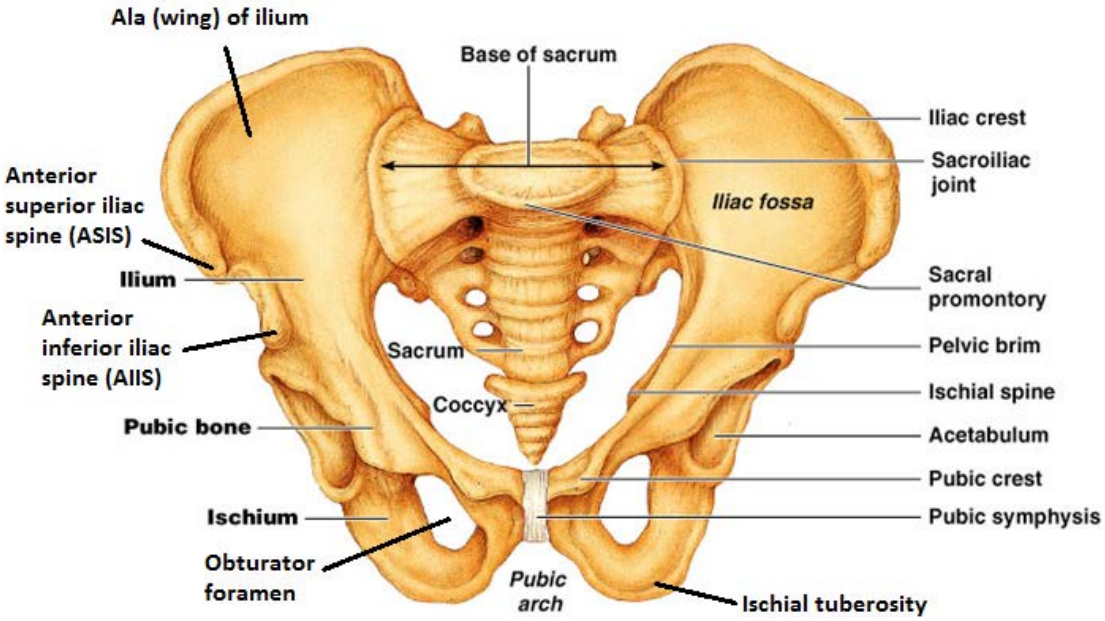
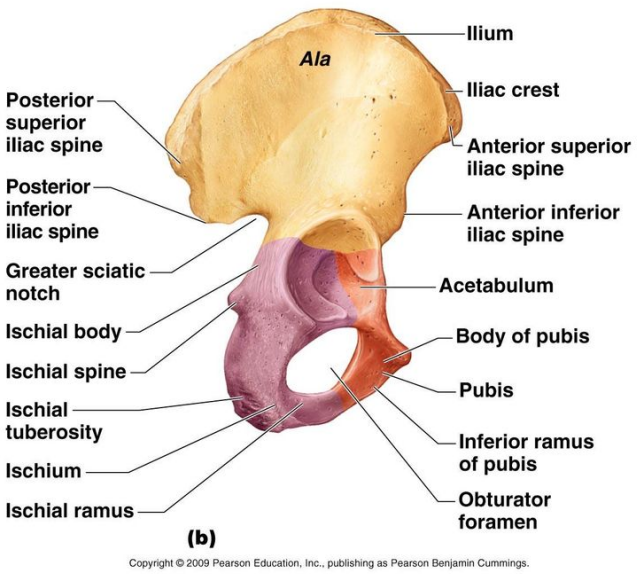
L3, 16-18 Gross Anatomy of Pelvis and Perineum

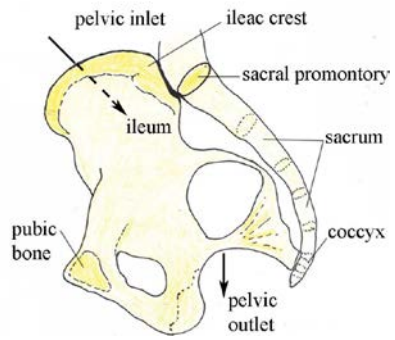
A. Gross Anatomy of Pelvis

1. Pelvic Bone



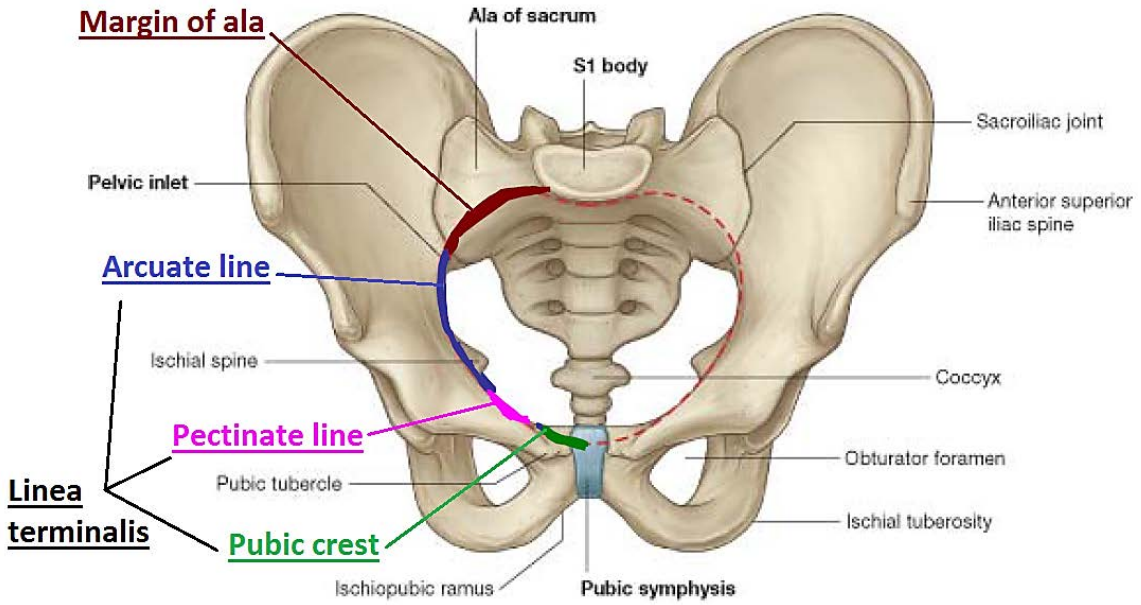
- **Pelvic bone** on each side is formed from **ilium**, **ischium**, **pubis** fused together at the **acetabulum**
  - **Acetabulum**: depression in pelvic bone at which **femur** articulates the pelvic bone
- **Ischium** and **pubis** joined inferiorly via **ischiopubic ramus**
  → forms a ring enclosing **obturator foramen**
- Pelvic bone on two sides are joined by:
  - Posterior: **sacrum**
  - Anterior: **pubic symphysis**



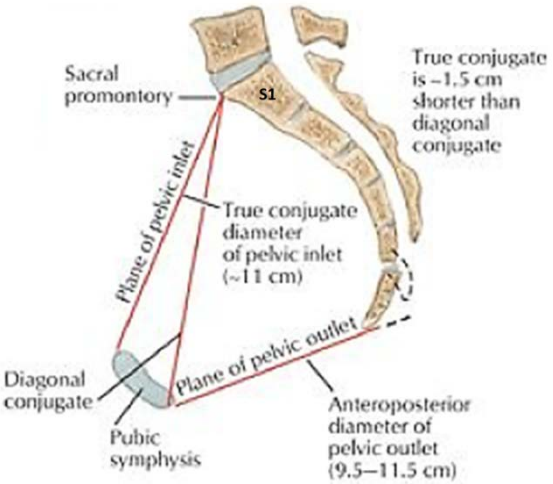


- Pelvic bone can be treated as a tubular bone with **inlet** and **outlet**
- Significance: inadequate size of female pelvic inlet or outlet may warrant caesarian section in pregnancy
  → pre-partum size estimation

a. Pelvic Inlet



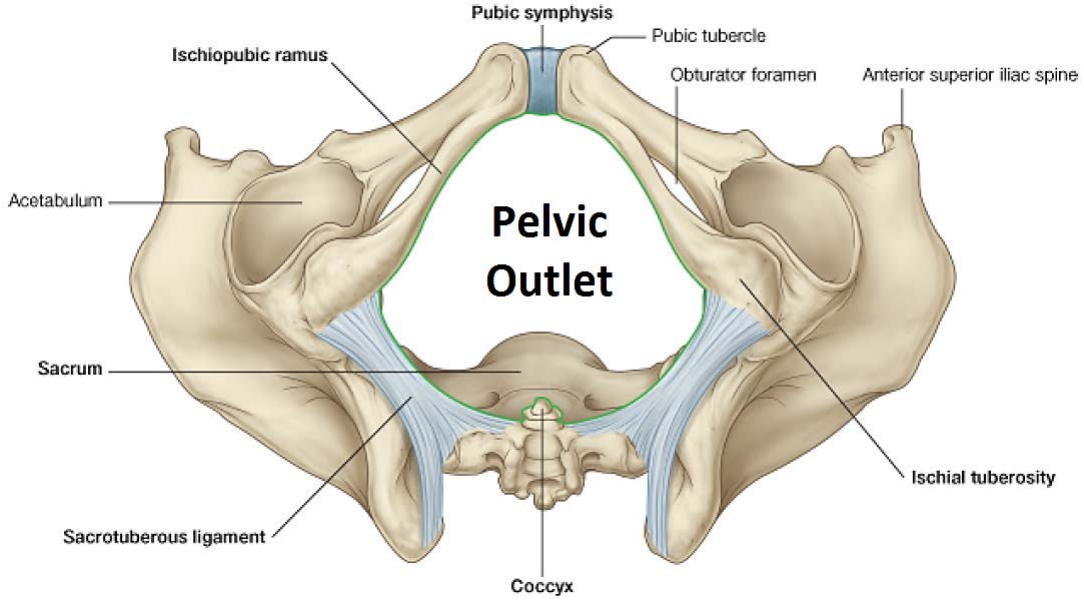
- **Pelvic inlet** is delineated by the **pelvic brim**
- Separates **abdominal cavity** from the **pelvic cavity** or **false pelvic cavity** from **true pelvic cavity**
- Two parts:
  - Posterior: margin of **ala (wing) of sacrum**
  - Anterior: **linea terminalis**
    → **Arcuate line** on **ilium**
    → **Pectinate line** on **pubis**
    → **Pubic crest**



- **True (obstetrical) conjugate**: distance from tip of S1 to upper boundary of pubic symphysis
  - True AP diameter of pelvic inlet
  - ~11.5 cm in Caucasians
  - Difficult to estimate *in vivo*
- **Diagonal conjugate**: distance from tip of S1 to lower boundary of pubic symphysis
  - ~13.5 cm in Caucasians
  - Can be estimated trans-vaginally *in vivo*

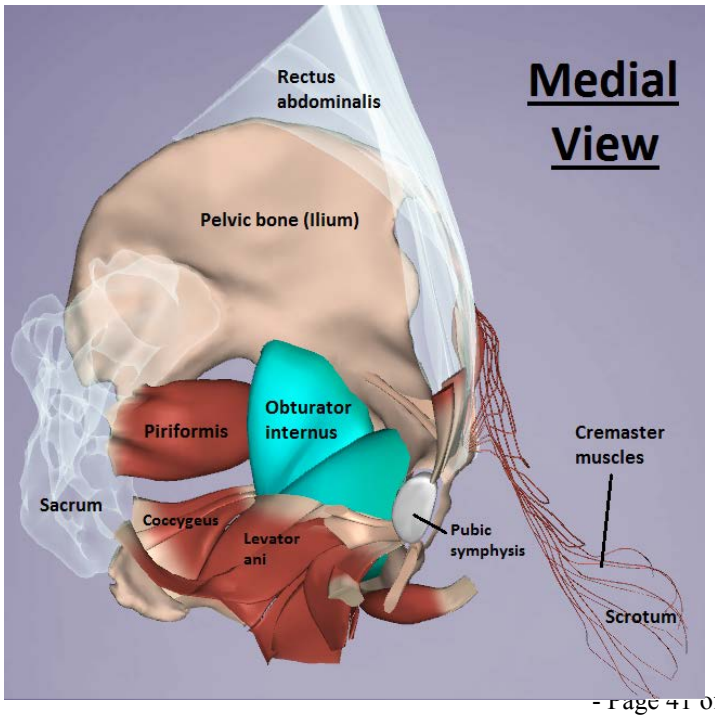
Some sources quote margin of sacral ala as part of the **linea terminalis*

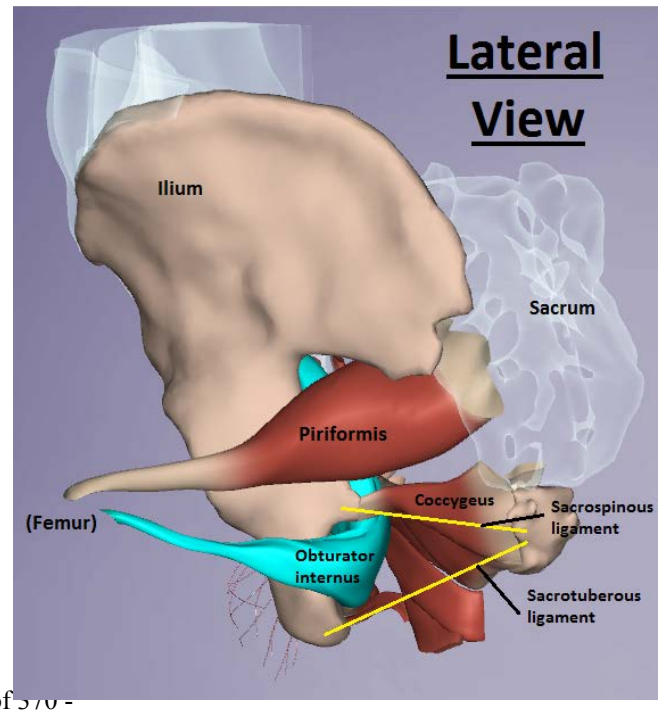
b. Pelvic Outlet

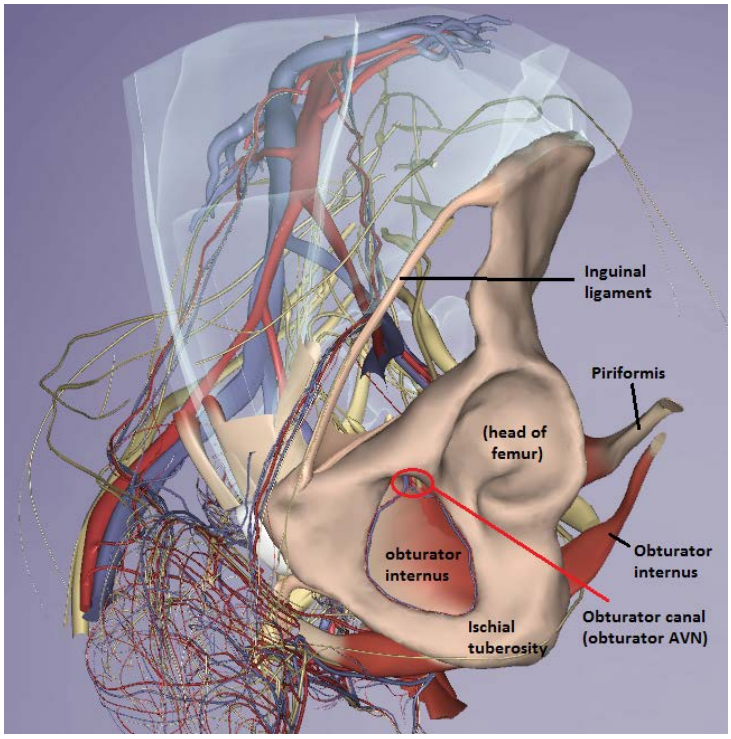


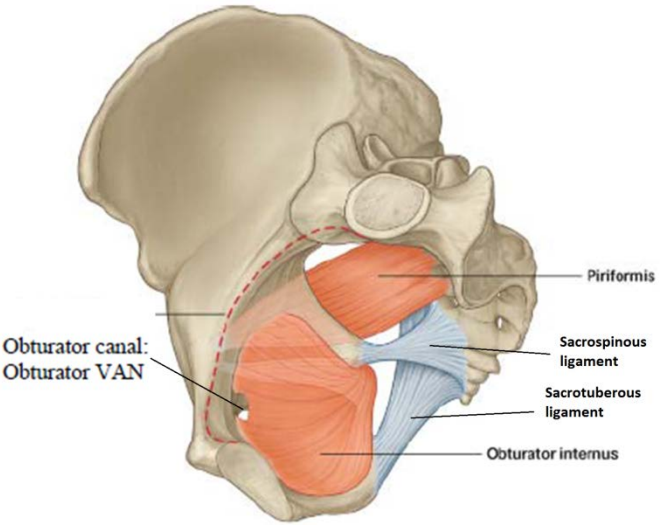
- **Pelvic outlet** formed by:
  - Anterior: **pubic symphysis**
  - Anterolateral: **ischiopubic ramus**
  - Lateral: ischial tuberosity
  - Posterolateral: inferior margin of **sacrotuberous ligament**
  - Posterior: coccygeal tip
- **Sacrotuberous ligament**: ligament connecting **sacral body** and **ischial tuberosity**
- Size estimated by measuring distance between bilateral **ischial tuberosities**

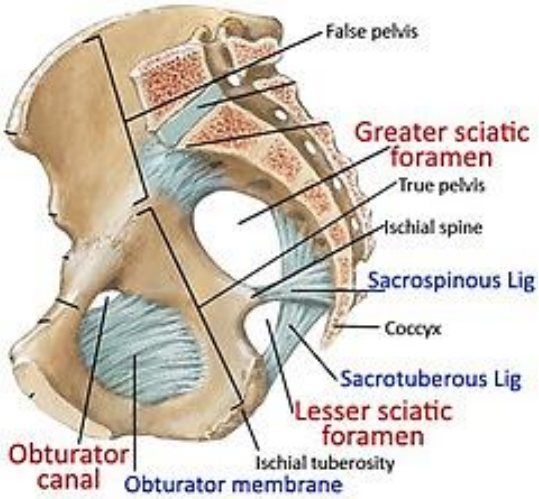
2. Lateral Wall of Pelvis







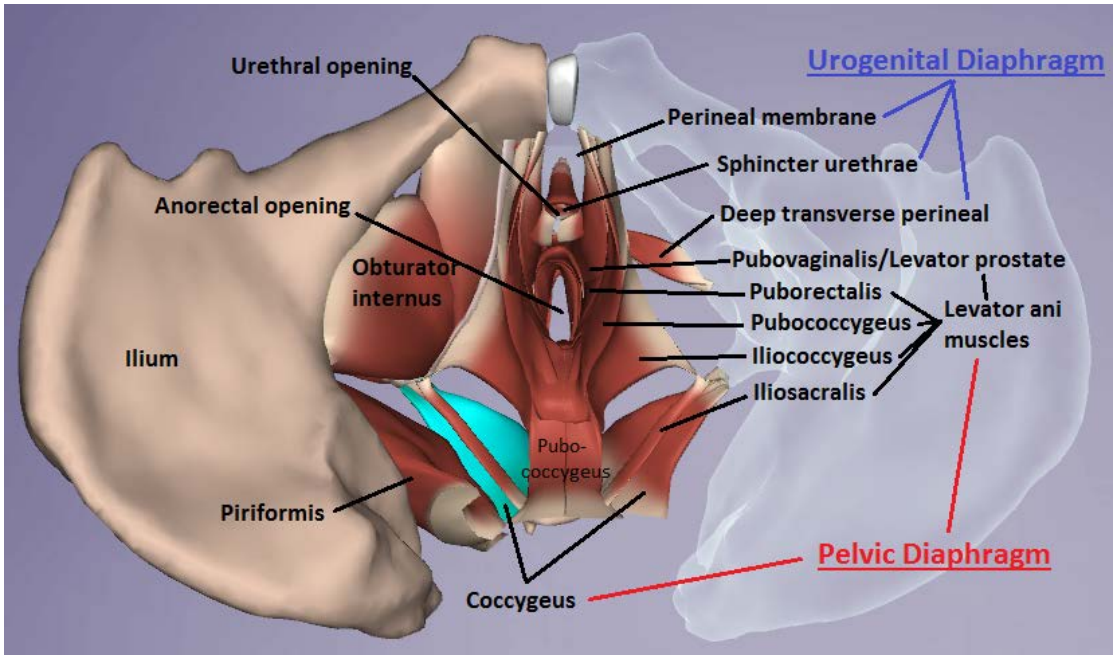




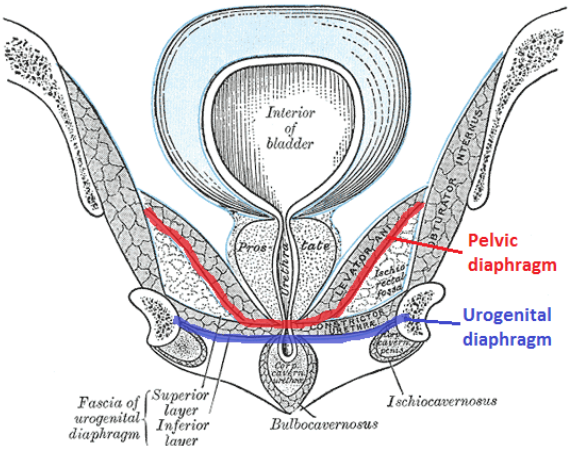
- **Piriformis**: lateral rotator of hip joint
  - Origin: anterior sacrum
  - Insertion: head of femur
  - Forms posterolateral wall of pelvis
- **Obturator internus**: lateral rotator of hip joint
  - Origin: ischiopubic ramus + **obturator membrane**
  - Insertion: head of femur
  - Forms anterolateral wall of pelvis
  - **Obturator canal**: hole formed by **obturator internus** and **obturator membrane** in the **obturator foramen** → allows **obturator A/V/N** to supply adductor muscles of the thigh
- **Sacrospinous ligament**: connects sacrum and ischial spine
  - Separates **greater sciatic foramen** from **lesser sciatic foramen**
- **Sacrotuberous ligament**: connects sacrum and ischial tuberosity
  - Composes the inferior boundary of the **lesser sciatic foramen**

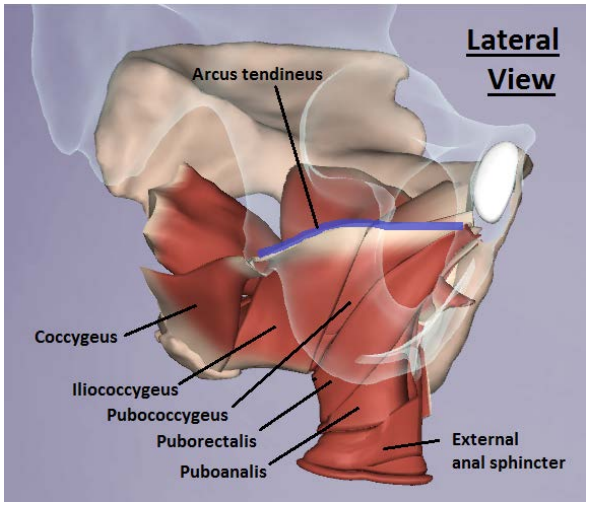
Obturator membrane* *covers the obturator foramen and is between* ***obturator internus* *and* ***obturator externus***

3. Pelvic Floor



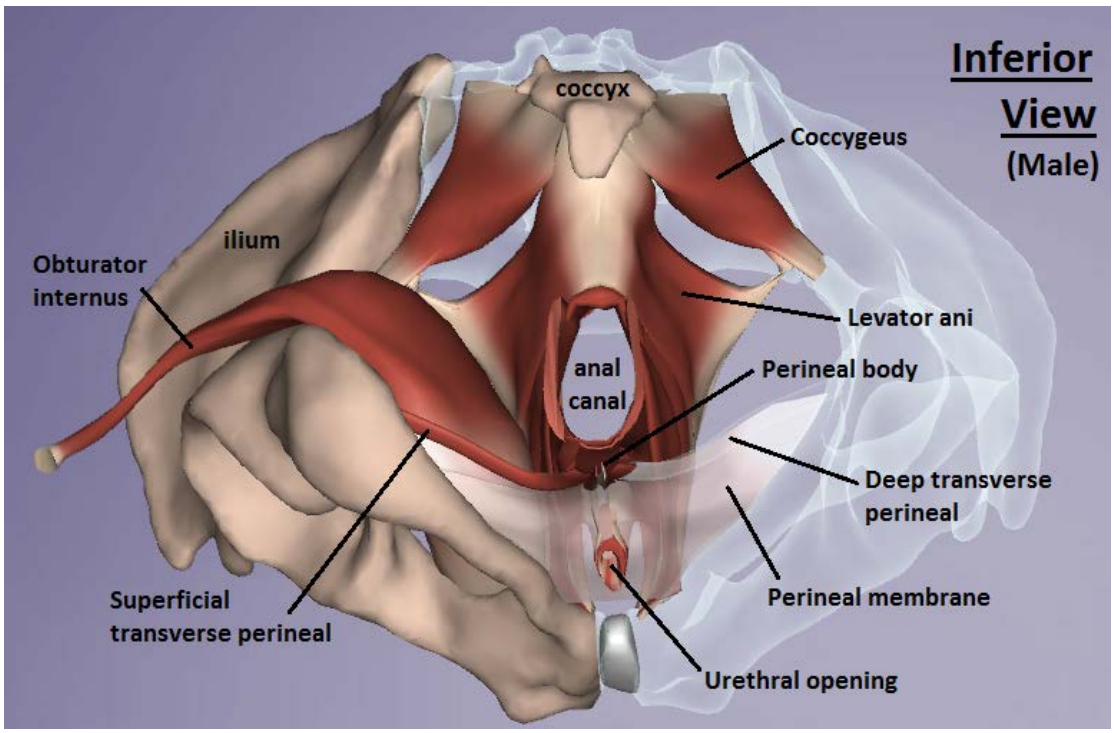
- **Pelvic floor** formed by multiple muscles collectively known as **pelvic diaphragm**
- **Pelvic diaphragm** separates the **perineum** from superior parts of the pelvic cavity
- Anterior urogenital part of **pelvic diaphragm** further covered by **urogenital diaphragm** (refer to anatomy of perineum)
- Formed by **levator ani** (anterior) and **coccygeus** (posterior) muscles
- **Levator ani muscle** divided into three main parts:
  - **Puborectalis**: originates from pubic symphysis and wraps around rectum → Important for rectal continence
  - **Pubococcygeus**: pubis → coccyx
  - **Iliococcygeus**: ischial spine → coccyx
- **Coccygeus muscle**:
  - Origin: ischial spine
  - Insertion: coccyx (and sacrum)



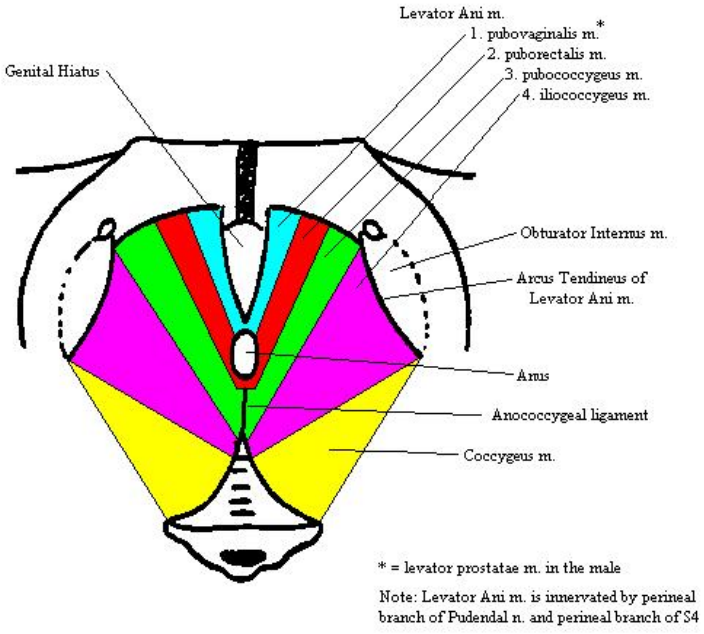


Some parts of levator ani originates from **arcus tendinous instead of bony structures*

***__Levator ani__ also contain __puboanalis__ (wrap around anal canal), __pubovaginalis__ (wrap around vagina) and __iliosacralis__ (connecting ischial spine to sacrum)*

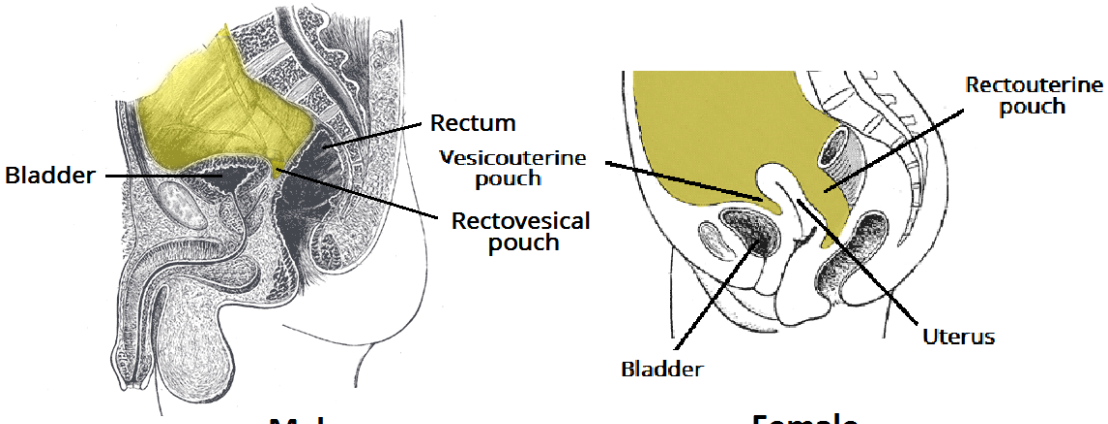


- Function:
  - Support and stabilize position of pelvic viscera
  - Acts as a sphincter for anorectal junction and vagina
- **Perineal body** located between **urogenital** and **pelvic diaphragms**
- Clinical significance: destruction of pelvic diaphragm or perineal body → prolapse of bladder, uterus, vagina and rectum → surgical repair under GA
- Nerve supply: S4-5, branches of **pudendal nerve**



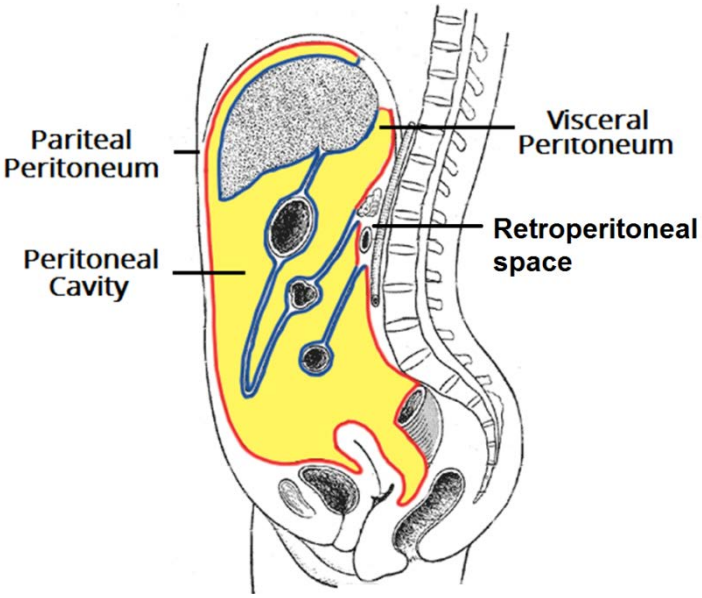
Pelvic Diaphragm, Superior View

4. Pelvic Reflection in Pelvic Cavity



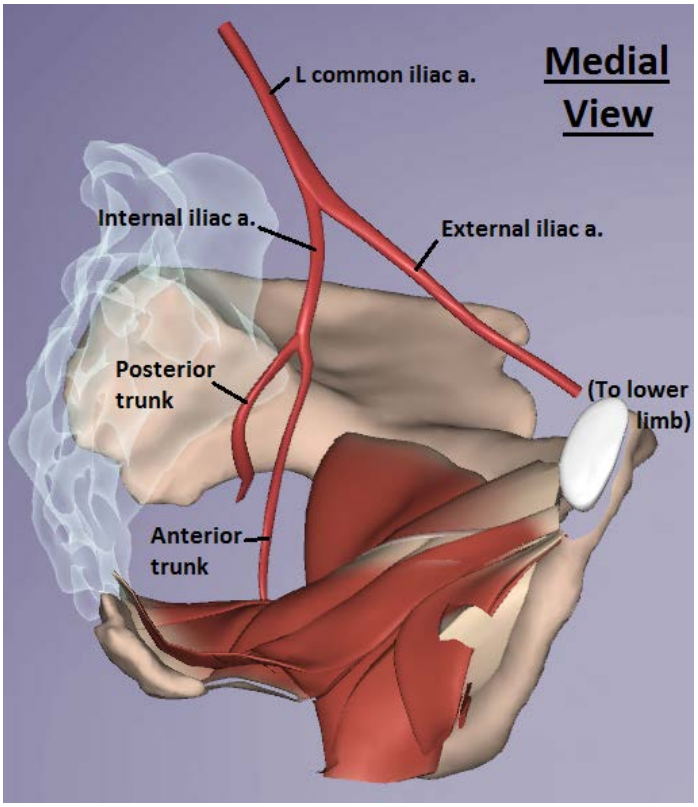
Male **Female**

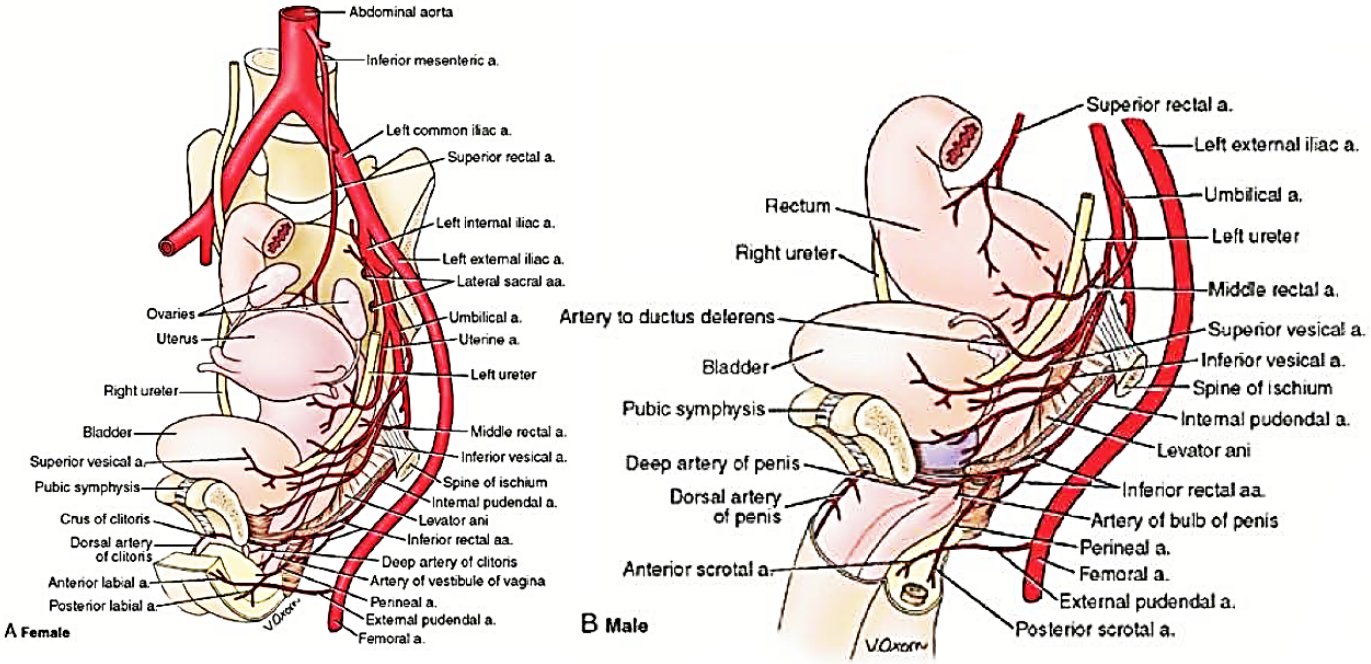
- Abdominal viscera lined by **visceral peritoneum**
- Abdominal wall lined by **parietal peritoneum**
- **Peritoneal cavity**: space between **visceral** and **parietal peritoneum**
- **Retroperitoneal space**: space behind posterior parietal peritoneum
  - Contains kidneys, adrenals, ureters, spine, muscles, blood vessels and nerves
- At pelvic cavity, peritoneum reflects against pelvic organs to form pouches
- In male, space between rectum and bladder is known as **rectovesical pouch**
- In female,
  - **Rectouterine pouch**: space between rectum and uterus
  - **Rectovesical pouch**: space between uterus and urinary bladder



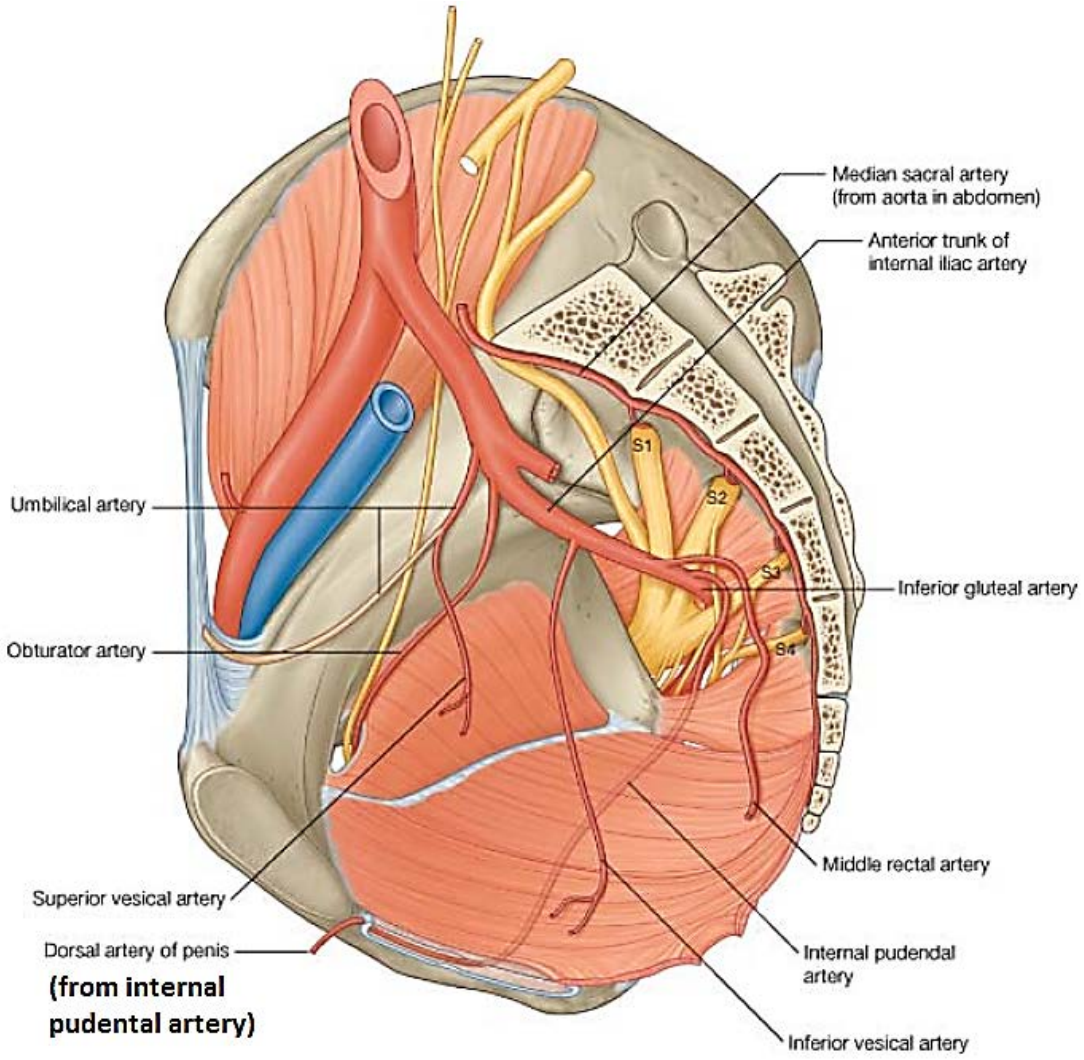
5. Blood Supply of Pelvis

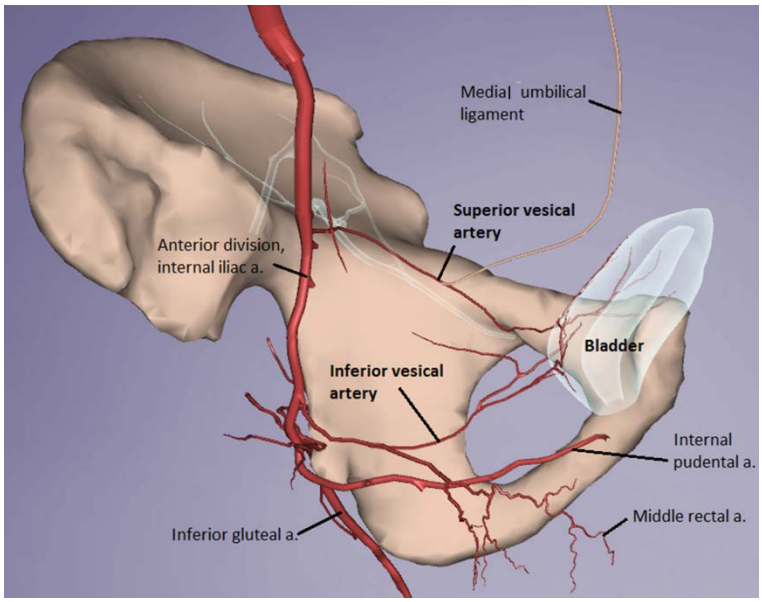
- All pelvic structures supplied by **internal iliac artery**
- **Internal iliac artery** divided into two divisions:
  - Anterior trunk: 9 branches
  - Posterior trunk: 3 branches

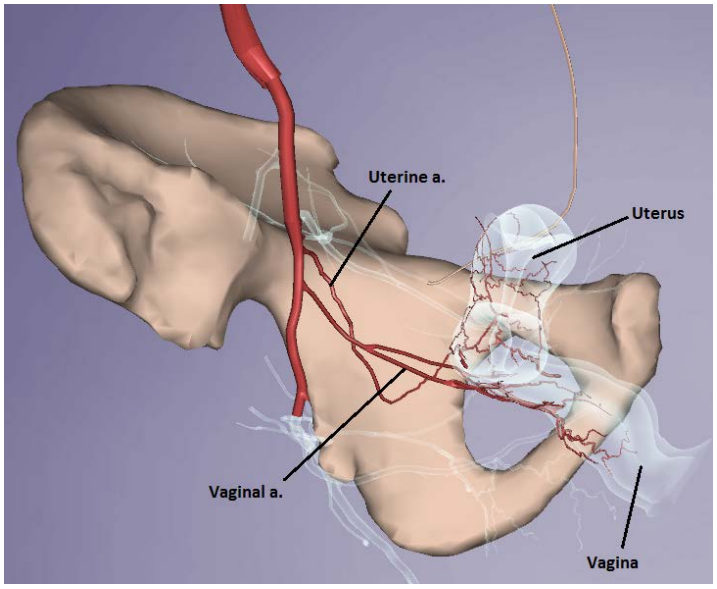


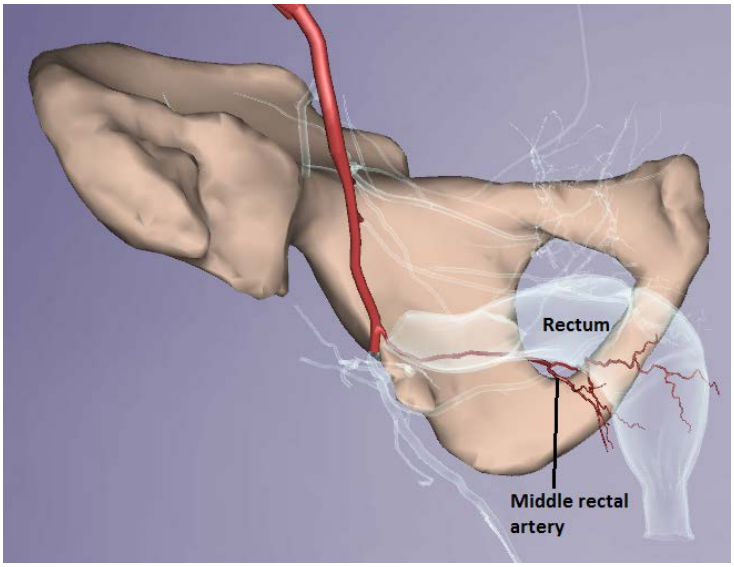


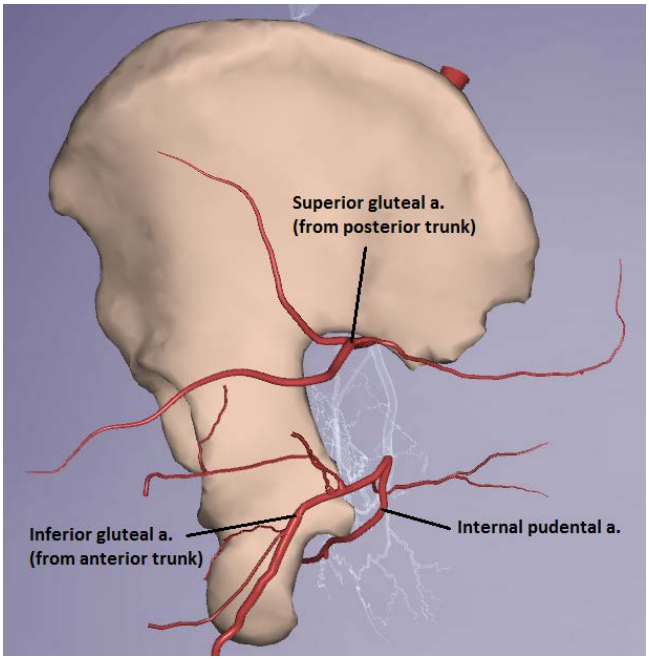
a. Anterior Division of Internal Iliac Artery









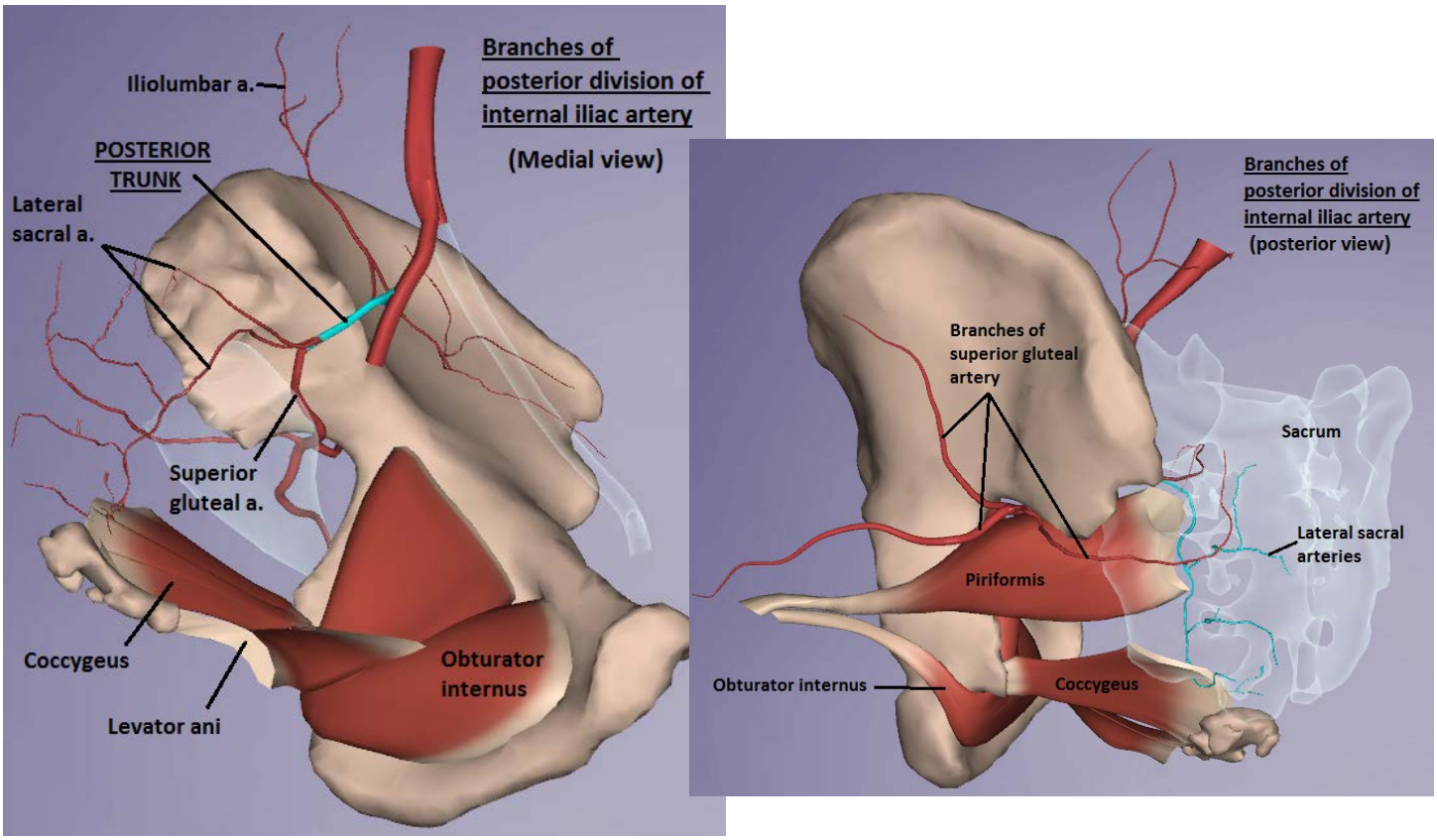


- **Superior vesical artery** → bladder
- **Obturator artery** → obturator externus and thighs
- **Inferior vesical artery** → bladder and vas deferens
- **Vaginal artery** → vagina
- **Uterine artery** → uterus
- **Middle rectal artery** → rectum
- **Internal pudental artery** → perineum
- **Inferior gluteal artery** → gluteal muscles
- **Umbilical artery**

  → obliterated and continues as **median umbilical ligament** to **umbilicus**

**Mnemonic: SO IV(4) U MR PIG*

b. Branches of Posterior Division of Internal Iliac Artery

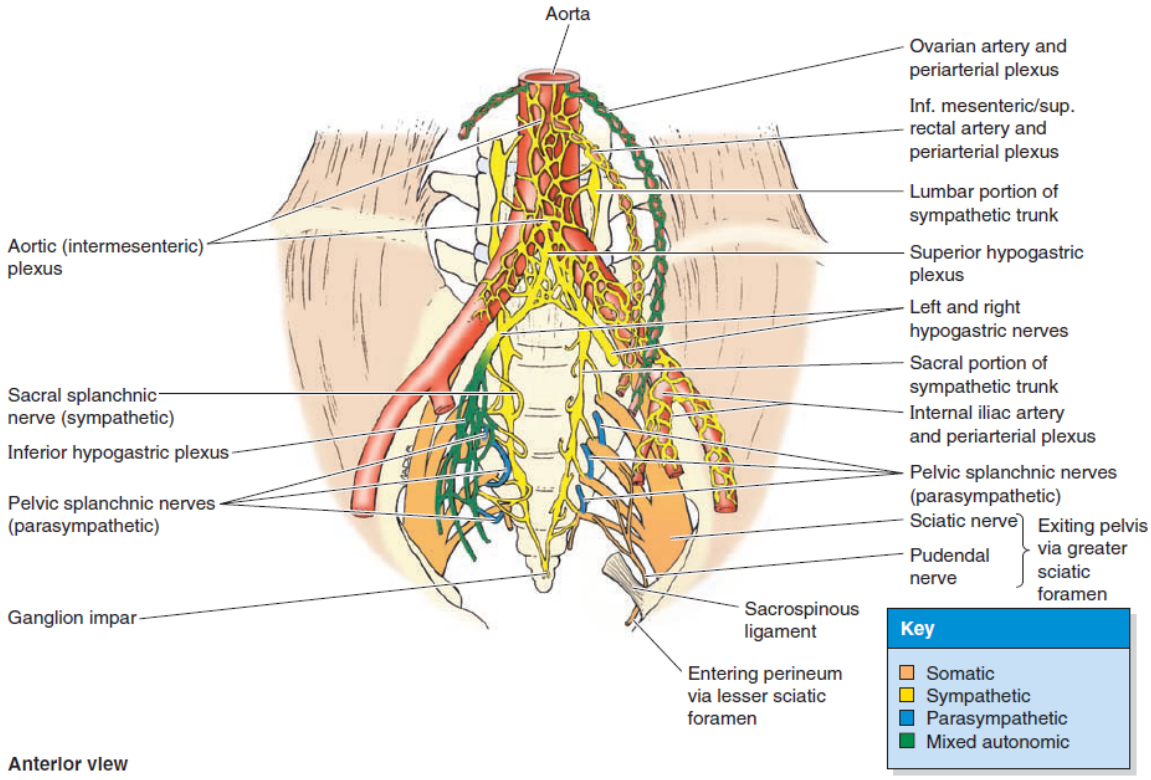


- **Iliolumbar artery** → muscles of posterior wall (**iliacus**, **quadratus lumborum** and **psoas major**)
- **Lateral sacral artery** → structures around sacrum and coccyx
- **Superior gluteal artery** → exits pelvis just above **piriformis**
  → supplies gluteal muscles

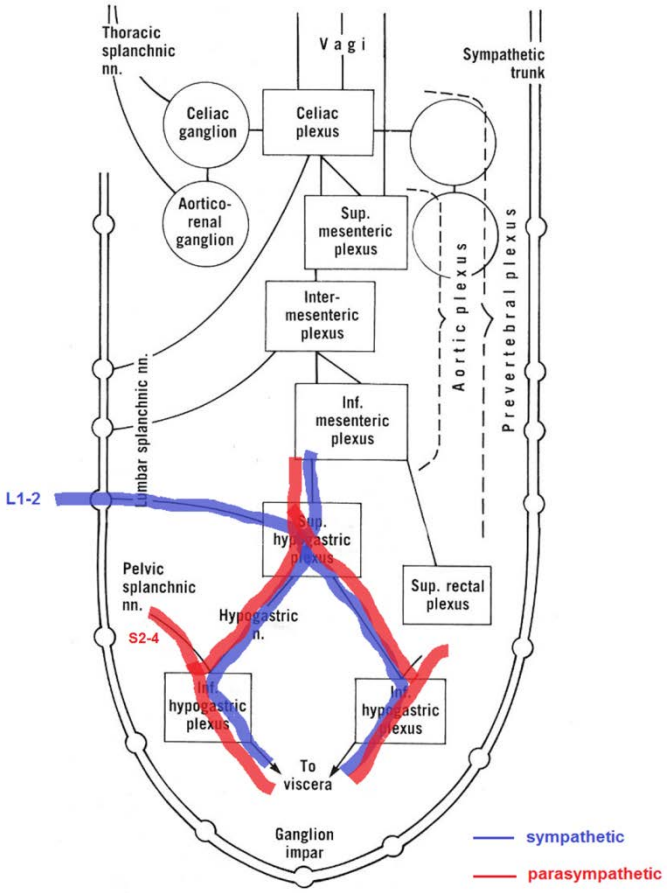
**Mnemonic: PILLS G (posterior division, iliolumbar, lateral sacral, superior gluteal)*

***Arterial branching of internal iliac artery may vary greatly from individual to individual*

6. Nerve Supply of Pelvic Viscera

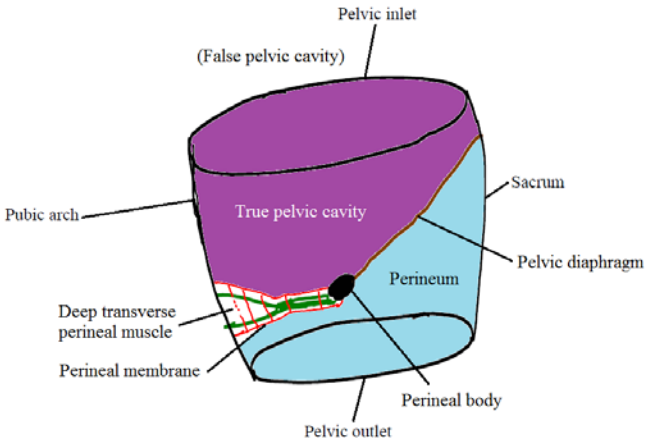


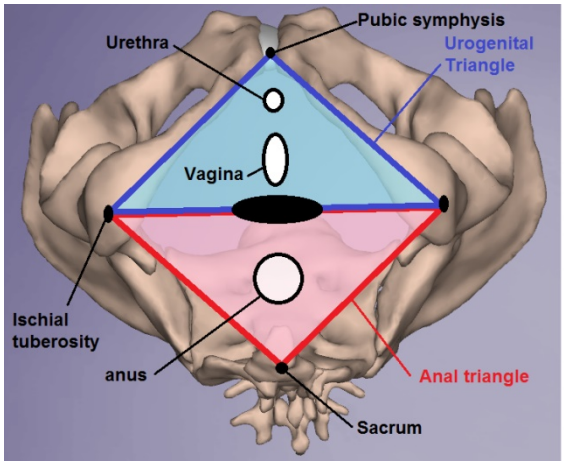
- **Hypogastric plexus** consists of **superior** and **inferior hypogastric plexuses**
- An autonomic plexus responsible for supplying pelvic viscera
- **Superior hypogastric plexus**: ANS plexus located just below aortic bifurcation
- Superior HP gives rise to two hypogastric nerves to form inferior hypogastric plexuses
- Contributed by:
  - SN: L1-2 → SN trunk
    → lumbar splanchnic nerves (SN)
    → superior hypogastric plexus
  - PN: S2-4
    → pelvic splanchnic nerves (PN)
    → inferior hypogastric plexus
- Function: provide ANS innervation of most pelvic organs

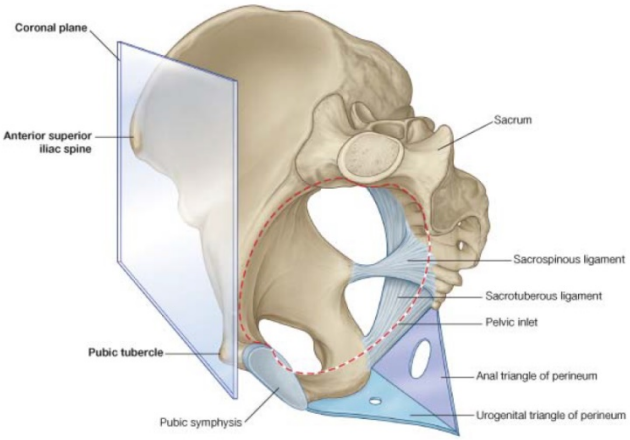


B. Gross Anatomy of the Perineum

- **Perineum**: region below the pelvic diaphragm
- Blood supply: **internal pudendal a.**
- Nerve supply: **pudendal n.**
- Can be divided into three divisions:
  - **Anal triangle**
  - **Deep perineal pouch** of **urogenital triangle**
  - **Superficial perineal pouch** of **urogenital triangle**

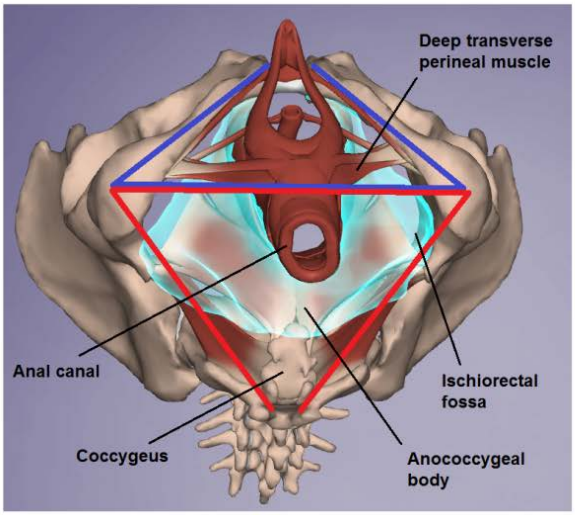


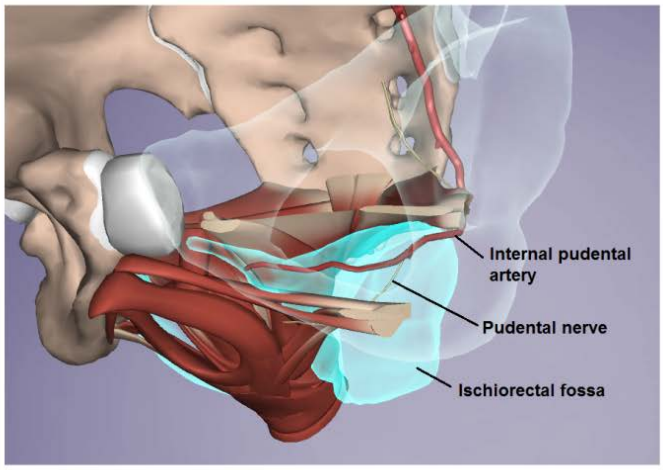


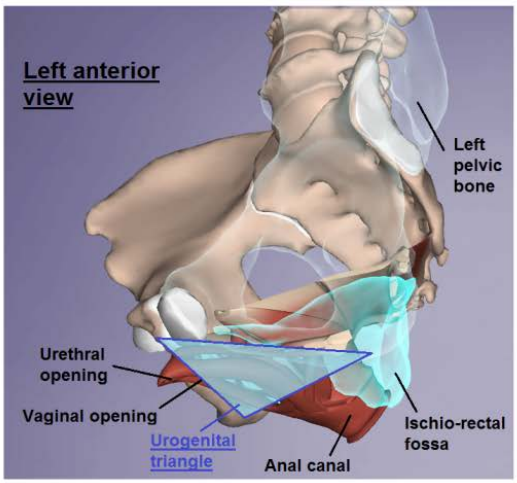


- **Urogenital** and **anal triangles** are separated by the line through ischial tuberosities of the two pelvic bones
- **Perineal body** is located between the two triangles
- **Anal canal** penetrates **anal triangle**
- **Urethra** and **vagina** (F) penetrates **urogenital triangle**

1. Anal Triangle







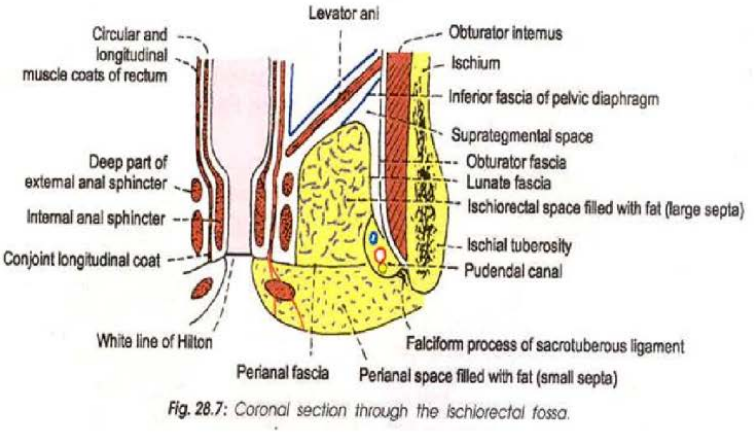
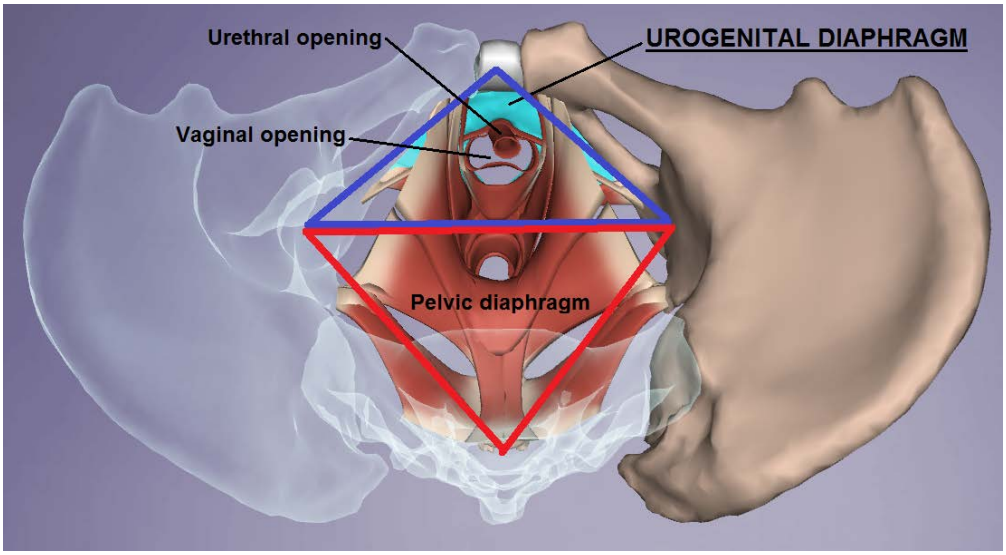
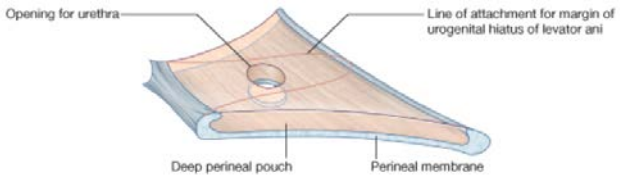


Fig. 28.7: Coronal section through the ischiorectal fossa.

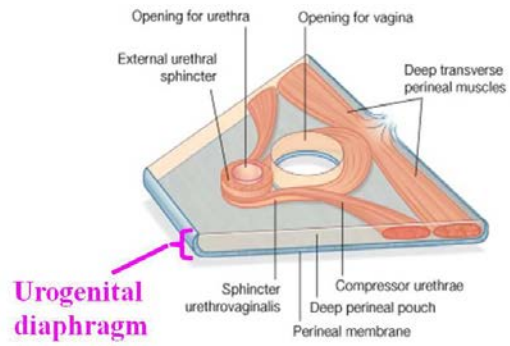
- Contents of anal triangle:
  - **Anal canal** connecting rectum to anus
  - **Ischiorectal fossa**: space lateral to the anal canal
  - **Anococcygeal body** or **ligament** posterior to perineal body
  - **Perineal body** at junction with urogenital triangle
- **Ischiorectal fossa**: space found lateral to anal canal
  - Filled with adipose tissue
  - Poor blood supply → vulnerable to infection and abscess formation
  - Contains:
    - → **Internal pudendal artery** from internal iliac (ant) supplying perineum
    - → **Pudendal nerve** supplying perineal structures
    - → **External anal sphincter**
    - → **External anal venous plexus**
  - **Pudendal canal** holds both internal pudendal a. and pudendal n.
  - Anterior recesses extend to urogenital triangle lateral to urogenital hiatus

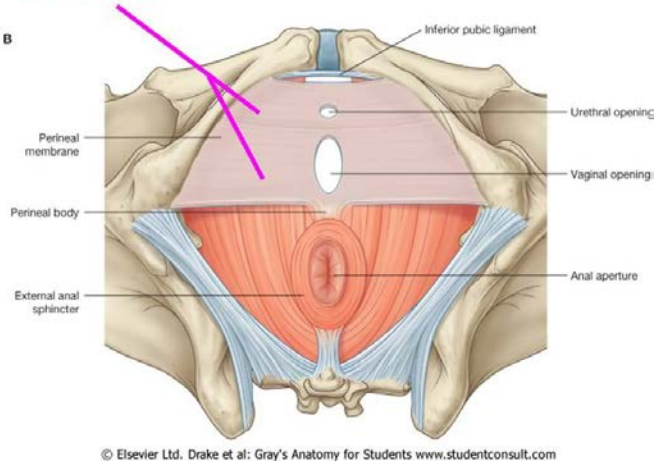
2. Urogenital Triangle

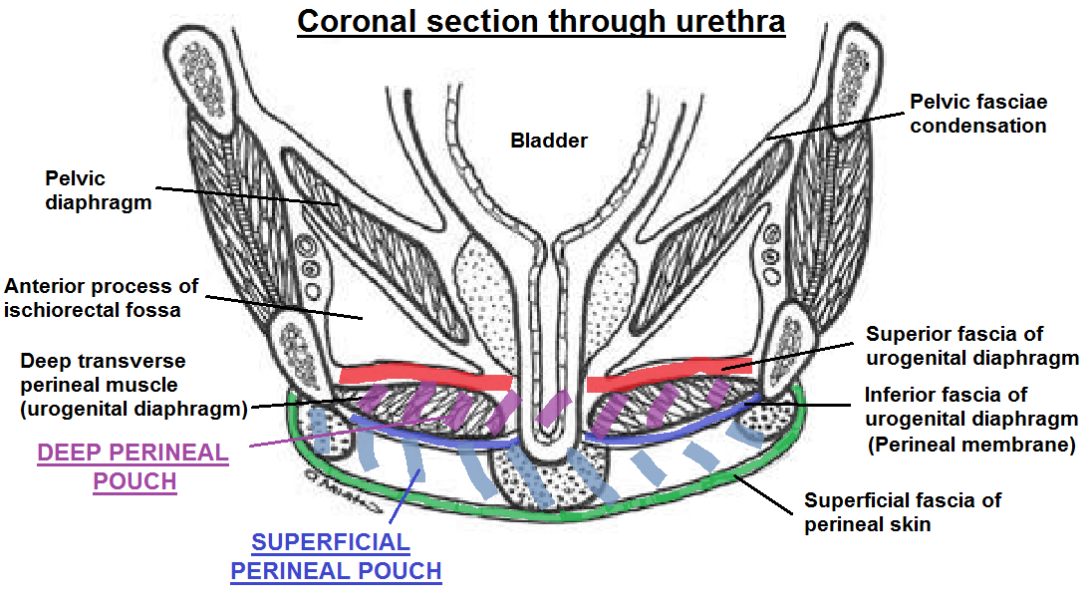




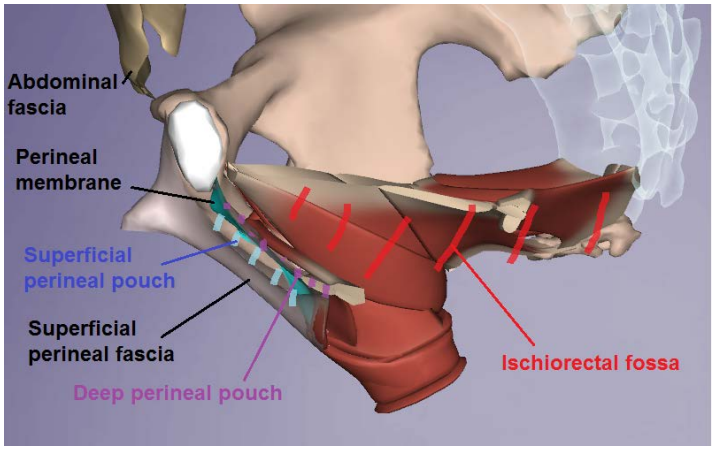
- **Pelvic diaphragm** (levator ani) has a U-shaped gap (**urogenital hiatus**) in the urogenital triangle
- **Urogenital diaphragm (UD)**: a triangular structure covering the urogenital triangle
- UD attached to anterior part of pelvic diaphragm and covers its urogenital hiatus
- Consists of **perineal membrane**, **deep transverse perineal muscle (DTPM)** and **sphincter urethrae (external urethral sphincter)**
- Penetrated by urethra and vagina
- Muscle contents of urogenital diaphragm:
  - **Deep transverse perineal muscle**
  - **Sphincter urethrae**
  - **Sphincter urethrovaginalis**
- Note that the muscles inside urogenital diaphragm are incomplete and do not form a complete layer
- Fasciae of the muscles are continuous and form:
  - **Superior fascia of urogenital diaphragm**
  - **Inferior fascia of urogenital diaphragm**, also known as **perineal membrane**







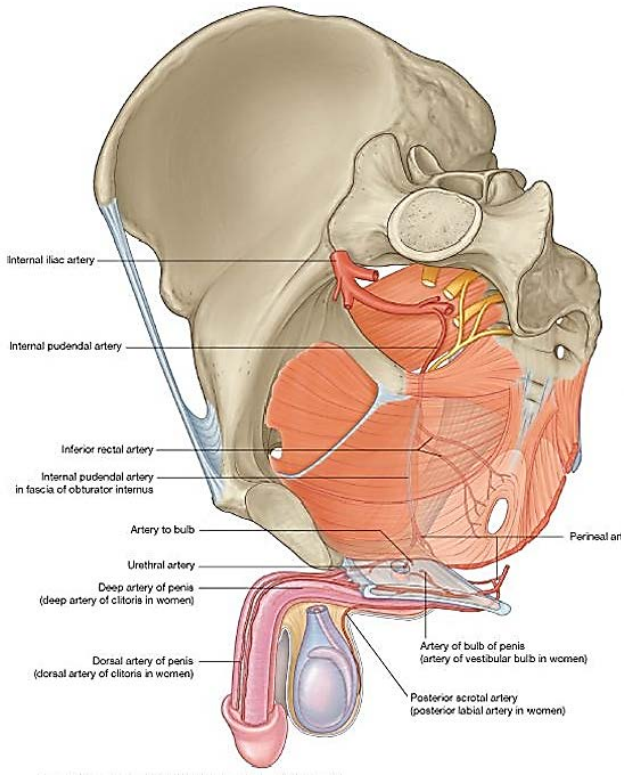
- **Perineal membrane** usually covers the whole urogenital triangle
  - Plays a major part in support
  - Has a small opening near pubic symphysis to allow a branch of the internal pudendal artery (from ischiorectal fossa, i.e. above urogenital diaphragm) to supply the external genitalia

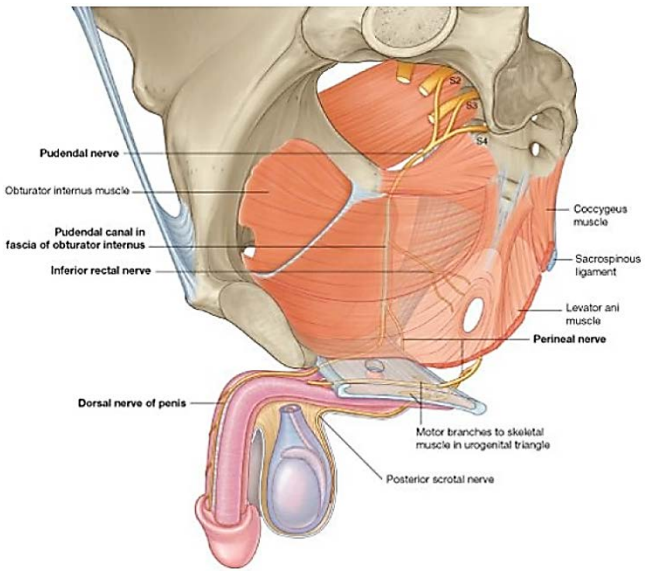


- **Deep perineal pouch (DPP)**: space between superficial fascia and inferior fascia of urogenital diaphragm
- **Superficial perineal pouch (SPP)**: space between perineal membrane and **superficial perineal fascia**
- **Superficial perineal fascia** is continuous with abdominal superficial fascia
  - **Campers fascia**: superficial fatty layer
  - **Colles fascia**: deep membranous layer
- Also contain **bulbourethral glands** (M) and **greater vestibular gland** (F)
- Clinical significance:
  - Penile urethra rupture → urine leakage into superficial perineal pouch → pass upward along penile superficial fasciae and anterior abdominal wall
  - Membranous urethra rupture → urine leakage into deep perineal pouch
  - Prostatic urethra rupture → urine leakage into pelvic cavity

a. Male Urogenital Triangle

i. Deep Perineal Pouch

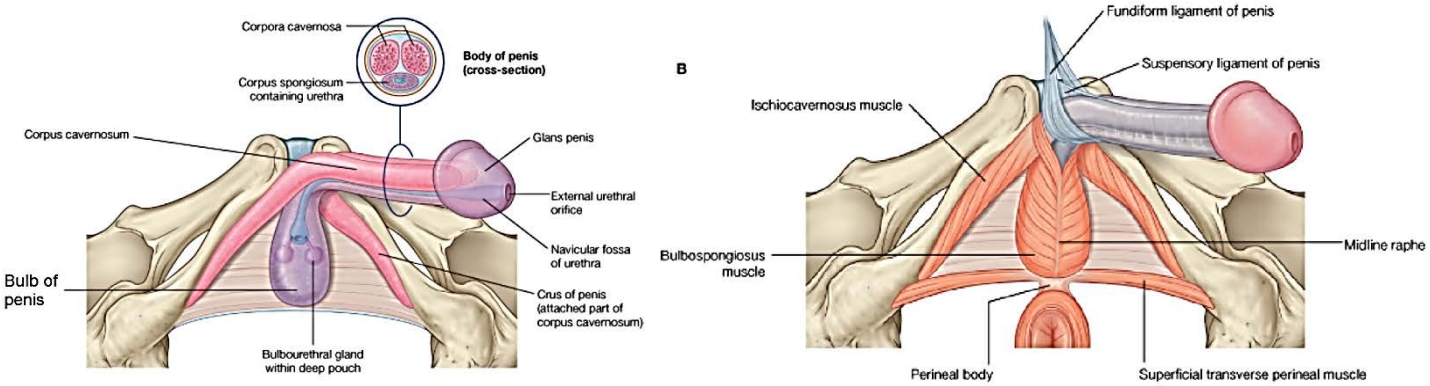




- Bounded by superior and inferior fascia of urogenital diaphragm
- Contents include:
  - **Membranous urethra**
  - **Bulbourethral glands**
  - **Internal pudendal vessels**
  - **Dorsal nerve of penis**
  - **Deep transverse perineal muscle**
  - **Sphincter urethrae**
- The two muscles are supplied by **perineal nerve** from **pudendal nerve**

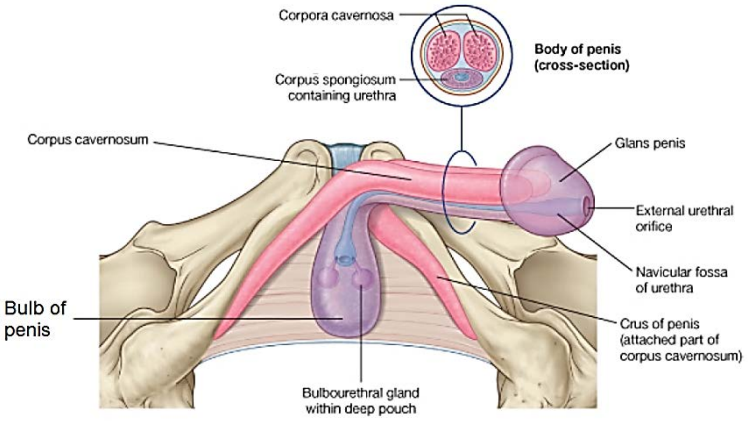
**Note that the internal urethral sphincter (sphincter vesicae) is located at the bladder neck and is under ANS control (not part of DPP)*

ii. Superficial Perineal Pouch

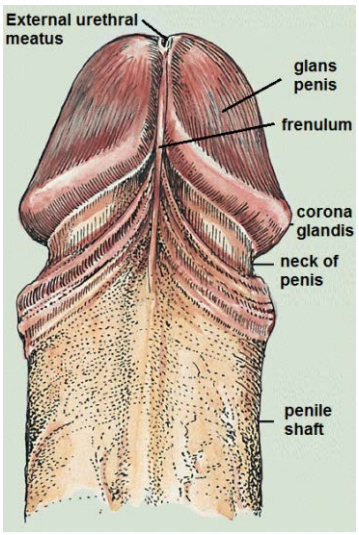


- Inferiorly bound by superficial fascia of perineum
  - **Dartos muscle** in scrotum from **Campers fascia** in abdomen
  - **Colles' fascia** in scrotum from **Scarpa's fascia** in abdomen
- Contains:
  - Erectile tissues: **bulb of penis** and **crura of penis**
  - Muscles associated with erectile tissues: **bulbospongiosus** and **ischiocavernosus**
  - **Superficial transverse perineal muscle (STPM)** to fix position of perineal body
  - Deep perineal branch of pudendal nerves
  - Internal pudendal vessels
- Erectile tissues in superficial perineal pouch:
  - External genitalia consists of three erectile tissues: **corpus spongiosum** and two **corpora cavernosa**
  - Extensions of **corpus spongiosum** and **corpora cavernosa** into the perineum are called **bulb of penis** and **crura of penis** respectively
- Muscles associated with erectile tissues:
  - **Bulbospongiosus muscle** encloses bulb of penis (CS)
  - **Ischiocavernosus muscle** encloses crura of penis (CC), stopping near pubic symphysis
  - Nerve supply: perineal branch of pudendal nerve
  - Function:
    - → Assist in emptying during urination (bulbospongiosus only)
    - → Erection and ejaculation (both)

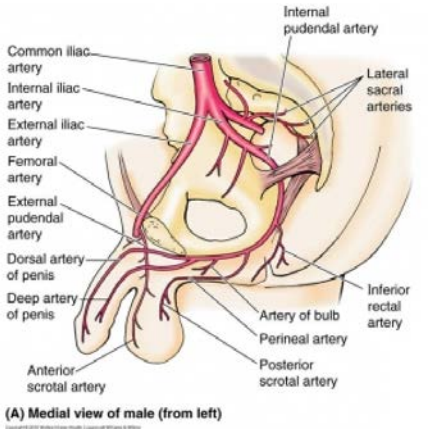
iii. Male Genitalia

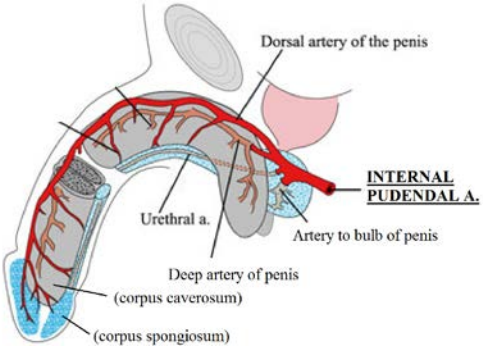


- **Penis** can be divided into **root** and **body**
- **Root** consists of two **crura** and **bulb** of penis
- **Body** consists of two **corpora cavernosa** and one **corpus spongiosum** (ventral)
- **Crura of penis**:
  - Located laterally along ischiopubic ramus
  - Continuous with **corpora cavernosa**
- **Bulb of penis**:
  - Located at the midline attaching to inferior floor of urogenital diaphragm
  - Continuous with **corpus spongiosum**
- Distal end of **corpus spongiosum** expands to form the **glans penis**
  - **External urethra meatus** can be found on the tip of glans penis
  - **Corona glandis**: circular base of glans penis
  - **Frenulum (of glans penis)**: an elastic band of tissue connecting the prepuce to the external urethral meatus → helps retract the prepuce



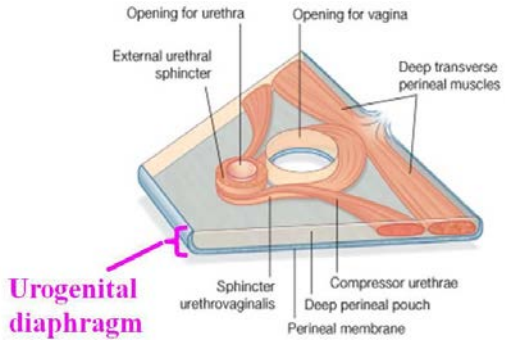
- **Scrotum** houses testes and epididymis outside the pelvic cavity
- Blood supply: mainly from branches of internal pudendal artery
- **Internal pudendal artery** gives six branches (from ant to post):
  - **Dorsal a. of penis** → skin and superficial layer of dorsal penis, corpora cavernosa
  - **Deep a. of penis** → corpora cavernosa
  - **Urethral a.** → spongy urethra
  - **A. to bulb of penis** → bulb of penis, corpus spongiosum and bulbourethral gland
  - **Perineal a.** → superficial perineal muscles and scrotum
  - **Inferior rectal a.** → lower 1/3 of anal canal





- Note that the blood supply of testis comes from **testicular a.**, a direct branch from abdominal aorta at a level close to kidney → follows spermatic cord down to scrotum
- Venous drainage: generally follows arterial pattern
  - **Superficial dorsal v. → superficial femoral v. → femoral v.**
  - **Deep dorsal v. → internal pudendal v. + prostatic plexus**
  - **Vein to bulb of penis → internal pudendal v.**
  - **Scrotal v. → perineal v. → internal pudendal v.**
  - **Testicular v.** → (spermatic cord) → **inferior vena cava**
- Lymphatic drainage:
  - Superficial structures of penis and scrotum → superficial inguinal nodes
  - Deep structures of penis → internal iliac and deep inguinal nodes
  - Testis → (spermatic cord) → paraaortic nodes
- Nerve supply: mainly by branches of **pudendal nerve** (S2-4)
- **Pudendal nerve** gives three branches:
  - **Inferior rectal nerve** supplying the external anal sphincter, lower 1/3 of anal canal and perianal skin
  - **Perineal nerve** supplying all striated muscle of perineum (muscular branch) and posterior skin of scrotum (posterior scrotal branch)
  - **Dorsal nerve of penis**

b. Female Urogenital Triangle



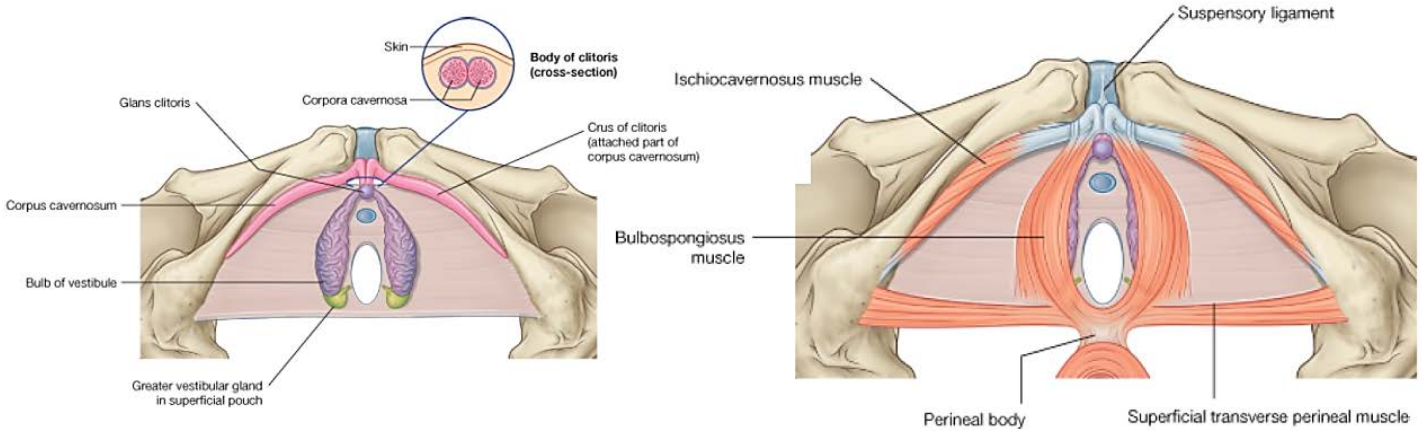
- Similar pattern with male except for:
  - Presence of vaginal canal
  - Absence of extra-abdominal gonads
  - Urethra does not traverse the clitoris

i. Deep Perineal Pouch

- Contents include:
  - **Urethra** (3.8cm, with paraurethral and greater vestibular glands at side)
  - **Vagina**
  - **Sphincter urethrae** and **sphincter urethrovaginalis**
  - **Deep transverse perineal muscle**
  - **Internal pudendal vessels**
  - **Dorsal nerve of clitoris**

**Note that the vagina is 8cm in length → much longer than the urethra*

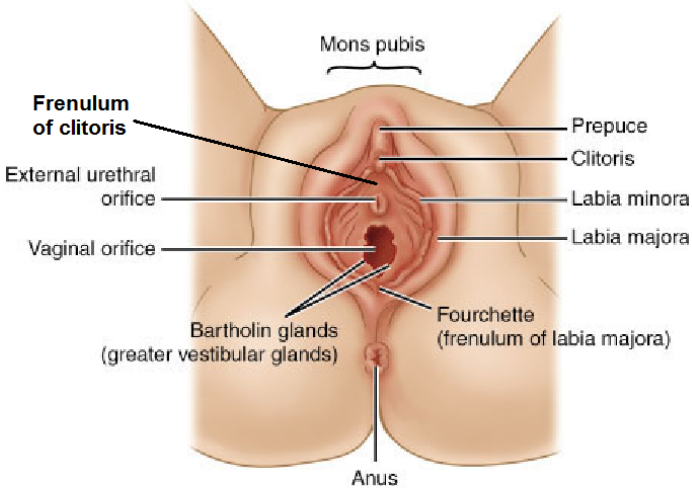
ii. Superficial Perineal Pouch



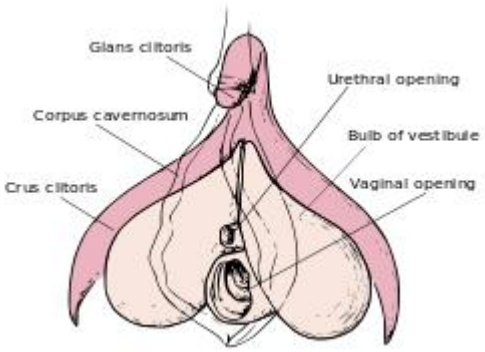
- Contains:
  - Erectile tissues: **bulb of vestibule** and **clitoris**
  - Muscles associated with erectile tissues: **bulbospongiosus** and **ischiocavernosus**
  - **Greater vestibular glands**
  - **Superficial transverse perineal muscle (STPM)**
  - Deep perineal branches of pudendal nerves
  - Deep perineal branches of internal pudendal vessels
- **Root of clitoris** formed by **bulb of vestibule** and **crura of clitoris**
- **Body of clitoris** formed by **corpora cavernosa** and **glans clitoris** (corpus spongiosum)
- **Bulbospongiosus** surrounds vaginal orifice and compresses deep dorsal vein of clitoris to assist in erection
- **Ischiocavernosus** surrounds crura of clitoris and assists in erection of clitoris
- Note that the **perineal body** is larger in female
  - Provides attachment for levator ani and three superficial muscles (external ani sphincter, superficial transverse perineal muscle and bulbospongiosus)
  - More important role in support of pelvic viscera
- Blood supply: mainly derived from branches of **internal pudendal a.**
  - **Posterior labial artery** (~posterior scrotal a. in male)
  - **Artery of bulb of vestibule**
  - **Deep artery of clitoris**
  - **Dorsal artery of clitoris**
  - **Perineal a.**
  - **Urethral a.**
- **Vaginal a.** from **internal iliac a.** supplies lower 1/3 of vagina

- Venous drainage: most drain into internal pudendal v. → internal iliac v.
  - Deep dorsal v. of clitoris → vesical venous plexus
- Lymphatic drainage: superficial inguinal nodes
- Nerve supply: mainly by branches of pudendal nerve
  - Inferior rectal nerve → external ani sphincter
  - Perineal nerve → all striated muscle in SPP
  - Dorsal nerve of clitoris

iii. Female External Genitalia

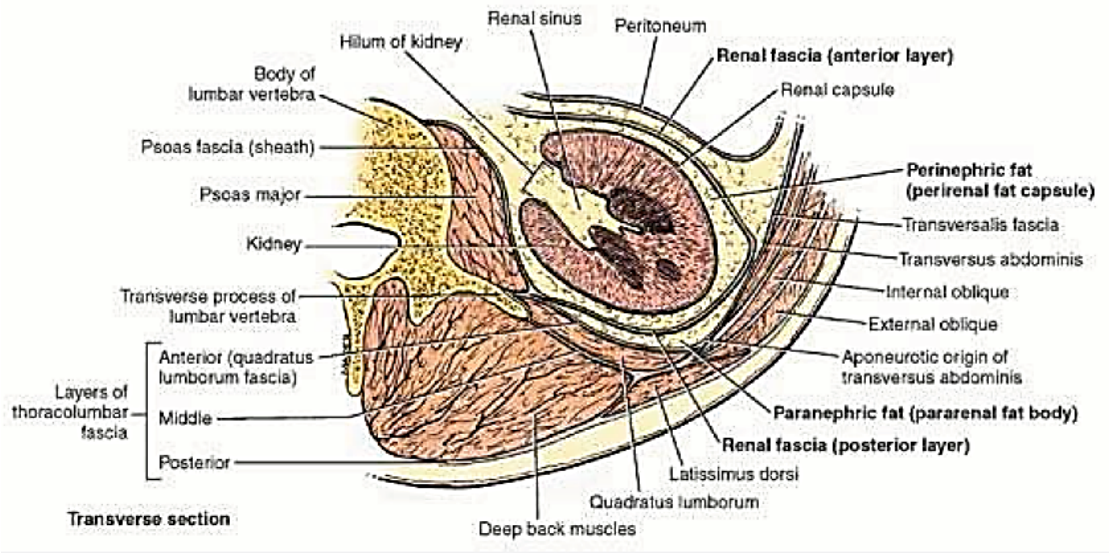


- Partly pass through superficial perineal pouch of the perineum
- Laterally bound by **labia majora** and **labia minora**
- Anterior labia minora forms two laminae:
  - Medial laminae unite posterior to clitoris as **frenulum of clitoris**
  - Lateral laminae unite anterior to clitoris as **prepuce of clitoris**
  - Fusion of labia minora posterior to vaginal orifice forms **fourchette**
- **Mon pubis**: rounded fatty tissue found over the pubic symphysis
- **Vestibular fossa**: boat-shaped cavity found between labia minora and labia majora
- **Clitoris** consists of:
  - **Root of clitoris** = **bulb of vestibule** + **crus of clitoris**
  - **Body of clitoris** = **corpora cavernosa** + **glans clitoris**
- **Hymen (virgin membrane)** covers part of vaginal orifice

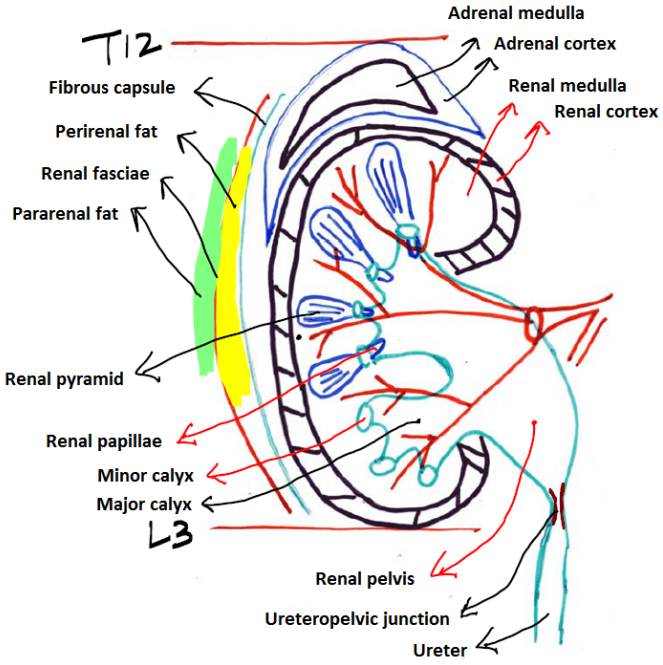


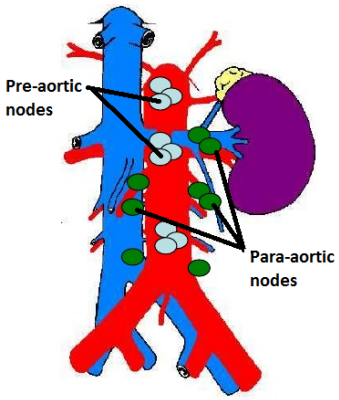
C. Gross Anatomy of the Urinary System

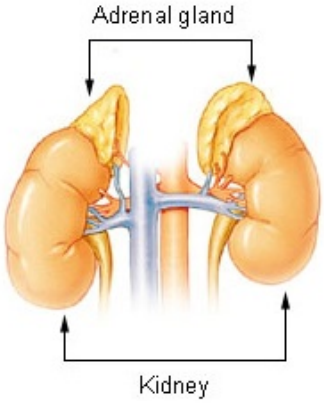
1. Kidneys



- **Kidneys**: retroperitoneal paired organs for urine formation
- Right kidney is lower than the left
- Level: T12-L3
- Size: 11cm × 6cm × 3cm (AP)
- Covering (from innermost to outermost): fibrous capsule, **perirenal fat**, renal fascia, **pararenal fat**
  → support of kidney
- Internal layers:
  - **Pelvis**: collection of urine
  - **Medulla**: concentration of urine
  - **Cortex**: formation of urine
- **Renal pyramids** formed by collecting tubules end at **renal papillae** and drains into **minor** and then **major calyces**
- Blood supply:
  - **Renal artery** from abdominal aorta
  - **Renal vein** (at L2) draining into IVC
- Lymphatic drainage: **para-aortic nodes**
- Nerve supply:
  - Sympathetic: **renal sympathetic plexus** (T12 via the least thoracic splanchnic)
  - Parasympathetic: vagus nerve



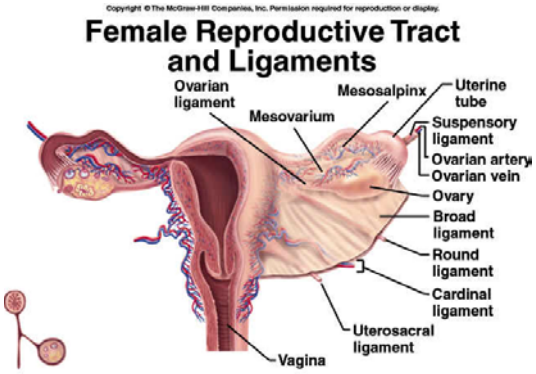




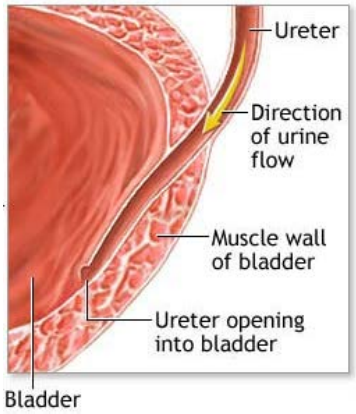
a. Adrenal Glands

- **Adrenal glands**: retroperitoneal paired organs responsible for secretion of adrenaline and a variety of steroids
- Located at superior pole of kidneys
- Internal structure: cortex and medulla
- Blood supply:
  - Artery: **inferior phrenic artery**, **renal artery** and direct branches from **abdominal aorta**
  - Vein: **L** and **R suprarenal vein** draining into **L renal vein** (L) (→ IVC) and **IVC** (R) respectively
- Lymphatic drainage: **para-aortic nodes**
- Nerve supply: sympathetic only
  - **Greater splanchnic nerve** from **T5-T9**
  - Preganglionic fibres only (adrenaline secretion replaces function of post-ganglionic fibres)

2. Ureters



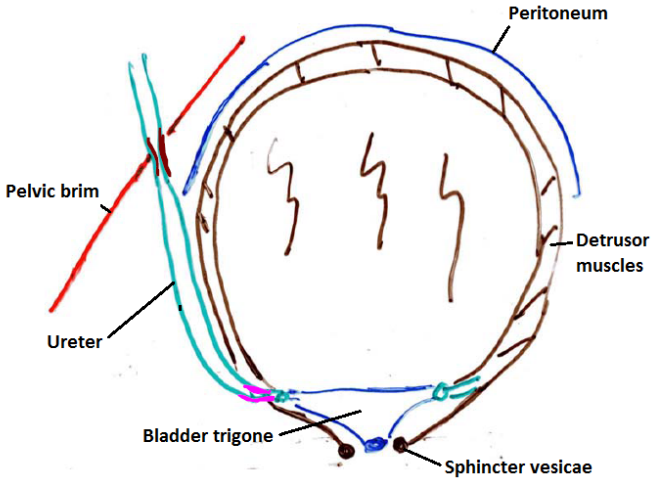
- Begins at renal pelvis and ends at bladder
- Retroperitoneal in entire course
- Three physiological narrowing:
  - **Ureteropelvic junction**
  - Site where ureter crosses **pelvic brim**
  - Site where ureter joins the bladder
  - Significance: may trap kidney stone
- In male, ductus deferens crosses superiorly over ureter towards the posterior side
- In female, ureter passes below **uterine artery** at base of **broad** and **cardinal ligament**
  - Caution not to ligate ureter during **hysterectomy** or **abdomino-pelvic surgery**
- Oblique insertion into bladder trigone
  → acts as a valve to prevent **vesicoureteral reflux**
- Blood supply:
  - Renal part: **renal A/V**
  - Middle part: **gonadal A/V**
  - Pelvic part: **iliac** and **vesical A/V**
- Lymphatic drainage: **para-aortic nodes**
- Nerve supply: **renal**, **testicular** and **hypogastric plexuses**



**Hysterectomy*: surgical removal of uterus*

***Urethral stone pain referred to loin (sides), scrotum, penis or labia majora*

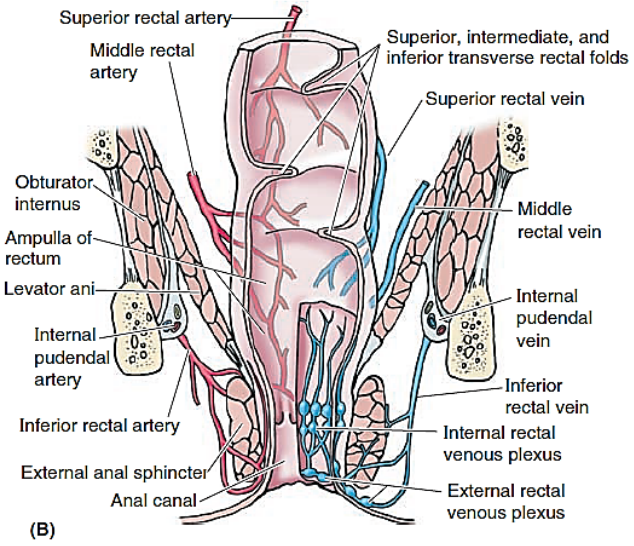
3. Urinary Bladder



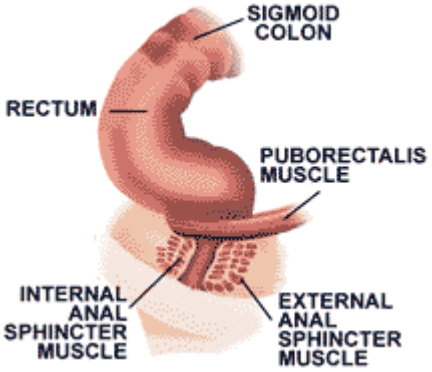
- **Bladder**: true pelvic organ responsible for storage of urine
- Wall of bladder:
  - Serous peritoneum (superior only)
  - **Detrusor muscles** (smooth muscle)
  - **Urothelium** (transitional epithelium)
- **Sphincter vesicae**: smooth muscle at neck of bladder
  - Control release of urine from bladder
  - Autonomic innervation
  - Fixed by:
    - → **Pubovesical ligament** (female): connects bladder neck to pubis
    - → **Puboprostatic ligament** (male): connects prostate to pubis
- Support of bladder given by:
  - **Urogenital diaphragm**
  - **Pelvic fascia**:
    - → Parietal: fascia of pelvic floor (diaphragm)
    - → Visceral: fascia of pelvic viscera
  - **Median umbilical ligament**: apex of bladder to umbilicus
  - **Medial umbilical ligament**: remnant of fetal umbilical artery
- **Trigone**: smooth triangular area at base of bladder
  - Most sensitive to pain
  - Lies between **urethral orifice** and the two **ureteric orifices**
- Superior margin can reach umbilicus when full (400-600 mL)
- Blood supply:
  - **Superior** and **inferior vesical** (M) or **vaginal** (F) **arteries**
  - **Vesical venous plexus** → **prostatic venous plexus** → **internal iliac vein**
- Lymphatic drainage: **internal** and **external iliac nodes**
- Nerve supply: **hypogastric plexus** (ANS)
  - Sympathetic: L1-2
  - Parasympathetic: S2-4
- **Transurethral cystoscopy**: invasive procedure in which a fibre-optic cystoscope is inserted via urethra into the bladder → allow you to view internal features of bladder, prostate, urethra, ureters and extract ureteral stones
- **Suprapubic aspiration**: distended bladder rises above pubic symphysis → use of needle puncture above pubic symphysis to drain the bladder

D. Anatomy of the Anorectal Canal

1. Rectum



- Located in **retroperitoneum**
- Not covered with mesentery and is fixed in location
- Starts at S3 level
- Curved along the shape of the sacrum
- **Valves of Houston (transverse folds)**: horizontal folds to help hold faeces
  - Two on the left and one on the right
- **Ampulla**: dilated terminal part
- **Anorectal junction**: meeting point of rectum and anus



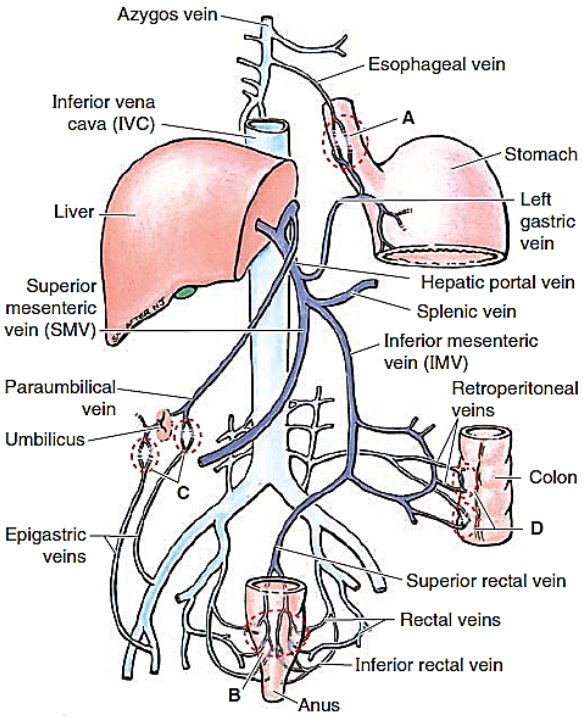
- **Puborectalis muscles** support rectal canal at anorectal junction and helps maintain continence
  - Supplied by S4-5 and branches of pudendal nerve
- Anterior relation: **rectovesical pouch** (M) or **rectouterine pouch** (F)
- Posterior relation: sacral nerves, sacrum and lymph nodes
- Blood supply: five arteries form anastomoses
  - One **superior rectal A/V** as terminal branch of inferior mesenteric A/V
  - Two **middle rectal A/V** from internal iliac A/V
  - Two **inferior rectal A/V** from internal pudendal A/V
- Lymphatics: preaortic nodes, pararectal nodes, inferior mesenteric nodes → intestinal trunk → cisterna chyli → thoracic duct
- Nerve supply: inferior hypogastric plexus or hypogastric plexus (L1-2 (SN), S2-4 (PN))

**Note that superior rectal v. drains into inferior mesenteric v. which then drains into hepatic portal v. while the other two veins drain into the systemic circulation (internal iliac v.)*

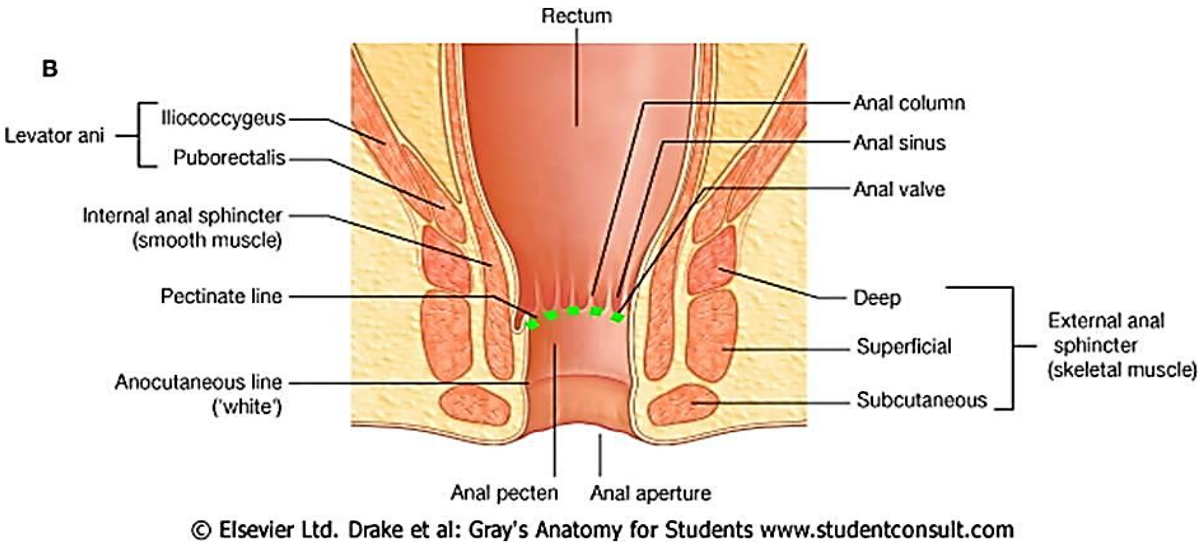
- **Rectal cancer** accounts for 65% of all cancers of large bowels
  - Can be detected by digital rectal examination or direct visualization via **proctosigmoidoscopy** or **colonoscopy**
  - Spread of rectal cancer can be:
    - → Posterior: sacral plexus → **sciatica** (pain radiating from back along the legs)
    - → Anterior: bladder, prostate, seminal vesicles, uterus, vagina
    - → Lymphatics: deep lymphatic nodes → liver
- **Cirrhosis** can lead to obstruction in liver
  → compression on hepatic blood vessels → **portal hypertension**
  - **Inferior mesenteric v.** originally drains the distal part of intestines into the portal venous system
  - Blockage of portal venous system → blood shunted through **middle/lower rectal v.** into systemic venous system
  - Presentation: dilation of rectal veins → hemorrhoids

Hepatic portal vein** drains blood from GI via **left gastric v.**, **sup** and **inf mesenteric v.

Portosystemic anastomoses**: communication between portal venous system and systemic venous system → provide collateral drainage when hepatic portal v. is blocked. They include: **oesophageal veins** (left gastric v. or azygos vein), **inf** and **mid rectal v.** (inferior mesenteric v. or internal iliac v.) and **para-umbilical veins** (fetal umbilical vein) anastomosing with **superficial epigastric veins



2. Anal Canal



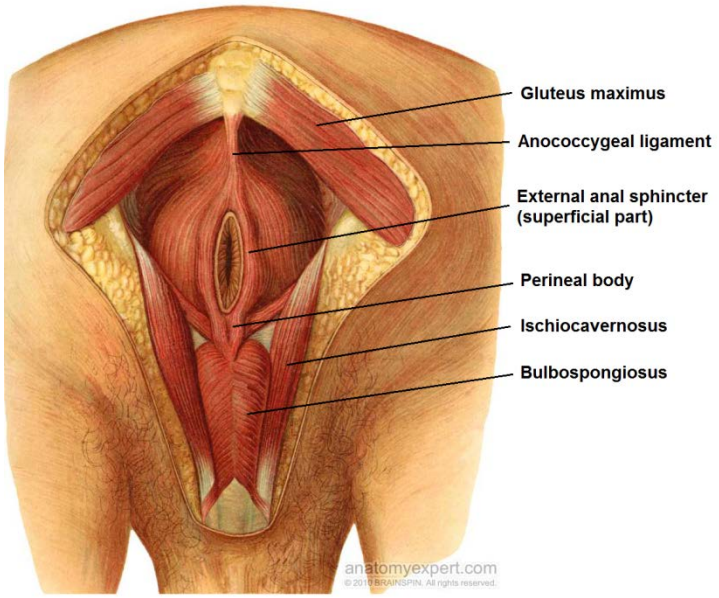
- **Anal canal** is divided into upper and lower parts by the **pectinate line**:

	Upper part	Lower part
Lining	Columnar (endoderm)	Stratified squamous (ectoderm) (non-keratinized transits into keratinized at anocutaneous line)
Blood supply	Superior rectal A/V from inferior mesenteric A/V	Inferior rectal A/V from internal pudendal A/V
Nerve supply	Hypogastric plexus (ANS)	Inferior rectal nerves From pudendal nerve (somatic)
Lymphatics	Pararectal nodes → inferior mesenteric nodes	Medial group of superficial inguinal nodes

- **White line** or **anocutaneous line** marks:
  - Transition of non-keratinized to keratinized epithelium
  - Transition of internal anal sphincter to external anal sphincter

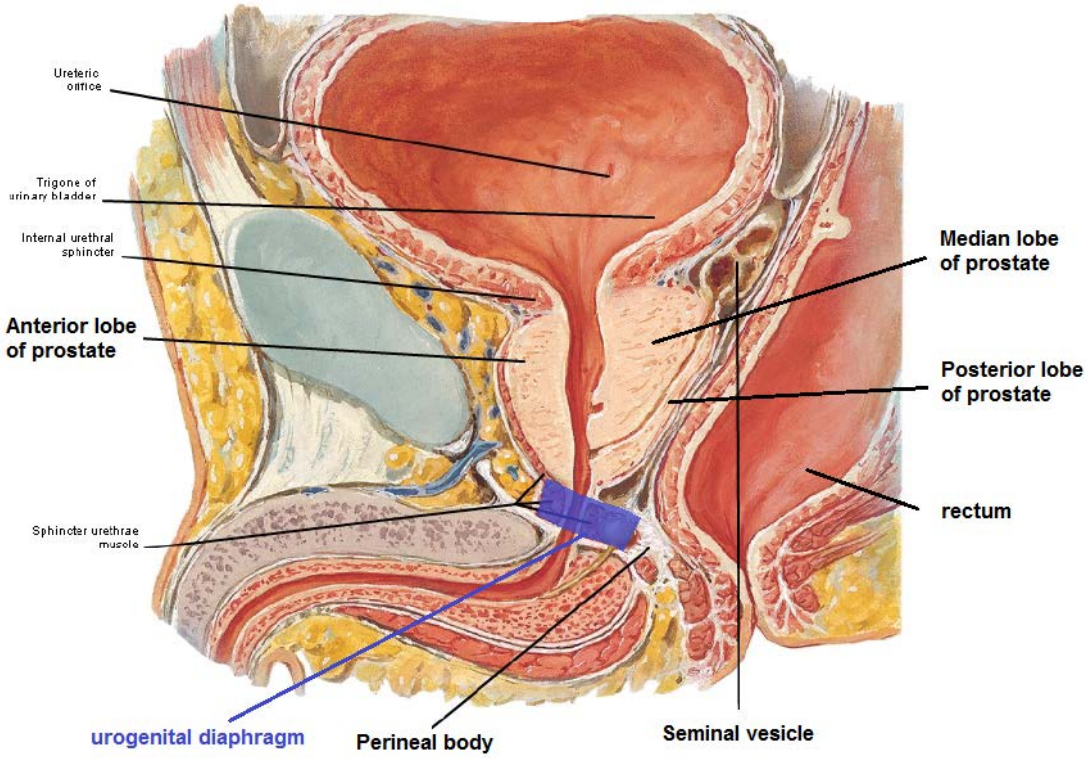
Note that **superior rectal a. sends branches to supply the upper part of the anal canal*

- **Internal anal sphincter**: circular sm acting as involuntary sphincter
  - Located in the upper part of anal canal along **white line** (just below pectinate line)
  - Nerve supply: PN fibres from inferior hypogastric plexus
- **External anal sphincter**: located outside internal anal sphincter
  - Three parts:
    - → Deep: circular muscle fibres continuous with puborectalis
    - → Superficial: elliptical muscle fibres attaching along anococcygeal ligament onto coccyx and perineal body
    - → Subcutaneous: circular muscle fibres beneath anal skin
  - Supplied by perineal branch of S4 and inferior rectal nerve (a branch of pudendal nerve)

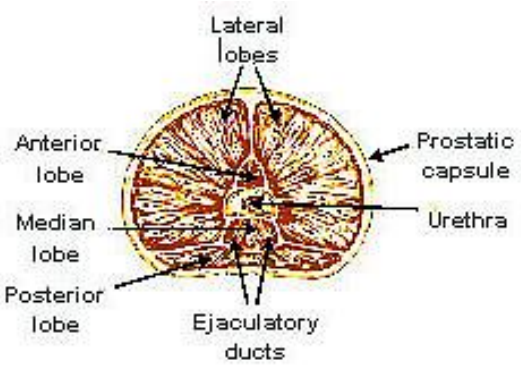


E. Anatomy of the Male Reproductive Organs

1. Prostate

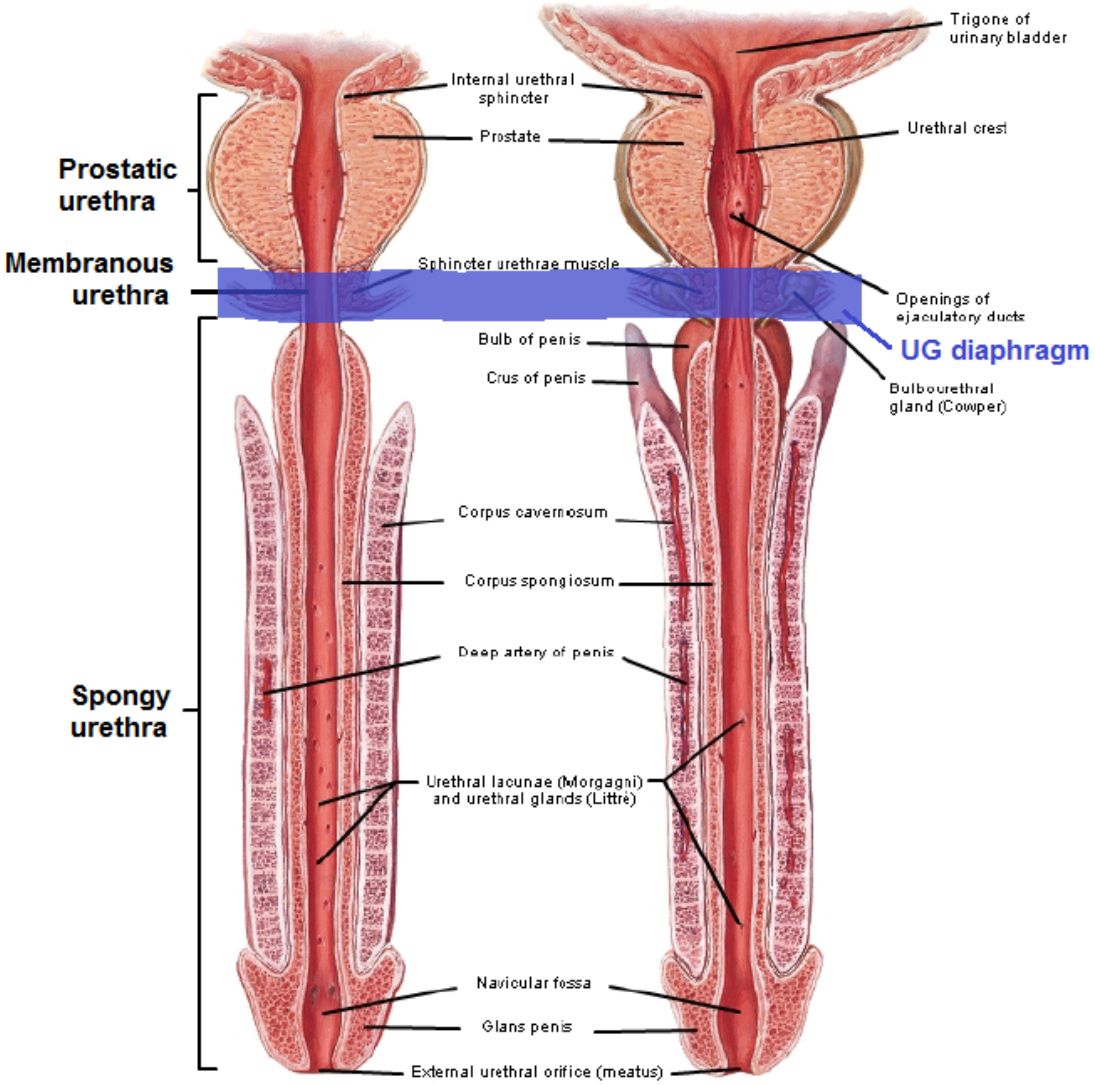


- **Prostate**: chestnut-shaped organ functioning as an accessory sex glands in males
- Located between bladder and urogenital diaphragm
- Base is attached to the bladder
- Apex points inferiorly
- Consists of fibromuscular connective tissue
- Dimensions: 4×3×2 cm
- Divided into five lobes: **left lateral**, **right lateral**, **anterior**, **median** and **posterior lobe**



- **Ejaculatory duct** forms by joining of bilateral vas deferens
  - Inserts between posterior and median lobes
- **Prostatic urethra** inserts between median and anterior lobes
- Prostatic secretion high in citric acid and acid phosphatase and contributes to majority of semen
- Blood supply: **inferior vesical** and **middle rectal a.**
- Venous drainage: **prostatic plexus → internal iliac v.**
- Lymphatics: internal iliac nodes
- Nerve supply: inferior hypogastric plexus
- Clinical correlation:
  - **Digital rectal examination**: posterior lobe of prostate in close proximity with rectum → palpation of anterior rectal wall can check if prostate is enlarged
  - **Median lobe** is highly glandular and is the common site for benign prostatic hyperplasia → can lead to urinary obstruction
  - **Posterior lobe** is more prone to carcinoma → haematogenous spread to prostatic plexus → internal iliac v. → vertebral plexus → CNS spread
  - Cancer can cause secretory obstruction → high level of acid phosphatase

2. Male Urethra



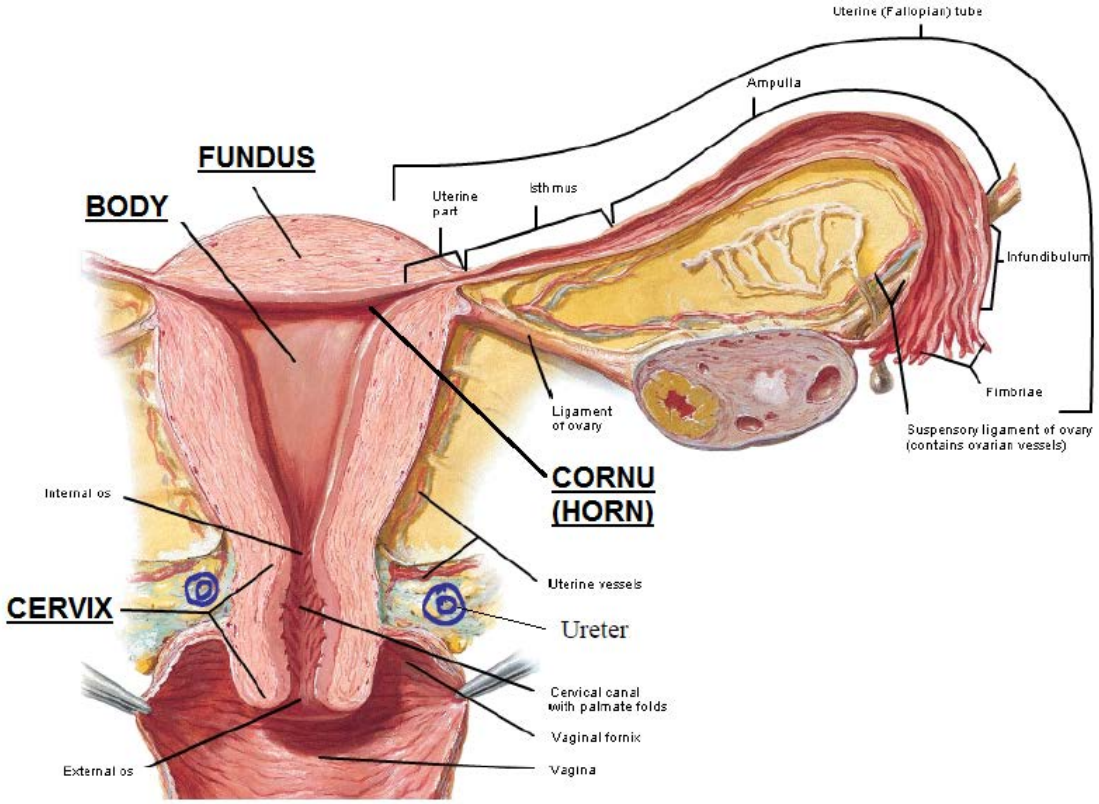
- Length: 20cm in male and 4cm in female
- **Prostatic urethra**: most dilatable part with openings of ejaculatory duct
- **Membranous urethra**:
  - Located within urogenital diaphragm
  - Surrounded by **sphincter urethrae** (part of urogenital diaphragm)
  - Fixed and narrowed due to urogenital diaphragm
- **Spongy urethra**: longest part
  - Openings of **bulbourethral glands** near entrance
  - **Fossa navicularis**: terminal dilated part in glans penis
  - **Urethra lacunae**: openings of urethral glands (commonly infected in STDs and may later complicate as strictures)

**As the female urethra is too short, it is usually not separated into parts. Its short length also contributes to frequent ascending urinary tract infections in female.*

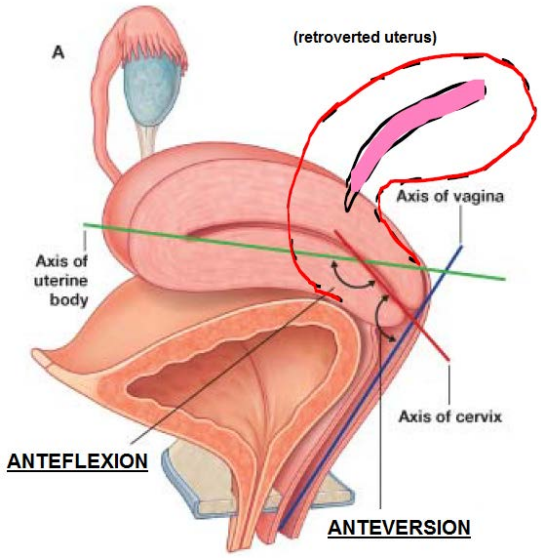
******Urethral glands*** *are mucosal glands of urethral epithelium*

F. Anatomy of the Female Reproductive System

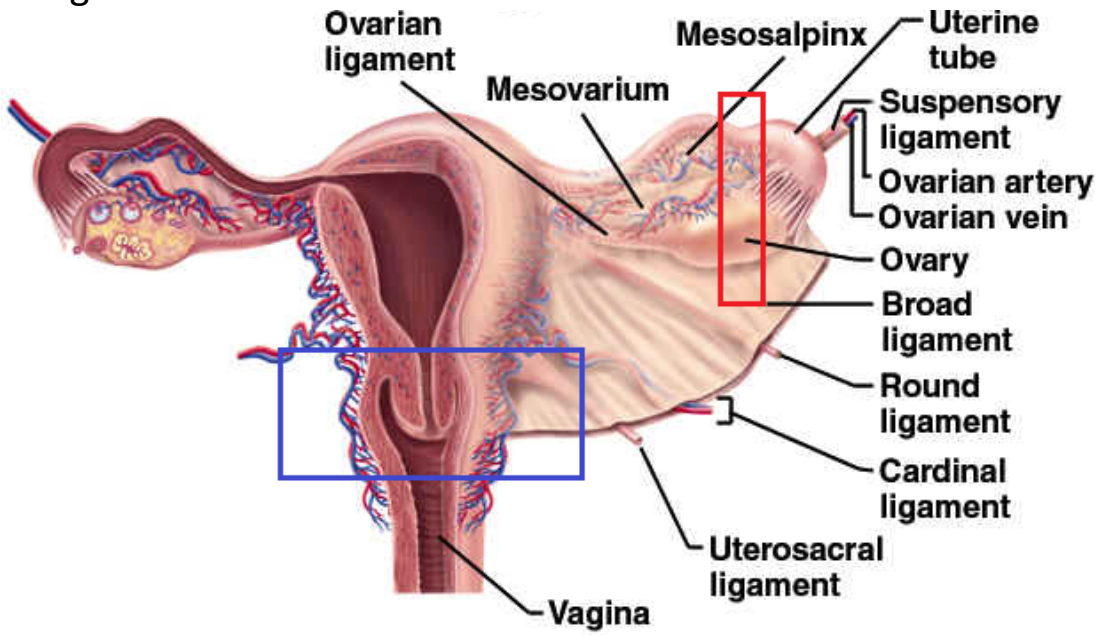
1. Uterus



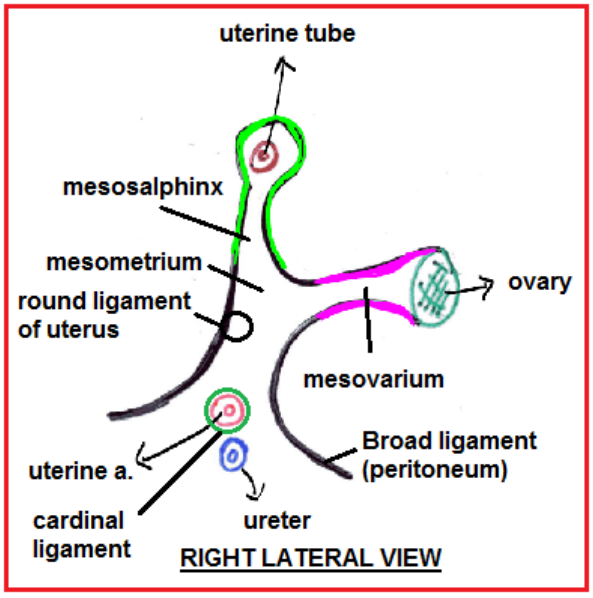
- Uterus consists of four parts: **fundus**, **cornu**, **body** and **cervix**
- Position:
  - **Anteflexed**: body axis more forward compared to cervical axis
  - **Anteverted**: cervical axis more forward compared to vaginal axis
- Support:
  - Primary: pelvic and urogenital diaphragms
  - Secondary: ligaments of uterus (not very essential)
- Blood supply: **uterine A/V** from **internal iliac A/V**
- Lymphatics: external and internal iliac nodes and sacral nodes
- Nerve supply: inferior hypogastric plexuses
- Clinical correlations:
  - Ureter passes just behind **uterine a.** → prone to ligation during **hysterectomy** (removal of uterus)
  - Destruction of pelvic diaphragm can cause uterine prolapse
  - Retroverted uterus can cause infertility (disputed)

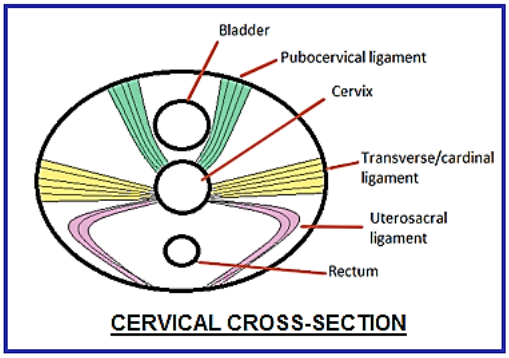


a. Ligaments of Uterus

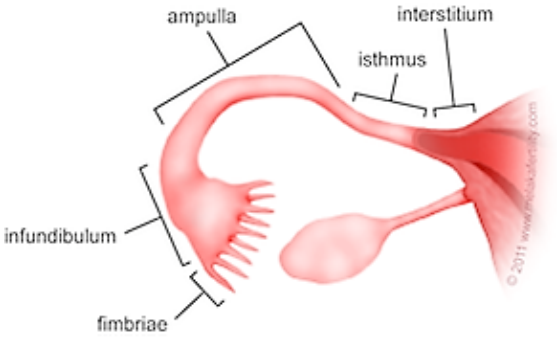


- Function: provides <u>secondary</u> support for uterus
- Can be divided into two groups:
  - Superior: broad and round ligaments
  - Cervical: pubocervical, cardinal and uterosacral ligaments
- **Broad ligament**: double fold of peritoneum enclosing uterus, fallopian tubes and ovaries
  - **Mesosalpinx**: part surrounding fallopian tubes
  - **Mesovarium**: part surrounding ovaries
  - **Mesometrium**: main part of broad ligament
- **Round ligament of uterus** from uterine horn passing over pelvic brim → inguinal canal → attaches to labia majora underneath
  - Remnant of fetal **gubernaculum**
  - Originally attached to labioscrotal fold
- **Pelvic fasciae condensation**: conglomeration of c.t. derived from muscular fasciae at pelvic walls and floor, forming **major ligaments of uterus**:
  - **Transverse cervical (cardinal) ligament** attaching to ischial spine (houses the uterine A/V)
  - **Uterosacral ligament** attaching to anterior sacrum
  - **Pubocervical ligament** attaching to pubic symphysis



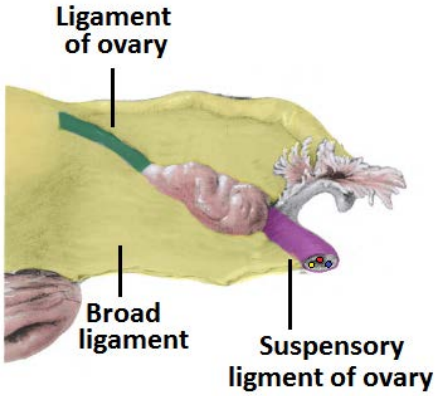


2. Fallopian Tubes



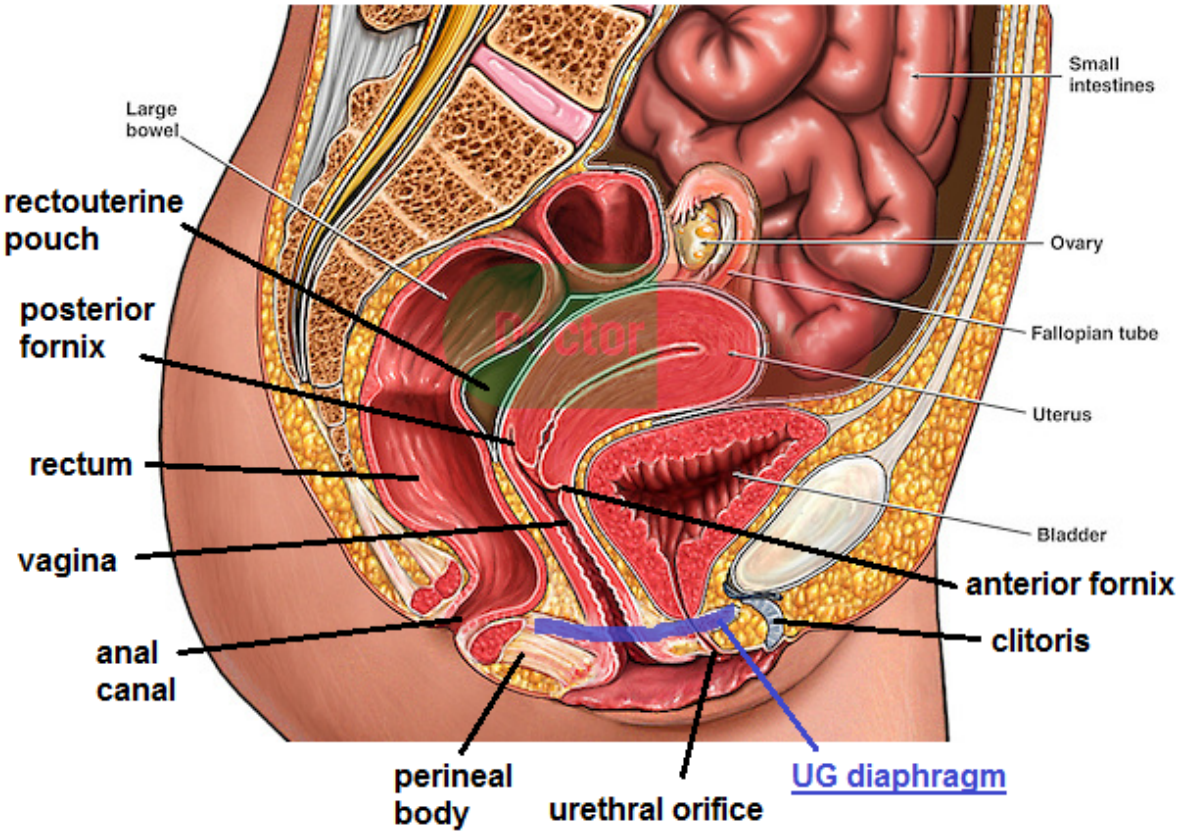
- Four parts:
  - **Isthmus**: narrowest part
  - **Ampulla**: widest part (95% of fertilization occurs here)
  - **Infudibulum**
  - **Fimbriae**: finger-like projections to receive ovum from ovaries
- Support: **mesosalpinx**
- Blood supply: **ovarian A/V** and **uterine A/V**
- Clinical correlation:
  - **Pelvic inflammatory disease**: infection of upper female reproductive tract (fallopian tubes, uterus, ovaries and other parts of pelvis)
    → Usually a result of ascending infection from perineum → uterine cavity → pelvic cavity
  - **Ectopic pregnancy** commonly occurs at ampulla
  - **Uterosalpingography**: a procedure in which a dye is injected to test patency of the uterine tube

3. Ovaries

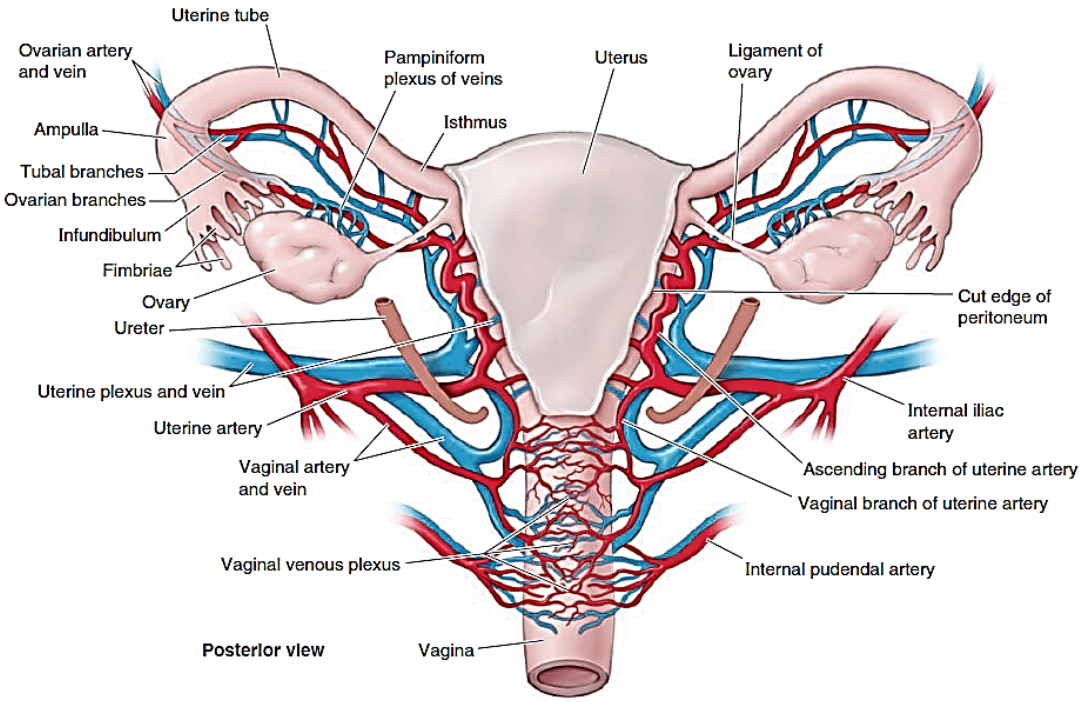


- Located in the posterior aspect of broad ligament
- Support derived from:
  - **Mesovarium** from broad ligament
  - **Suspensory ligament of ovary** to wall of pelvis
    → Formed by peritoneal folds over **ovarian A/V**
  - **Proper ligament of ovary** from uterine body to ovary (some consider to be an extension of the round ligament of uterus)
- Arterial supply:
  - **Ovarian a.** arising directly from **abdominal aorta** below renal a.
  - Ovarian and tubal branches of uterine arteries
- Venous drainage: **ovarian v.** drains into **L renal v.** (L) or **IVC** (R)
- Lymphatic drainage: para-aortic nodes
- Nerve supply: aortic plexus → ovarian plexus (along ovarian a.)
- Clinical correlation:
  - **Ovarian torsion** (rotation of ovary leading to occlusion of ovarian A/V) can occur secondary to a tumour due to long mesovarium and mesosalpinx
  - **Obturator nerve** closely related to the ovaries
    → ovarian disease can cause referred pain to medial aspect of thigh and knee

4. Vagina

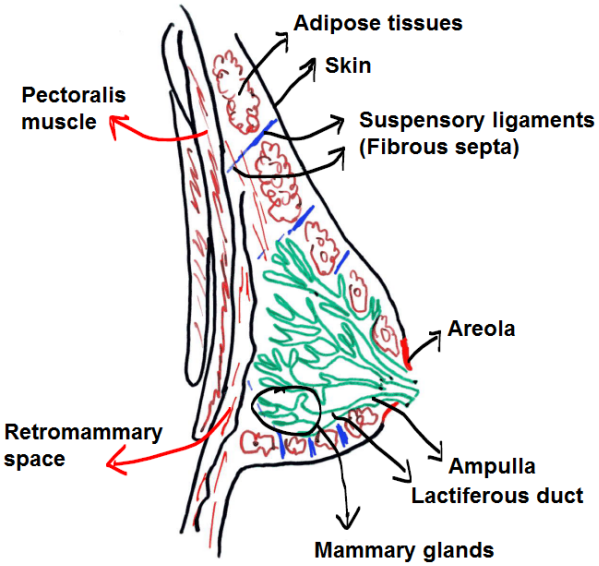


- **Fornices**: potential spaces surrounding the cervix where the vagina is attached
  - Two fornices: **anterior** and **posterior fornices**
  - **Posterior fornix** has a close relationship with rectouterine pouch
- Support:
  - Upper part: pelvic diaphragm, pelvic fascia (near cervix)
  - Middle part: urogenital diaphragm
  - Lower part: perineal body



- Blood supply:
  - Superior: vaginal branch of **uterine A/V**
  - Middle: **vaginal A/V**
  - Lower: **internal pudendal A/V**
- Lymphatic drainage:
  - Upper and middle: internal and external iliac nodes
  - Lower: internal iliac and superficial inguinal nodes
- Nerve supply:
  - Upper: **uterovaginal plexus** from inferior hypogastric plexus
  - Lower: **pudendal nerve**
- Clinical correlations:
  - **Bimanual** and **digital examinations** can be used for diagnosis of tumour and determination of location and position of uterus in pregnancy
  - Posterior fornix closely related to rectouterine pouch
    → accidental puncturing during **dilatation and curettage (D&C)** can spread bacteria from vagina to pelvic cavity and peritoneum
    → pelvic inflammatory disease
  - **Perineal body** located posterior to vagina
    → damage can cause prolapse of uterus

5. Breast



- **Mammary glands**: specialized accessory glands on skin
- Well-developed among female when they reach puberty due to action of ovarian hormones
- Internal structure:
  - **Lobules**: functional glandular unit of milk production
  - **Lobes**: groups of lobular structure (15-20 lobes in each breast)
  - **Lactiferous duct**: drains each lobe towards the nipple
  - **Ampulla**: dilated part of duct prior to termination of duct
  - **Suspensory ligaments**: ligaments fixing lobules of mammary glands onto the deep fascia (forming **fibrous septa** between lobules)
  - **Retromammary space**: space between breast tissue and deep fascia
- External structures:
  - **Nipple**: where the ducts open
  - **Areola**: brown coloured skin surrounding the nipple
- During puberty, ducts elongate and glands increase in size due to fat deposition
- Blood supply:
  - **Lateral thoracic A/V** from **axillary A/V**
  - **Thoracoacromial A/V** from **axillary A/V**
  - Branches of **axillary A/V**
  - Perforating branches of **internal thoracic A/V**
  - Lateral cutaneous branches of **posterior intercostal A/V**
- Lymphatic drainage:
  - Medial quadrants → **internal thoracic nodes**
  - Lateral quadrants → **anterior**, **central** and **apical axillary nodes**
  - May also drain into **posterior intercostal nodes**
  - Communicate with the lymphatic system on the other side and the anterior abdominal wall
  - **Apical axillary nodes** then drain into subclavian trunk and then R lymphatic or thoracic duct