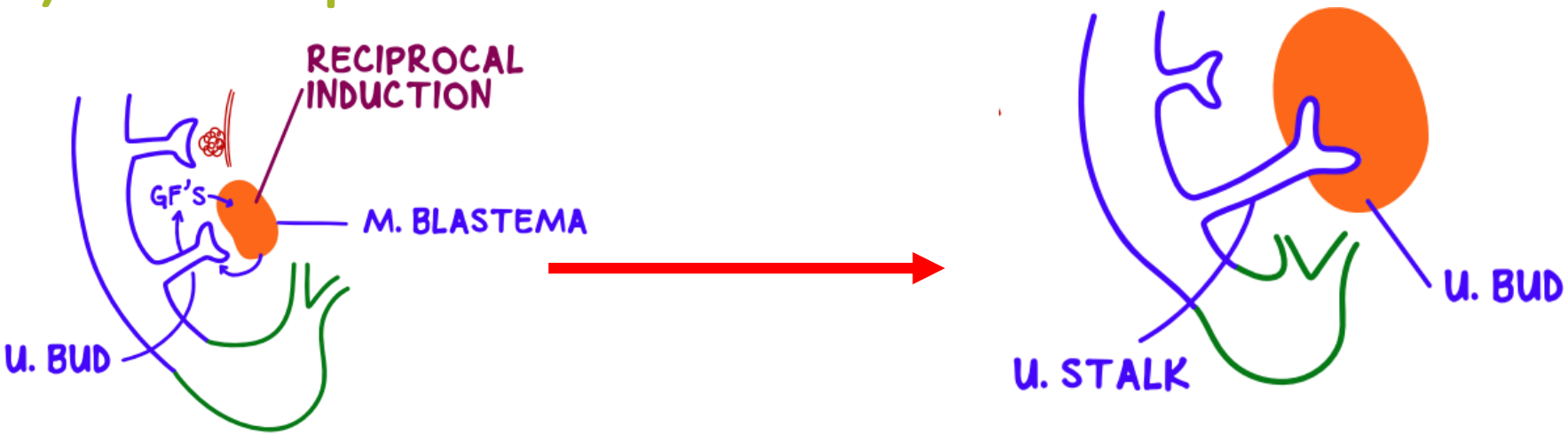
<u>Ureteric bud starts releasing more growth factors</u>

✓ Stimulate metanephric blastema to grow bigger

Two-way interaction between these two structures → **reciprocal induction**

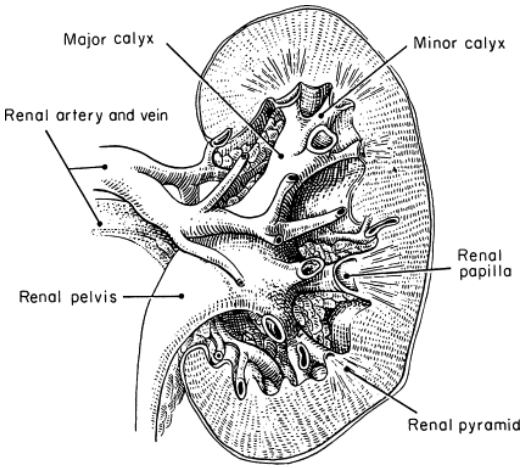
Metanephros

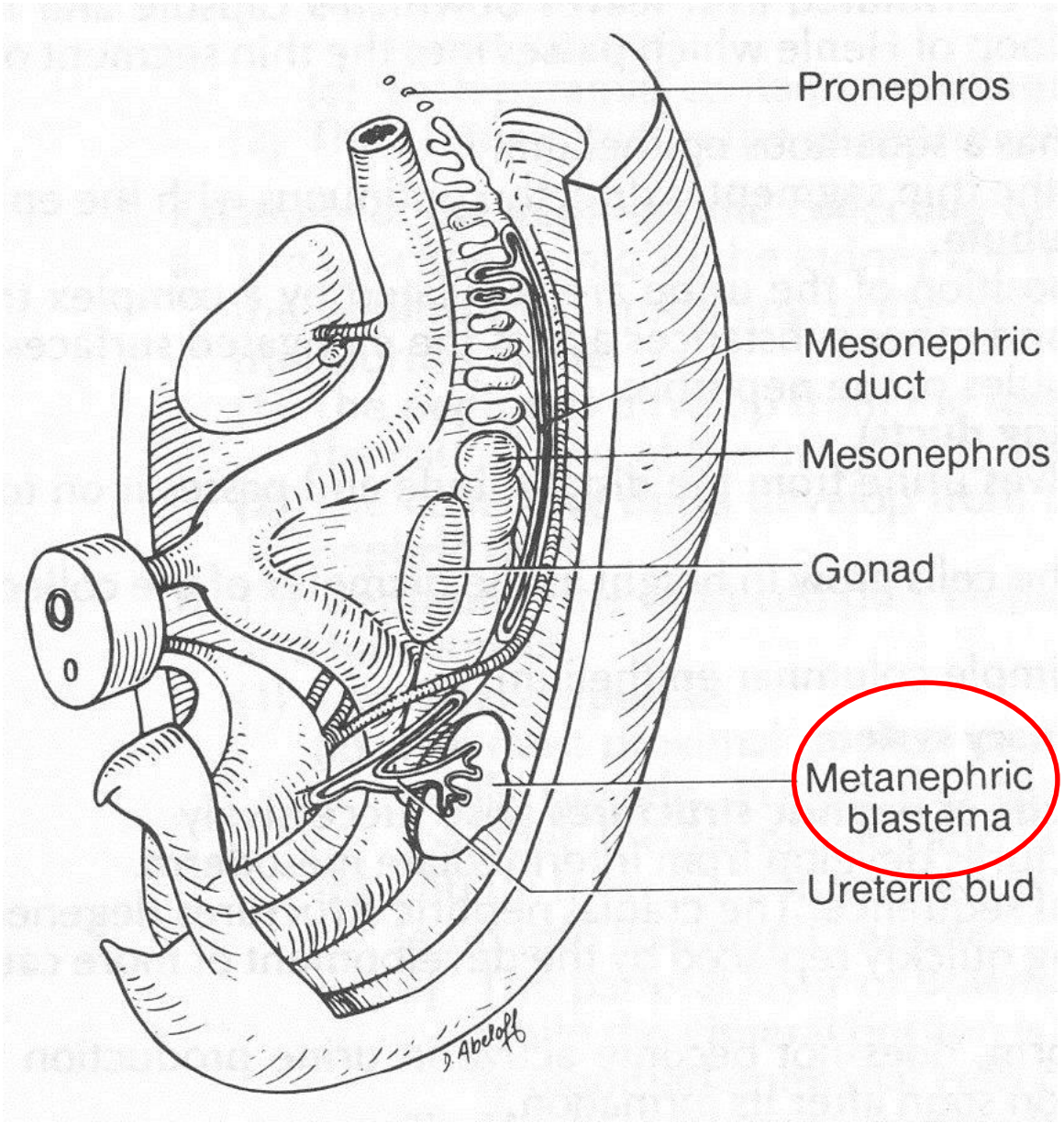
(1) Metanephric blastema



- Ureteric bud grows and creates a nice stalk → **ureteric stalk**
- Ureteric bud invades (grows inward into) the metanephric blastema

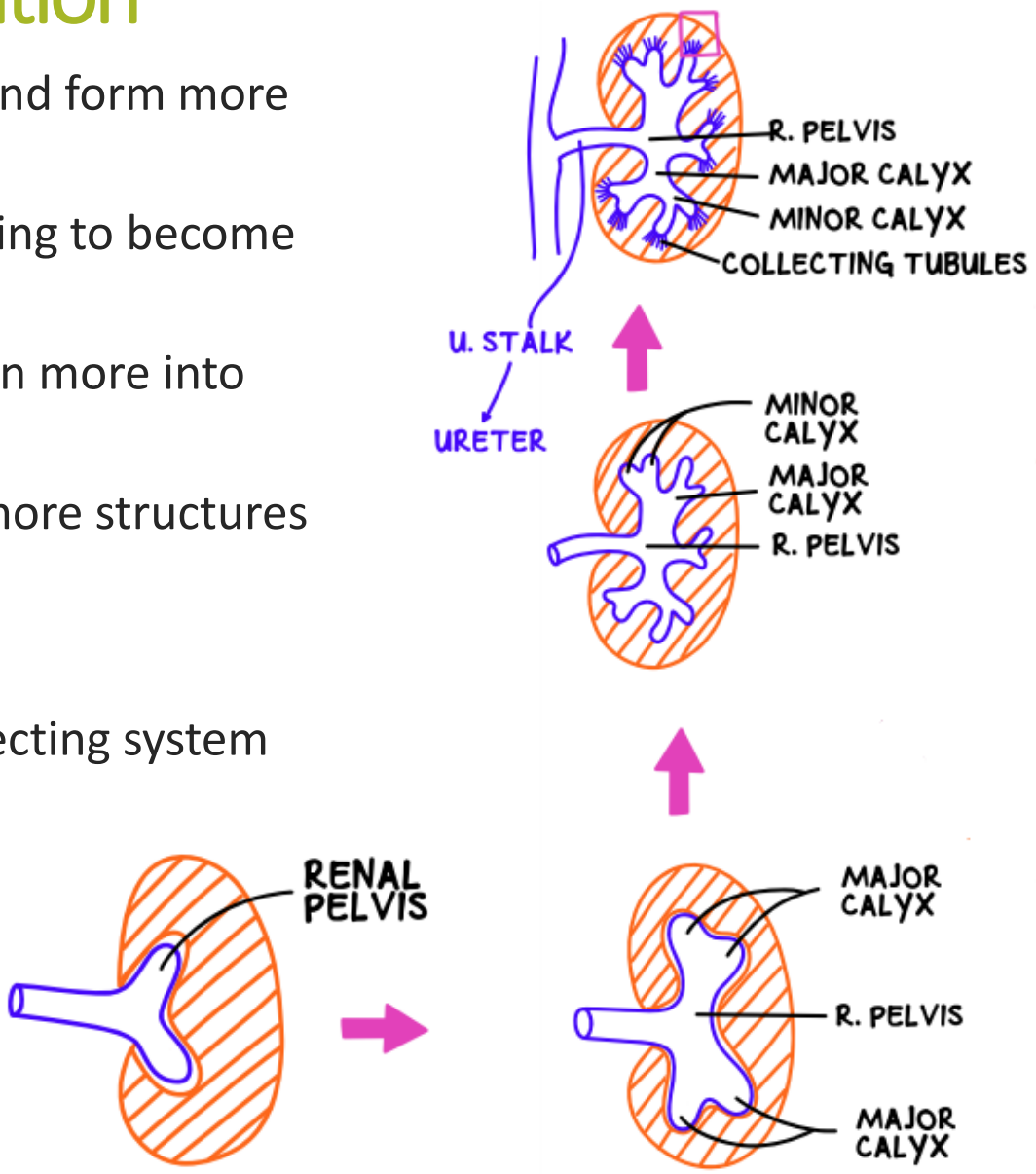
It creates a big tubular structure called **renal pelvis**



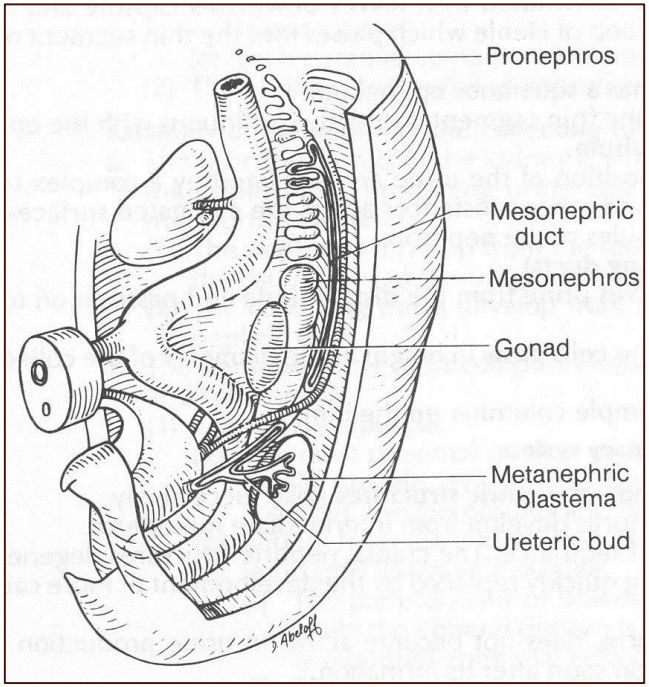

Pronephros
Mesonephric duct
Mesonephros
Gonad
Metanephric blastema
Ureteric bud
D. Abeloff

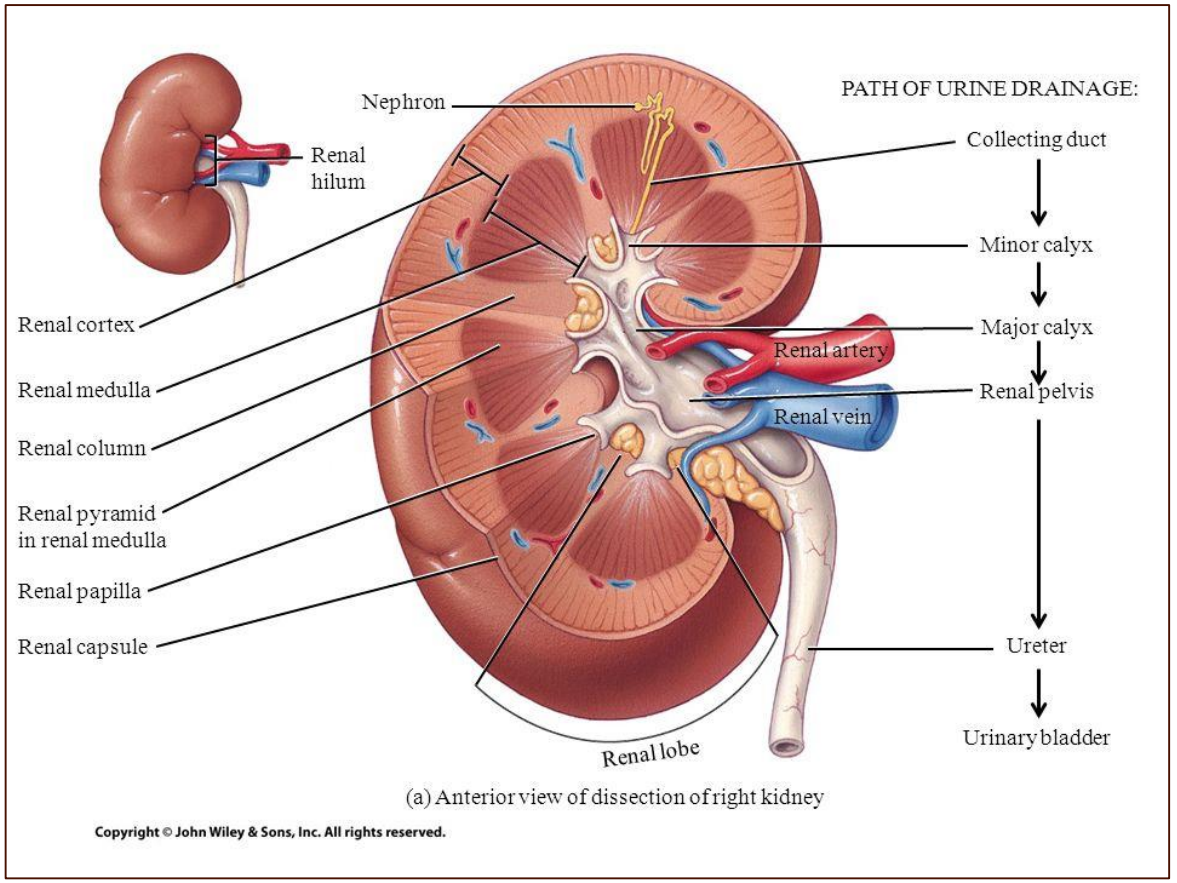
Metanephros
(2) Renal pelvis formation

- **Renal pelvis** is going to bifurcate and form more structure
- It grows some little knobby are going to become **major calyx**
- Growth of major calyx will bud even more into **minor calyx**
- Minor calyx will keep on growing more structures → **collecting tubules**
- Ureteric stalk becomes **ureter**
- Basically, we formed all of the collecting system for the urinary system



Metanephros is still continuing to become our urinary system

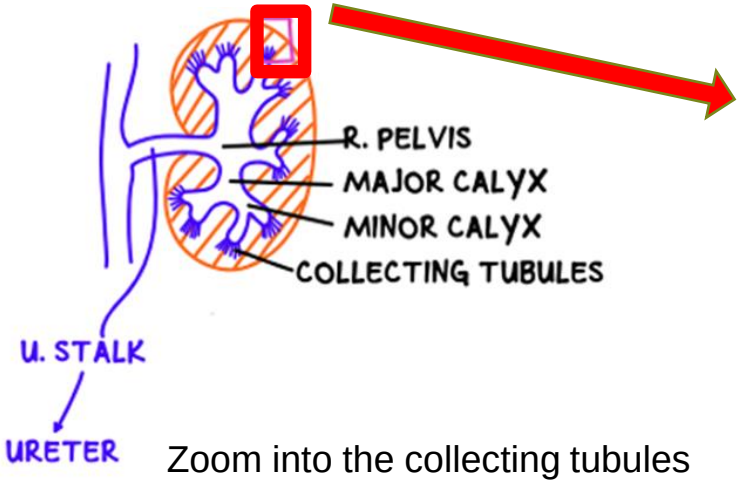




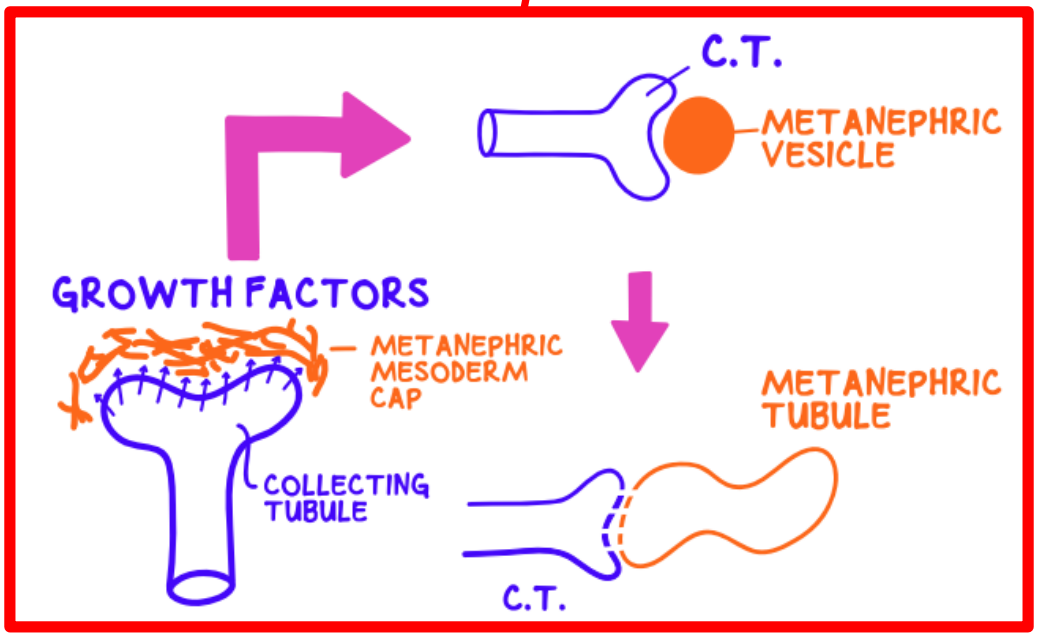
Ureteric bud gives rise to the urine-collecting elements:

1) Collecting tubules within the kidney
2) Papillary ducts
3) Major and minor calyces
4) Ureter

Metanephric mesoderm cap development



Zoom into the collecting tubules and metanephric mesoderm around it



Metanephric capping the collecting tubule

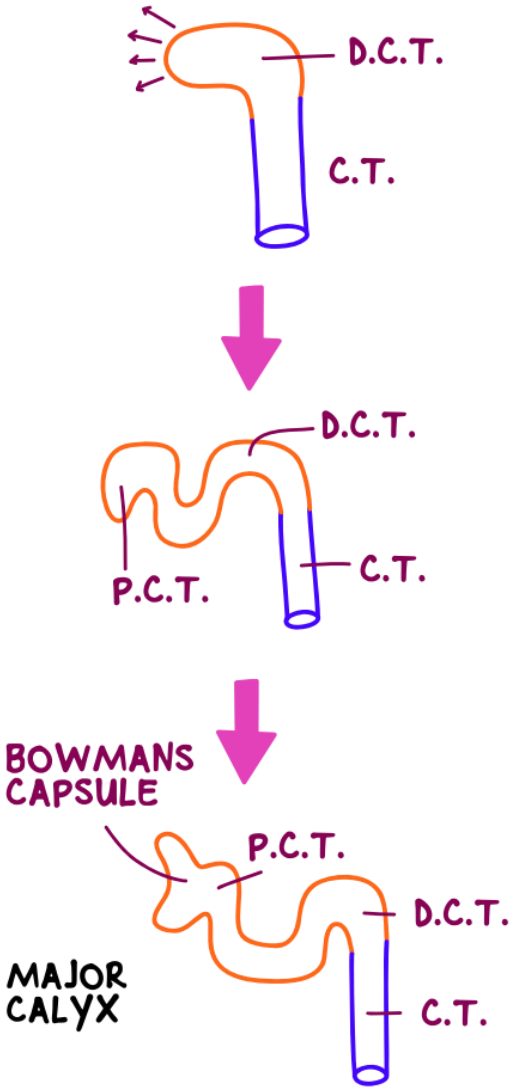
- Becomes **metanephric mesoderm cap**
  Cells of the collecting tubule starts secreting growth factors

- Influencing metanephric mesoderm cap
- Causes proliferation and condensing of metanephric mesoderm cap
- Metanephric mesoderm cap → **metanephric vesicle**
- Continuous release of growth factor
- **Metanephric vesicle** starts kind of becoming S-shaped (coiled) → **metanephric tubule**

https://ninjanerd.org

Metanephros

(3) Collecting tubules



We're going to have connection between collecting tubule and metanephric tubule

- ✓ **Metanephric tubule** becomes **distal convoluted tubule (DCT)**

- ✓ We have proximal convoluted tubule (PCT)
- ✓ It starts to make cup shaped called **Bowman's capsule**

Very similar to mesonephric tubules

Metanephros

(4) Kidney's migration

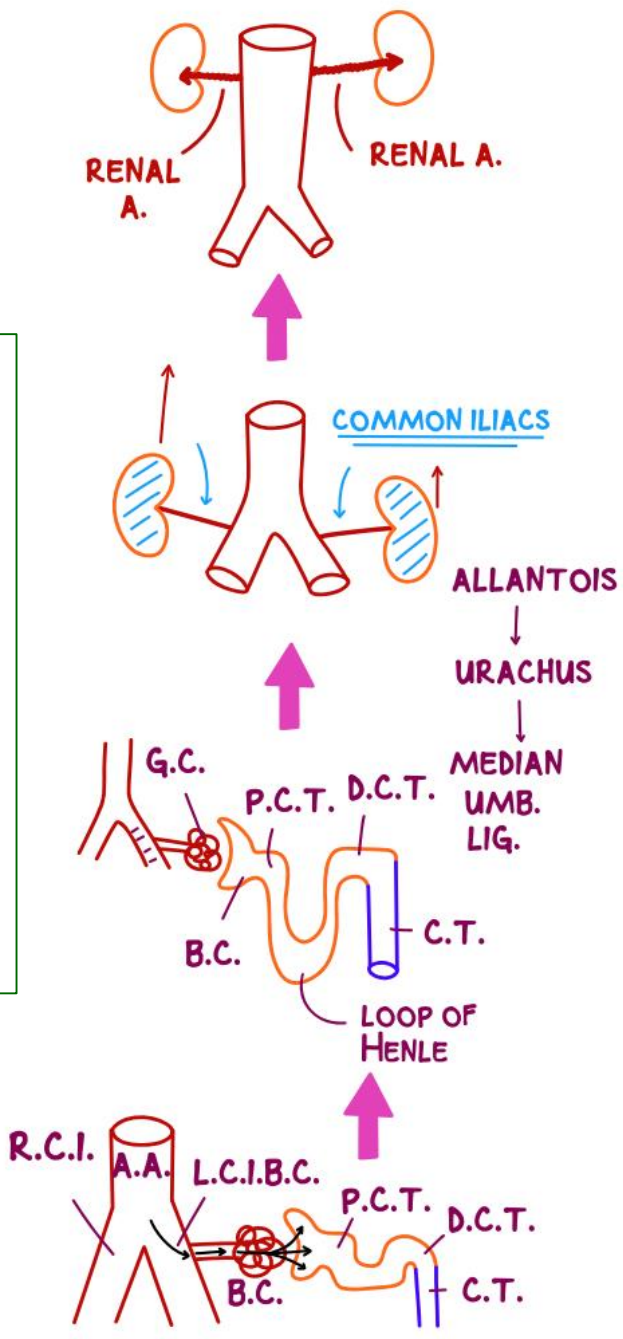
- Metanephros develop in the **pelvic region**
- Artery found in pelvic region is the common iliac arteries
- The actually **mature kidney develops in the pelvis** and **ascend upward**

From the common iliac, we have arterials and capillaries
→ create **glomerular capillaries**

- Starts making urine

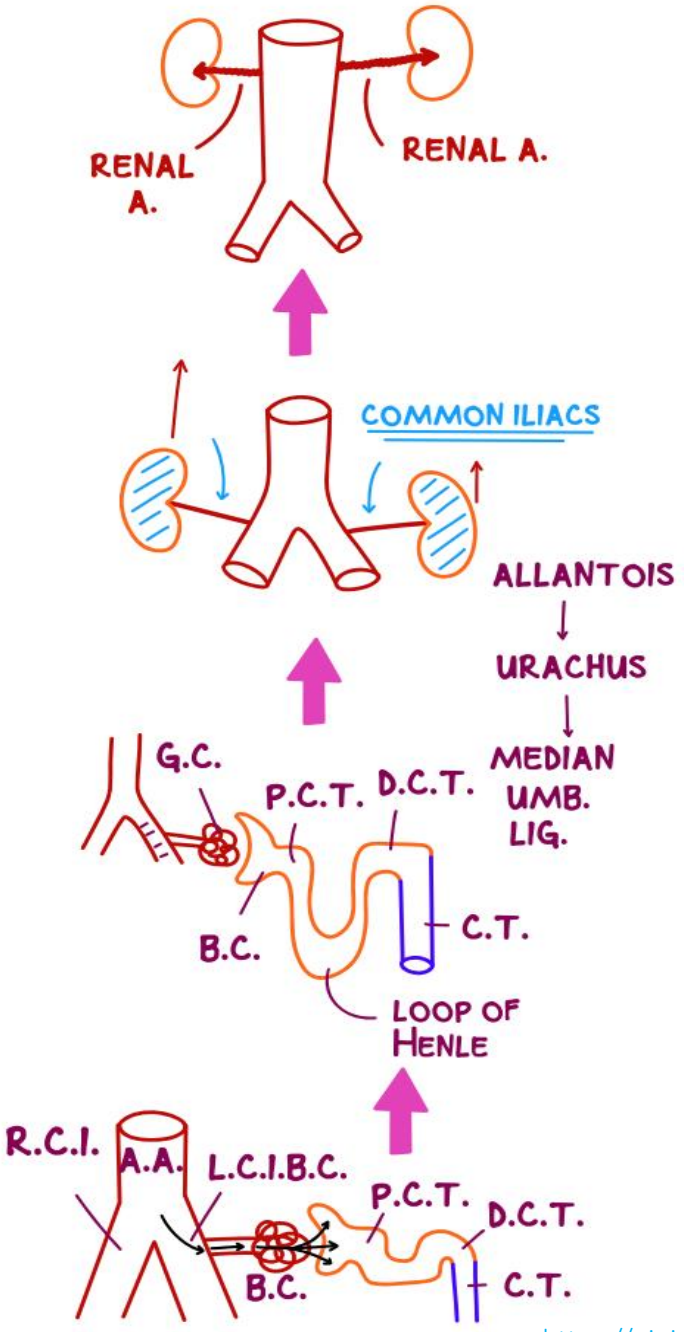
The **metanephric mesoderm between PCT and DCT** starts **grow downward** and form a loop called **loop of Henle.**

Urine
↓
Bowman's capsule
↓
PCT
↓
DCT
↓
collecting tubule
↓
cloaca

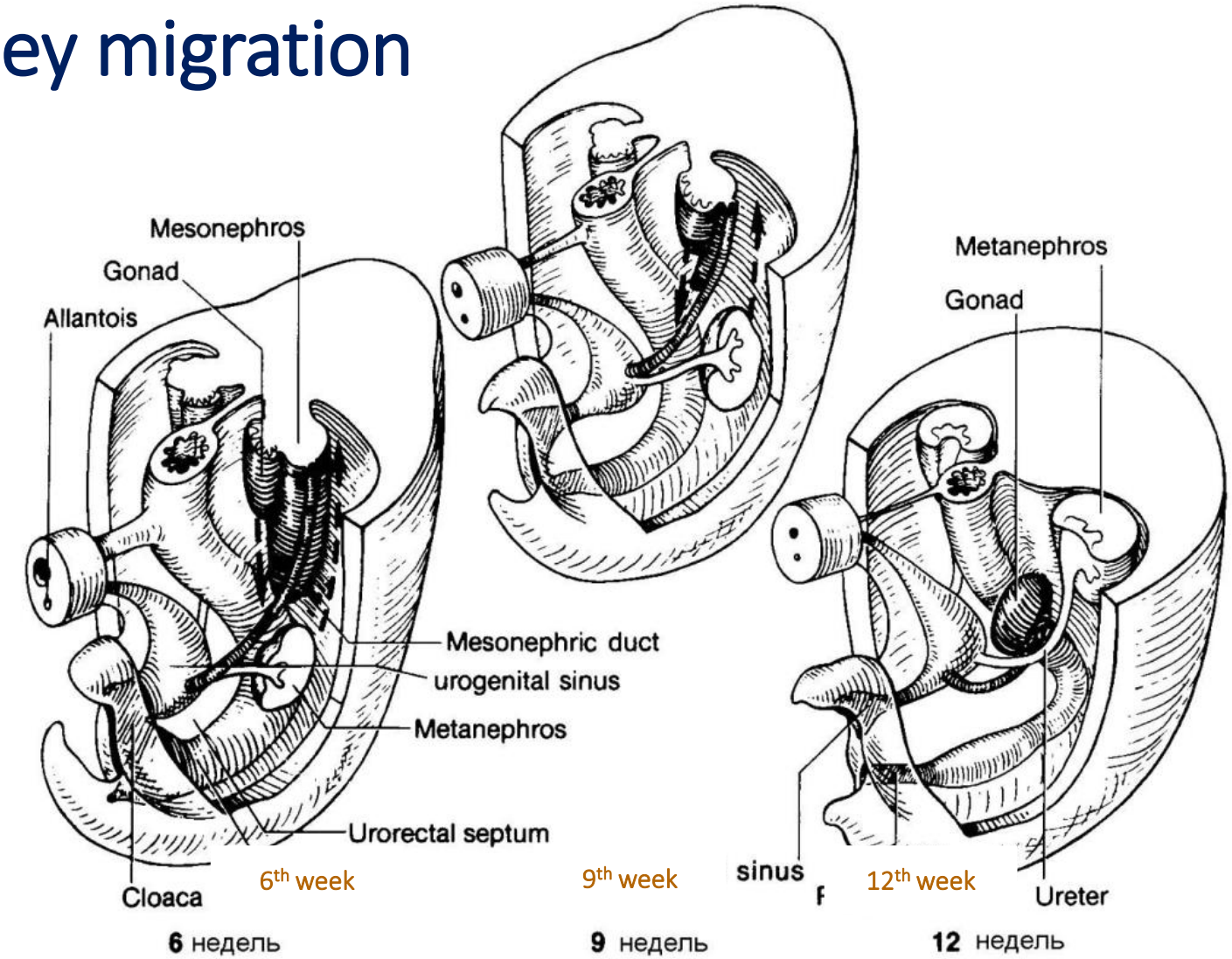


Metanephros
(4) Kidney's migration

- We made the nephron from metanephric mesoderm and collecting system from the ureteric bud
- Common iliac arteries start degenerating
- Kidney start ascending (moving upwards) into the upper quadrant of abdomen
- Aorta will develop lateral branches → renal arteries

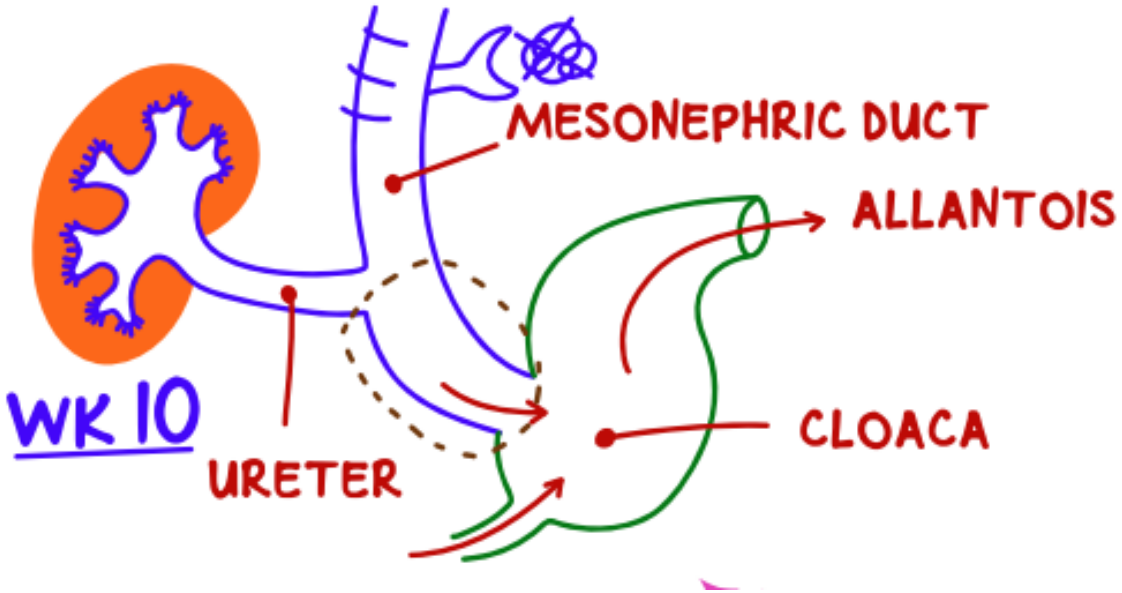


Kidney migration



- metanephros germ is below aortic bifurcation
- 9-10th week – kidney rises
- 90°Turn around vertical axis

Week 10



- Mesonephric duct draining urine from mesonephric tubule before week 10
- Connecting portion of ureter and mesonephric duct fuse with the cloaca
- Mesonephric duct moves a little bit backward;
- Ureter move a little bit more toward side

- When they're joining, creates a structure called **vesicular trigone**

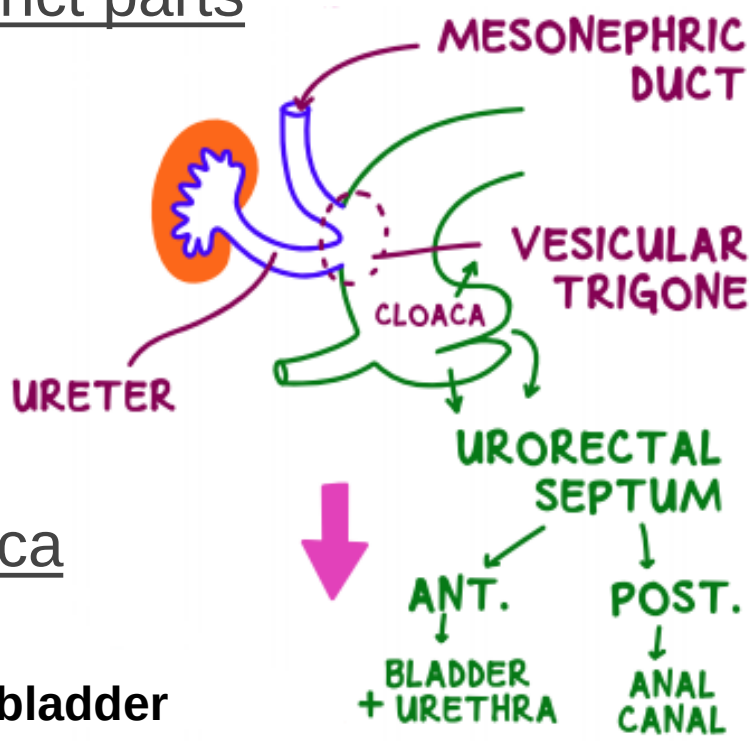
- <u>Mesonephric duct will become</u>
  - Vas deferens
  - Epididymis
  - Seminal vesicle
  - Common ejaculatory duct
  - Uterus

Urorectal septum

(a) Separate the cloaca into two distinct parts

Anterior portion
- Becomes **urogenital sinus**
- Becomes **bladder** and **urethra**

Posterior portion
- Anal canal



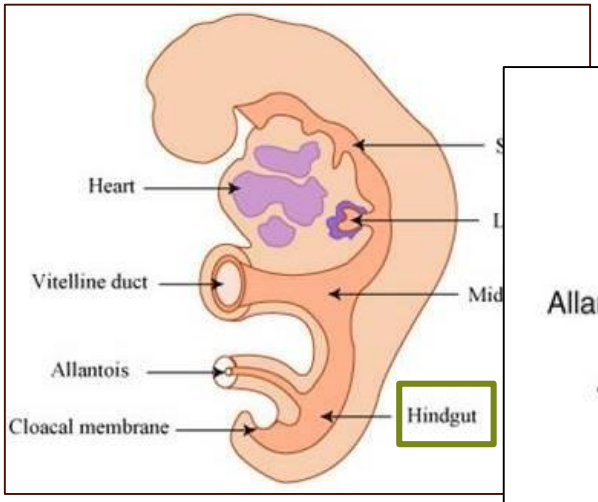
(b) Separate hindgut away from cloaca

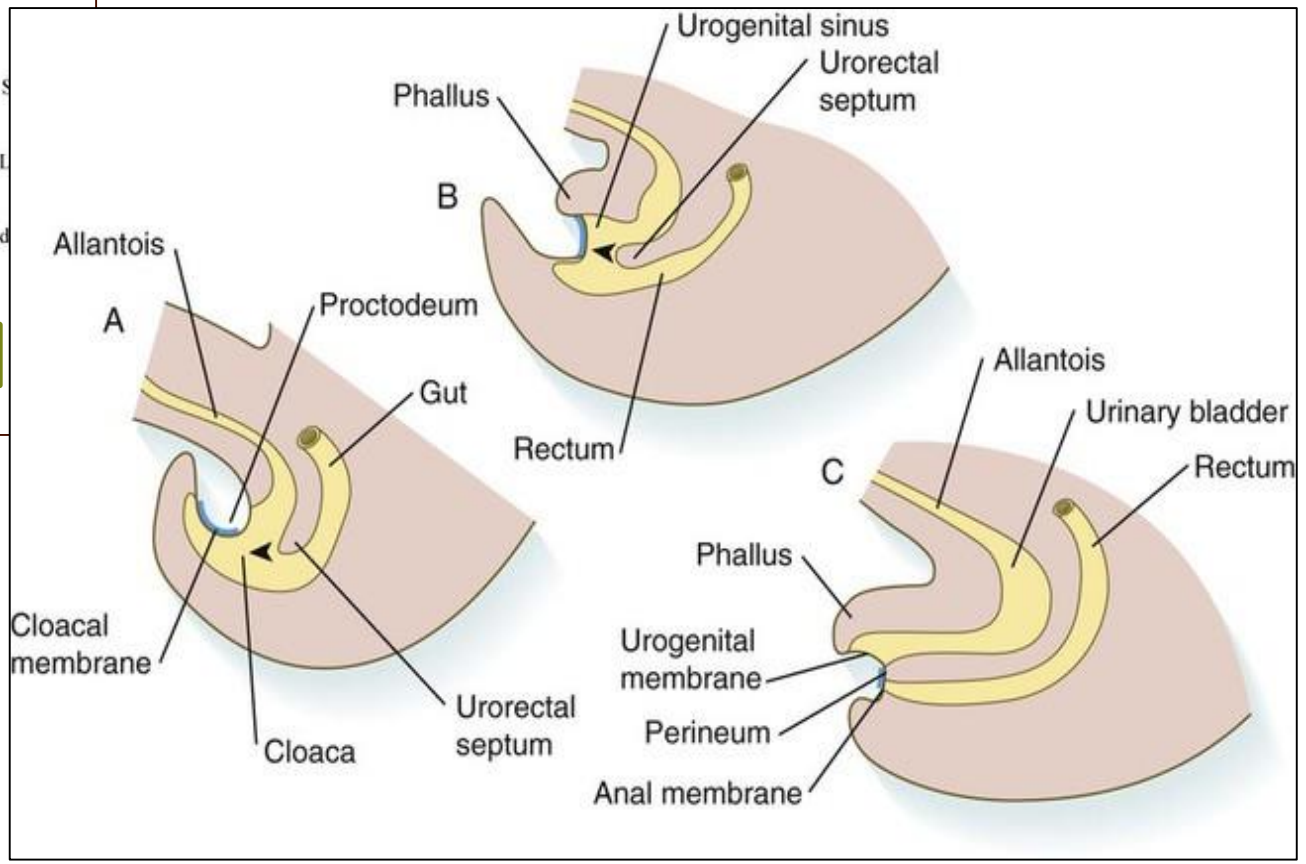
- **Proximal** portion of urogenital sinus becomes **bladder**
- **Middle** portion of urogenital sinus becomes **urethra**

- Female → female urethra
- Male → prostatic urethra, membranous urethra

- **Distal** portion of urogenital sinus becomes **penile urethra**

Separation of cloaca (5-6th week)





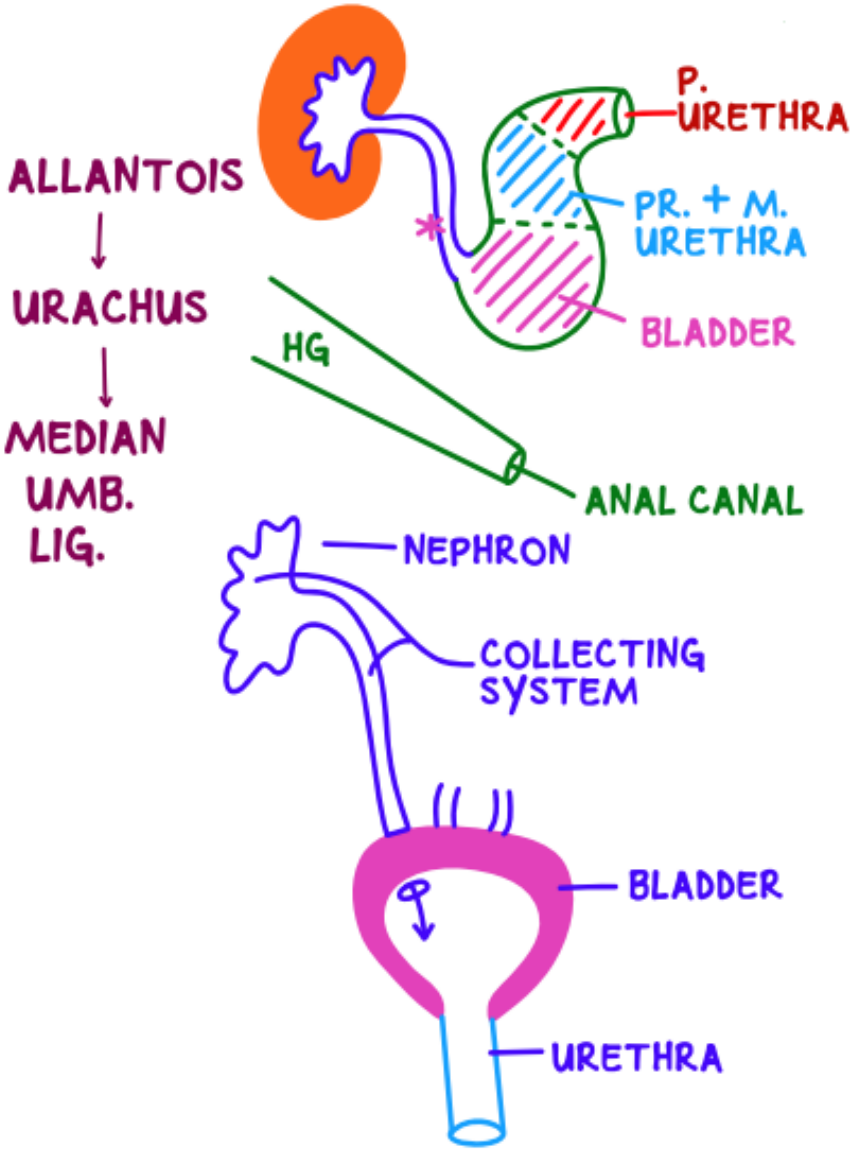
Stages:

- development of septum urorectale
- posterior part – rectum
- anterior part – urogenital sinus

Urogenital sinus form:

- Bladder and urethra (male - partially)
- Inferior part of the vagina (female)
- Prostate (male)

Allantois drains cloaca



<u>Allantois development</u>

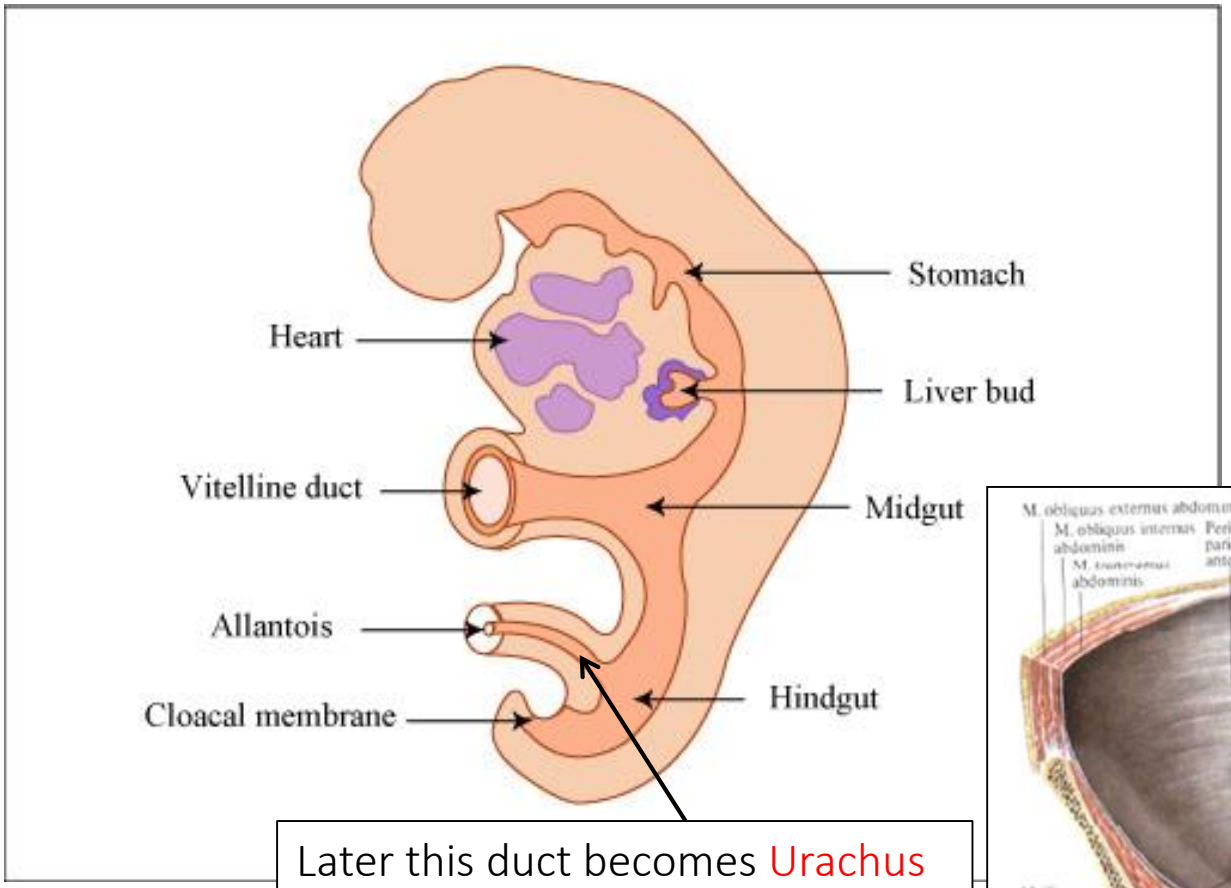
Allantois

↓

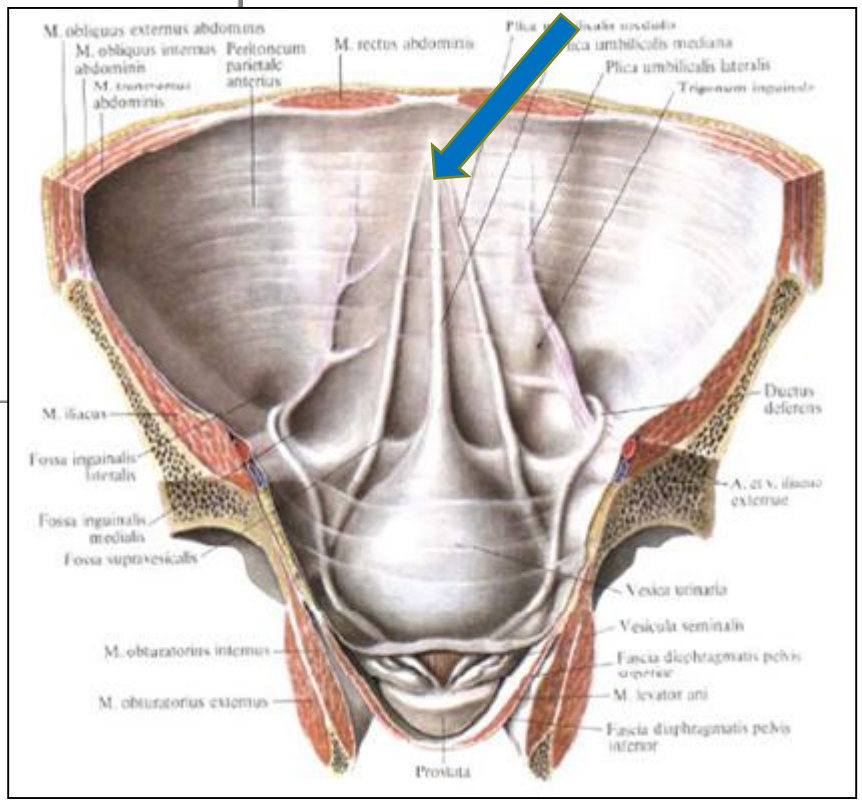
urachus

↓

median umbilical ligament

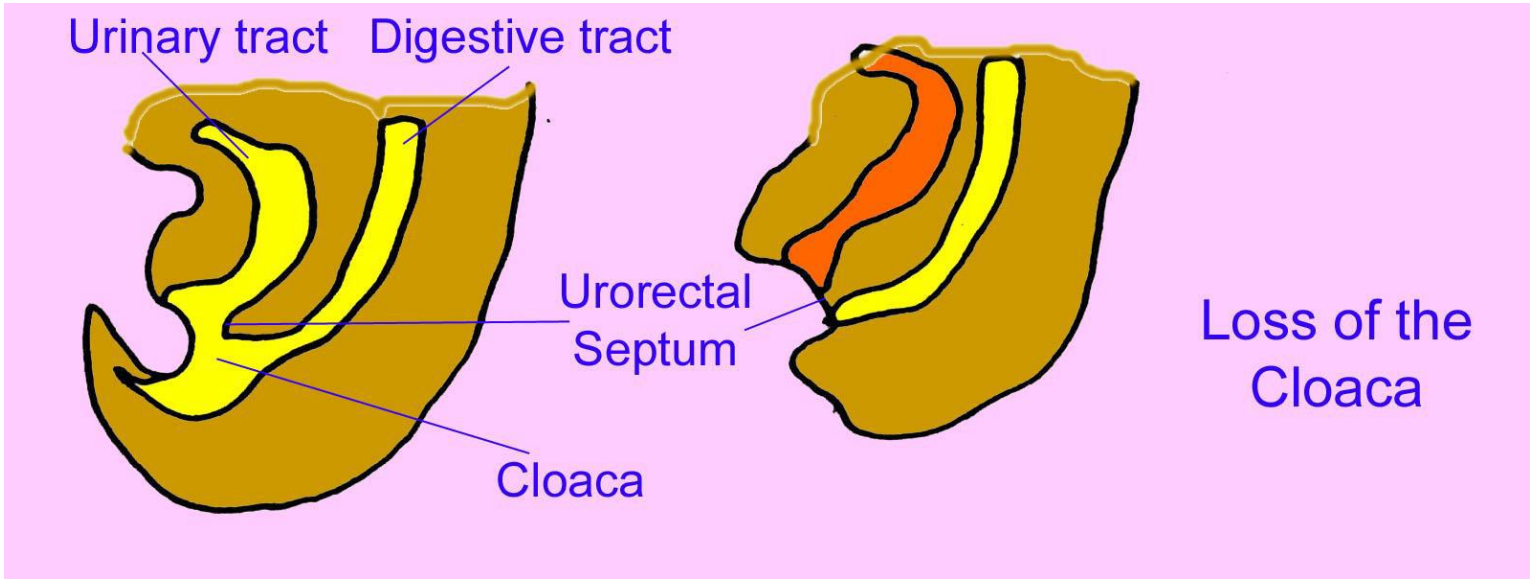


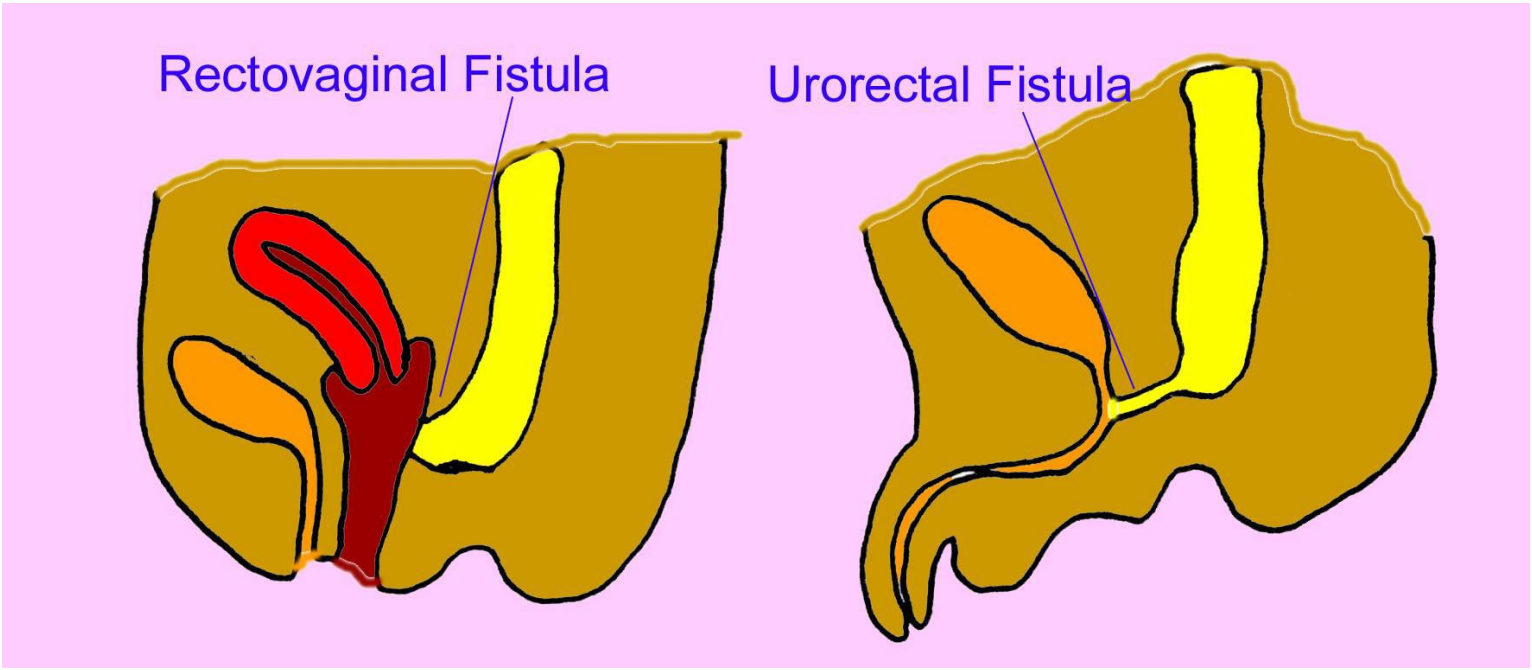
Later this duct becomes Urachus (canal that drains the urinary bladder of the fetus) – *Plica umbilicalis mediana*



Allantois * – blind-ending hindgut diverticulum that projects into the umbilical cord

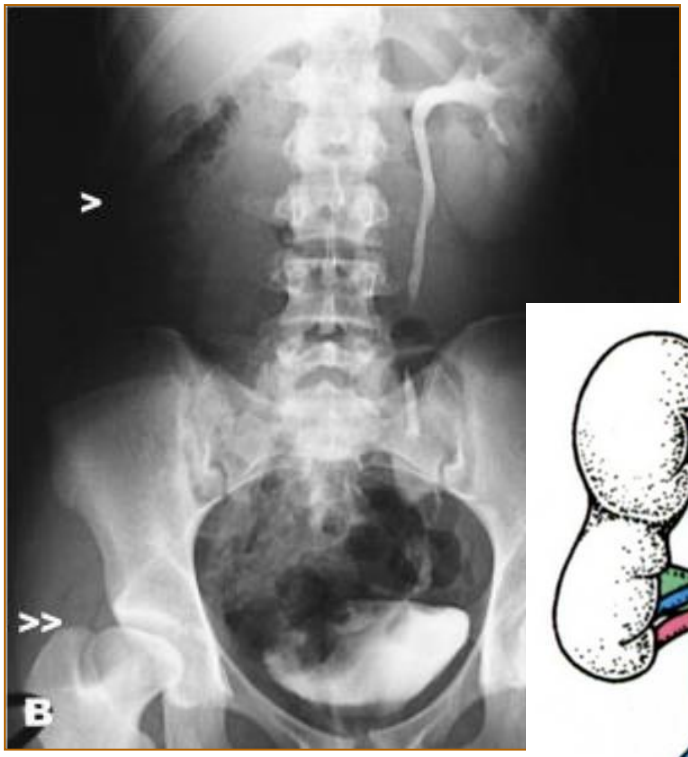
Congenital Anomalies

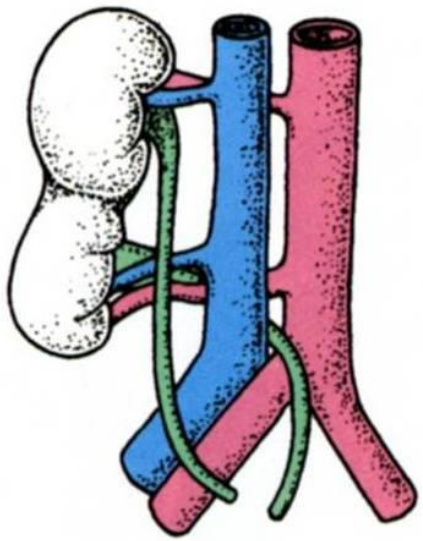

Urinary tract
Digestive tract
Urorectal
Septum
Cloaca
Loss of the
Cloaca

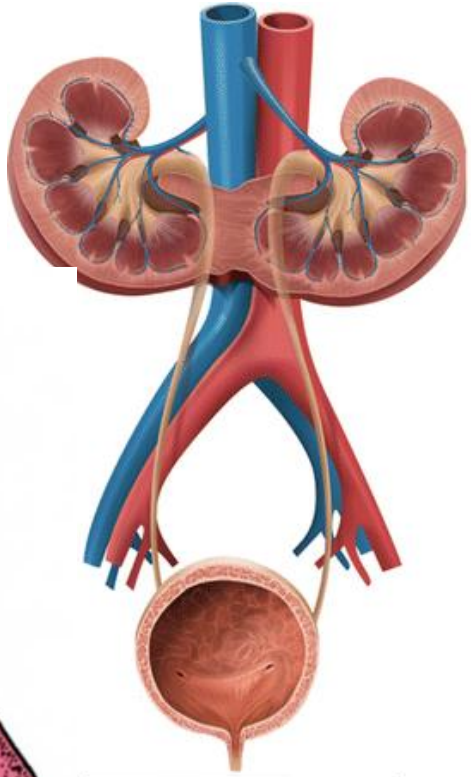

Rectovaginal Fistula
Urorectal Fistula

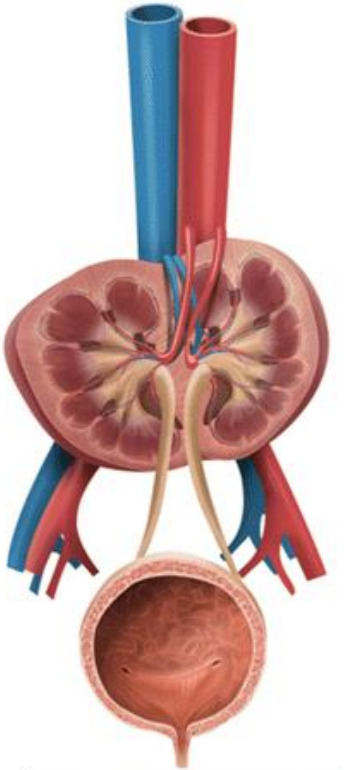
Congenital quantity abnormalities (Anomalies of number):

- Aplasia (absence of one or both kidneys)
- Accessory kidney
- Doubled kidney
- Fused kidney (horseshoe-, L-, S-shaped)



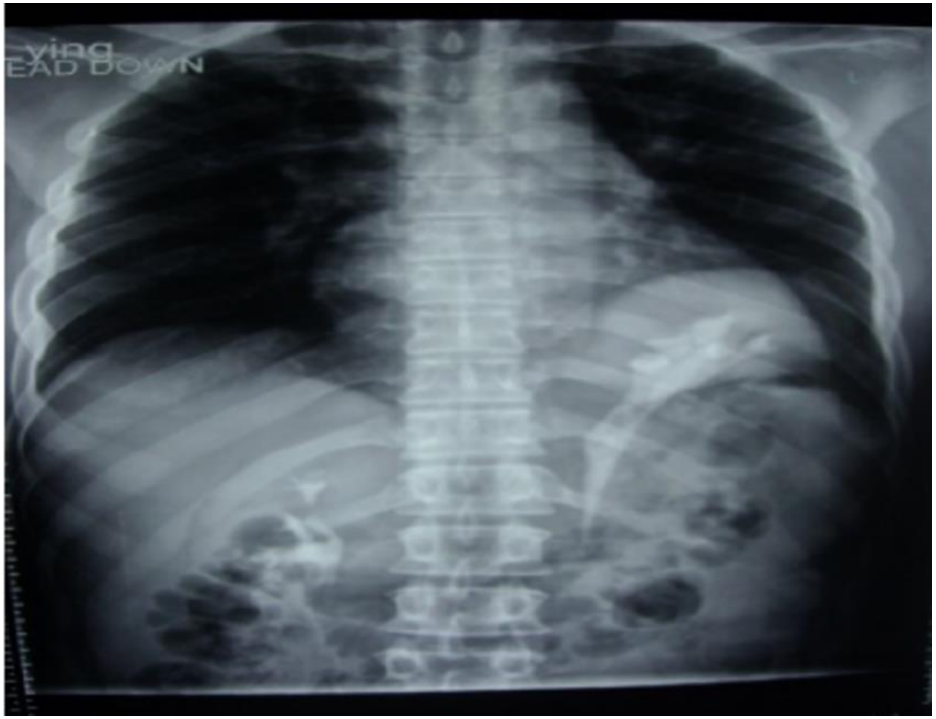


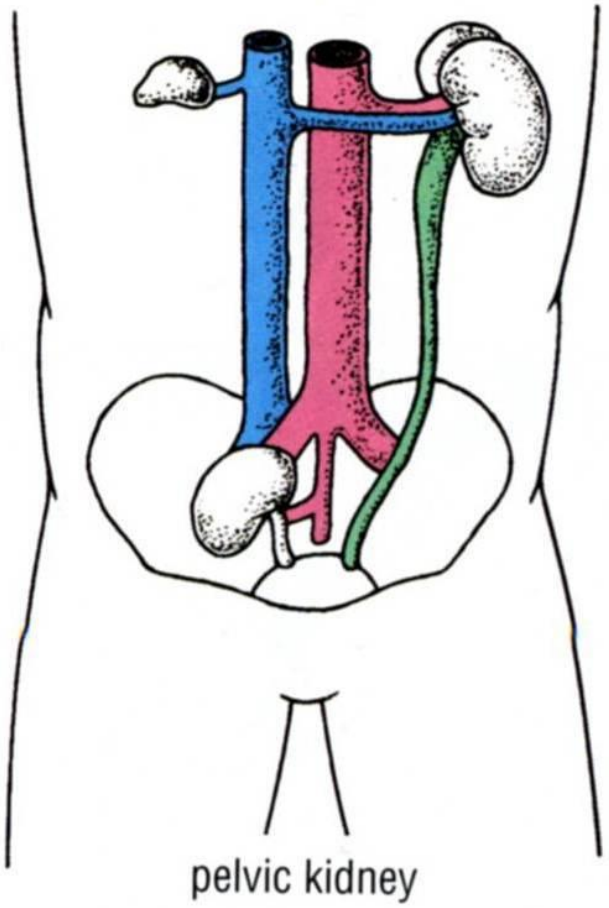




Congenital localization abnormalities (Anomalies of kidney position):

- Pelvic kidney
- Lumbar kidney
- Iliac kidney
- Thoracic kidney





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LEFT THORACIC KIDNEY: A RARE FINDING AT INTRAVENOUS UROGRAPHY

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Conflict of Interest: *None declared*

SUMMARY

Thoracic kidney is a rare type of renal ectopia. Patients with thoracic kidneys are usually asymptomatic and the condition is usually discovered incidentally during radiological evaluation for other conditions or during thoracic surgery. An intravenous urography done for a thirty-eight year old man referred on account of a seemingly small right kidney on an abdominal ultrasound scan, showed a normal right kidney and a left thoracic kidney. Thoracic kidney is a rare but an important cause of a thoracic 'mass' or 'elevated hemi diaphragm'. It should be considered in the evaluation of such patients to prevent unnecessary surgical interventions and image guided biopsies.

Key Words: Thoracic kidney, Ectopic kidney, intravenous urography.

INTRODUCTION:

In certain situations however, the ascending developing kidney may 'over-shoot' and ascend to a higher location than normal, resulting in thoracic ectopia. This is believed to be due to delayed closure of the diaphragm or accelerated ascent of the kidney.[2,3,5,6] Not much information on thoracic kidney is available in our part of the world. We are therefore presenting this case to add to the knowledge the world.

CASE REPORT

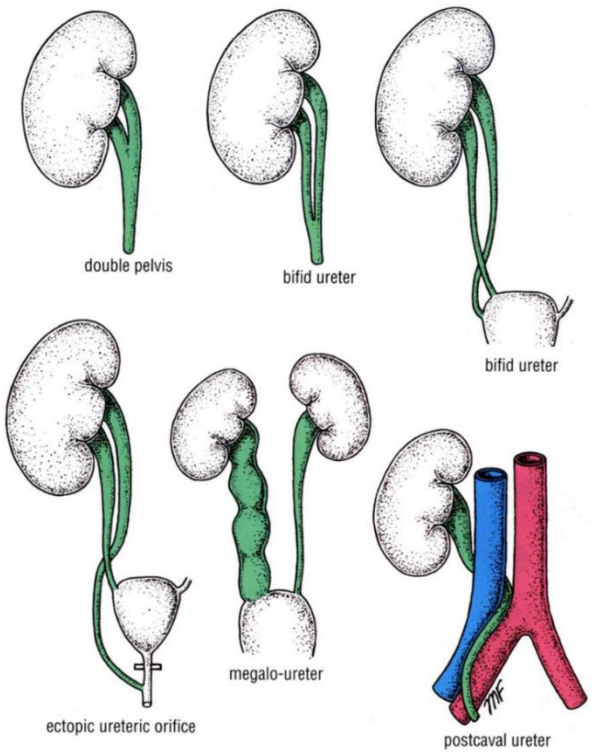
A 38 year old man w Accra to the Depart Teaching Hospital for assess the function of cause he had had an earlier for abdominal was small. No mentio the request. The pati

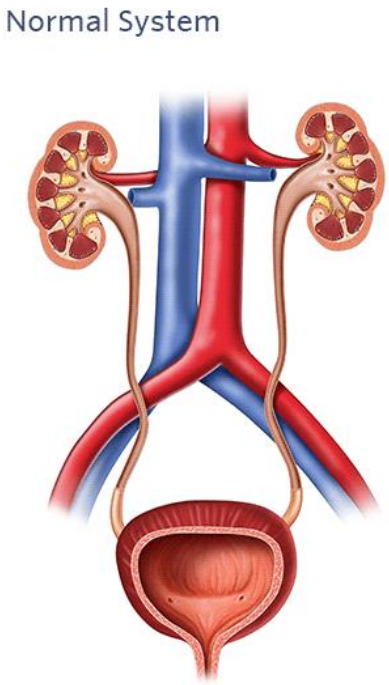
Thoracic kidney is a rare type of renal ectopia

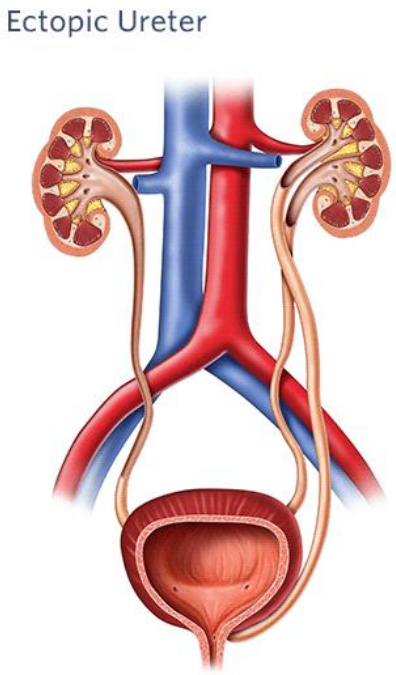
Intravenous urography with thoracic kidney

Congenital ureter openings abnormalities (Anomalies of relation):

- into intestine
- into urethra
- into genital organs (seminal vesicals – male and uterine or vagina – female)

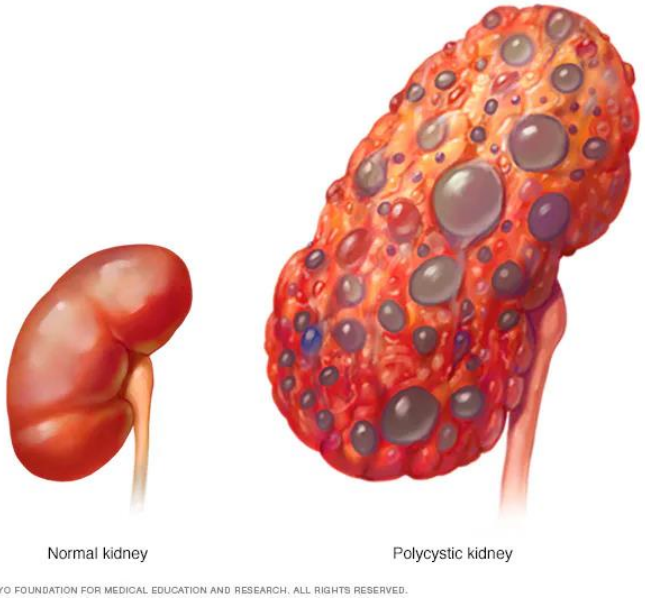


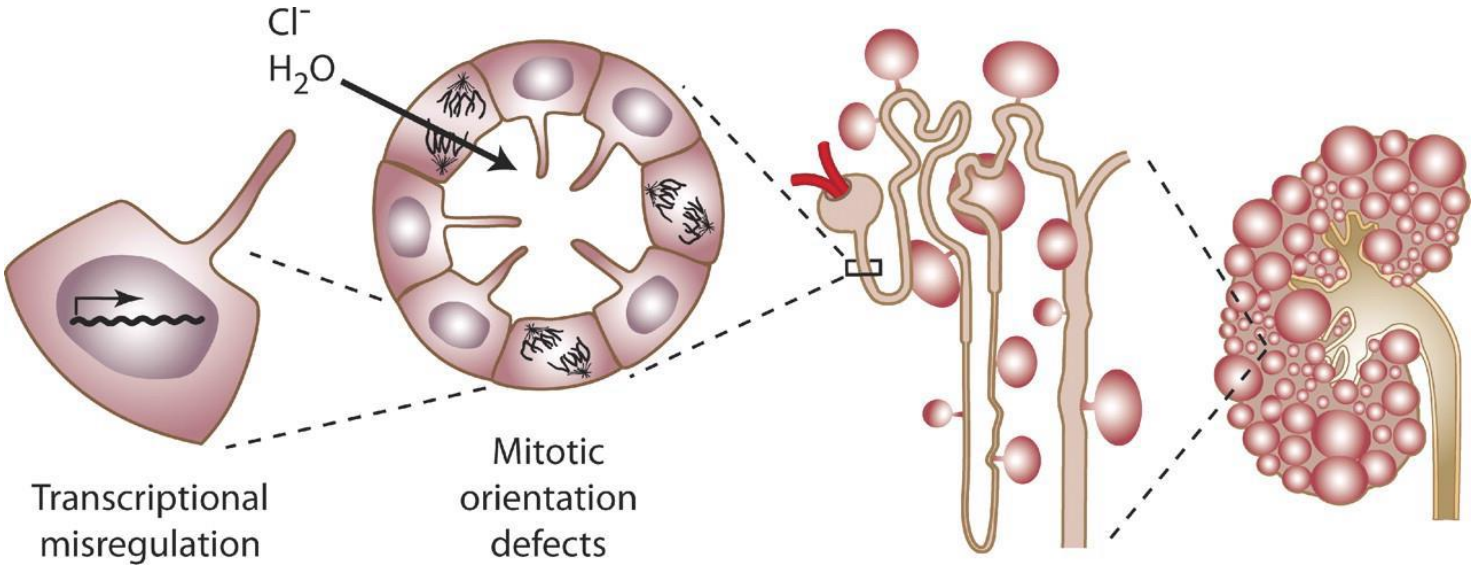




Congenital structure abnormalities (Anomalies of Structure):

- Polycystic kidney





Congenital Anomalies of the Upper Urinary Tract: A Comprehensive Review

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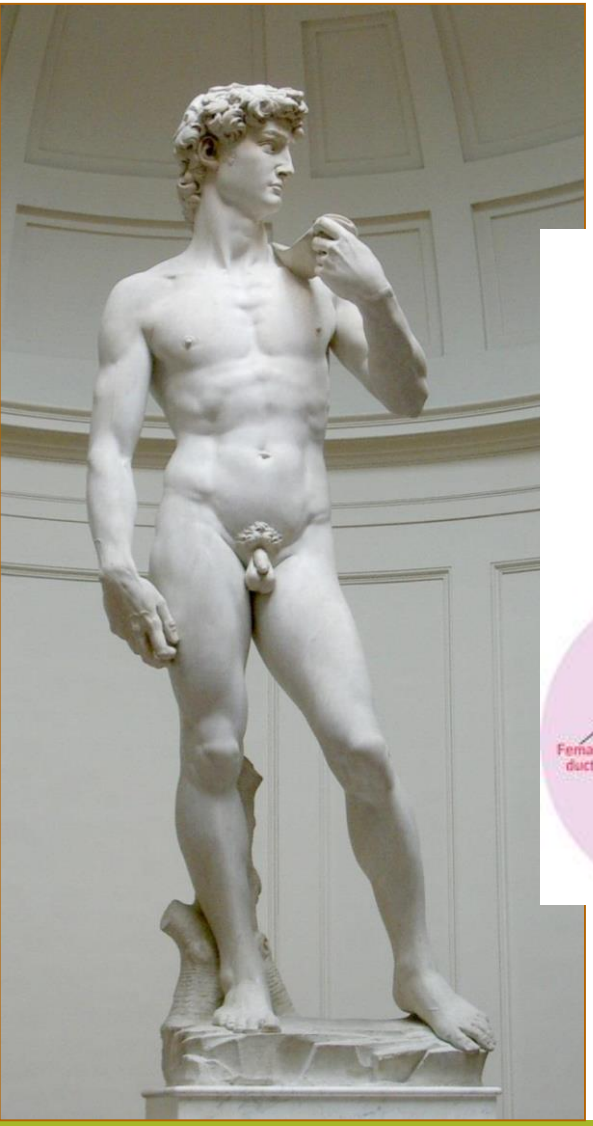
Cassia T. S. Guimarães, MD
Marcelo S. Takahashi, MD
Gustavo P. Rodi, MD
Taisa P. D. Gasparetto, MD, PhD
Roberto Blasbalg, MD, PhD
Fernanda G. Velloni, MD

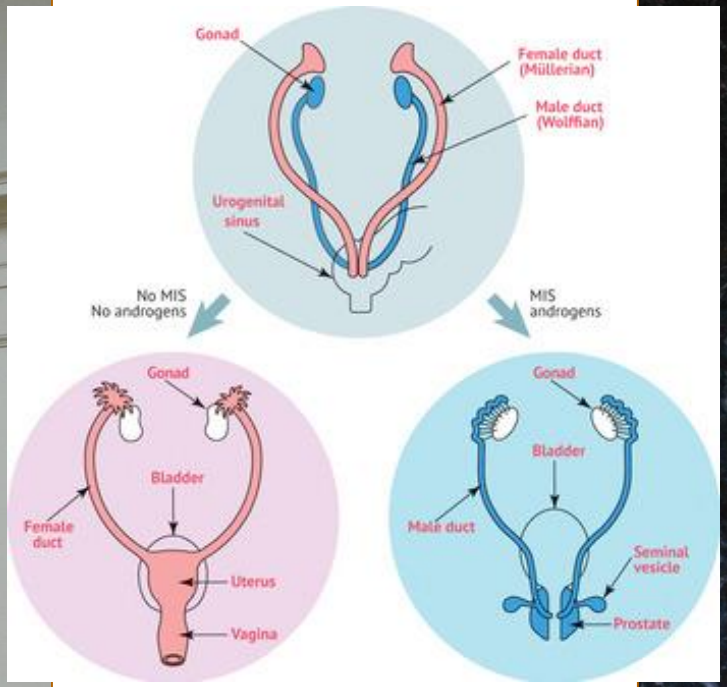
Abbreviations: CRE = crossed renal ectopia, SK = supernumerary kidney, UPJ = ureteropelvic junction, UPJO = ureteropelvic junction obstruction, VCUG = voiding cystourethrography, URA = unilateral renal agenesis

RadioGraphics 2021; 41:462–486

https://doi.org/10.1148/rg.2021200078

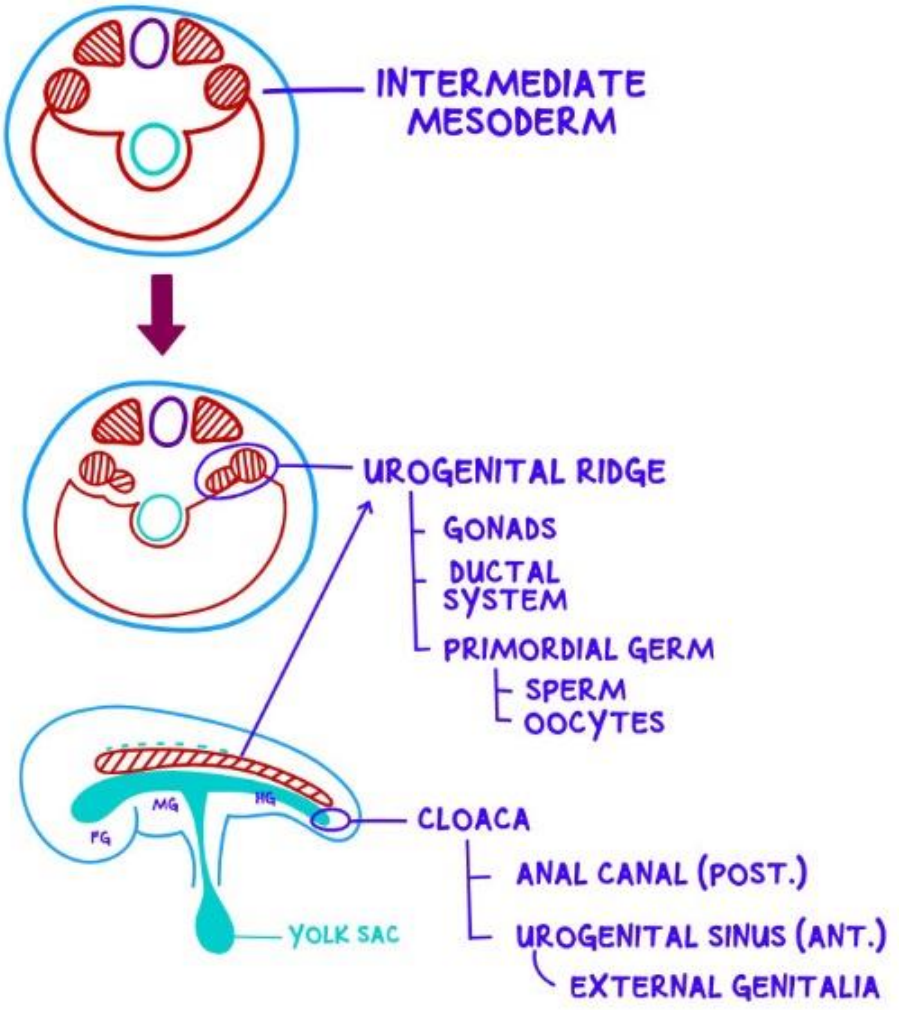
The upper urinary tract is the most common human system affected by congenital anomalies. Congenital anomalies of the kidneys and ureters comprise a wide spectrum of disorders ranging from simple variants with no clinical significance to complex anomalies that may lead to severe complications and end-stage renal disease. They may be classified as anomalies of renal form, which are subclassified as structural anomalies (eg, persistent fetal lobulation, hypertrophied column of Bertin, and dromedary hump) and fusion anomalies (eg, horseshoe kidney and pancake kidney); anomalies of renal position (eg, renal malrotation, simple renal ectopia, and crossed renal ectopia) and renal number (eg, renal agenesis and supernumerary kidney); and abnormalities in development of the urinary collecting system (eg, pyelocaliceal diverticulum, megacalycosis, ureteropelvic





Development of Reproductive System

The reproductive tract is derived from the **intermediate mesoderm**



- The intermediate mesoderm will condense and form the **urogenital ridge**

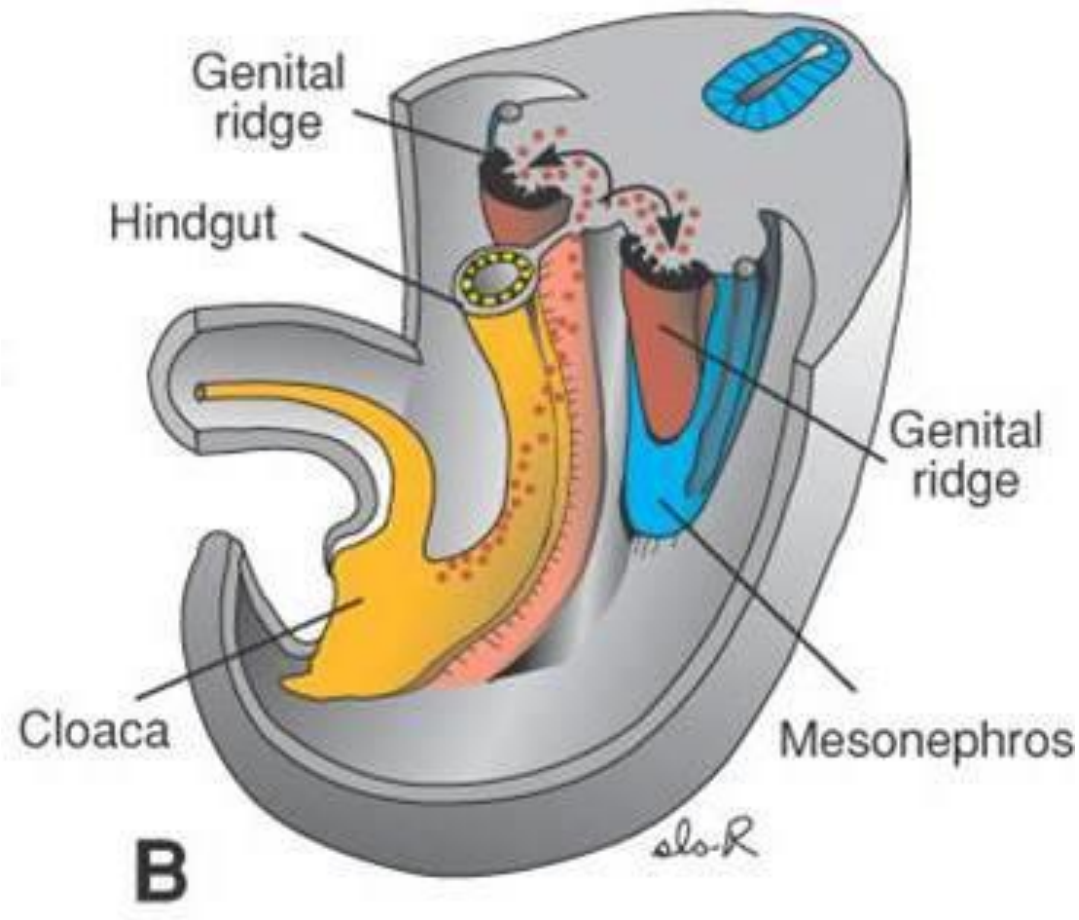
- The yolk sac contains the primordial germ cells (PGCs), which will:

  - Migrate through the vitelline duct; and
  - Invade the urogenital ridge

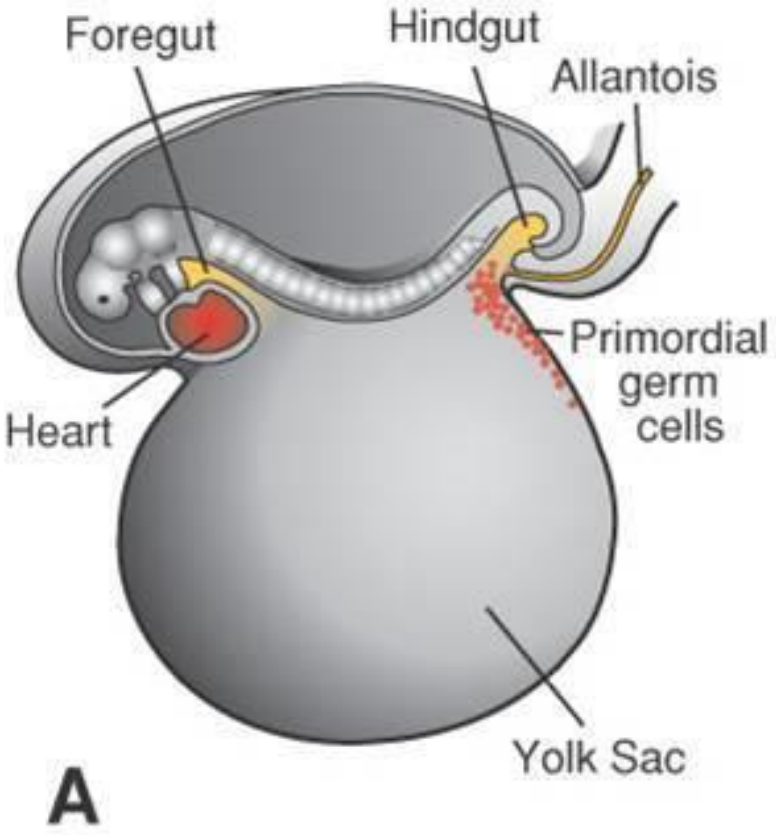
The PGCs will give rise to the gametes (sperm and oocytes)

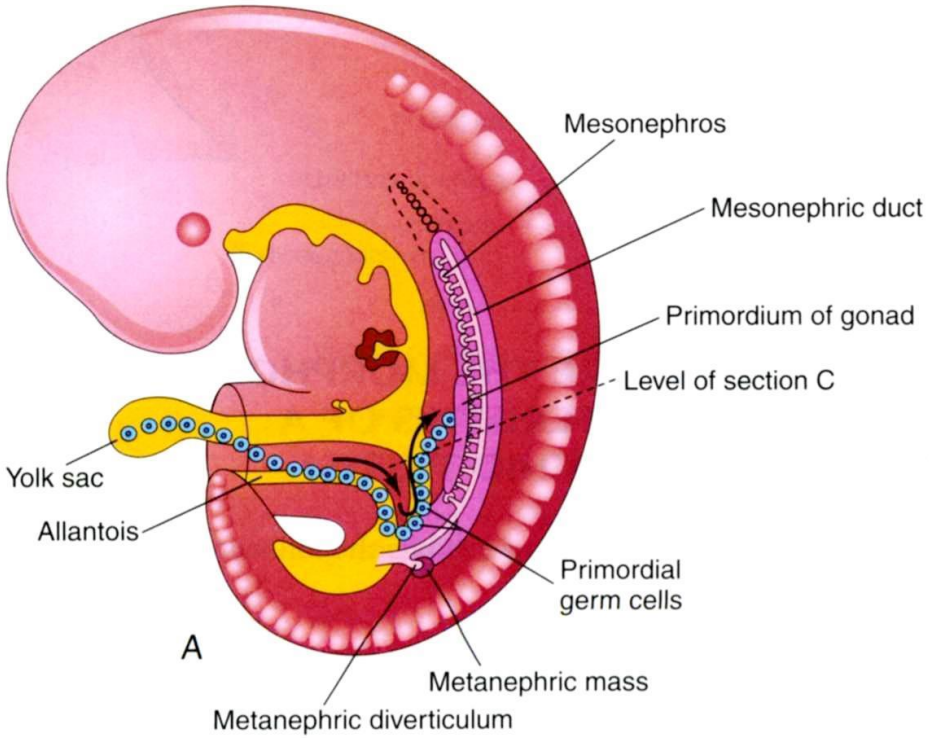
Gonads germ

- 5th week
- genital ridge – columnar thickening of the splanchnomesoderm on the surface of the mesonephros (future stroma of the glands)



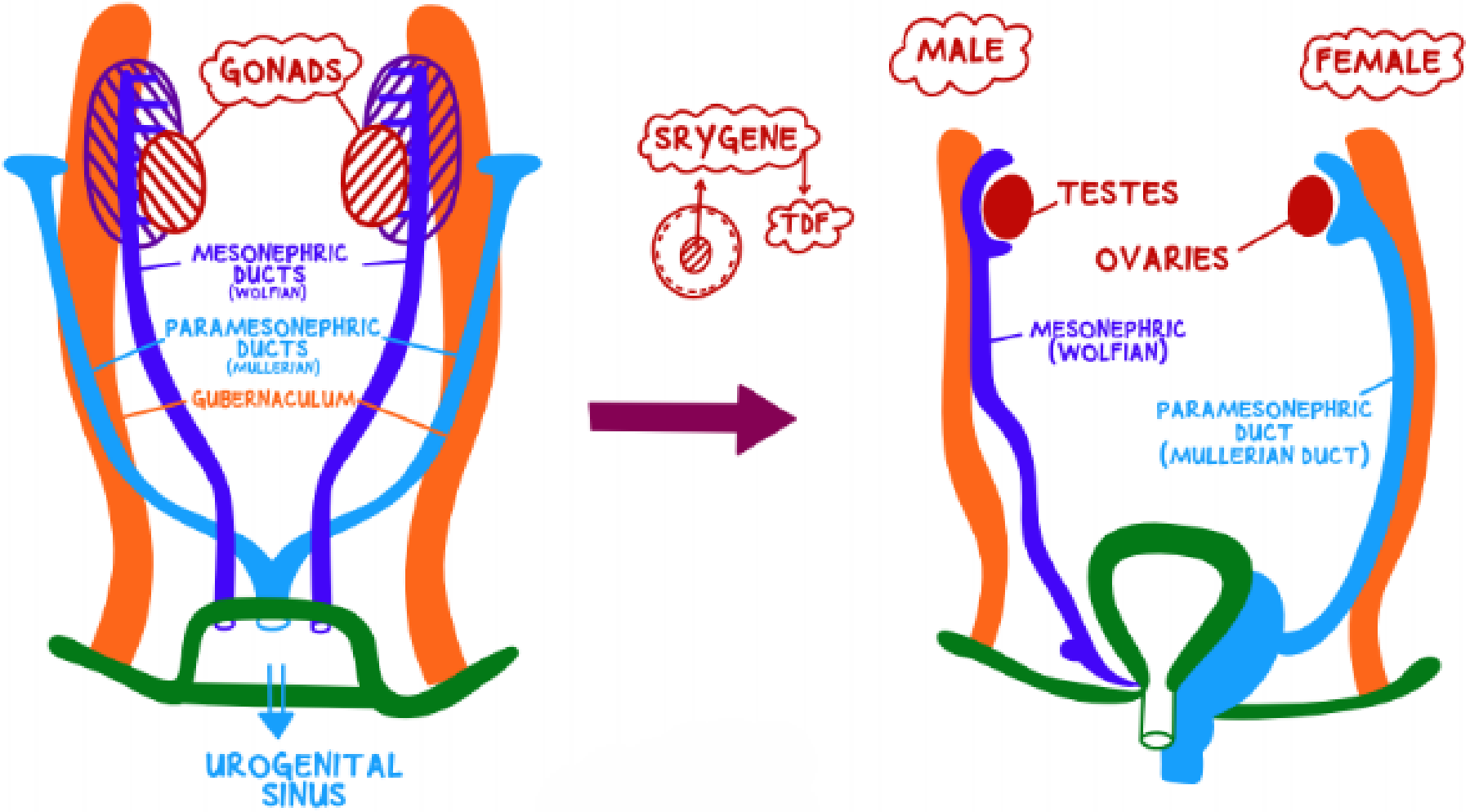
Primordial germ cells migrate from their primary germ in yolk sac endoderm (6th week)



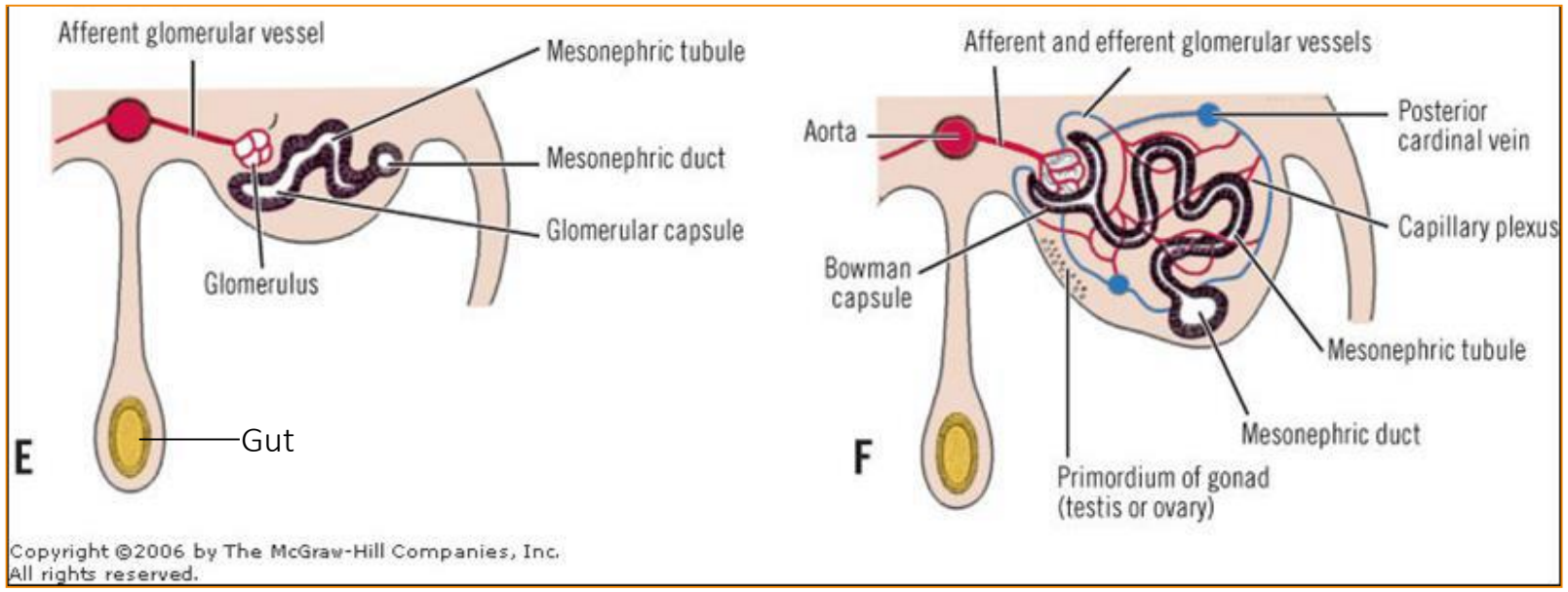


Primordial germ cells are precursors of spermatogonia and oogonia.

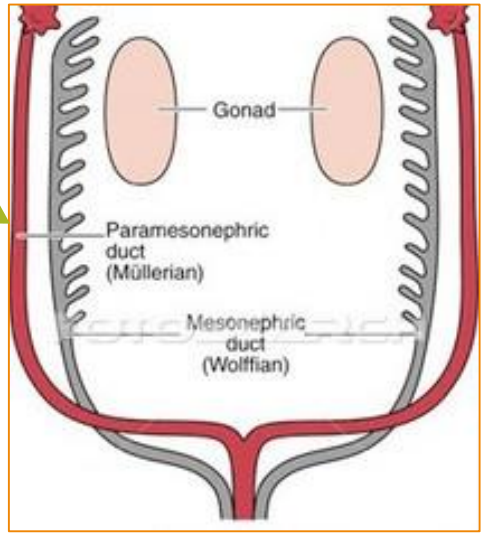
- Each fetus has two bipotential gonads and a ductal system which empties into the urogenital sinus
- The ductal system is made up of the following:
    - Mesonephric / Wolffian Ducts
    - Paramesonephric / Mullerian Ducts
    - Gubernaculum

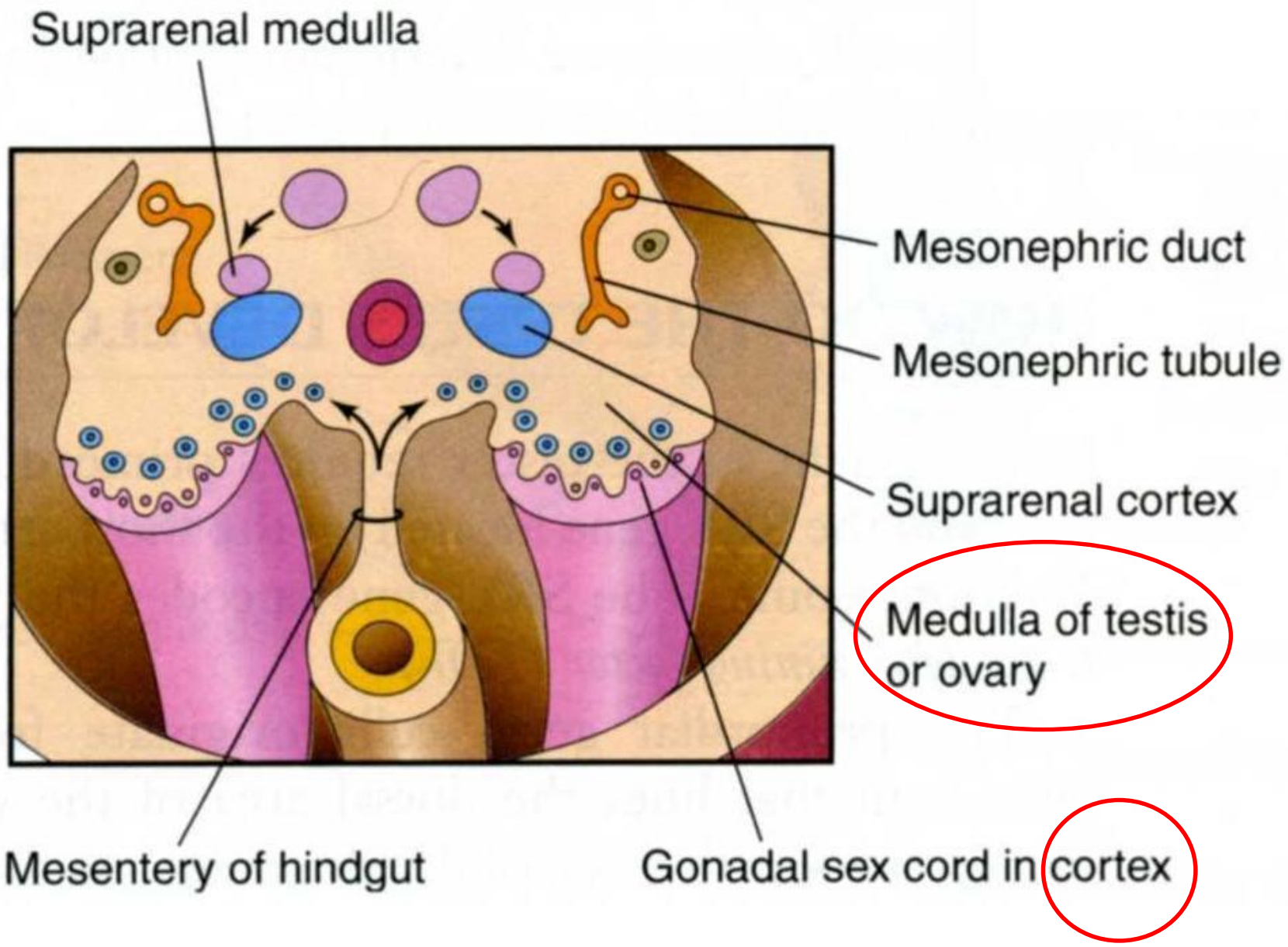


Mesonephros (Wolffian body)

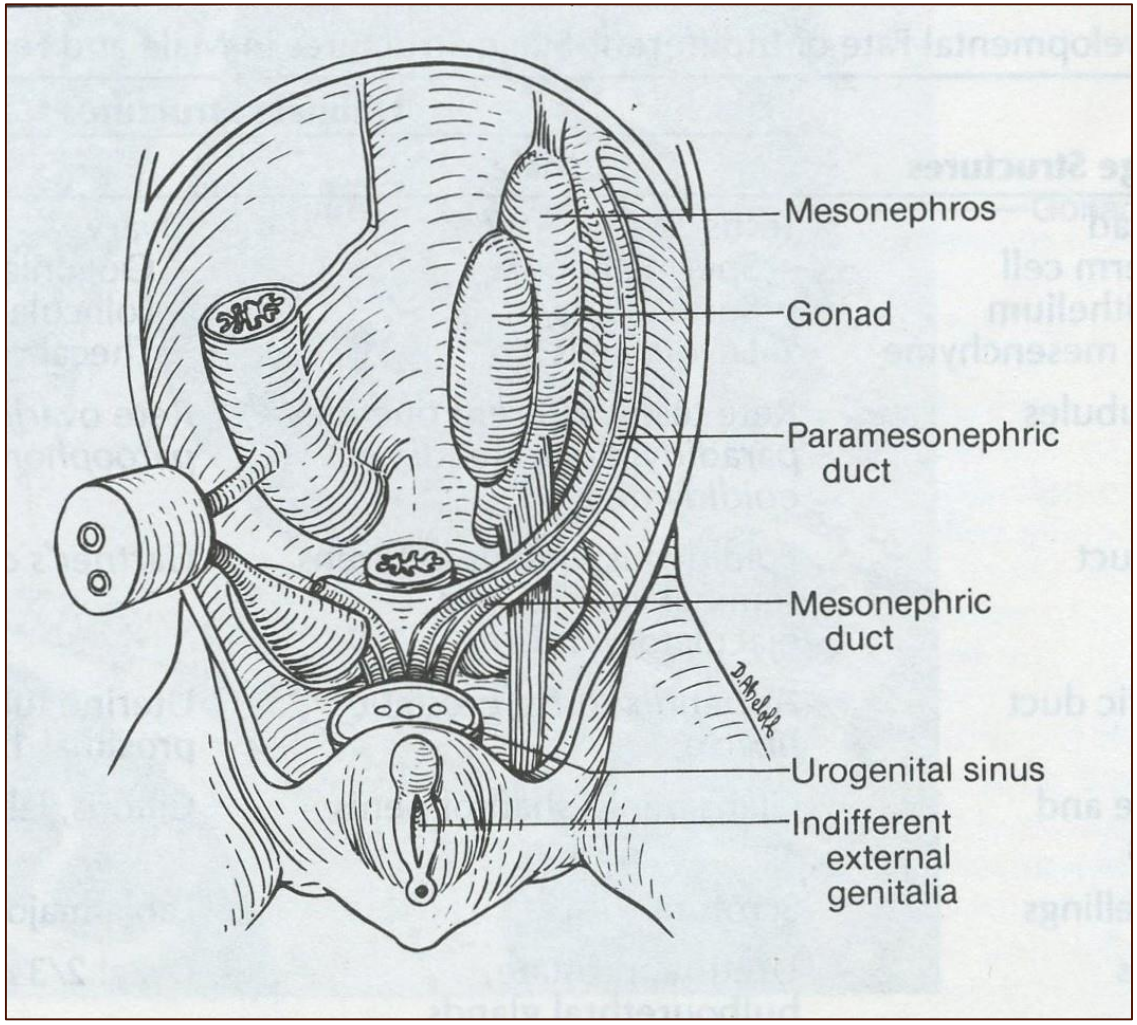


Paramesonephral duct
(Müllerian duct)
is developed near to
mesonephric one
- develops into organs of
reproductive system




Suprarenal medulla
Mesonephric duct
Mesonephric tubule
Suprarenal cortex
Medulla of testis or ovary
Mesentery of hindgut
Gonadal sex cord in cortex

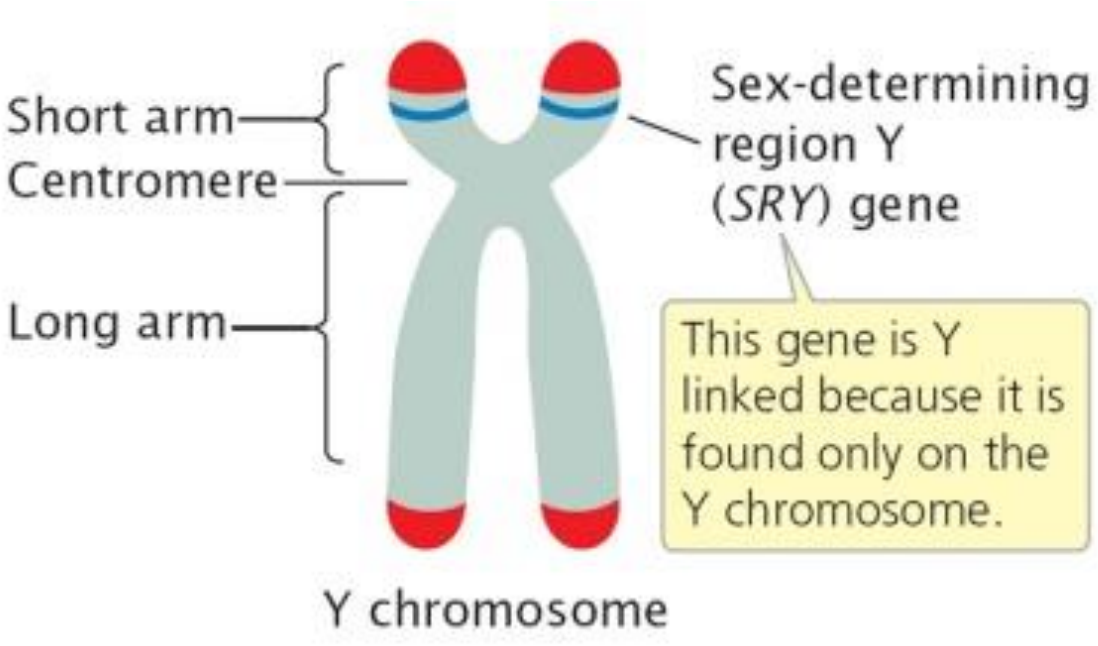
The reproductive system at the indifferent stage

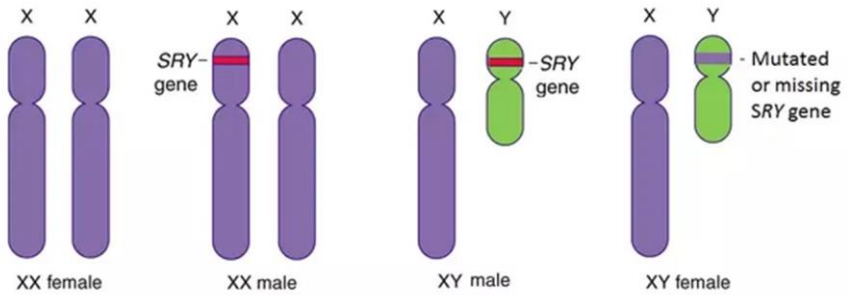


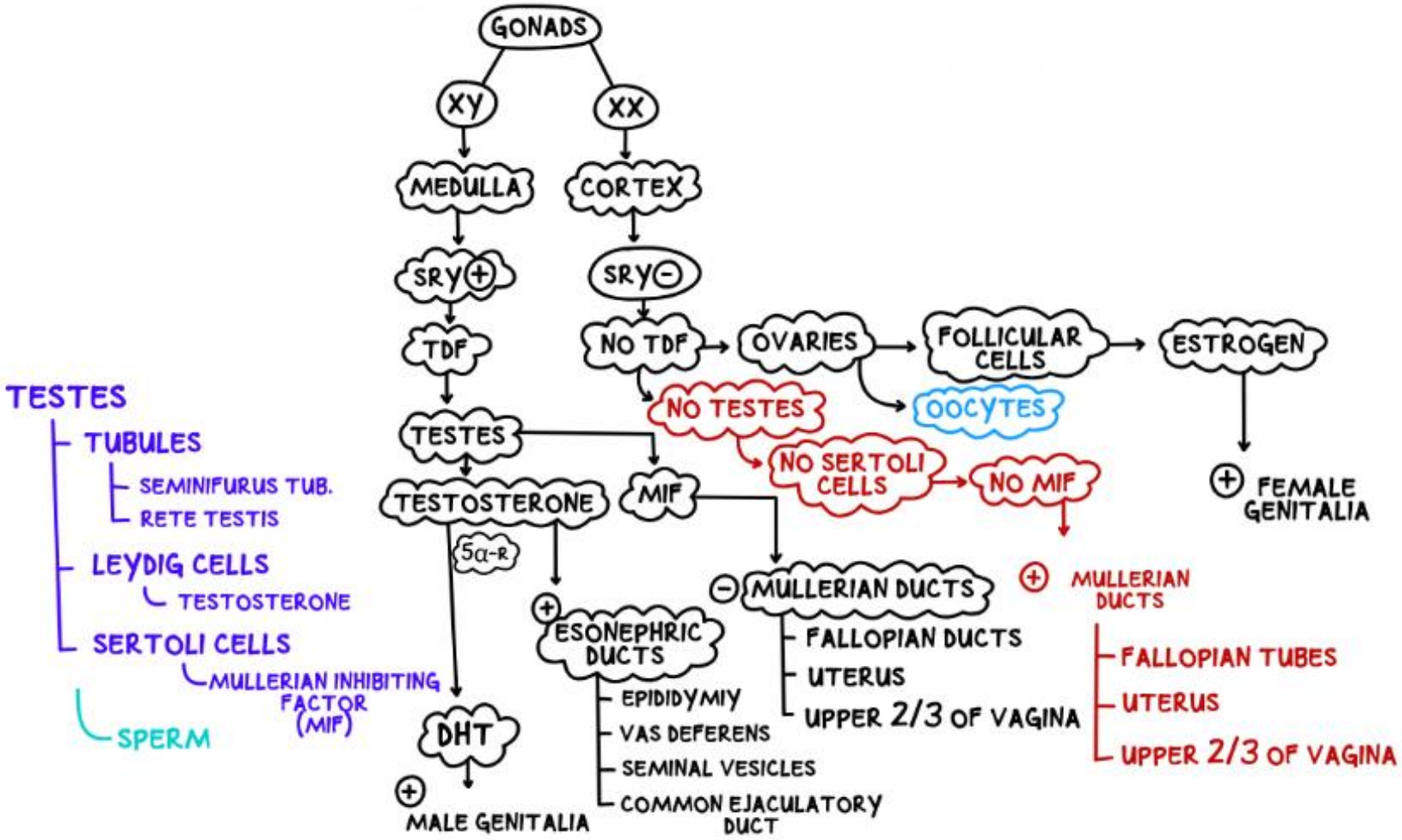
Chromosomal constitution + hormones = establishment of physical gender

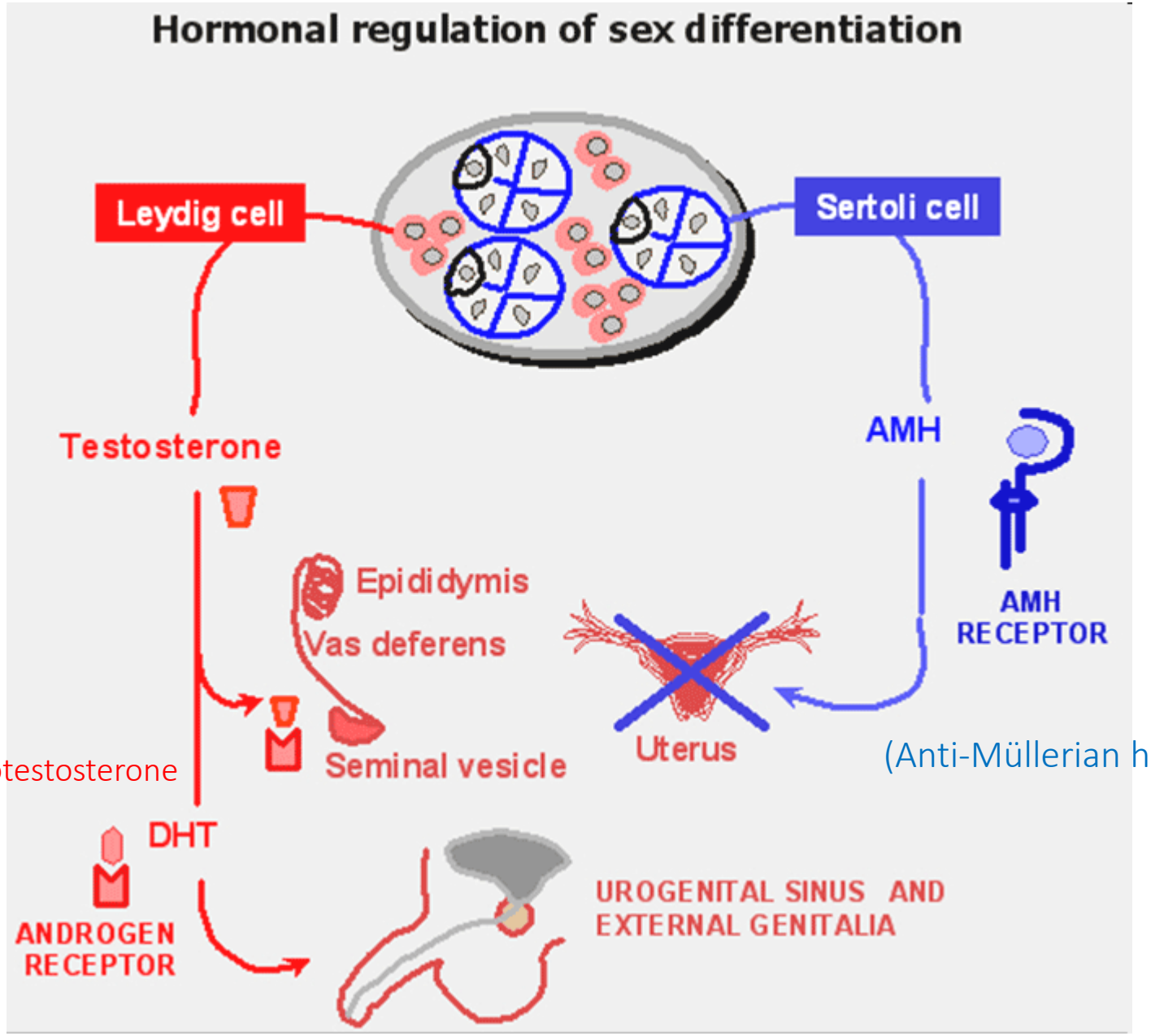
Sex-determining Region Y (SRY gene)

(this gene codes expression of TDF - testis-determining factor)



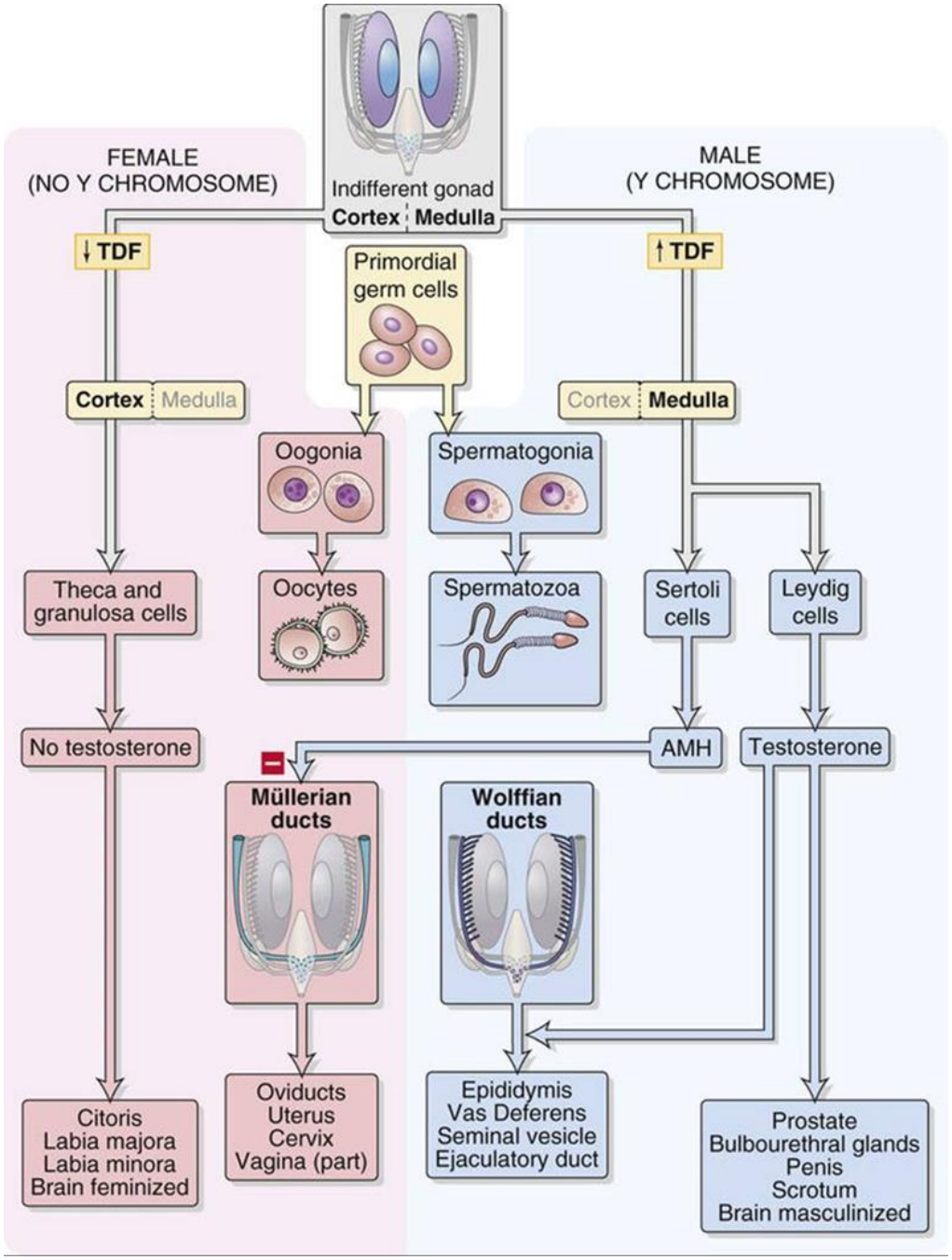


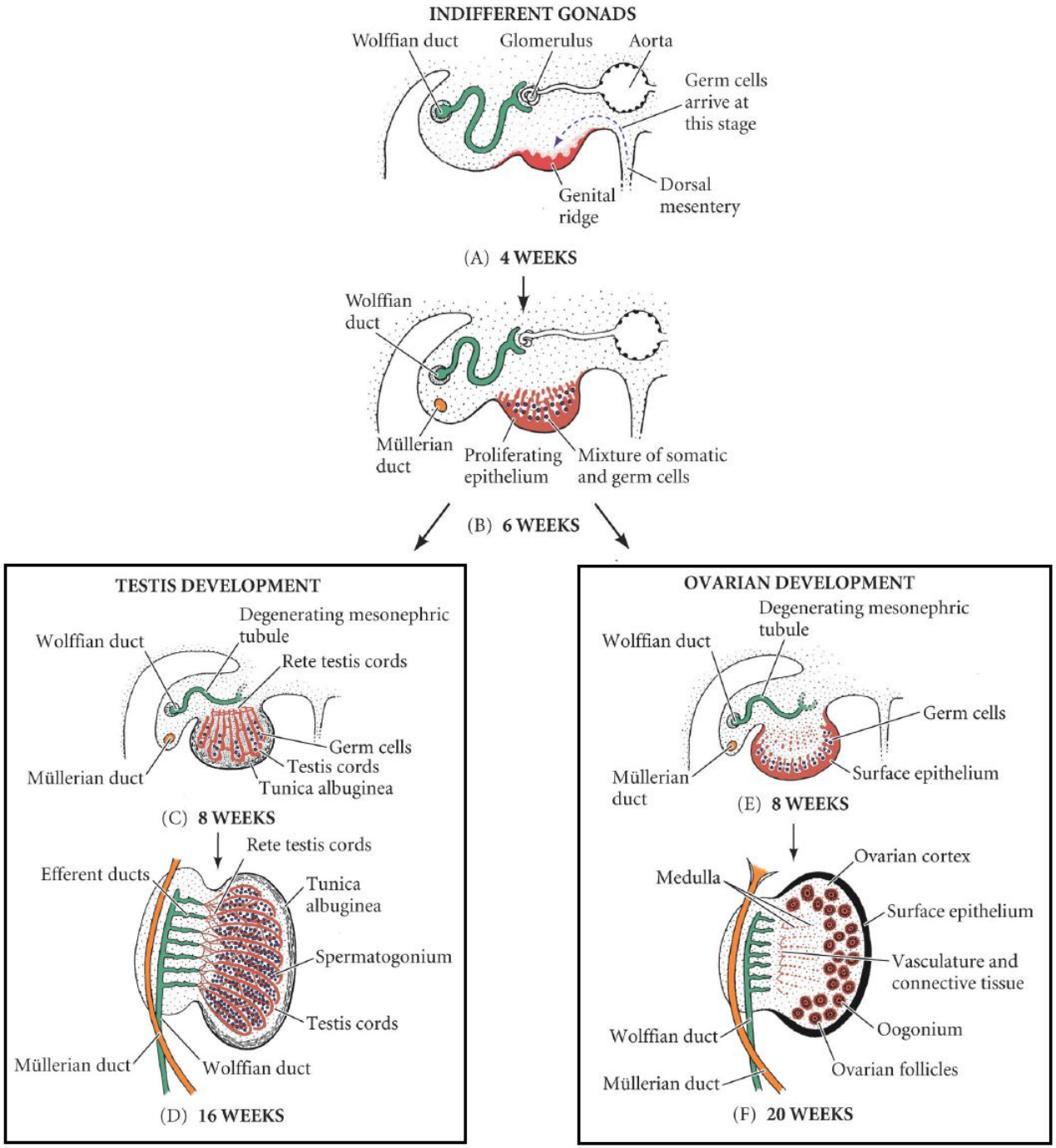

GONADS
XY
XX
MEDULLA
CORTEX
SRY (+)
SRY (−)
TDF
NO TDF
OVARIES
FOLLICULAR CELLS
ESTROGEN
NO TESTES
OOCYTES
NO SERTOLI CELLS
NO MIF
(+) FEMALE GENITALIA
TESTES
TESTOSTERONE
MIF
5α-R
(+) ESONEPHRIC DUCTS
(−) MULLERIAN DUCTS
(+) MULLERIAN DUCTS
DHT
(+) MALE GENITALIA
EPIDIDYMIY
VAS DEFERENS
SEMINAL VESICLES
COMMON EJACULATORY DUCT
FALLOPIAN DUCTS
UTERUS
UPPER 2/3 OF VAGINA
FALLOPIAN TUBES
UTERUS
UPPER 2/3 OF VAGINA
TESTES
TUBULES
SEMINIFURUS TUB.
RETE TESTIS
LEYDIG CELLS
TESTOSTERONE
SERTOLI CELLS
MULLERIAN INHIBITING FACTOR (MIF)
SPERM



Dihydrotestosterone

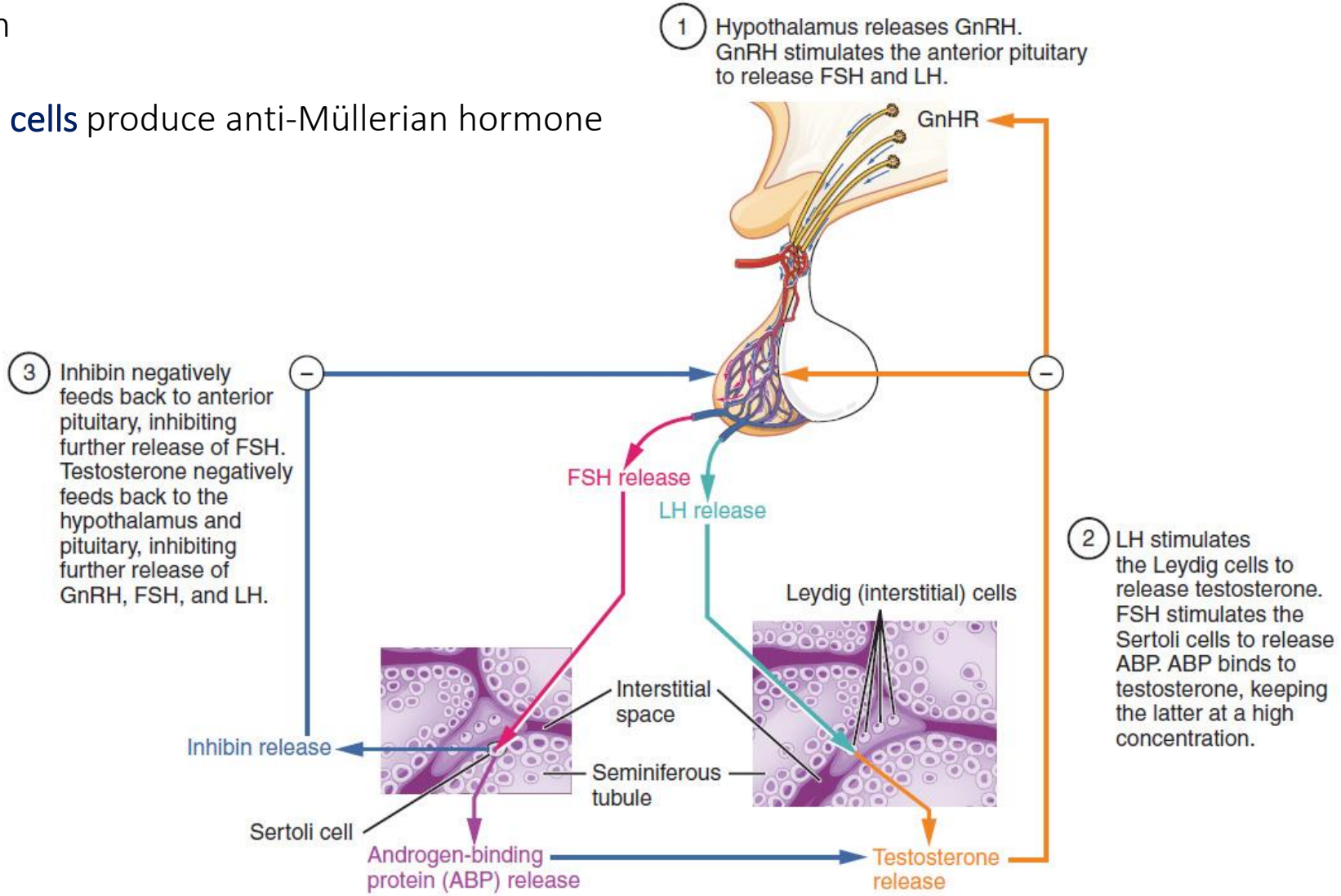
(Anti-Müllerian hormone)

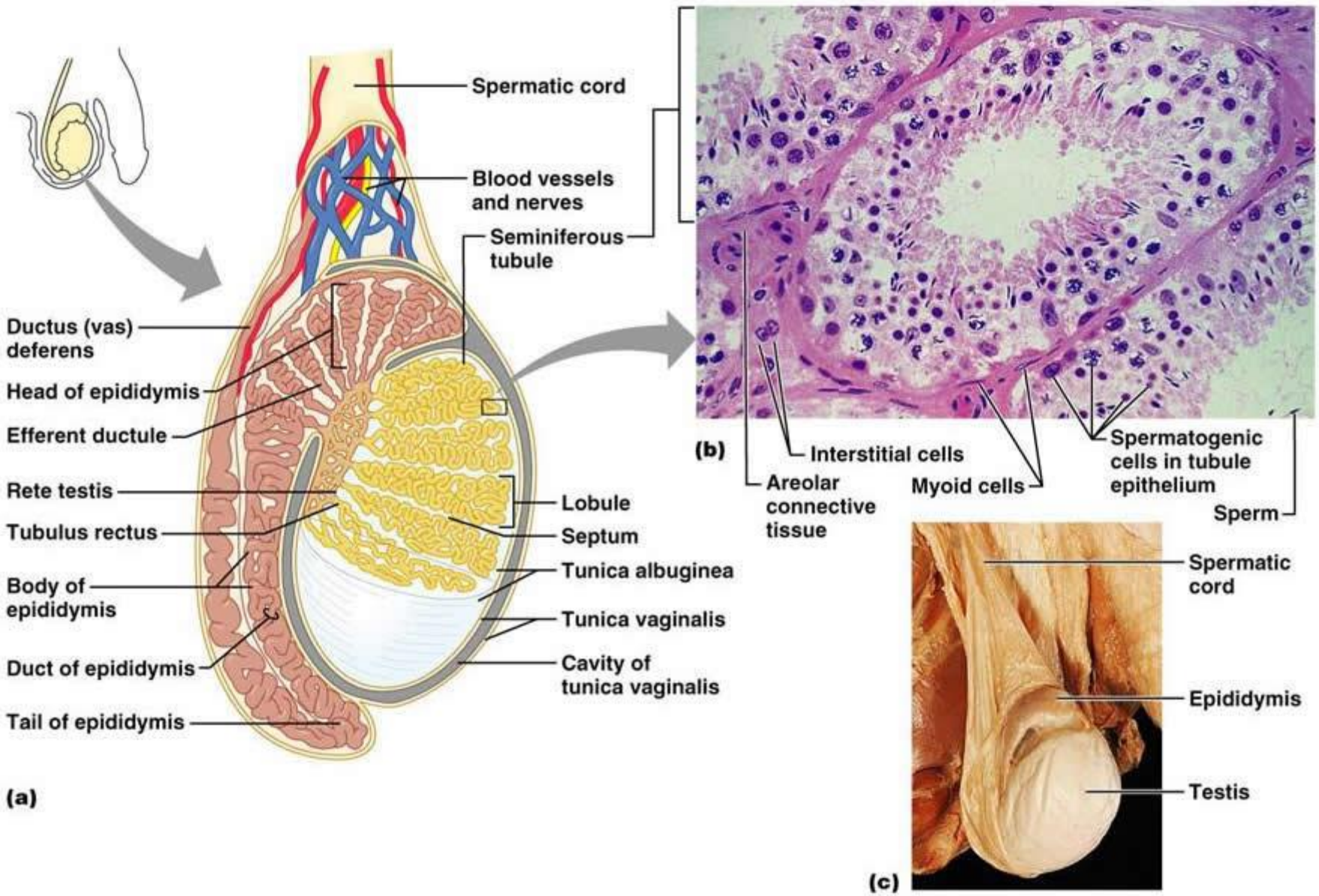

FEMALE
(NO Y CHROMOSOME)
Indifferent gonad
Cortex Medulla
MALE
(Y CHROMOSOME)
↓ TDF
Primordial germ cells
↑ TDF
Cortex Medulla
Oogonia
Spermatogonia
Cortex Medulla
Theca and granulosa cells
Oocytes
Spermatozoa
Sertoli cells
Leydig cells
No testosterone
AMH
Testosterone
Müllerian ducts
Wolffian ducts
Citoris
Labia majora
Labia minora
Brain feminized
Oviducts
Uterus
Cervix
Vagina (part)
Epididymis
Vas Deferens
Seminal vesicle
Ejaculatory duct
Prostate
Bulbourethral glands
Penis
Scrotum
Brain masculinized


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

Leydig cells produce androgenes – determine development of organs of male reproductive system

Sertoli cells produce anti-Müllerian hormone




Spermatic cord
Blood vessels and nerves
Seminiferous tubule
Ductus (vas) deferens
Head of epididymis
Efferent ductule
Rete testis
Tubulus rectus
Body of epididymis
Duct of epididymis
Tail of epididymis
Lobule
Septum
Tunica albuginea
Tunica vaginalis
Cavity of tunica vaginalis
(a)
(b)
Areolar connective tissue
Interstitial cells
Myoid cells
Spermatogenic cells in tubule epithelium
Sperm
Spermatic cord
Epididymis
Testis
(c)

Gubernaculum

In male

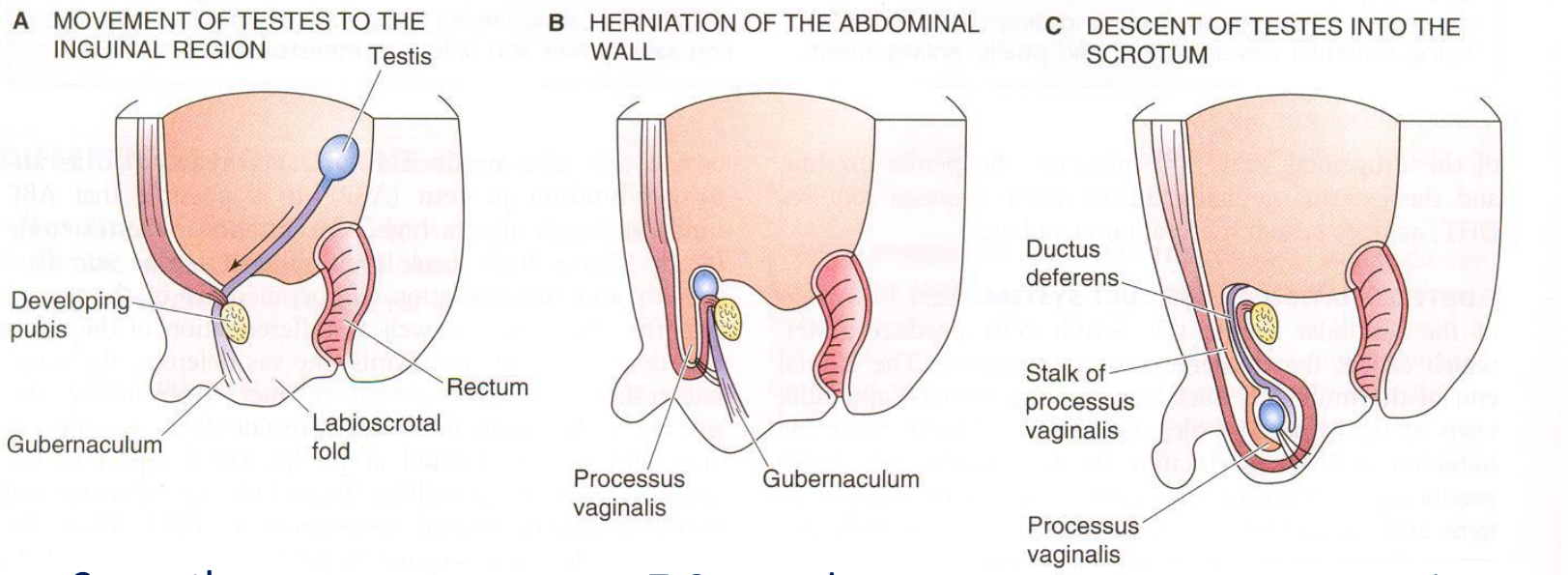
- The gubernaculum guides the descent of the testes into the scrotum
- Pulls down the ductal system and the testes to the scrotum, forming the spermatic cord

In female

- The gubernaculum guides the descent of the ovaries and ductal system into the pelvis
- It eventually splits to form:

-*Ovarian ligament* – connects the ovary and uterus

-*Round ligament* – connects the uterus and labia



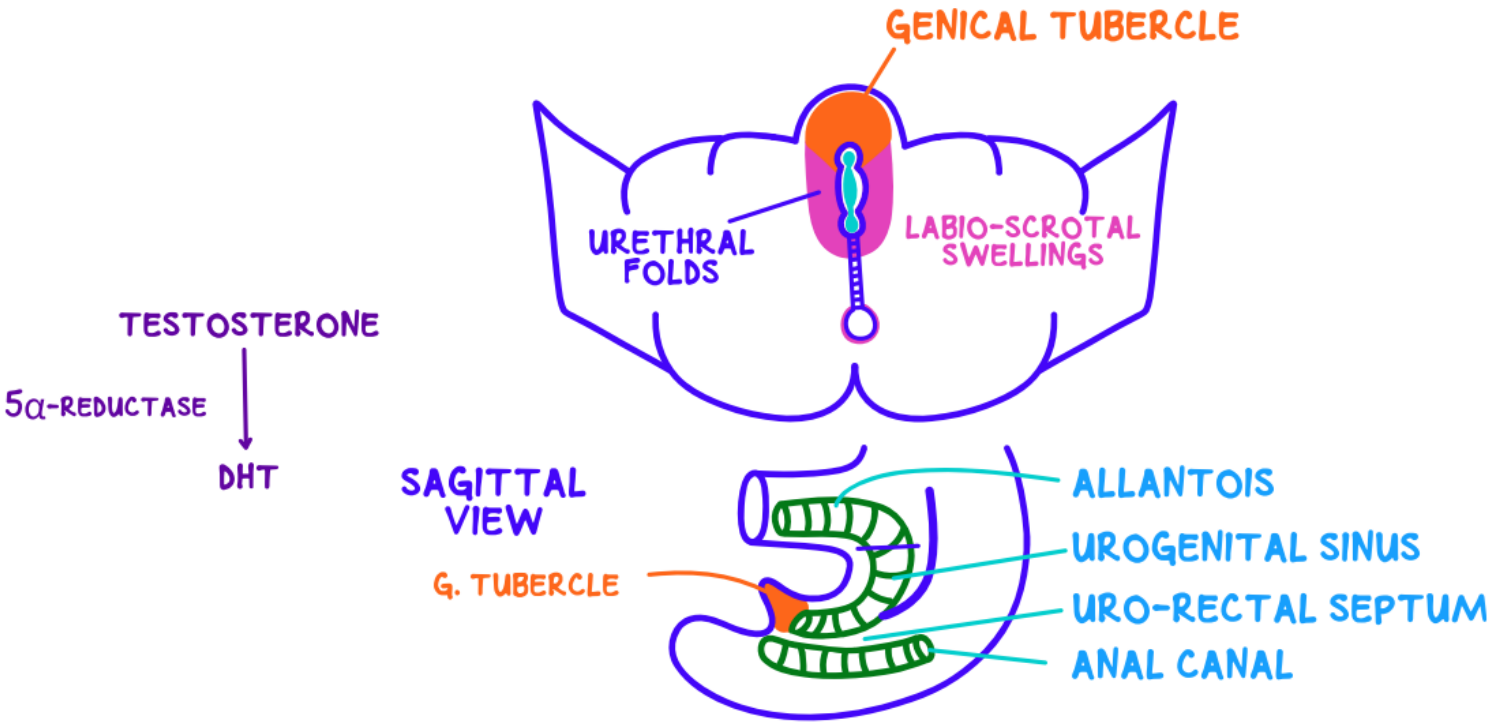
3 months

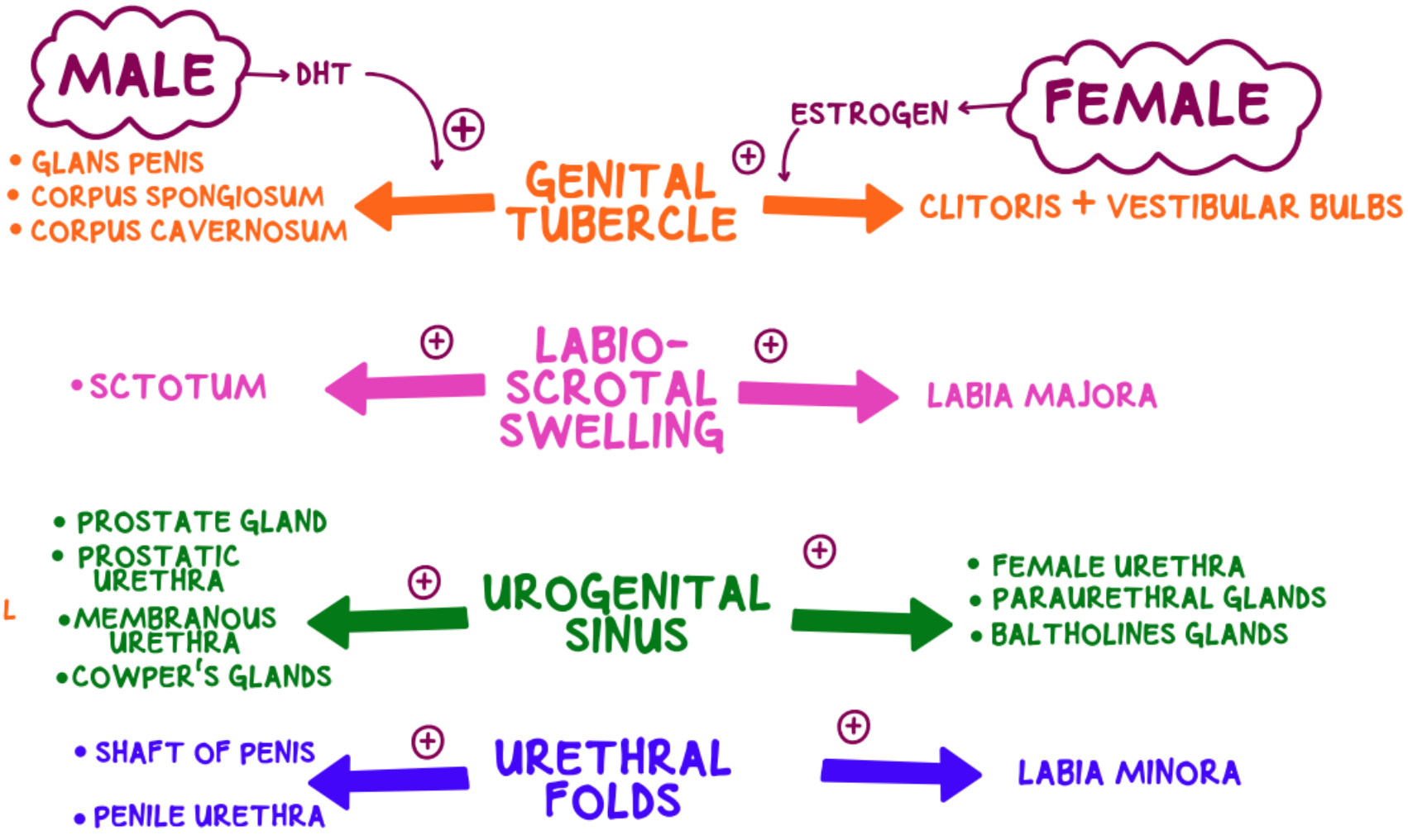
7-8 months

9 months

- The testis develops as part of the urogenital ridge on the posterior body wall inside the abdominal cavity.
- The testis is attached to the scrotum by a band of connective tissue – gubernaculum testis.
- 3rd month – start to descend with concomitant shortening of the gubernaculum.
- The scrotum is merely an outpocketing of the body wall.

External Genitalia



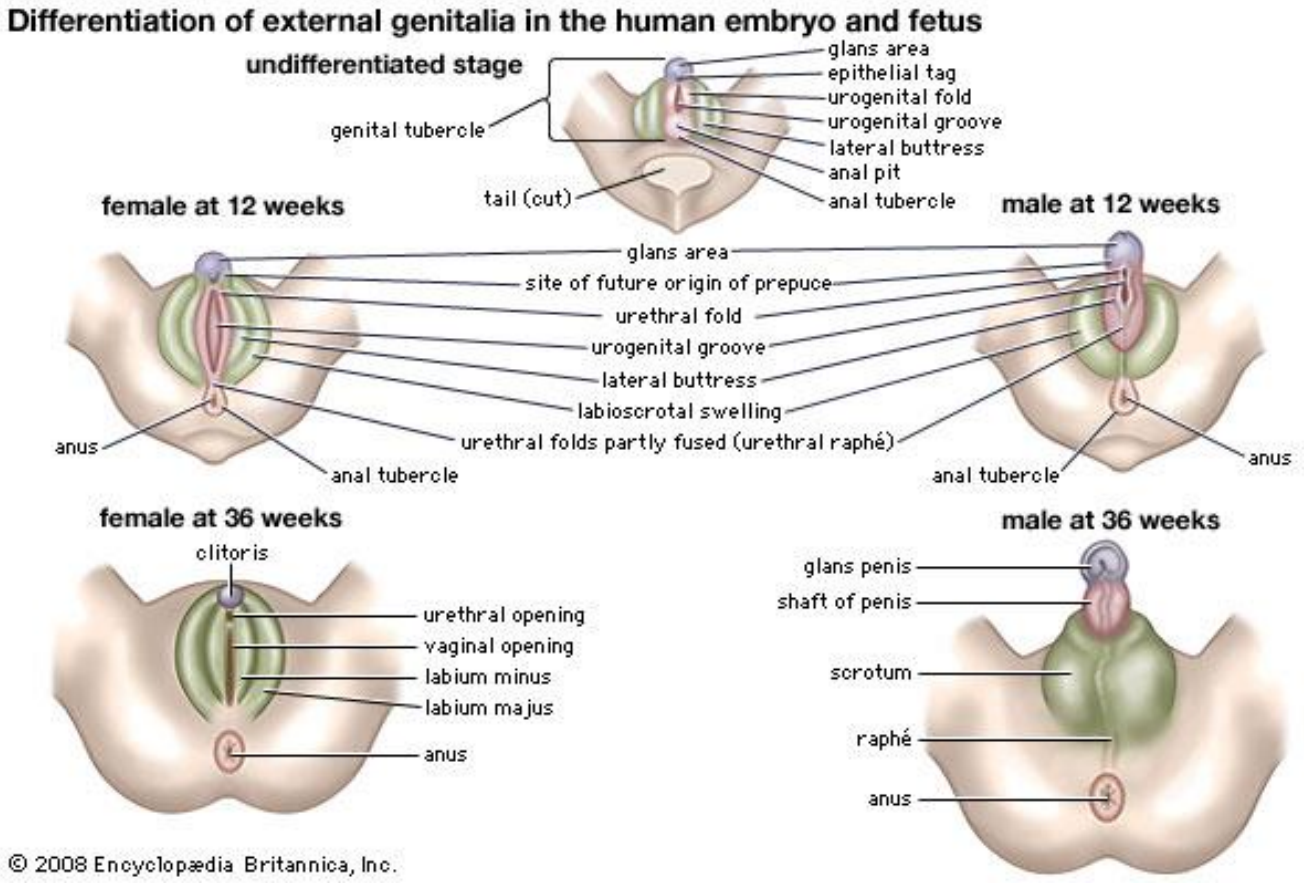

MALE
DHT
FEMALE
ESTROGEN
• GLANS PENIS
• CORPUS SPONGIOSUM
• CORPUS CAVERNOSUM
GENITAL TUBERCLE
CLITORIS + VESTIBULAR BULBS
•SCTOTUM
LABIO-SCROTAL SWELLING
LABIA MAJORA
• PROSTATE GLAND
• PROSTATIC URETHRA
•MEMBRANOUS URETHRA
•COWPER'S GLANDS
UROGENITAL SINUS
• FEMALE URETHRA
• PARAURETHRAL GLANDS
• BALTHOLINES GLANDS
• SHAFT OF PENIS
• PENILE URETHRA
URETHRAL FOLDS
LABIA MINORA

Female

Glans area – clitoris
Urogenital fold – labium minus
Lateral buttress – labium majus

Male

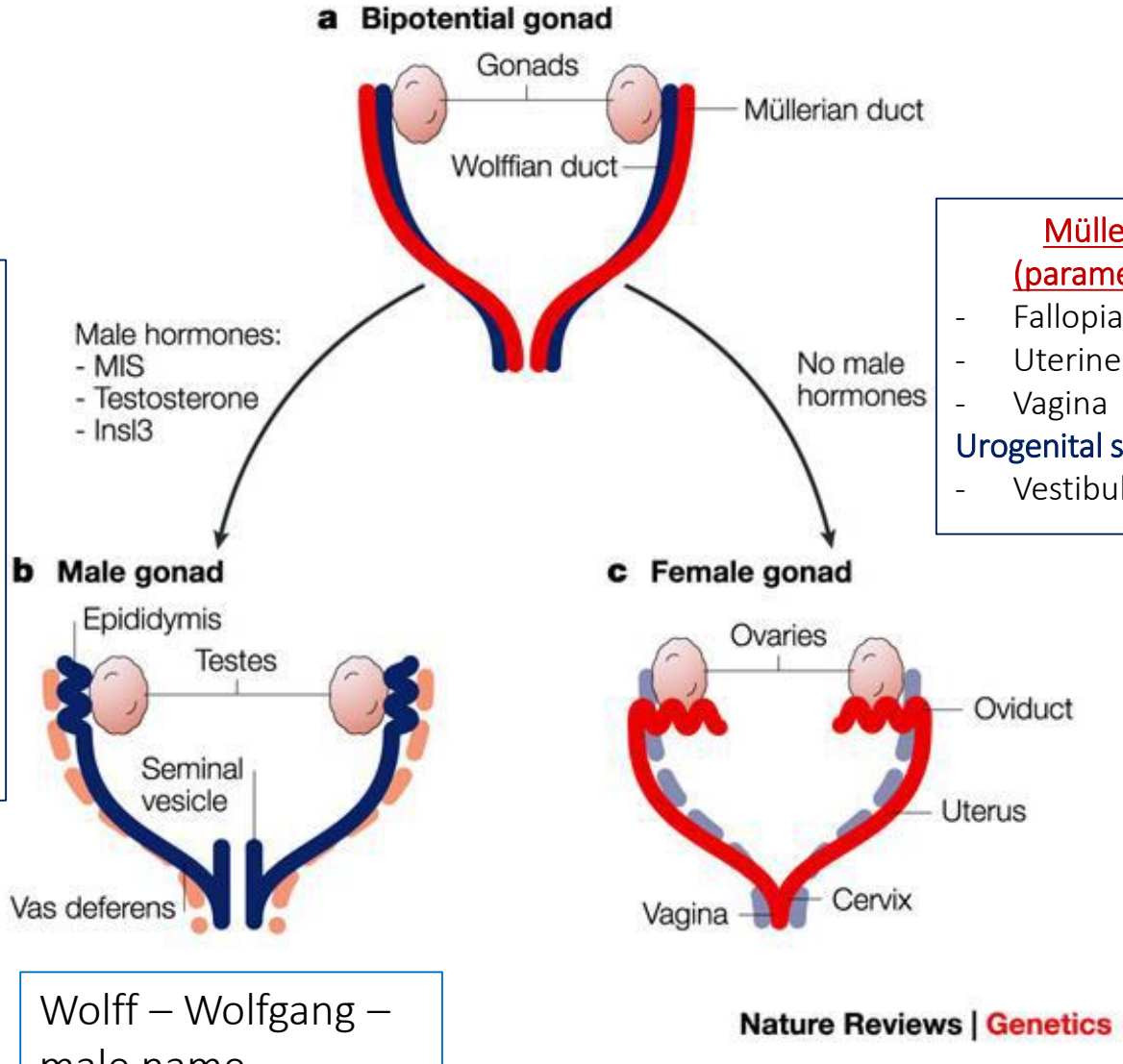
Glans area – corpus cavernosum and glans penis
Urogenital fold – corpus spongiosum and pars spongiosa urethrae
Lateral buttress – scrotum



Structure	Males	Females
Primordial Germ Cells	Sperm	Oocytes
Gonads	Testes	Ovaries
Mesonephric / Wolffian Ducts	Epididymis Vas deferens Common ejaculatory duct	None (regresses)
Paramesonephric / Mullerian Ducts	None (regresses)	Uterus Fallopian tubes Upper 2/3 of vagina
Gubernaculum	Spermatic cord	Ovarian ligament Round ligament
Urogenital Sinus	Bladder Prostatic urethra Membranous urethra Prostate gland Cowper's / Bulbourethral gland	Bladder Female urethra Paraurethral glands Bartholin's glands
Genital Tubercle	Glans penis Corpus spongiosum Corpus cavernosum	Clitoris Vestibular bulbs
Labioscrotal Swellings	Scrotum	Labia majora
Urethral Folds	Shaft of penis Penile urethra	Labia minora

Wolffian duct (mesonephric):
- Rete testis
- Efferent tubules of testis
- Epididimys canal
- Ductus deferens
- Seminal vesicles

Urogenital sinus
- Prostatic part of urethra
- prostate

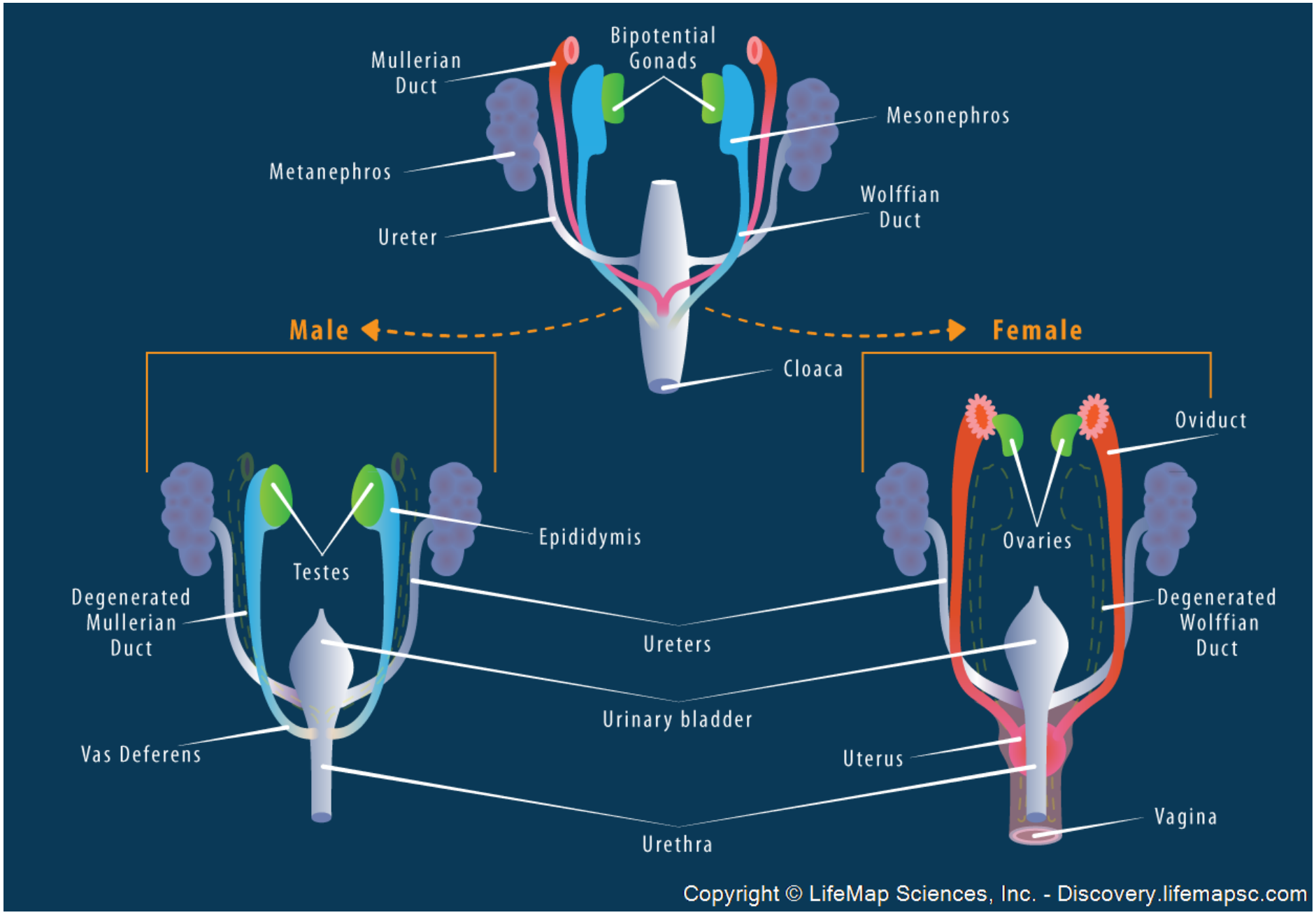


Müllerian duct (paramesonephric:
- Fallopian tubes
- Uterine
- Vagina

Urogenital sinus:
- Vestibulum vaginae

Wolff – Wolfgang – male name

Frau Müller - female


Mullerian Duct
Bipotential Gonads
Mesonephros
Metanephros
Wolffian Duct
Ureter
Male
Female
Cloaca
Oviduct
Epididymis
Ovaries
Testes
Degenerated Mullerian Duct
Ureters
Degenerated Wolffian Duct
Urinary bladder
Vas Deferens
Uterus
Vagina
Urethra
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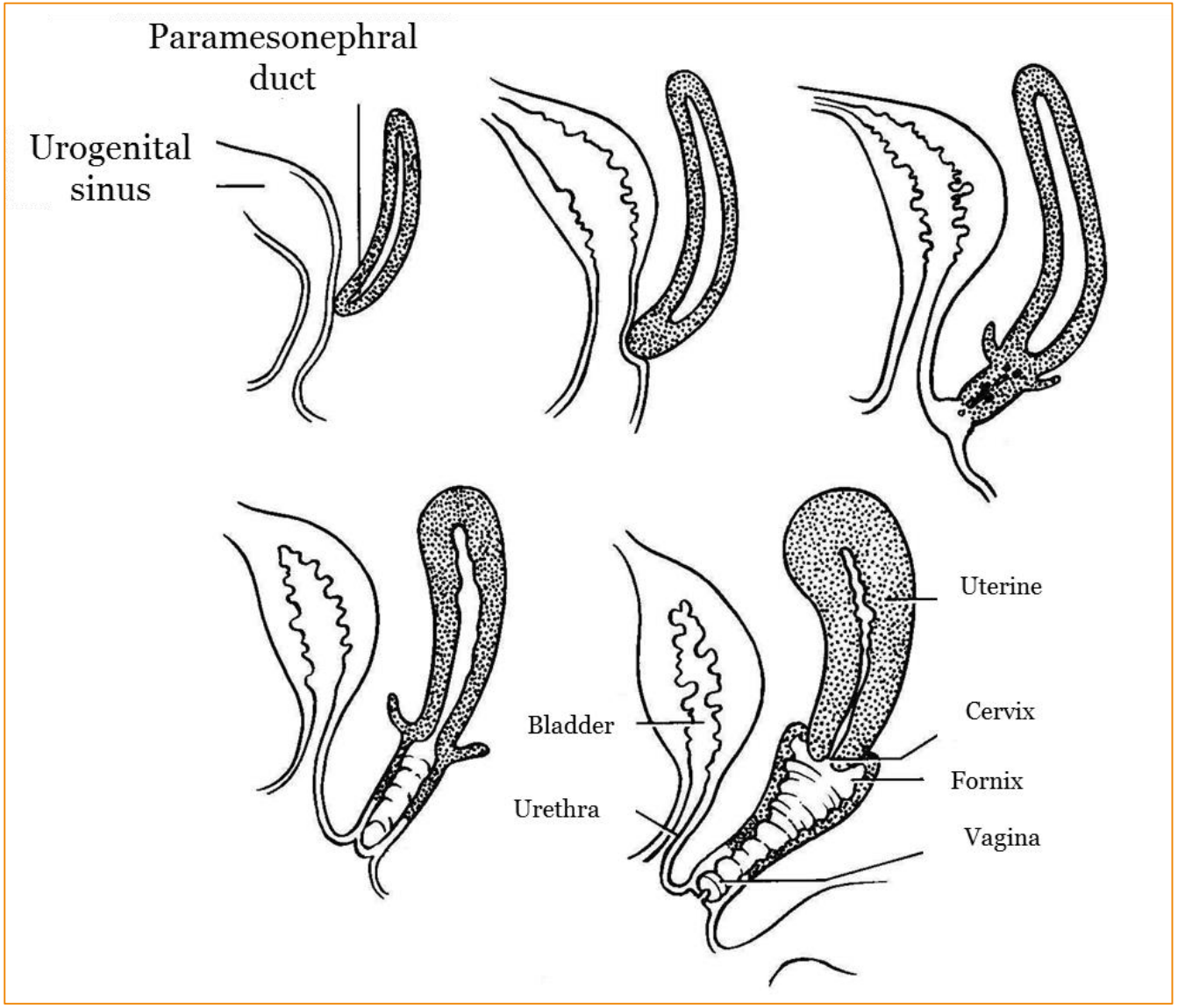
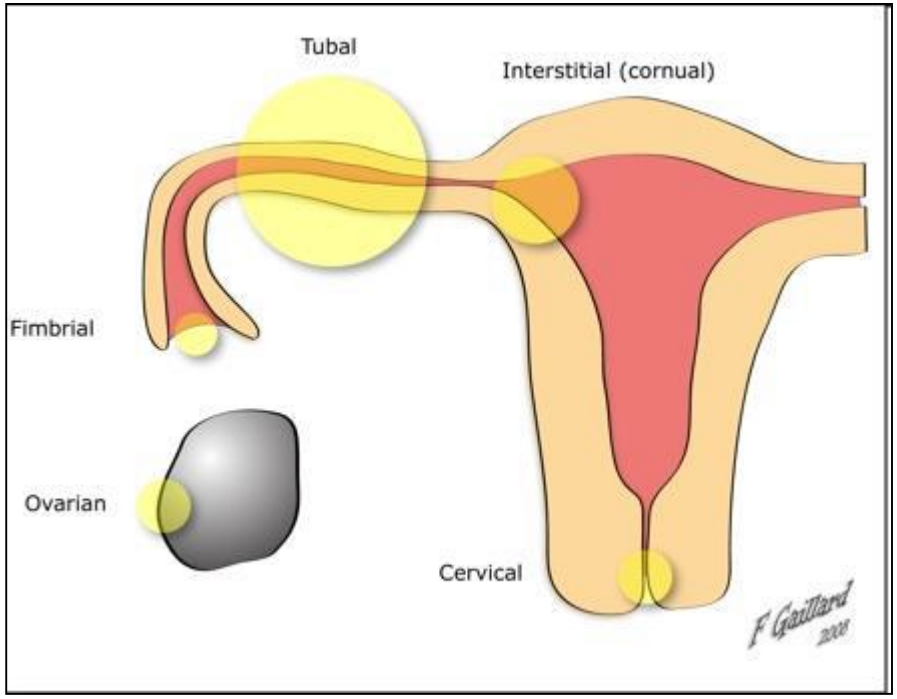
Hymen

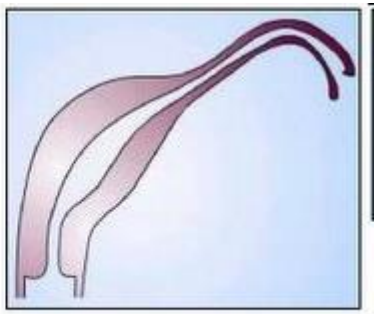

Paramesonephral duct
Urogenital sinus
Uterine
Cervix
Bladder
Fornix
Urethra
Vagina

Congenital abnormalities of female reproductive system:

- ectopy of the ovarian
- accessory ovarian
- hypoplasia of ovarian
- hermaphroditism
- aplasia of uterine, the fallopian tubes, vagina



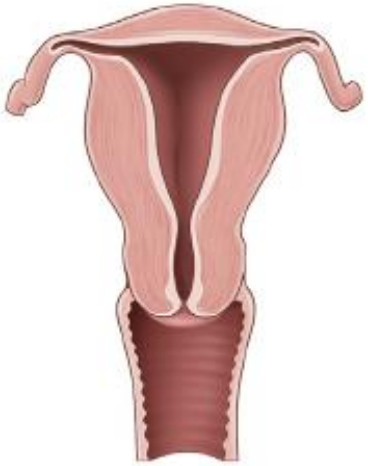
Normal uterus



Unicornuate uterus

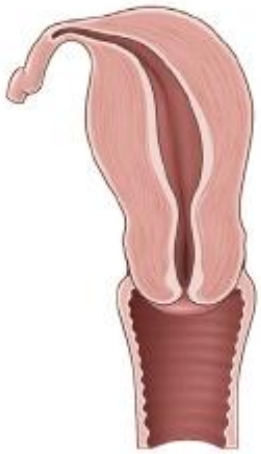
Congenital Müllerian Anommalies

Normal uterus

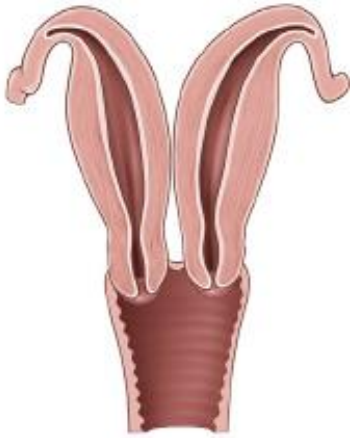


Class I: Uterine hypoplasia and/or agenesis

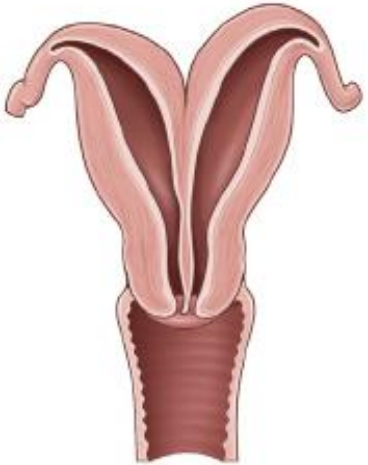
Class II: Unicornuate uterus



Class III: Uterus didelphys



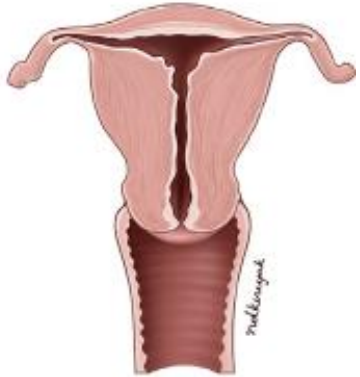
Class IV: Bicornuate uterus



Class V: Septate uterus

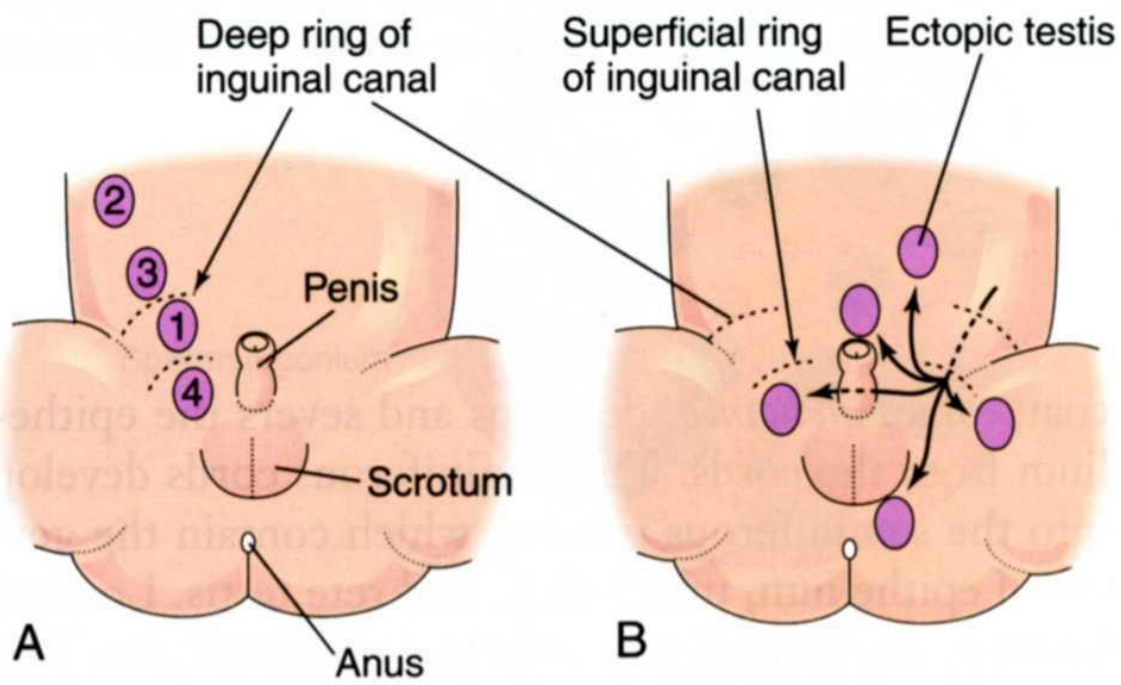
Class VI: Arcuate uterus

Class VII: Diethylstilbestrol (DES) drug related



Congenital abnormalities of testis:

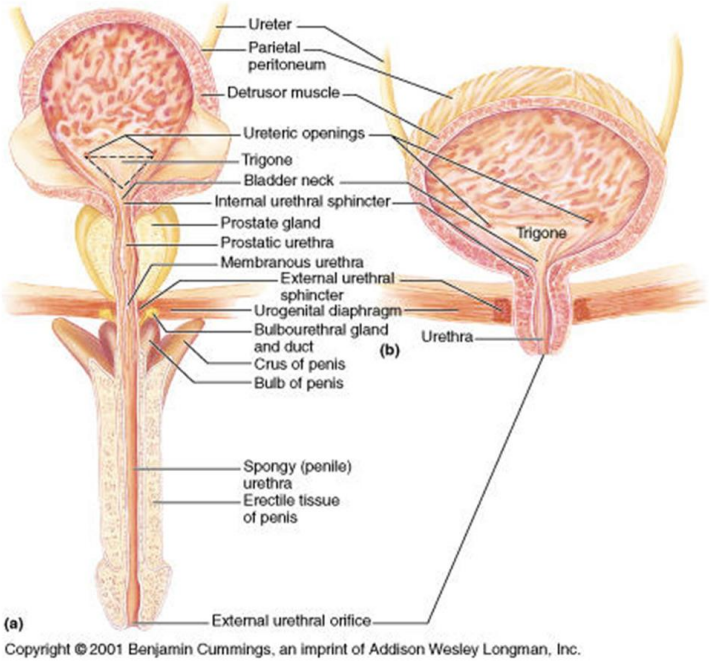
- Hypoplasia
- Retention (monorchism, criptorchism)
- Ectopy
- Inversion
- Synorchism, polyorchism
- Congenital herntiation
- Hermaphroditism



Differences between male and female urethra

Male urethra

- longer
- has 3 parts:
  - ➢ Pars prostatica
  - ➢ Pars membranosa
  - ➢ Pars spongiosa
- Conducts urine and spermen

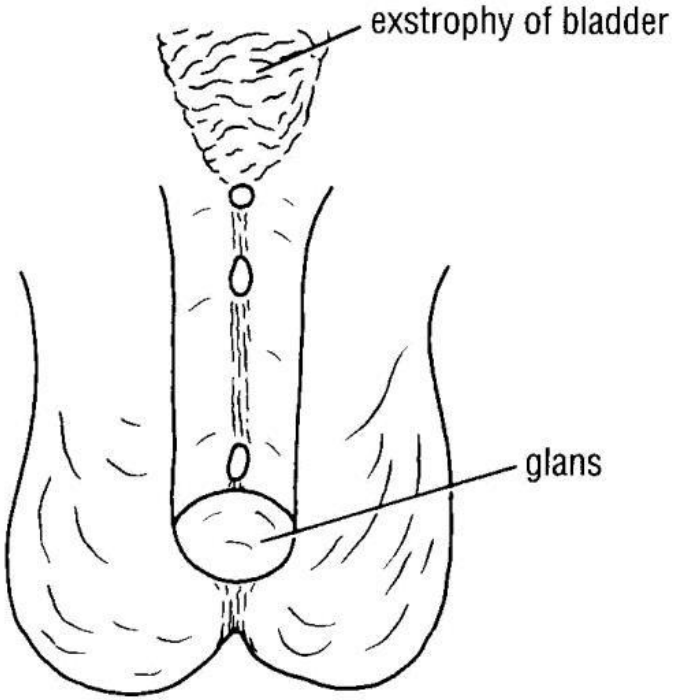


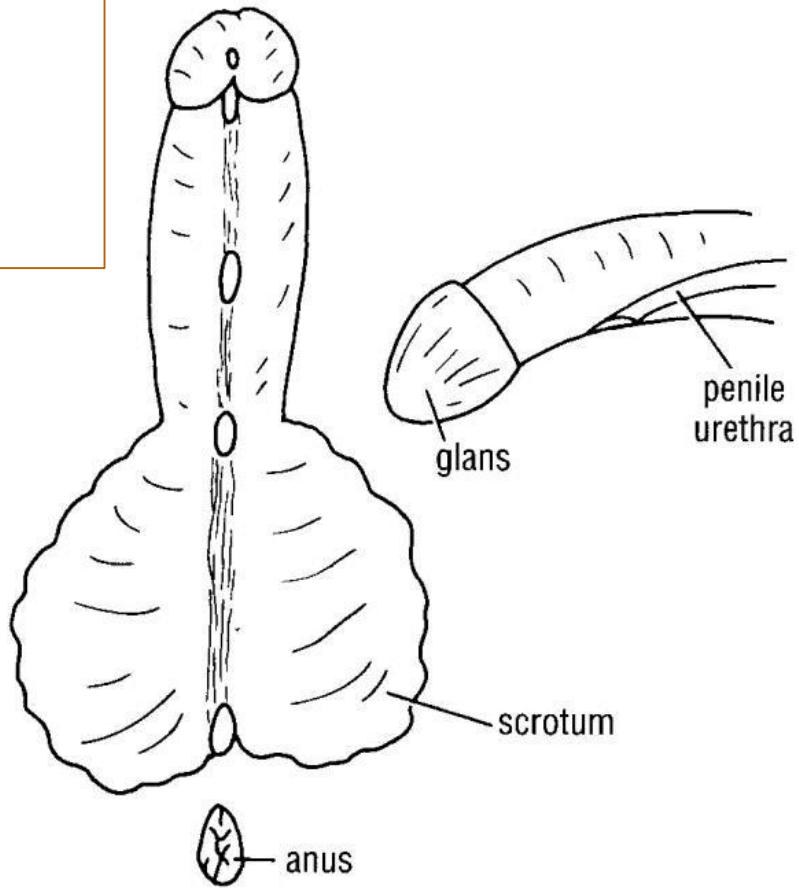
Female urethra

- Shorter, without parts determination, but wider
- Pelvic part is adjacent to cervix (danger of damage during surgical operation)
  - ➢ Easy infected
- Conducts urine only

Congenital abnormalities of male urethra:

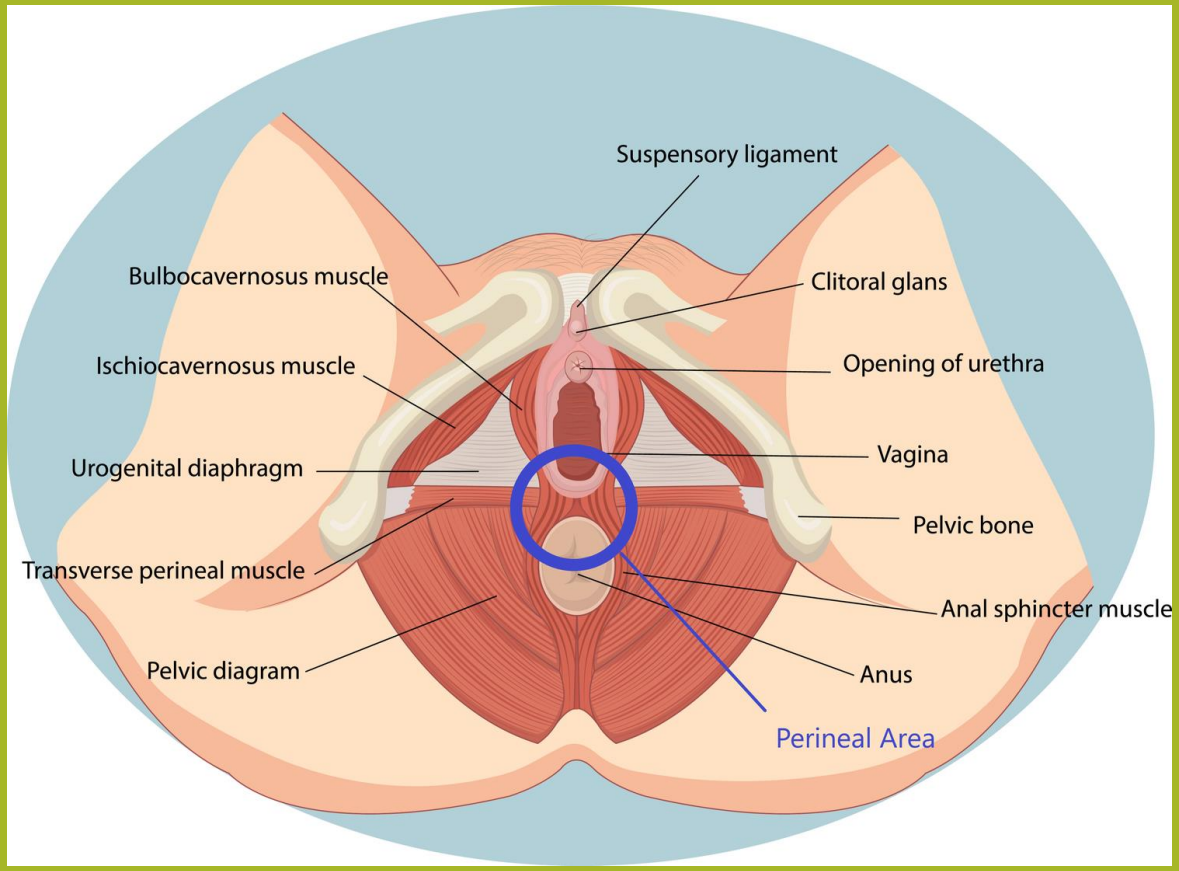
- Hypospadia
- Epispadia
- Doubled urethra
- Narrowed urethra



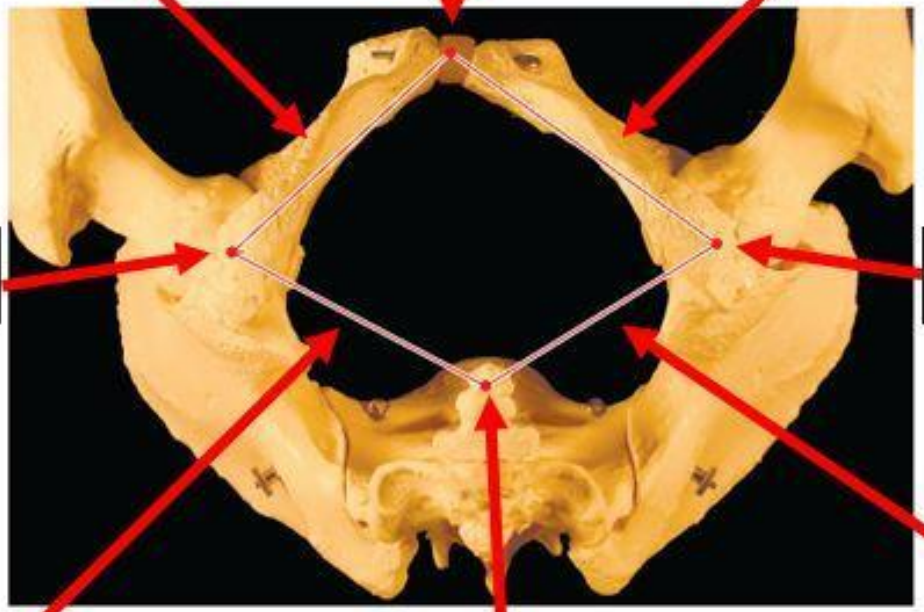


Perineum

composed of the soft tissues that close the pelvic outlet



Boundaries of the perineum



Anterolateral

Ischiopubic ramus

Anteriorly

Pubic symphysis

Anterolateral

Ischiopubic ramus

Laterally

Ischial tuberosity

Laterally

Ischial tuberosity

Posterolateral

Sacrotuberus lig.

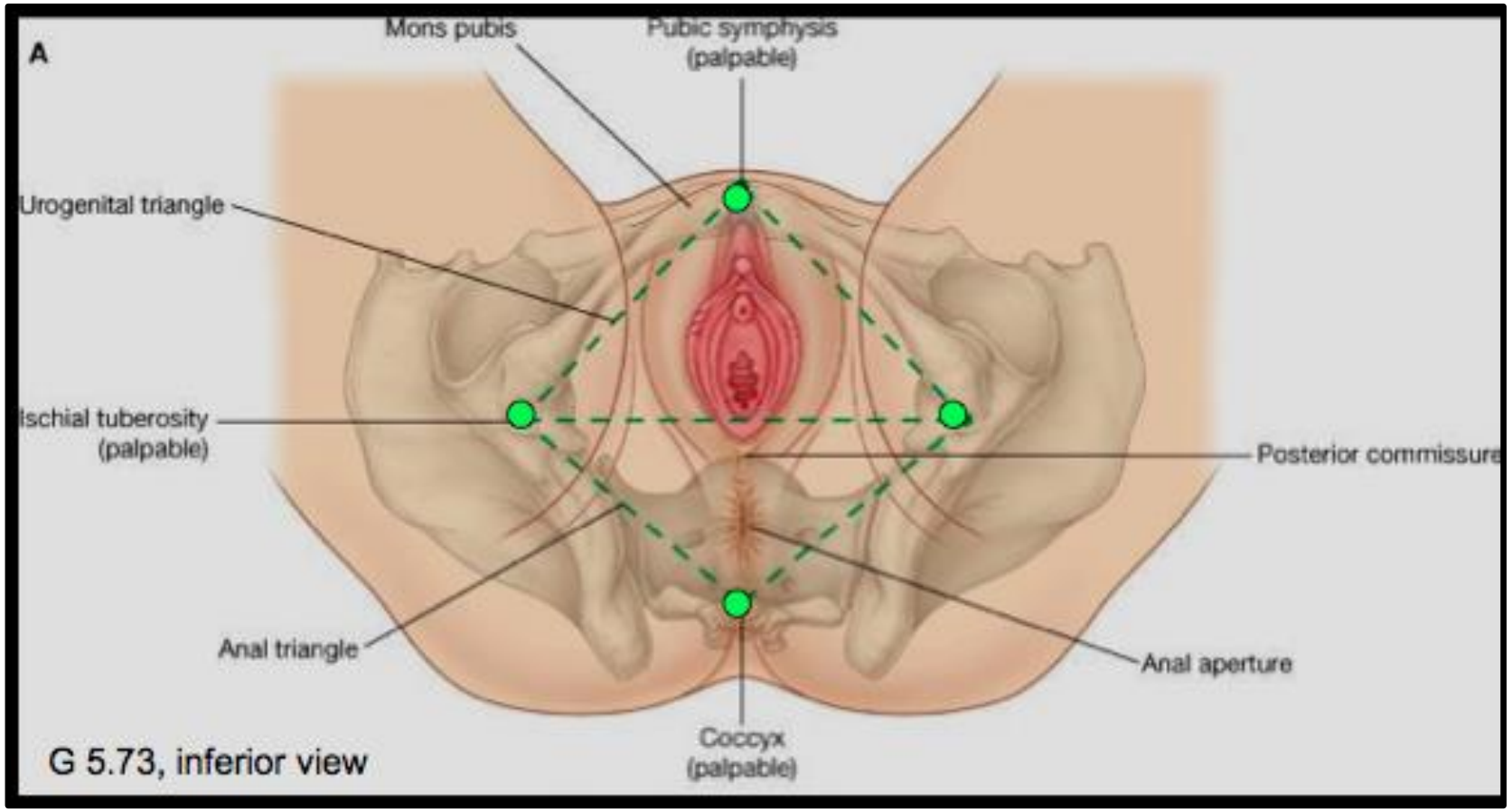
Posteriorly

sacrum/coccyx

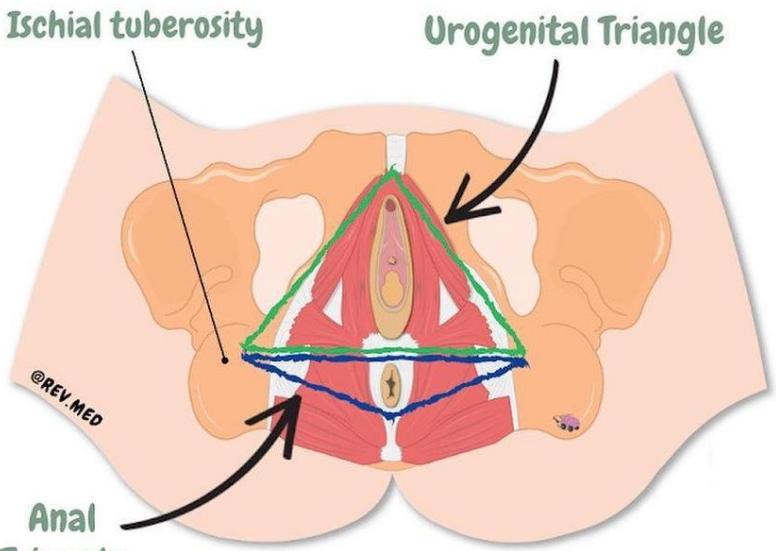
Posterolateral

Sacrotuberus lig.

Perineum


A
Mons pubis
Pubic symphysis
(palpable)
Urogenital triangle
Ischial tuberosity
(palpable)
Posterior commissure
Anal triangle
Anal aperture
Coccyx
(palpable)
G 5.73, inferior view

Triangles of Perineum



Contents of:

UROGENITAL TRIANGLE

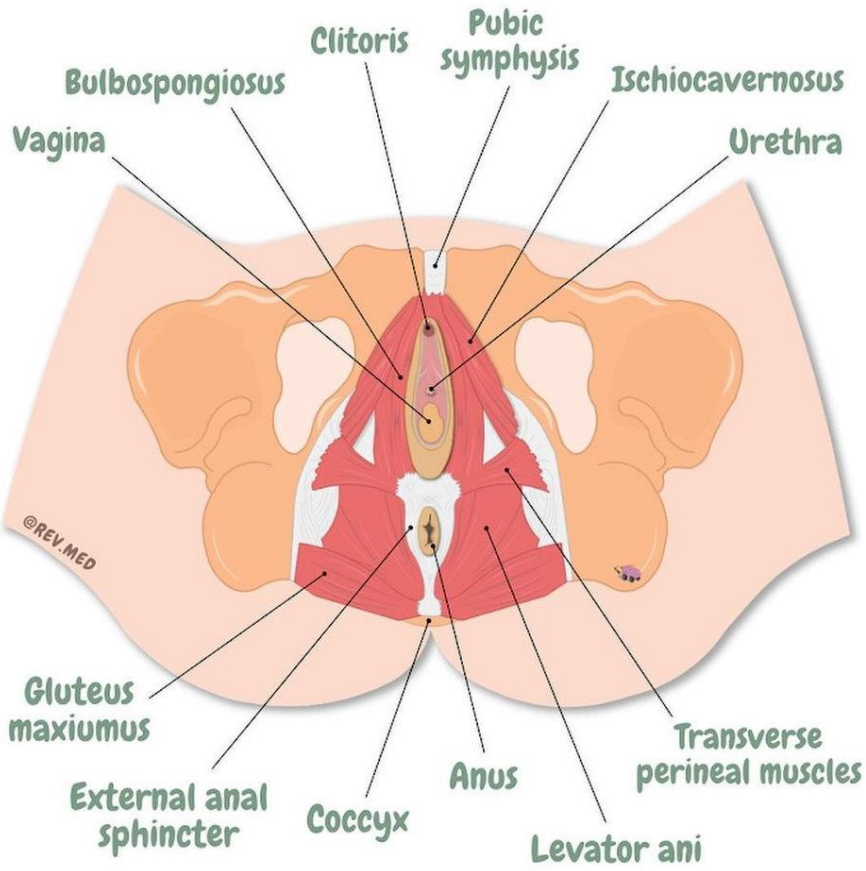
- Vagina
- Urethra
- Clitoris
- Perineal membrane

ANAL TRIANGLE

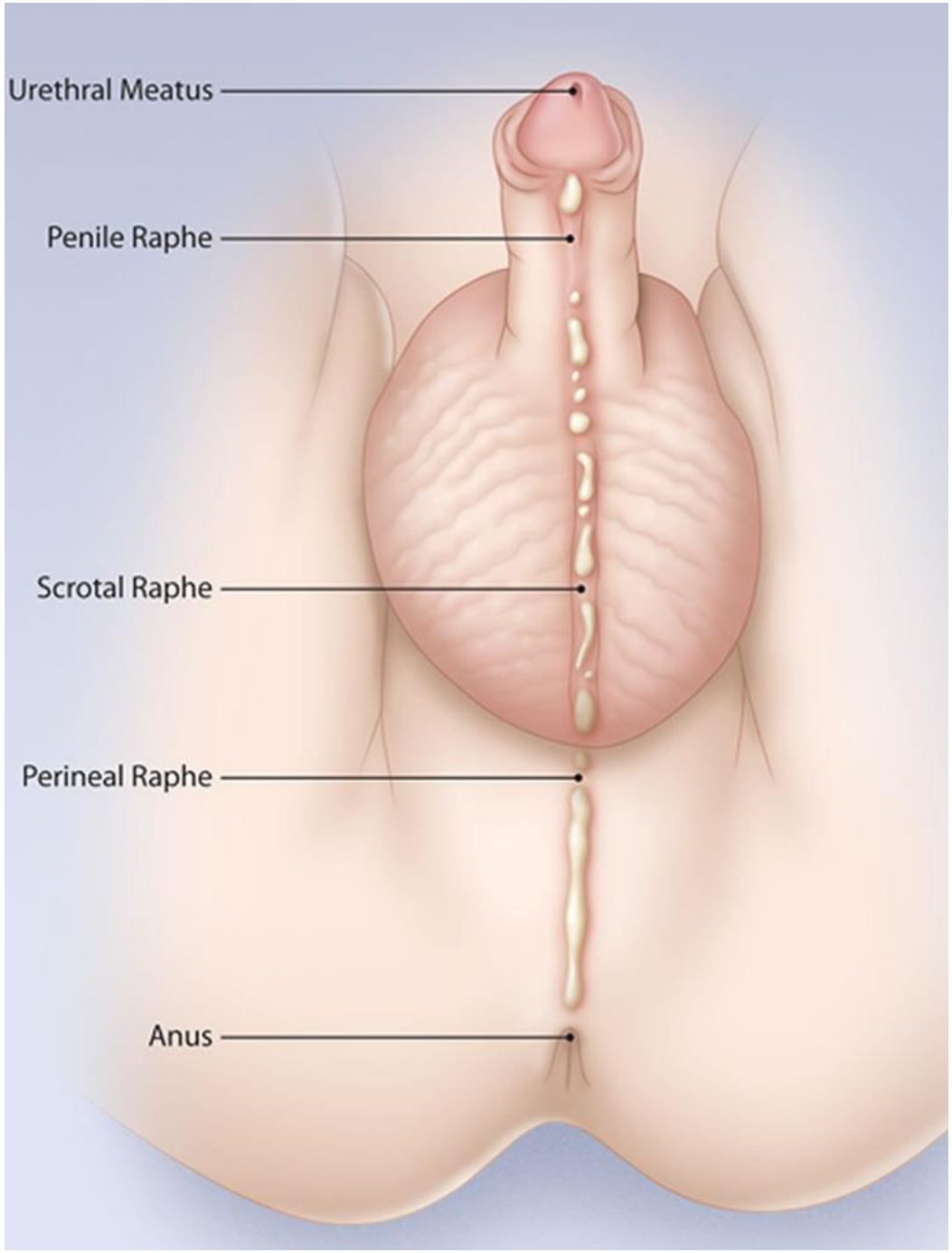
- Anus
- Ischioanal fossae
- External anal sphincter
- Pudendal nerve

REV Med

Perineum Muscles

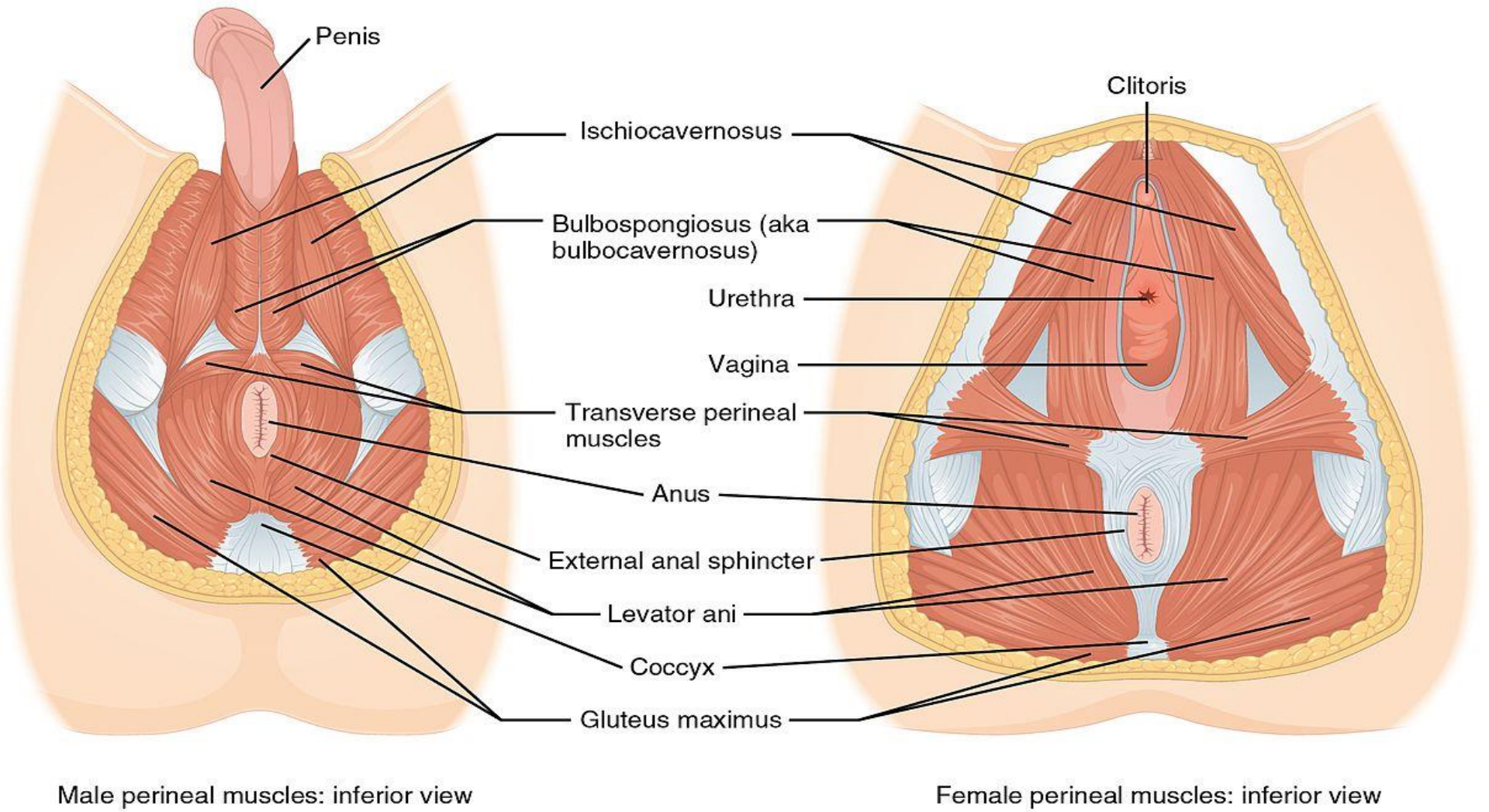


REV Med



RAPHE PERINEI

passes along the midline of the perineum; in males it is continued forwards as the scrotal raphe.



Male perineal muscles: inferior view

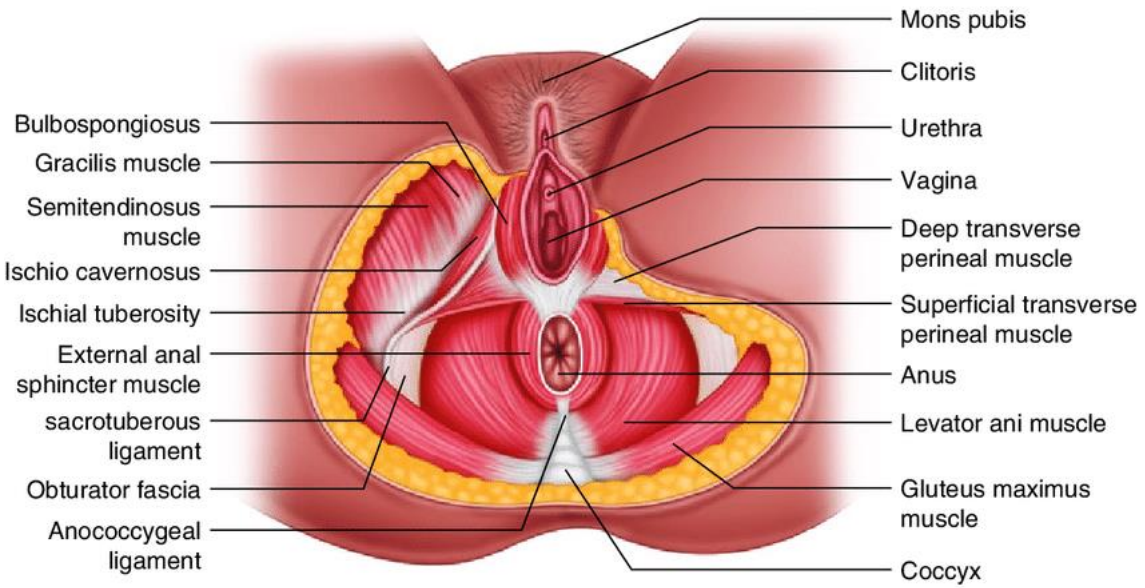
Female perineal muscles: inferior view

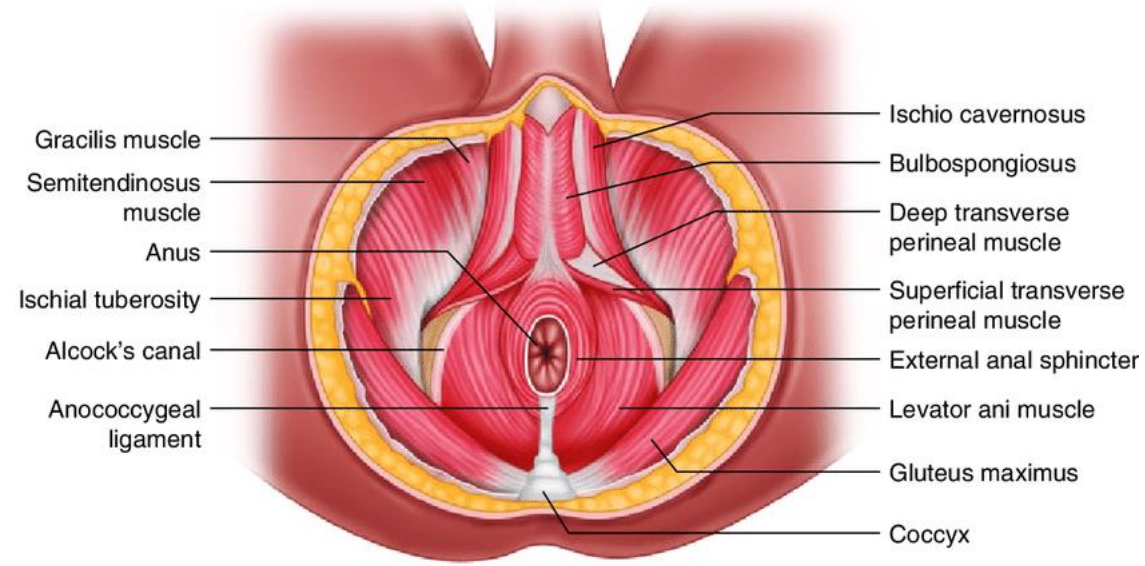
Muscles form the most important part of the peritoneum

Perineal muscles

- close the abdominal cavity from below;
- fix the pelvic organs
- maintain the intraabdominal pressure.
- form the sphincters around the rectum and urethra.

- ✓ *these sphincters are voluntary because they are composed of striated skeletal muscle fibers. In males the perineal muscles maintain penile erection.*



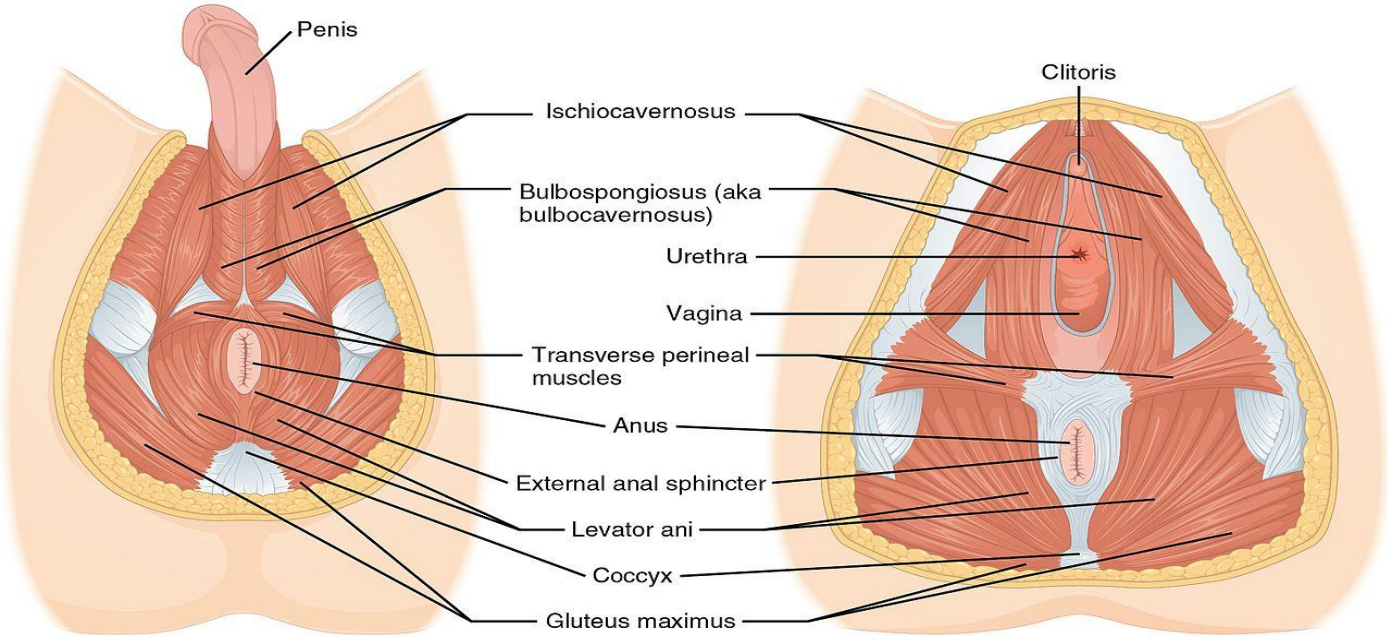


The muscles of the urogenital region

are divided into superficial and deep.

The superficial muscles are:
- m. transversus perinei superficialis
- m. ischiocavernosus
- m. bulbospongiosus

The deep muscles are:
- m. transversus perinei profundus
- m. sphincter externus



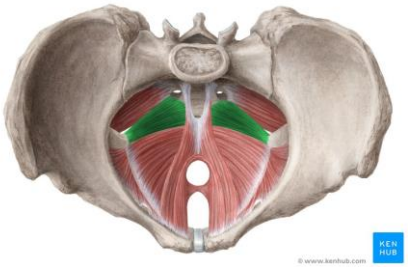
Male perineal muscles: inferior view

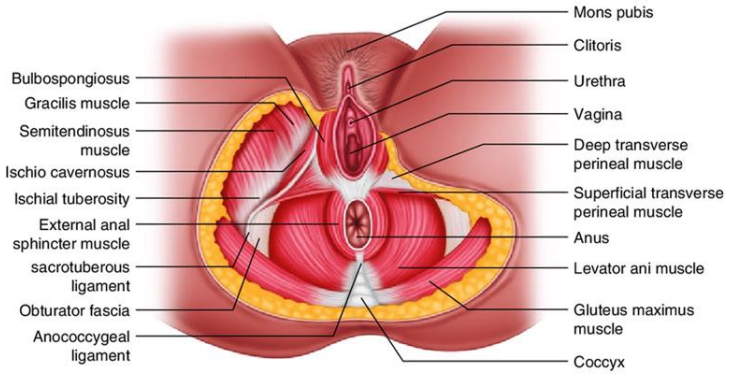
Female perineal muscles: inferior view

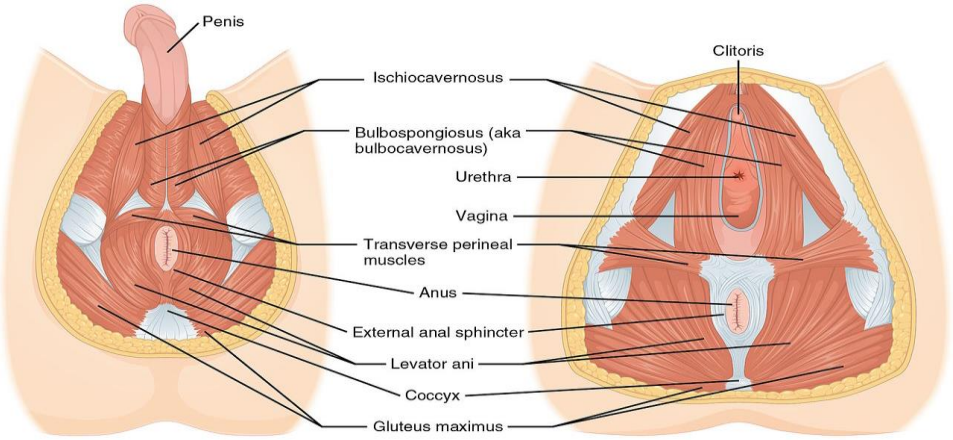
The muscles of the anal region are also divided into superficial and deep.

The superficial muscles are:
- m. sphincter ani externus

The deep muscles are:
- m. levator ani
- m. coccygeus

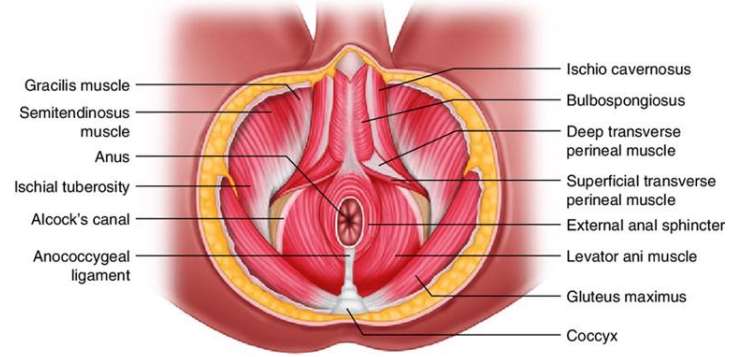


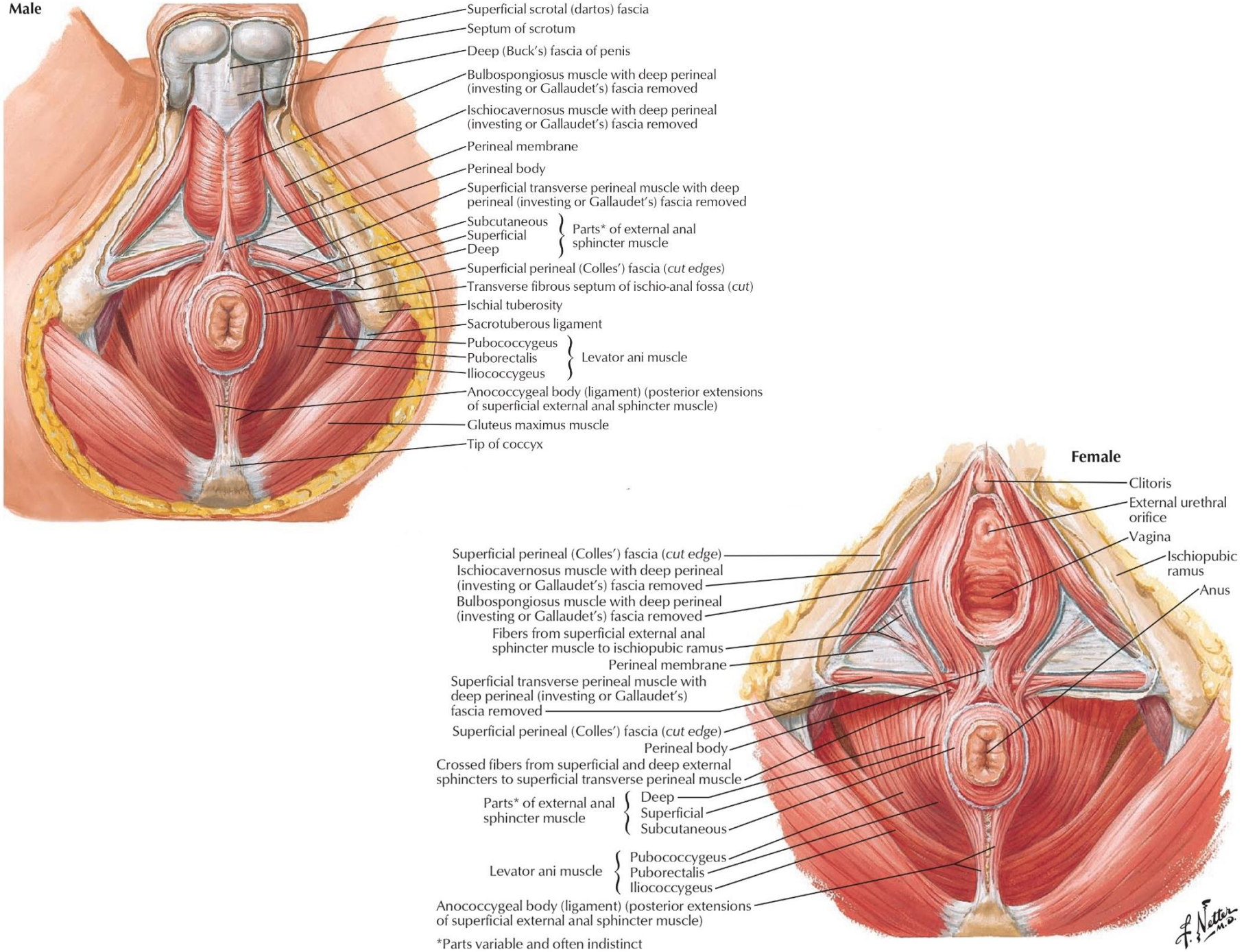


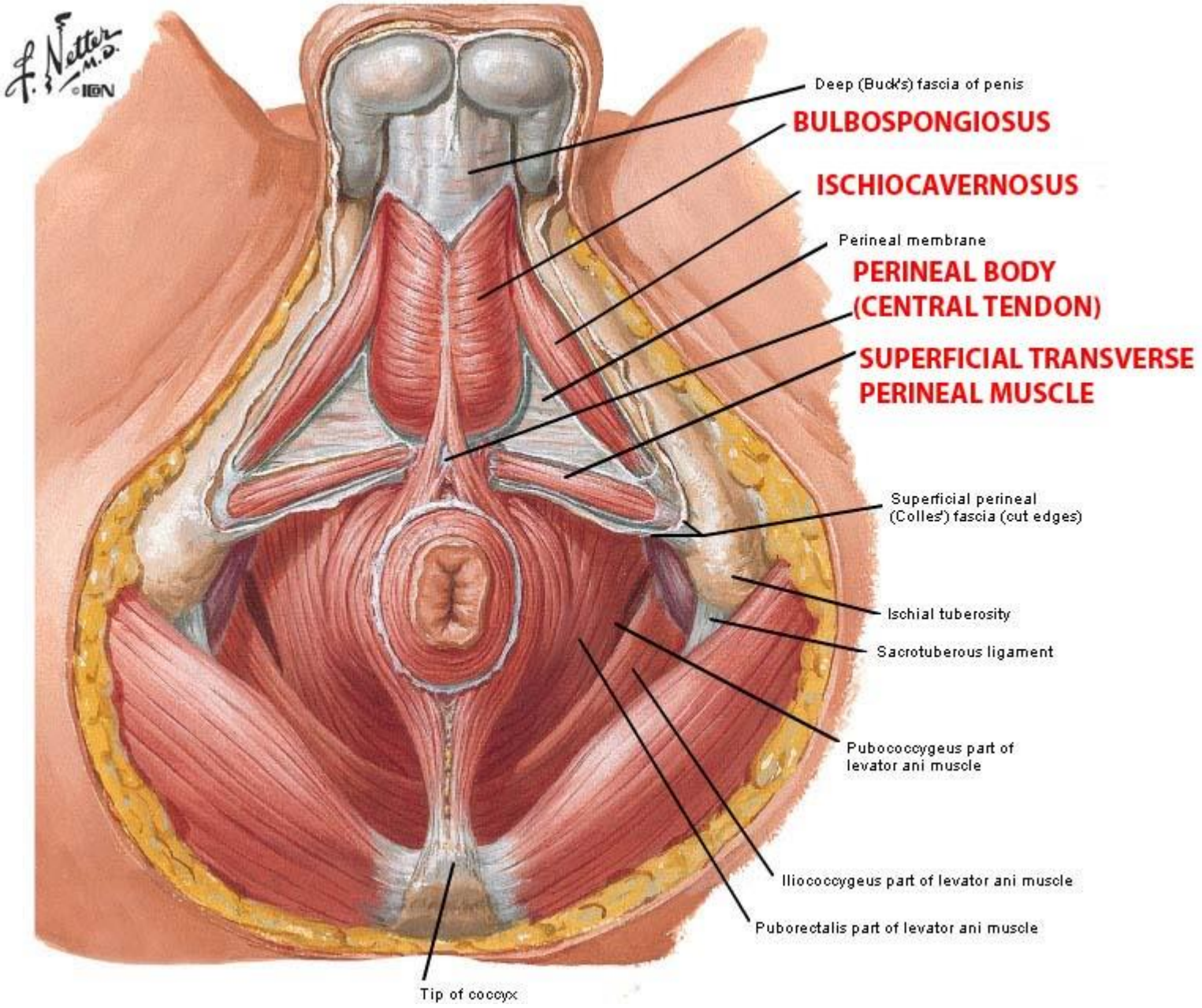


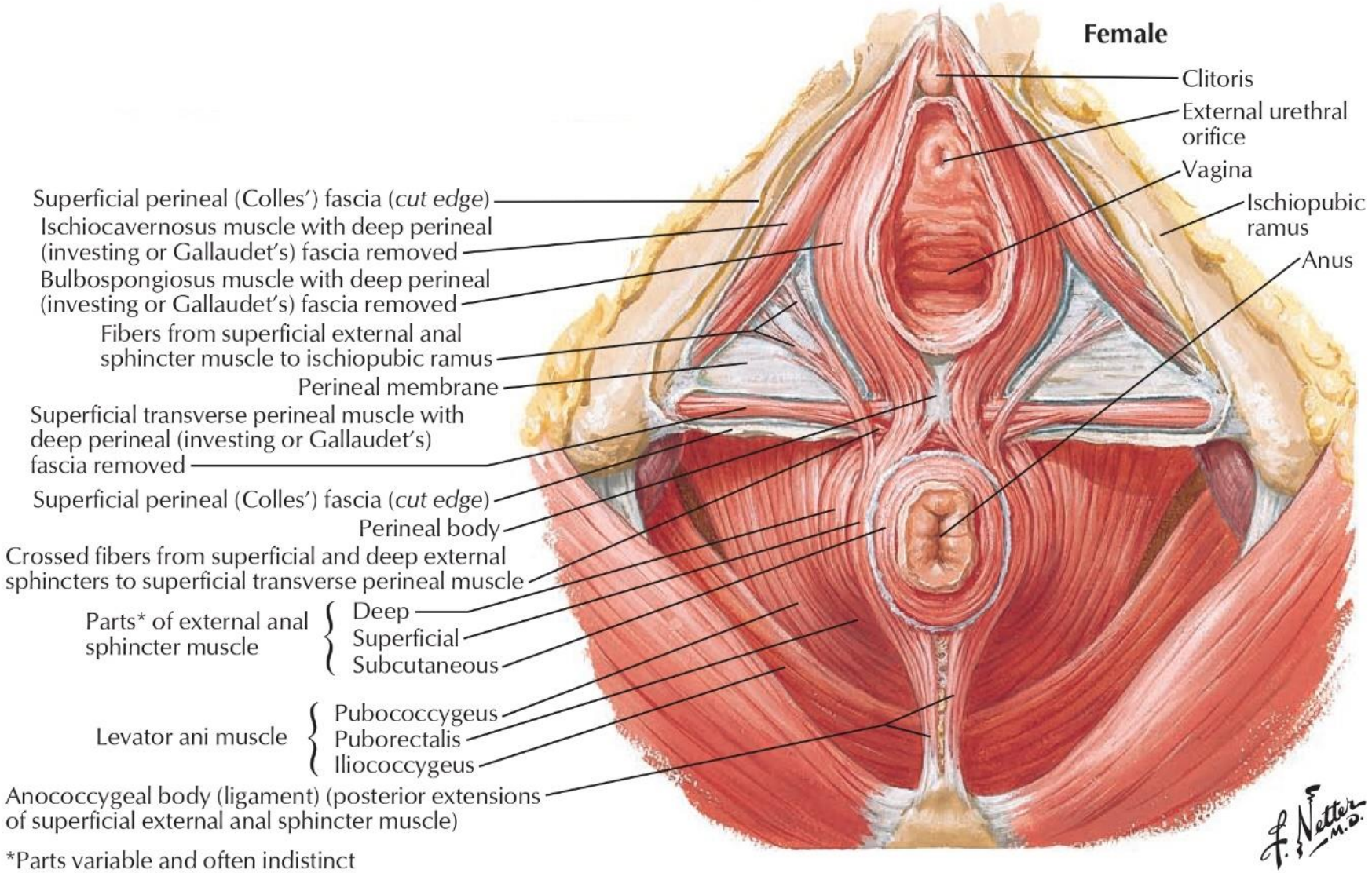
Male perineal muscles: inferior view

Female perineal muscles: inferior view

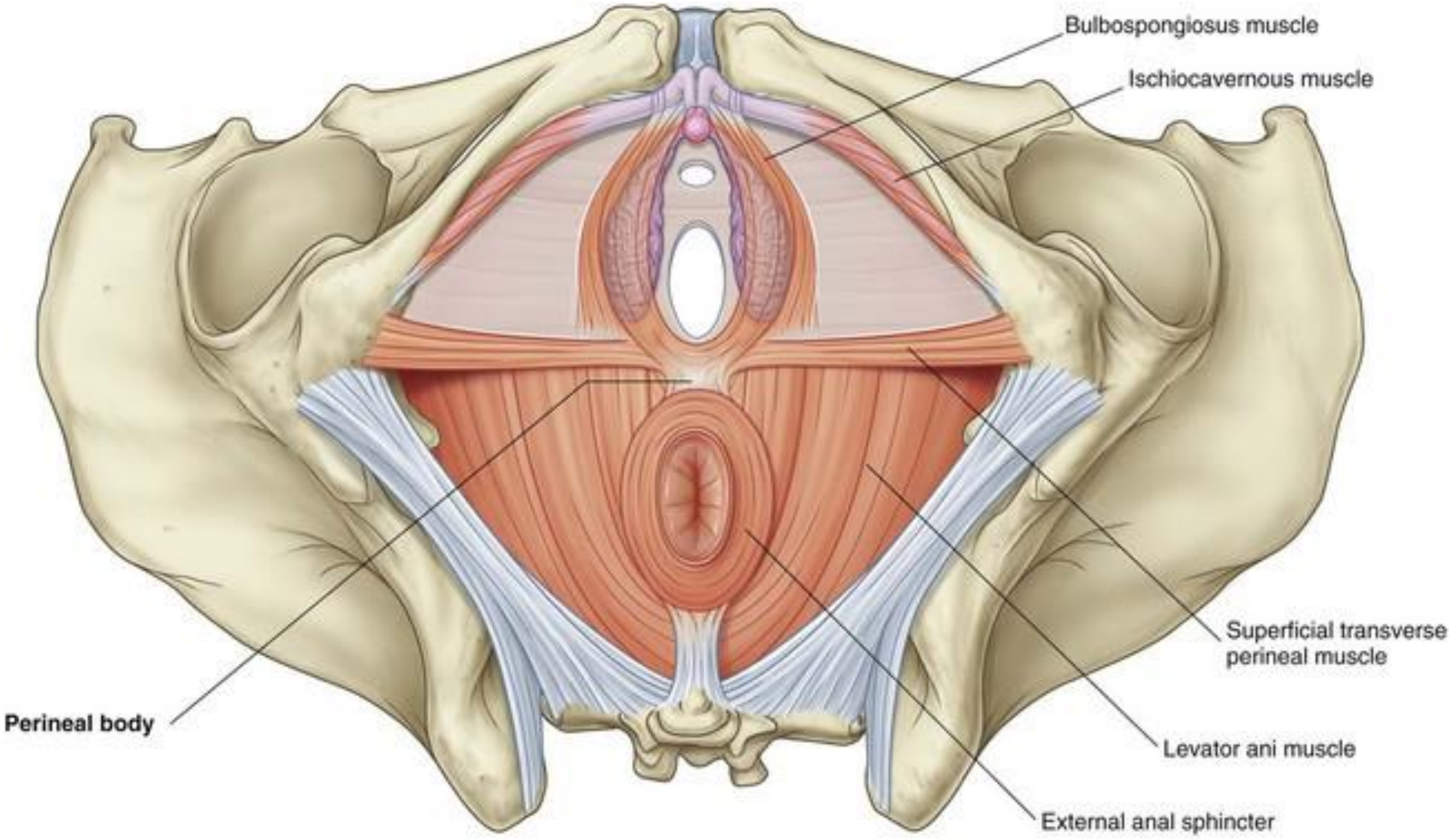



Male
Superficial scrotal (dartos) fascia
Septum of scrotum
Deep (Buck's) fascia of penis
Bulbospongiosus muscle with deep perineal (investing or Gallaudet's) fascia removed
Ischiocavernosus muscle with deep perineal (investing or Gallaudet's) fascia removed
Perineal membrane
Perineal body
Superficial transverse perineal muscle with deep perineal (investing or Gallaudet's) fascia removed
Subcutaneous
Superficial
Deep
Parts* of external anal sphincter muscle
Superficial perineal (Colles') fascia (cut edges)
Transverse fibrous septum of ischio-anal fossa (cut)
Ischial tuberosity
Sacrotuberous ligament
Pubococcygeus
Puborectalis
Iliococcygeus
Levator ani muscle
Anococcygeal body (ligament) (posterior extensions of superficial external anal sphincter muscle)
Gluteus maximus muscle
Tip of coccyx
Female
Clitoris
External urethral orifice
Vagina
Ischiopubic ramus
Anus
Superficial perineal (Colles') fascia (cut edge)
Ischiocavernosus muscle with deep perineal (investing or Gallaudet's) fascia removed
Bulbospongiosus muscle with deep perineal (investing or Gallaudet's) fascia removed
Fibers from superficial external anal sphincter muscle to ischiopubic ramus
Perineal membrane
Superficial transverse perineal muscle with deep perineal (investing or Gallaudet's) fascia removed
Superficial perineal (Colles') fascia (cut edge)
Perineal body
Crossed fibers from superficial and deep external sphincters to superficial transverse perineal muscle
Parts* of external anal sphincter muscle
Deep
Superficial
Subcutaneous
Levator ani muscle
Pubococcygeus
Puborectalis
Iliococcygeus
Anococcygeal body (ligament) (posterior extensions of superficial external anal sphincter muscle)
*Parts variable and often indistinct
F. Netter M.D.

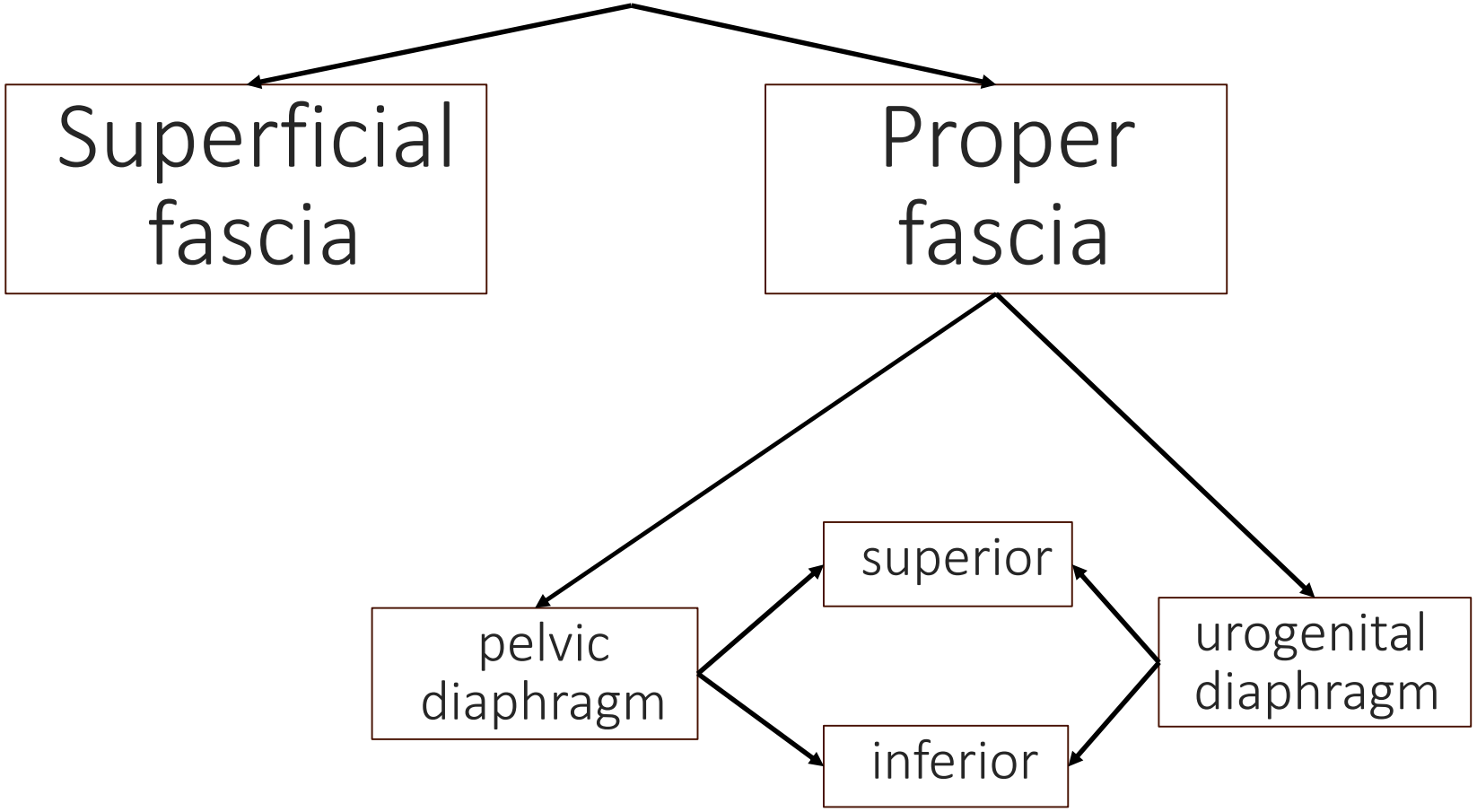

Deep (Buck's) fascia of penis
BULBOSPONGIOSUS
ISCHIOCAVERNOSUS
Perineal membrane
PERINEAL BODY
(CENTRAL TENDON)
SUPERFICIAL TRANSVERSE
PERINEAL MUSCLE
Superficial perineal
(Colles') fascia (cut edges)
Ischial tuberosity
Sacrotuberous ligament
Pubococcygeus part of
levator ani muscle
Iliococcygeus part of levator ani muscle
Puborectalis part of levator ani muscle
Tip of coccyx

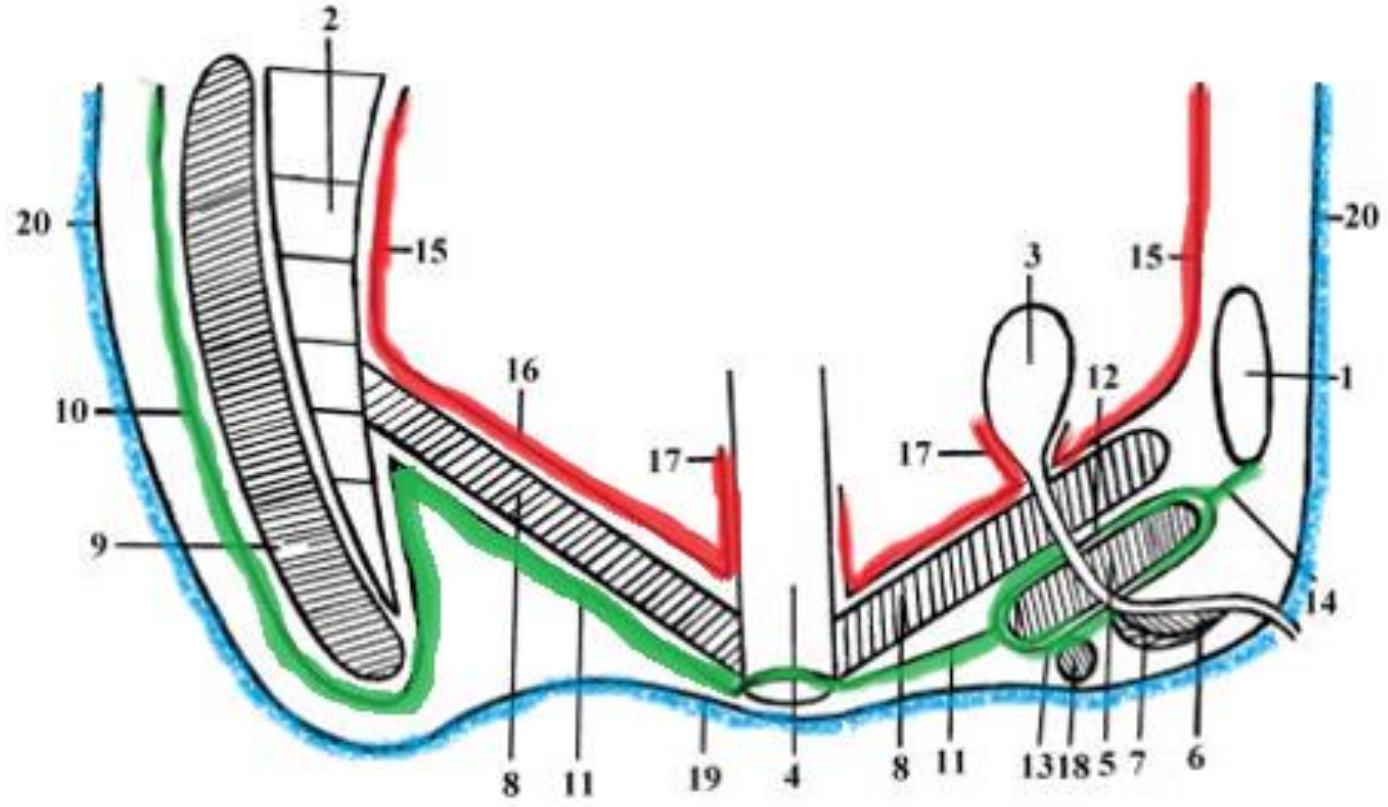


*Parts variable and often indistinct


Bulbospongiosus muscle
Ischiocavernous muscle
Superficial transverse perineal muscle
Perineal body
Levator ani muscle
External anal sphincter

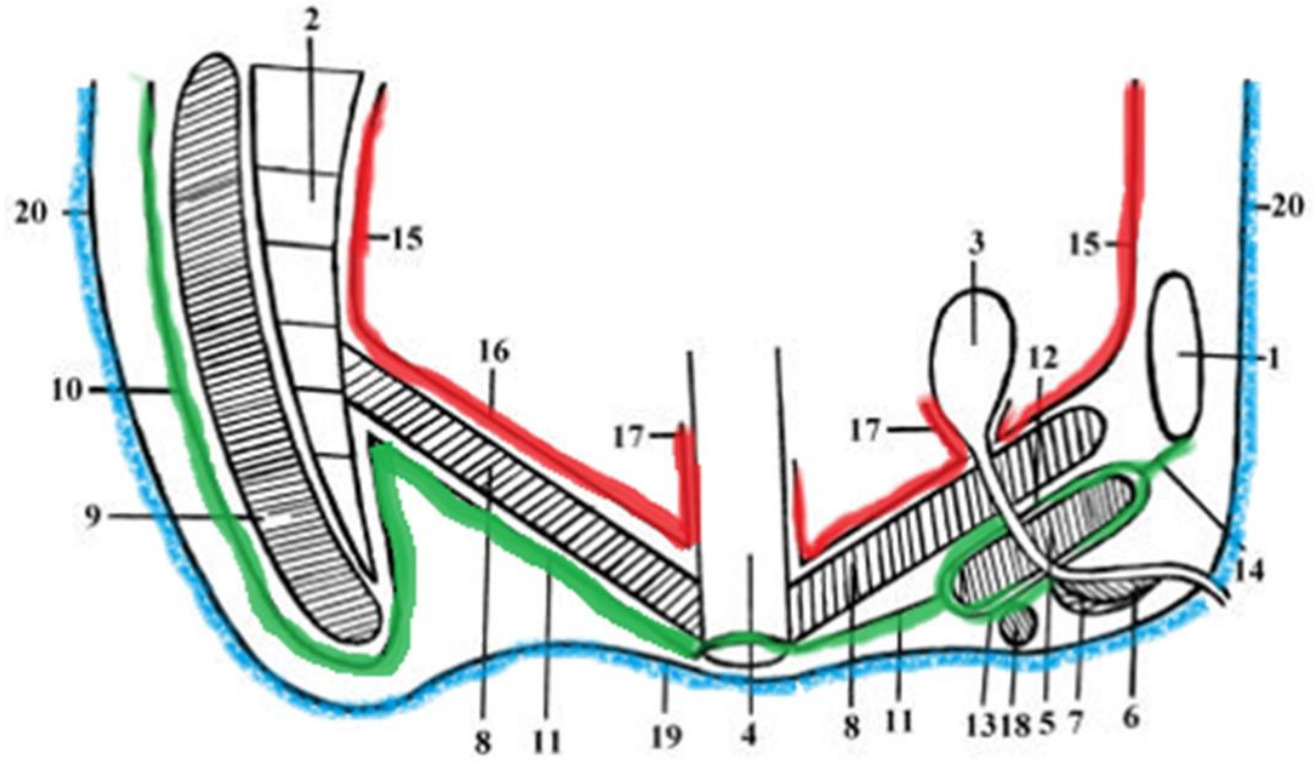
Perineal Fascia



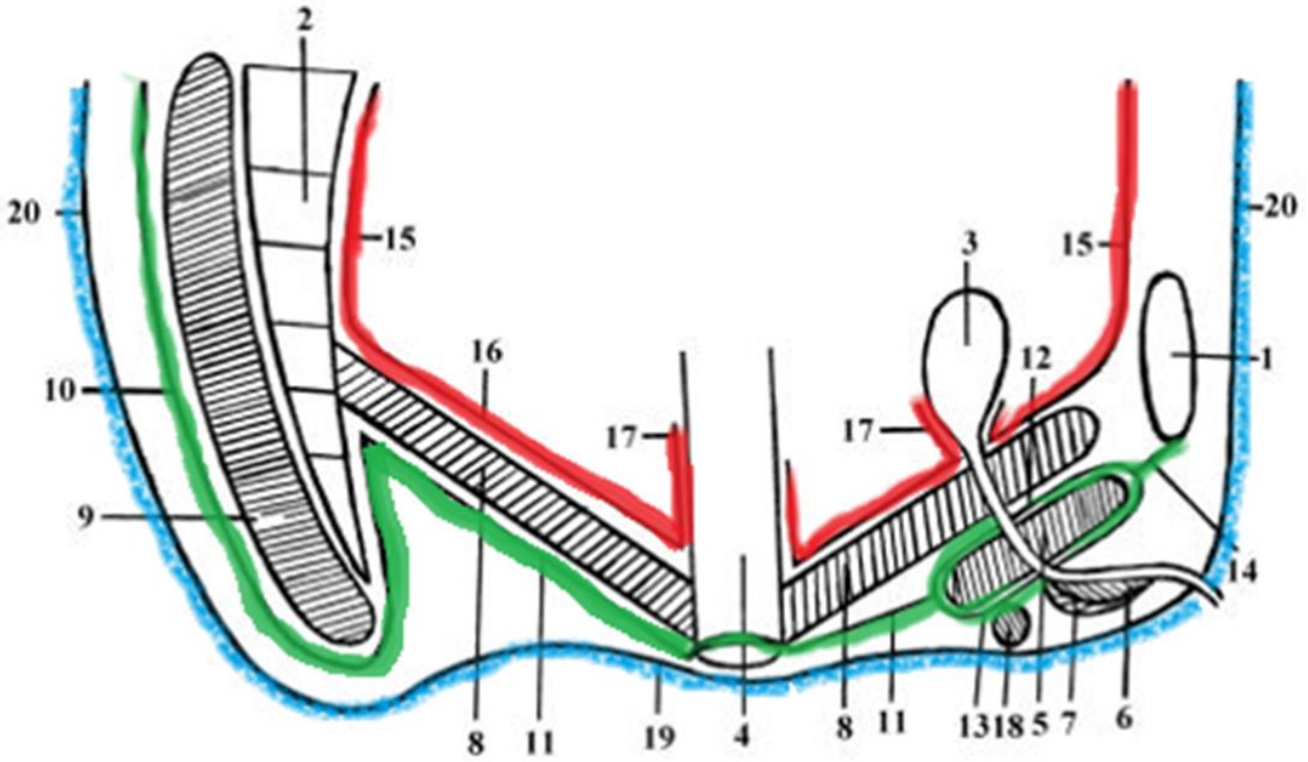


Regio analis – diaphragma pelvica

Regio et diaphragma urogenitalis

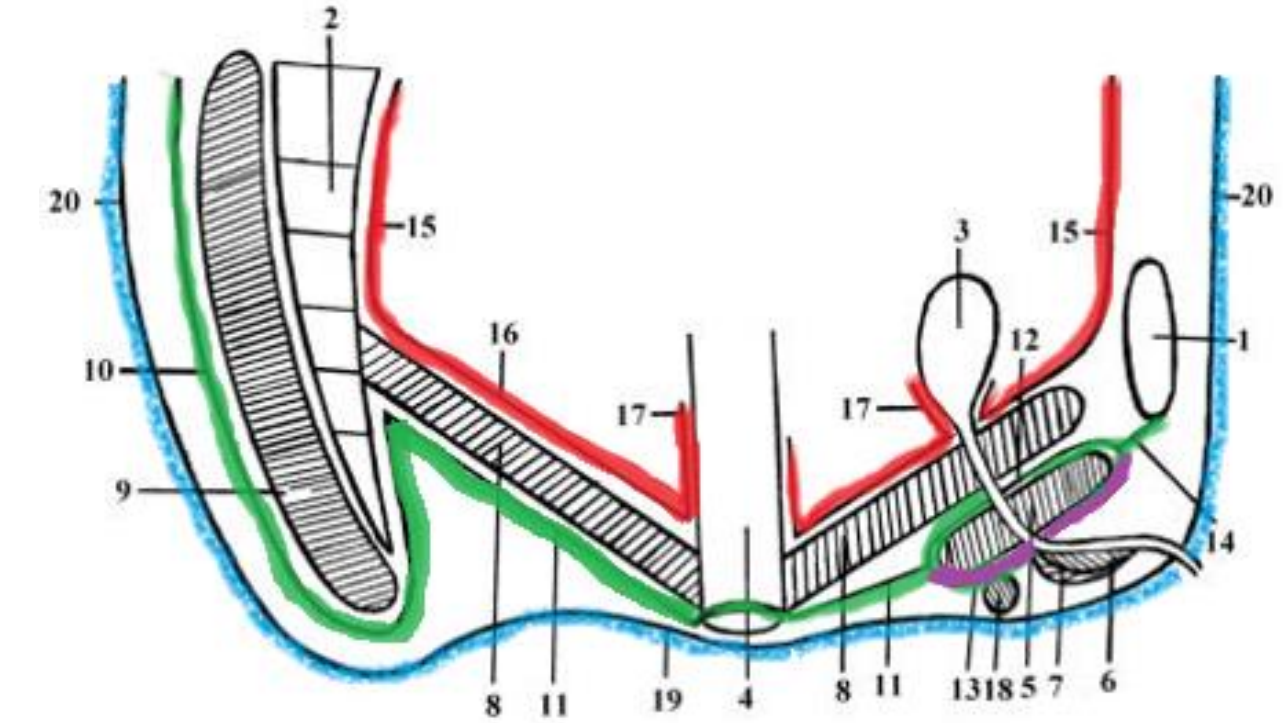


1 - symphisis pubica;
2 - os sacrum et os coccygis;
3 - vesica urinaria;
4 – rectum;
5 - m. transversus perinei profundus et m. sphincter urethrae;
6 - m. bulbospongiosus;
7 - m. ischiocavernosus;
8 - m. levator ani;
9 - m. gluteus maximus;
10 - fascia glutea;
11 - fascia diaphragmatis pelvis inferior;
12 – fascia diaphragmatis urogenitalis superior
13 – fascia diaphragmatis urogenitalis inferior
14 - lig. transversum perinei;
15 - fascia pelvis
16 - fascia diaphragmatis pelvis superior;
17 - lamina visceralis fasciae pelvis;
18 - m. transversus perinei superficialis;
19 – fascia superficialis perinea;
20 – fascia subcutanea.



Regio analis – diaphragma pelvica

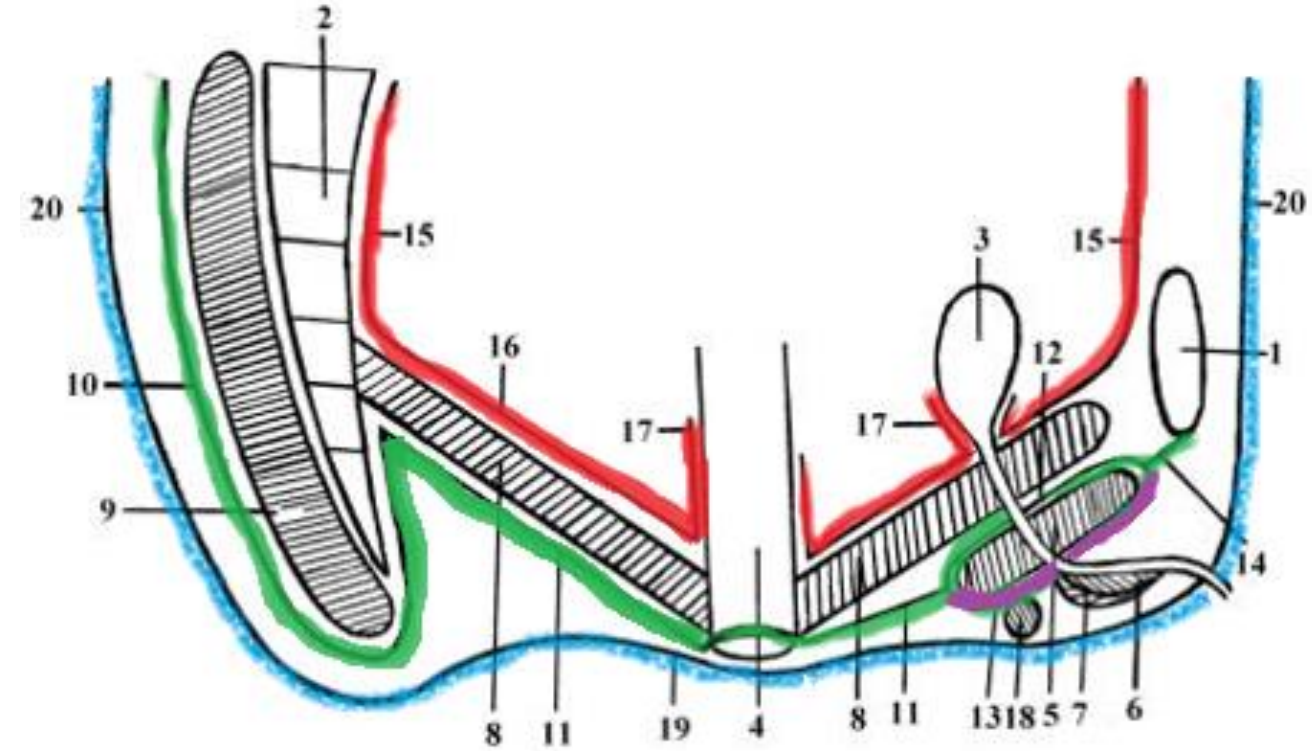
1) Fascia superficialis pelvis perinei (common subcutaneous fascia) – (19)
2) Fascia diaphragmatic pelvis inferior (from m.gluteus maximus till posterior border of m.transversus perinei profundus) – (11)
3) Fascia diaphragmatic pelvis superior (above m. levator ani – continuation of fascia pelvis) – (16)



Regio analis – diaphragma pelvica

Regio et diaphragma urogenitalis

1) Fascia perinei (common subcutaneous fascia) – (19)
2) Fascia diaphragmatic urogenitalis superior (above m. transversus perinei profundus and m.sph.urethrae externum) – (12)
4) Fascia diaphragmatic urogenitalis inferior– (separates superficial and deep muscles of UG diaphragm) (13)



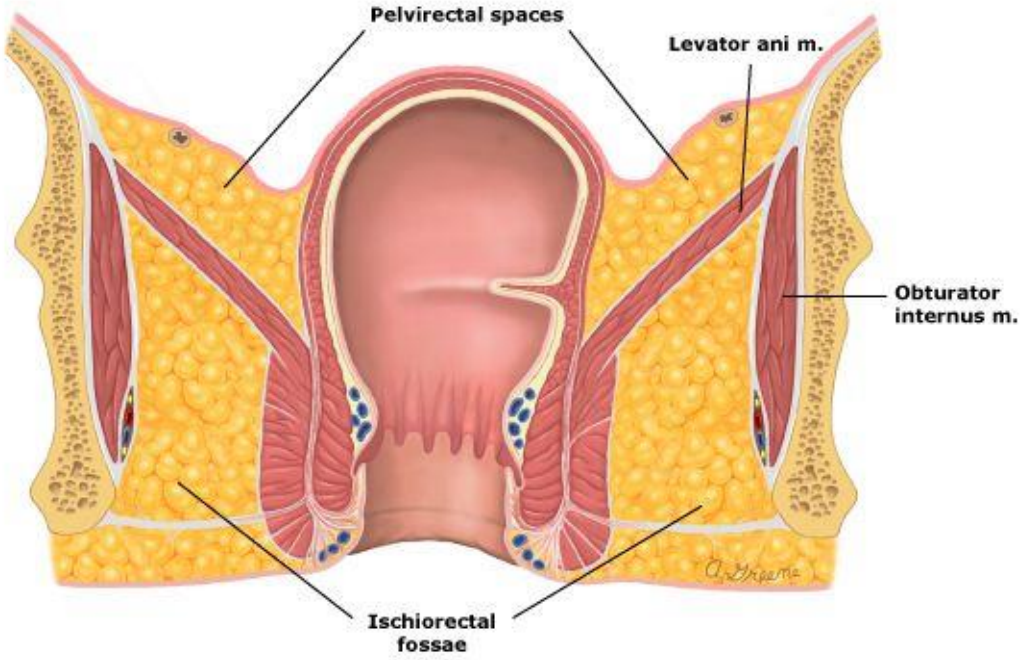
Regio analis – diaphragma pelvica

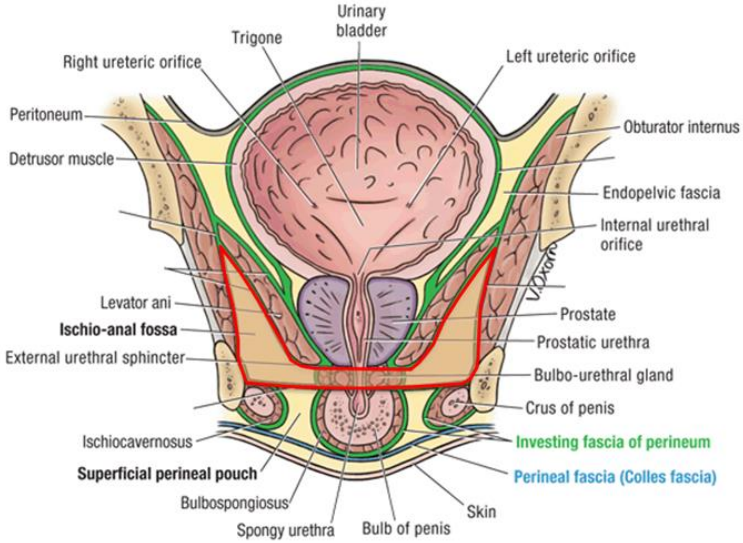
Regio et diaphragma urogenitalis

Between Fascia diaphragmatis urogenitalis inferior and Fascia diaphragmatis urogenitalis superior:

- sphincter externus uretherici
- m. transversus perinei profundus
- bulbourethral glands (male)/vestibular gland (female)

Ischiorectal fossa





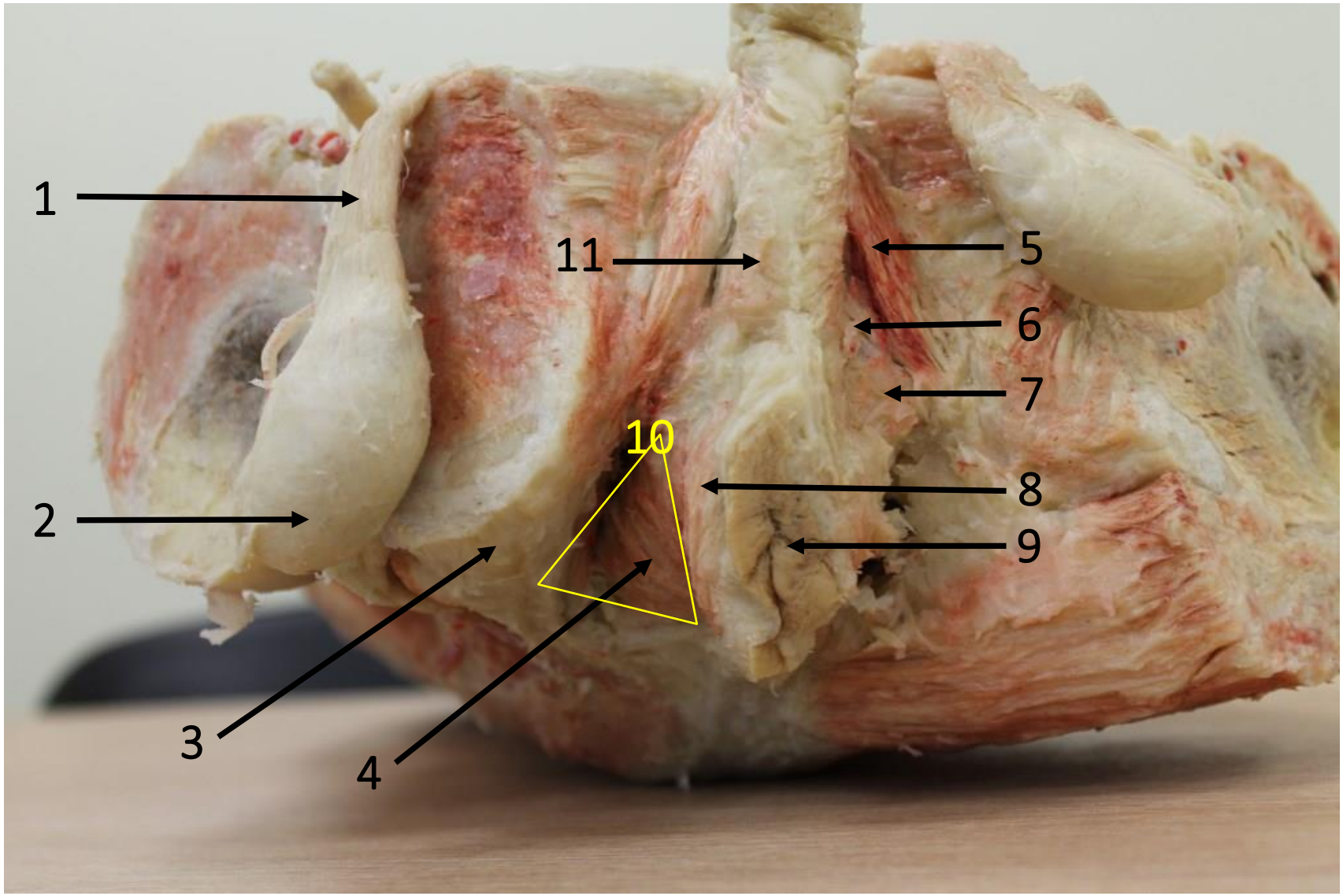
Walls:

Anterior – transverse muscles of perineum;

Posterior – posterior border of m.levator ani and m.cocccygeus

Medial – external surface of m.levator ani

Lateral – m.obturator internus, covered by its own fascia, and medial surface of tuber ischiadicum


1
11
5
6
7
10
8
2
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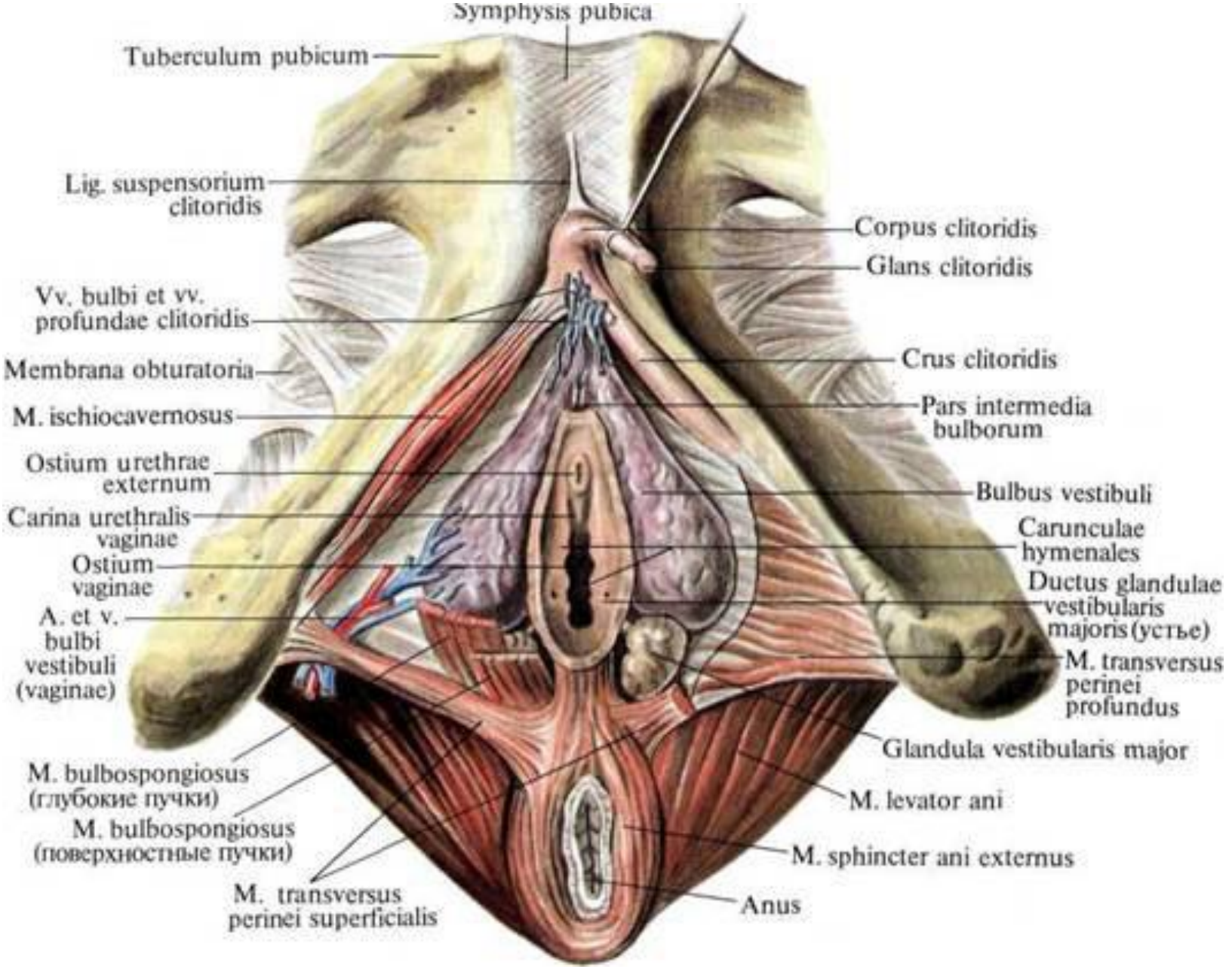
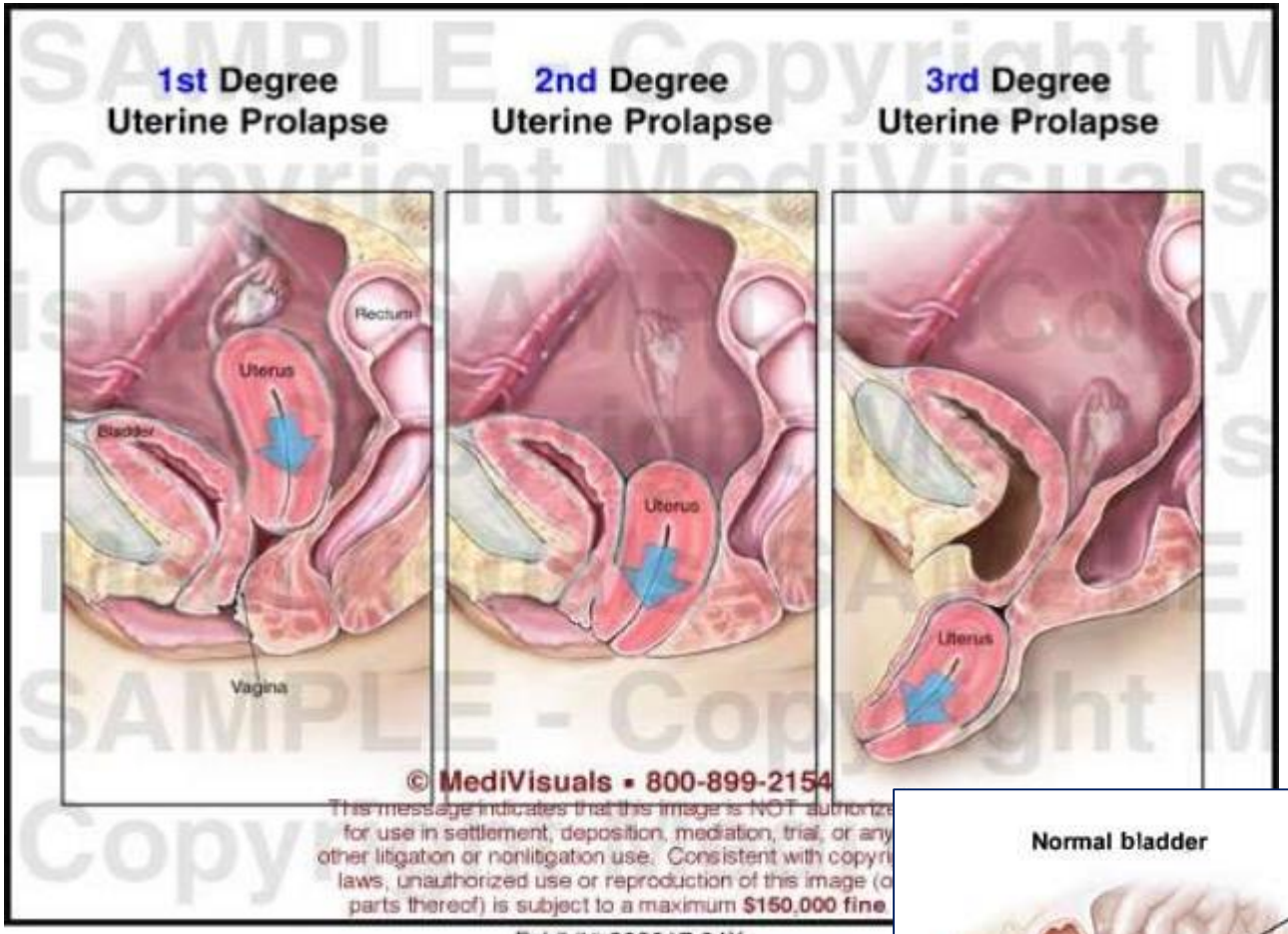
3
4


Symphysis pubica
Tuberculum pubicum
Lig. suspensorium clitoridis
Corpus clitoridis
Glans clitoridis
Vv. bulbi et vv. profundae clitoridis
Membrana obturatoria
Crus clitoridis
M. ischiocavernosus
Pars intermedia bulborum
Ostium urethrae externum
Bulbus vestibuli
Carina urethralis vaginae
Carunculae hymenales
Ostium vaginae
Ductus glandulae vestibularis majoris (устье)
A. et v. bulbi vestibuli (vaginae)
M. transversus perinei profundus
Glandula vestibularis major
M. bulbospongiosus (глубокие пучки)
M. levator ani
M. bulbospongiosus (поверхностные пучки)
M. sphincter ani externus
M. transversus perinei superficialis
Anus


1st Degree
Uterine Prolapse
2nd Degree
Uterine Prolapse
3rd Degree
Uterine Prolapse
Rectum
Uterus
Bladder
Vagina
Uterus
Uterus
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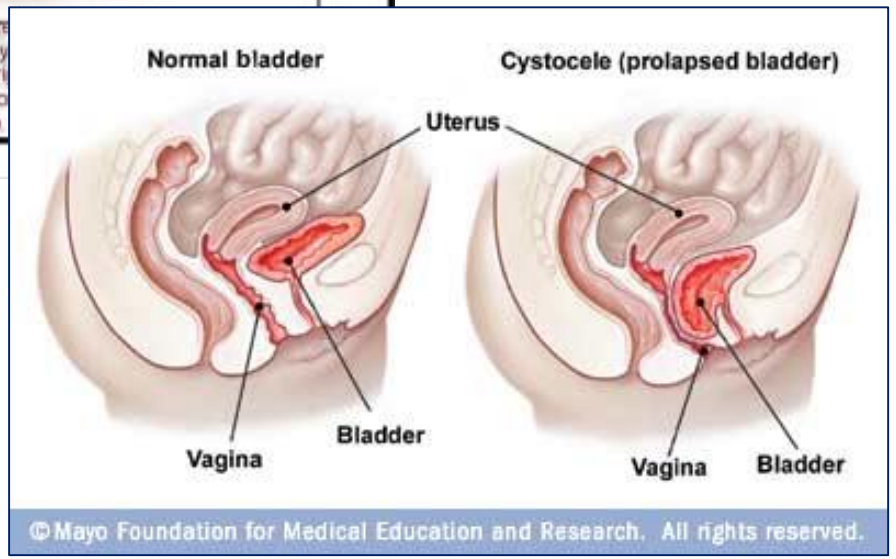
Normal bladder
Cystocele (prolapsed bladder)
Uterus
Vagina
Bladder
Vagina
Bladder
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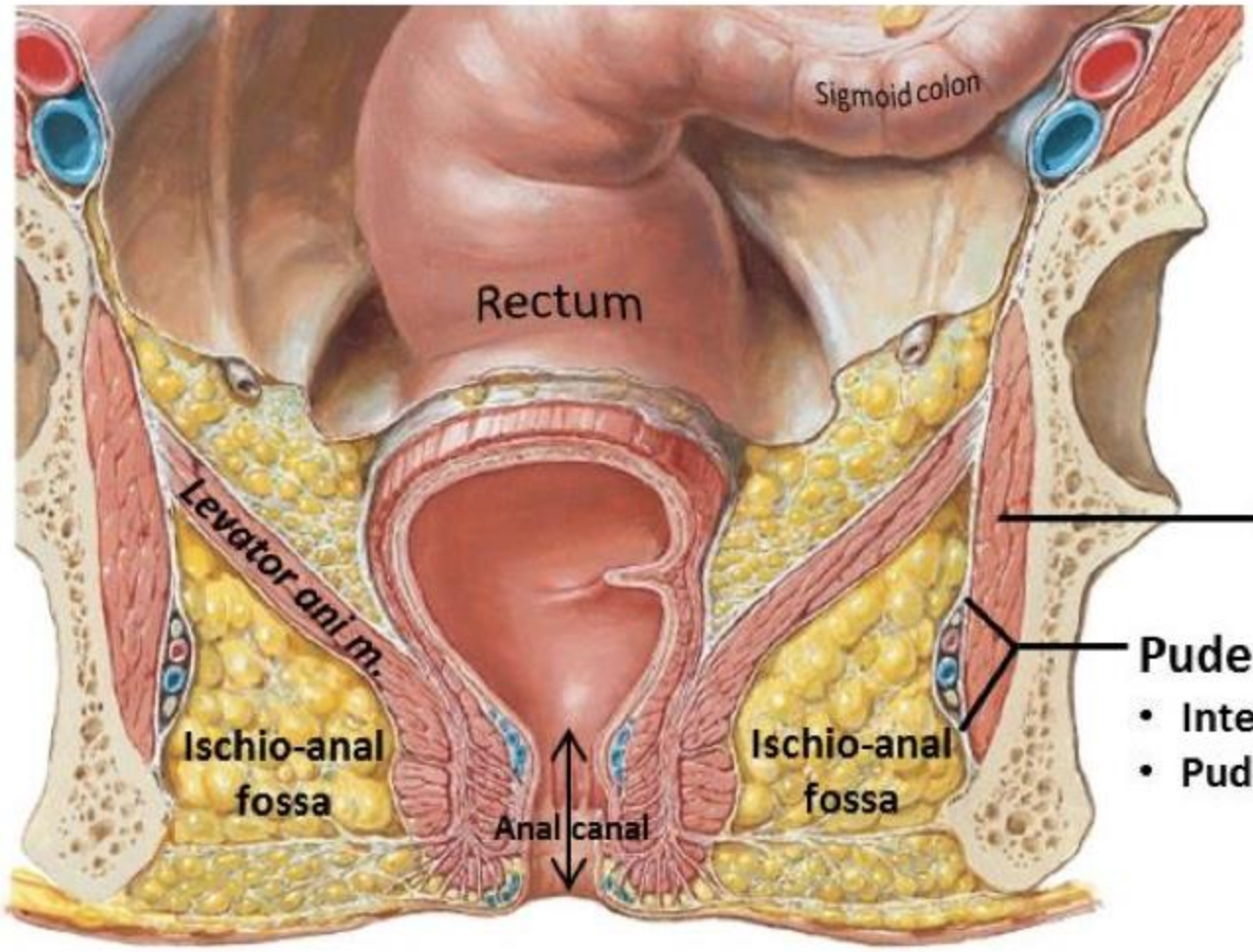
Additional slides

sphincter

Coronal section: anterior view *Netter6: 370*



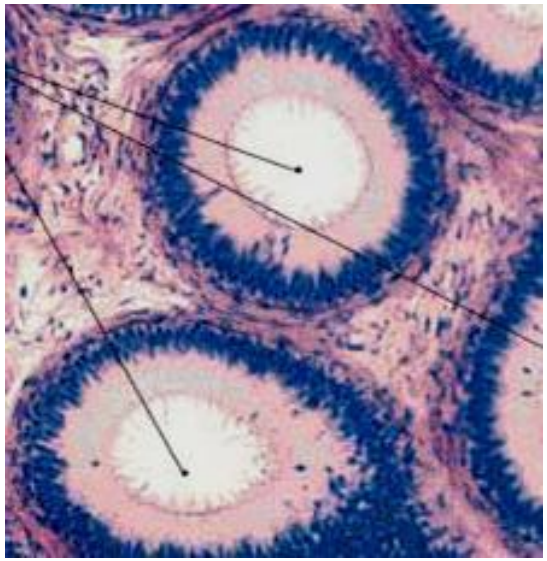
Obturator Internus m.

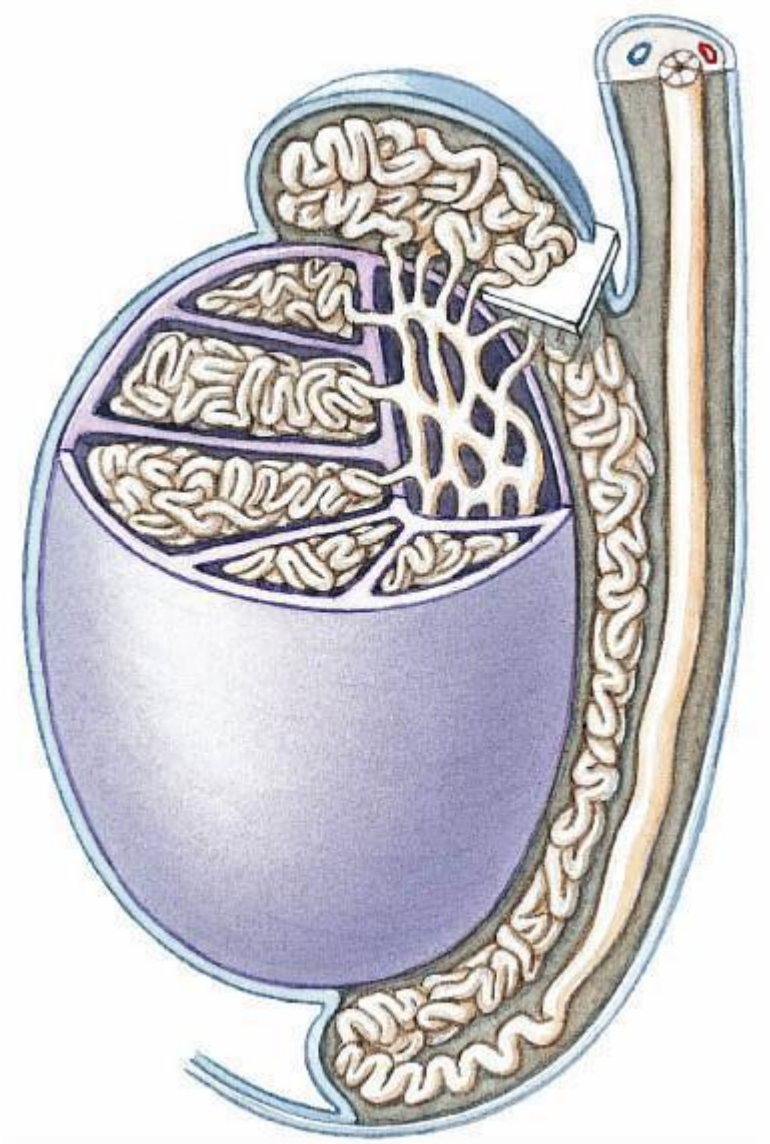
Pudendal (Alcock's) canal

- **Internal pudendal a. & v.**
- **Pudendal n.**

Epididymis canals

- control and regulation of semen secretion
- remove damaged sperm
- preservation of semen and stimulation of its maturation

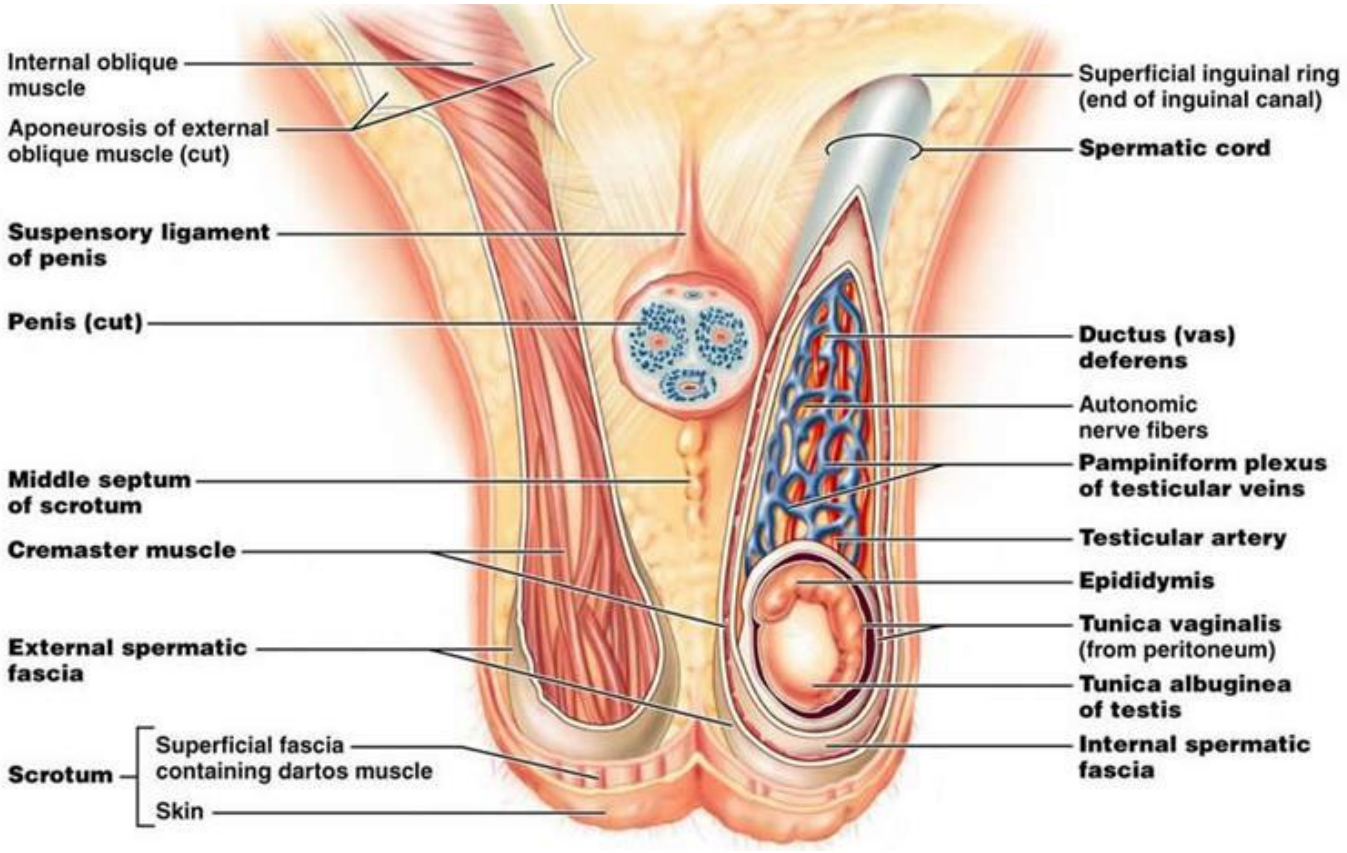




(a) Testis and epididymis

Funiculus spermaticus

- Pampiniform plexus of testicular veins
- Testicular artery
- Ductus deferens + artery
- Smooth muscle cells
- Lymphatic vessels
- Nerves:
- n. ilioinguinalis
- n. genitofemoralis

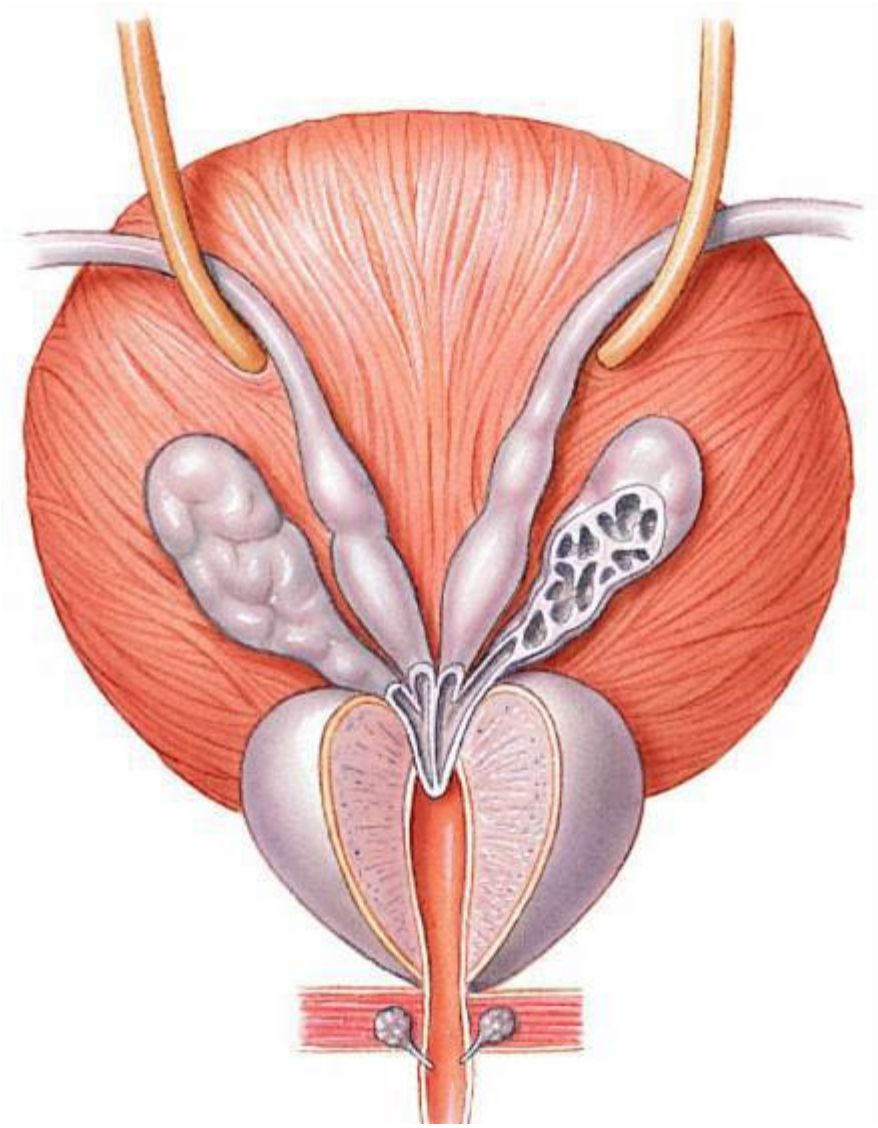


Seminal vesicles

- tubes 15sm
- alkaline liquid with fructose, ascorbic acid, enzymes and prostaglandins (95%)
- maturation of spermen

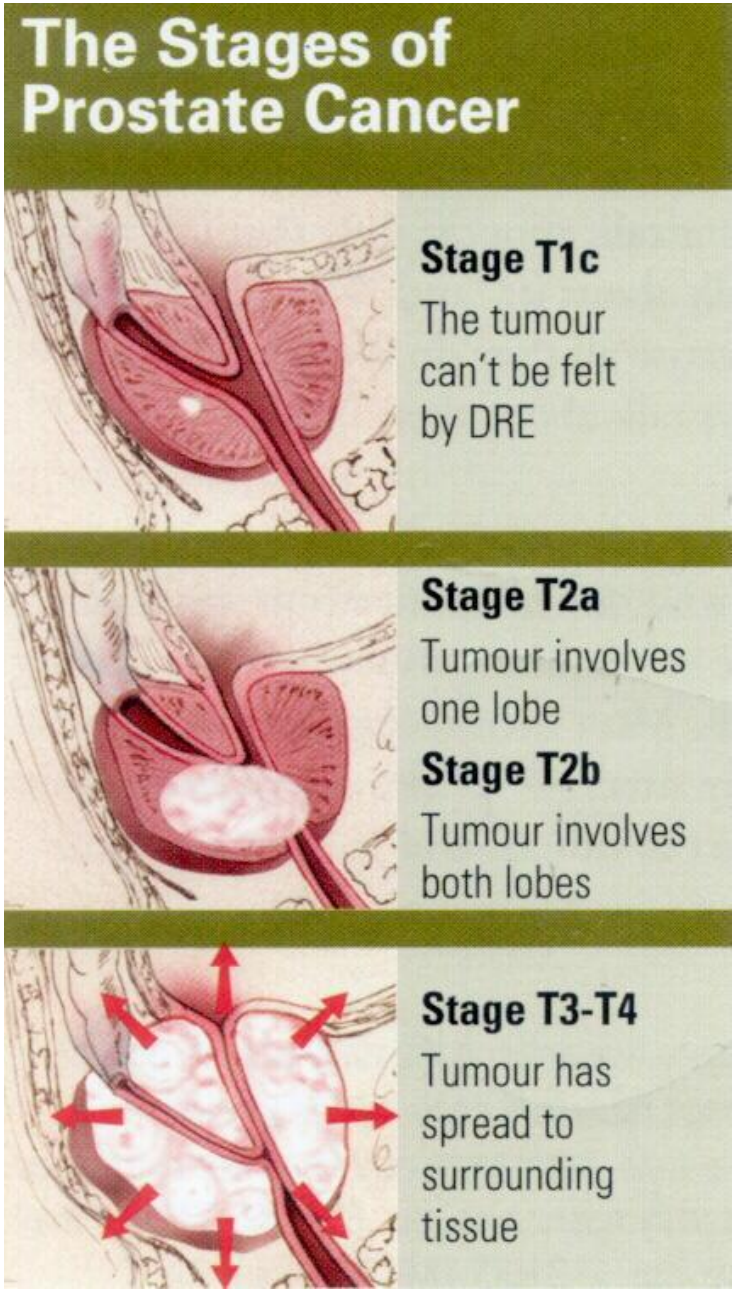
Bulbourethral glands

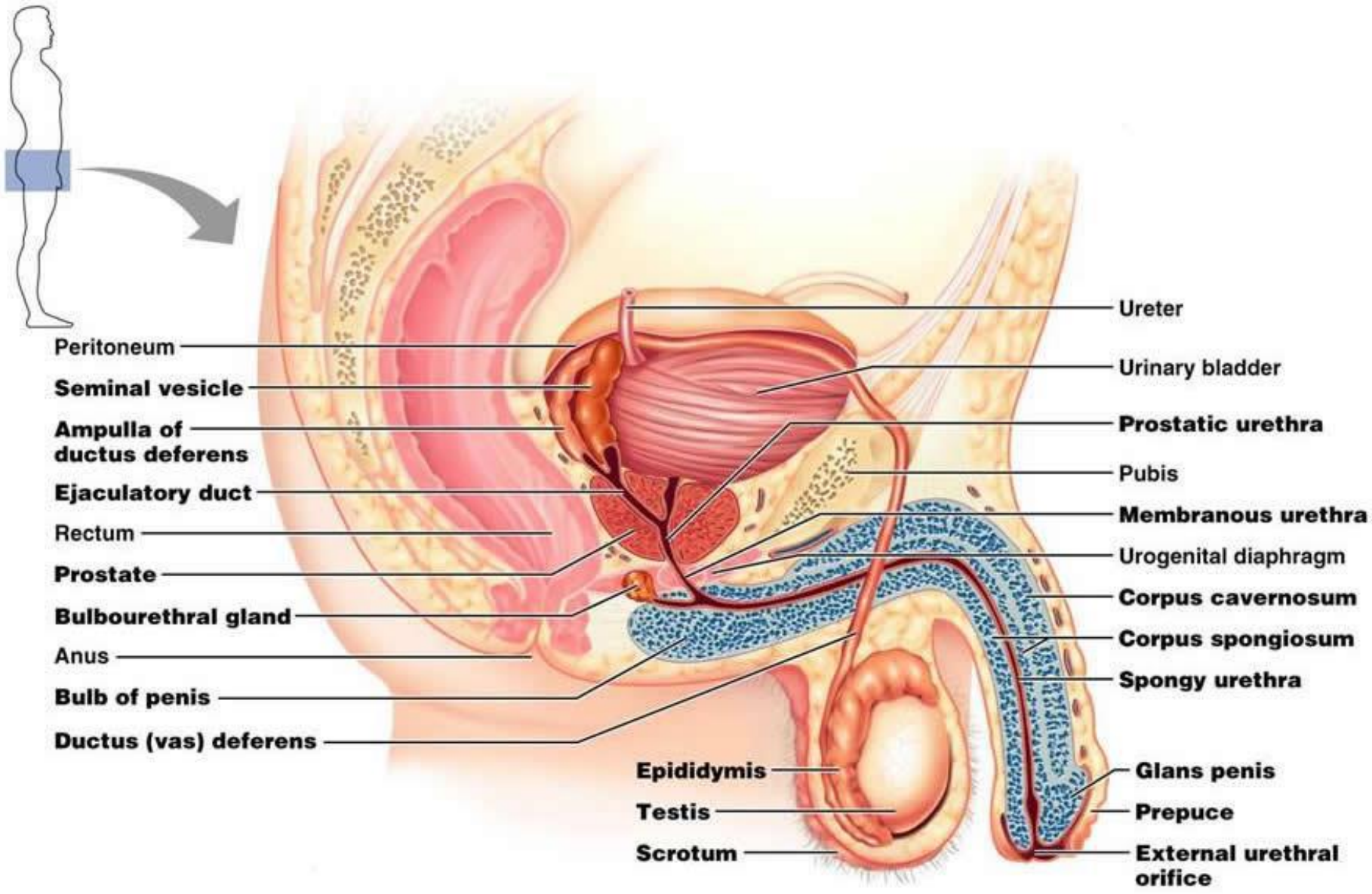
- Liquid for neutralization of urine acidity

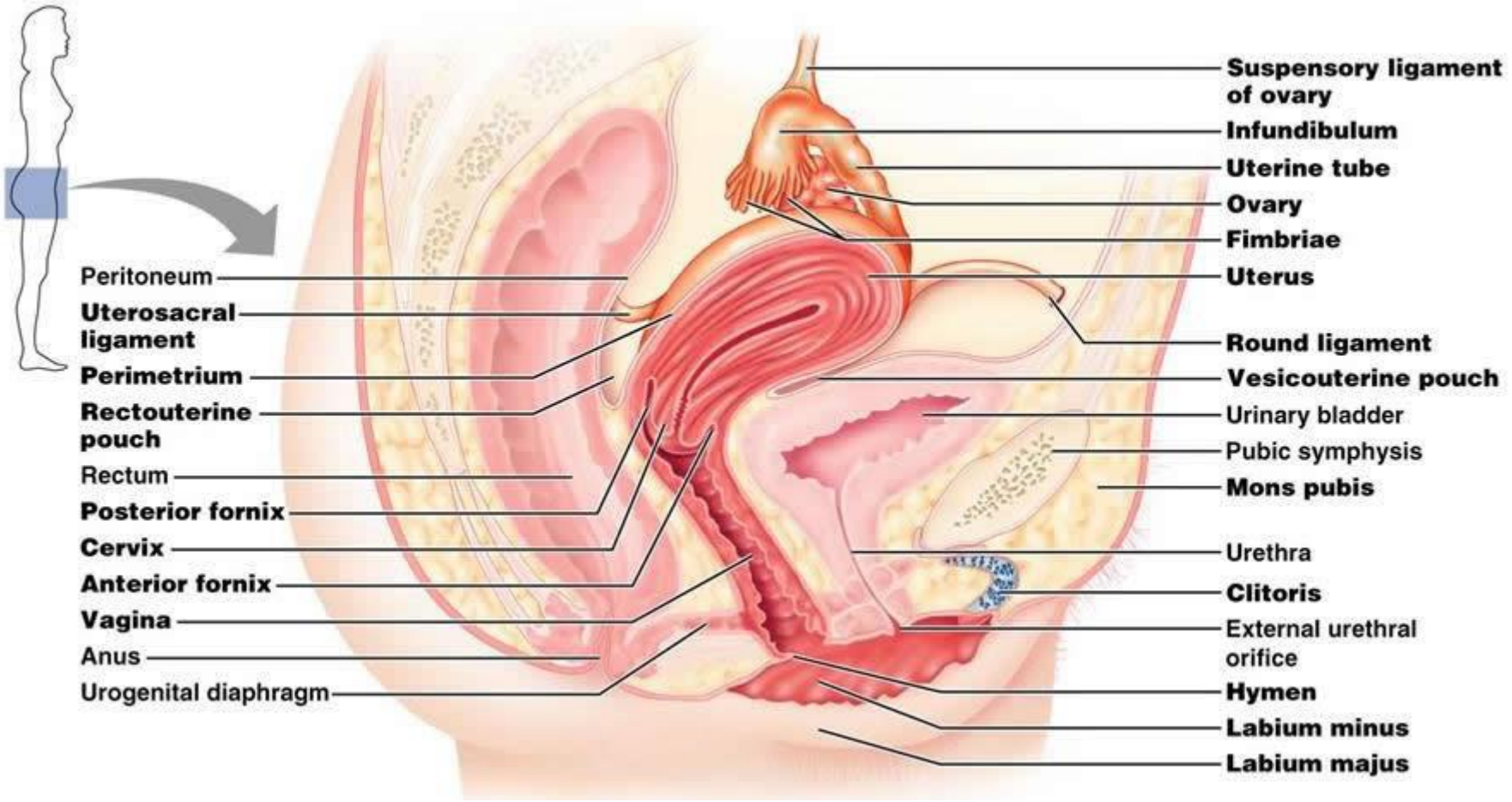


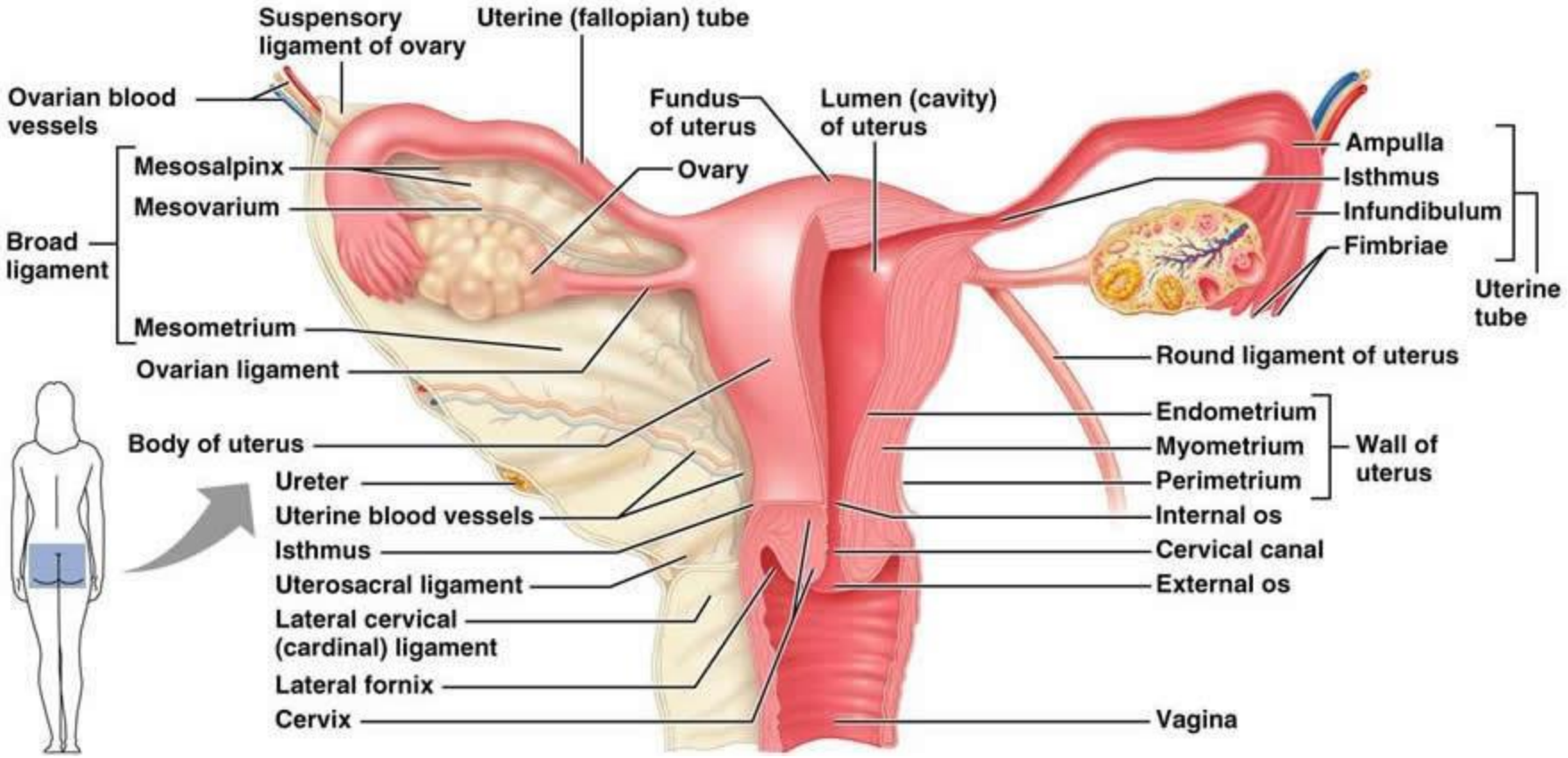
Prostate

- slightly acidic liquid with cytrate, enzymes, prostate-specific antigen (PSA)
- hypertrophy in adults – compression of urethra- risk of kidney infection
- prostate cancer – second place after lung cancer in males




Peritoneum
Seminal vesicle
Ampulla of ductus deferens
Ejaculatory duct
Rectum
Prostate
Bulbourethral gland
Anus
Bulb of penis
Ductus (vas) deferens
Epididymis
Testis
Scrotum
Ureter
Urinary bladder
Prostatic urethra
Pubis
Membranous urethra
Urogenital diaphragm
Corpus cavernosum
Corpus spongiosum
Spongy urethra
Glans penis
Prepuce
External urethral orifice


Peritoneum
Uterosacral ligament
Perimetrium
Rectouterine pouch
Rectum
Posterior fornix
Cervix
Anterior fornix
Vagina
Anus
Urogenital diaphragm
Suspensory ligament of ovary
Infundibulum
Uterine tube
Ovary
Fimbriae
Uterus
Round ligament
Vesicouterine pouch
Urinary bladder
Pubic symphysis
Mons pubis
Urethra
Clitoris
External urethral orifice
Hymen
Labium minus
Labium majus


Suspensory ligament of ovary
Uterine (fallopian) tube
Ovarian blood vessels
Fundus of uterus
Lumen (cavity) of uterus
Ampulla
Isthmus
Infundibulum
Fimbriae
Uterine tube
Broad ligament
Mesosalpinx
Mesovarium
Ovary
Mesometrium
Ovarian ligament
Round ligament of uterus
Endometrium
Myometrium
Perimetrium
Wall of uterus
Body of uterus
Ureter
Uterine blood vessels
Isthmus
Uterosacral ligament
Lateral cervical (cardinal) ligament
Lateral fornix
Cervix
Internal os
Cervical canal
External os
Vagina