MD Program
UNIVERSITY OF TORONTO

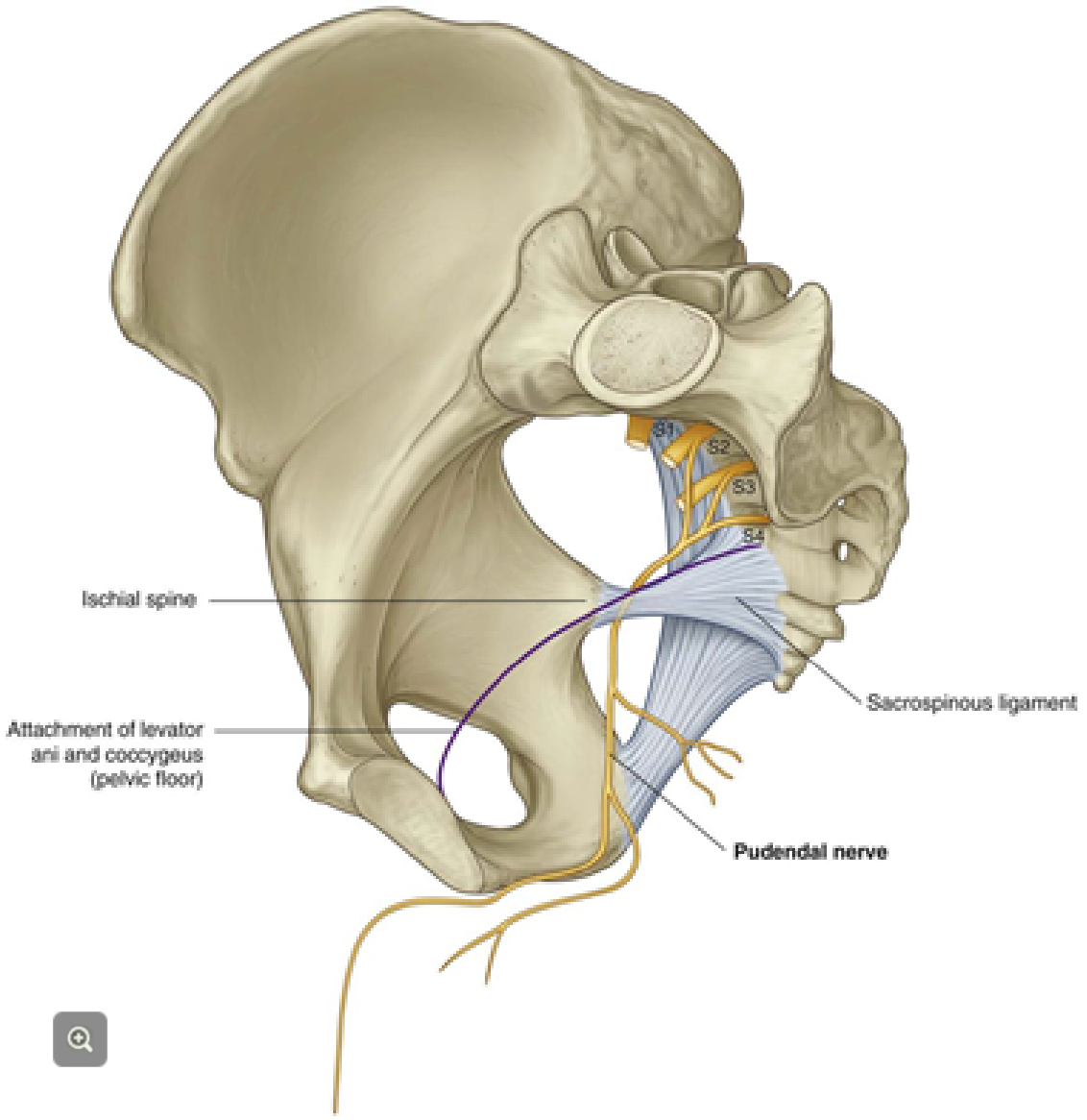
Anatomy

UNIT 4: Abdomen, Pelvis and Perineum
Lab 13

CLICK TO ENTER

13A Prelab SLM:
The Pelvis and Perineum

Complete this pre-lab SLM **prior to** Lab 13. You will be quizzed on its contents at the start of each of the two lab periods.

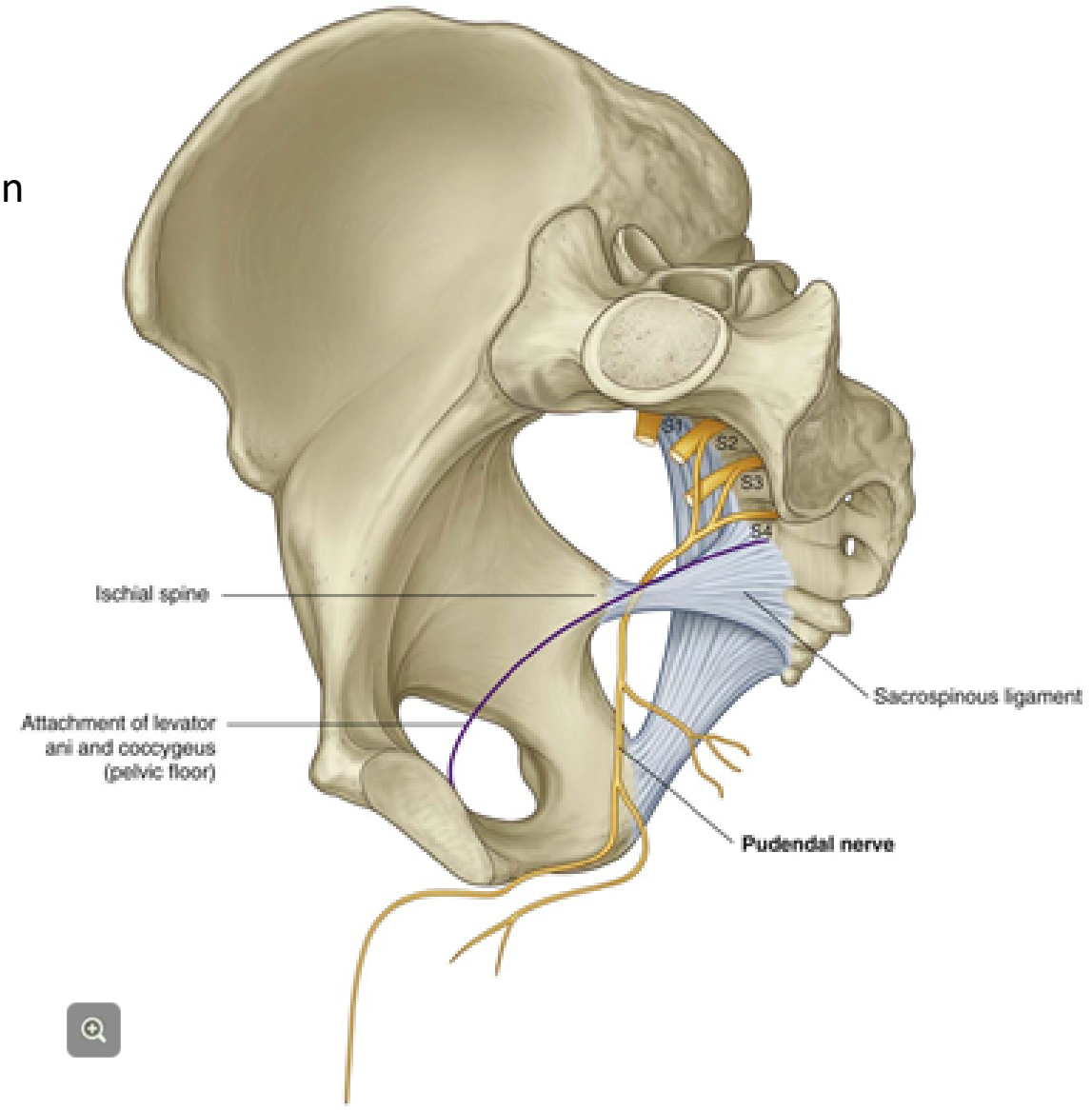


PREVIOUS

NEXT

When you have learned the content of this self-learning module, you will be able to describe the:

- skeletal muscles of the pelvis and perineum.
- pelvic diaphragm and its relationship to the pelvis and perineum.
- path taken by blood vessels and nerves between the pelvis and perineum
- the components of the digestive and urinary tracts located in the pelvis and perineum.
- autonomic innervation of pelvic and perineal structures.
- blood supply and venous drainage of the pelvis and perineum.
- lymphatic drainage of the pelvis and perineum.



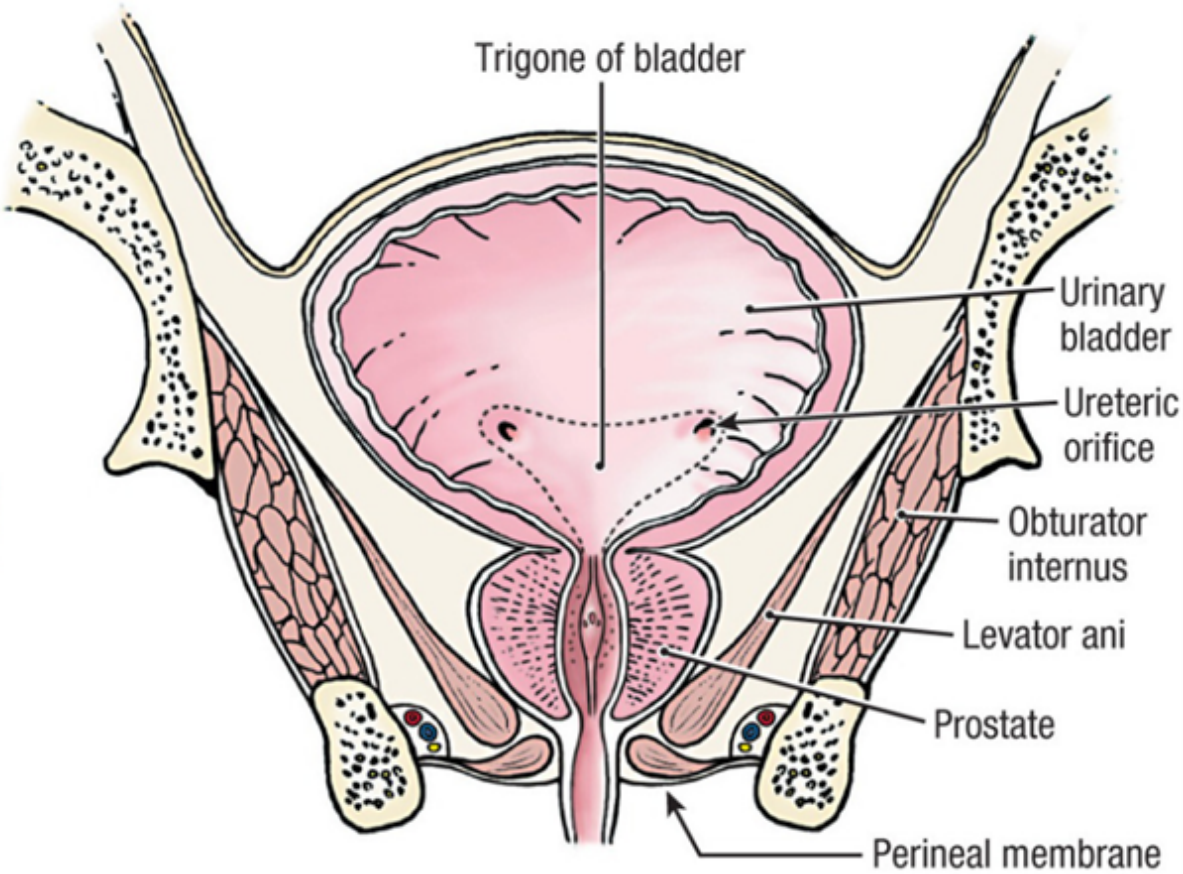
The bony pelvis is the skeleton of two connected regions, the **pelvis** and the **perineum**.

The pelvic cavity opens superiorly into the abdominal cavity. Inferiorly, the floor of the pelvis includes the **pelvic diaphragm**, a bowl-shaped muscular structure that consists largely of the **levator ani**. **Identify the levator ani in the figure below**; structures above it, such as the urinary bladder and prostate gland, are in the pelvis and structures below it, such as the perineal membrane, are in the perineum.

The contents of the pelvis are related to the urinary, gastrointestinal and reproductive systems. In both sexes, the **urethra** and **anal canal** pass through openings in the pelvic diaphragm. In the female, the **vagina** passes through as well.

The **perineum** is defined as the region below the pelvic diaphragm and between the thighs. The perineum contains the **external genitalia**, the penis and scrotum in the male and the vulva in the female, as well as the terminus of both the **genitourinary** and **gastrointestinal** systems.

This SLM will start with a description of the pelvis and move on to introduce you to the perineum.

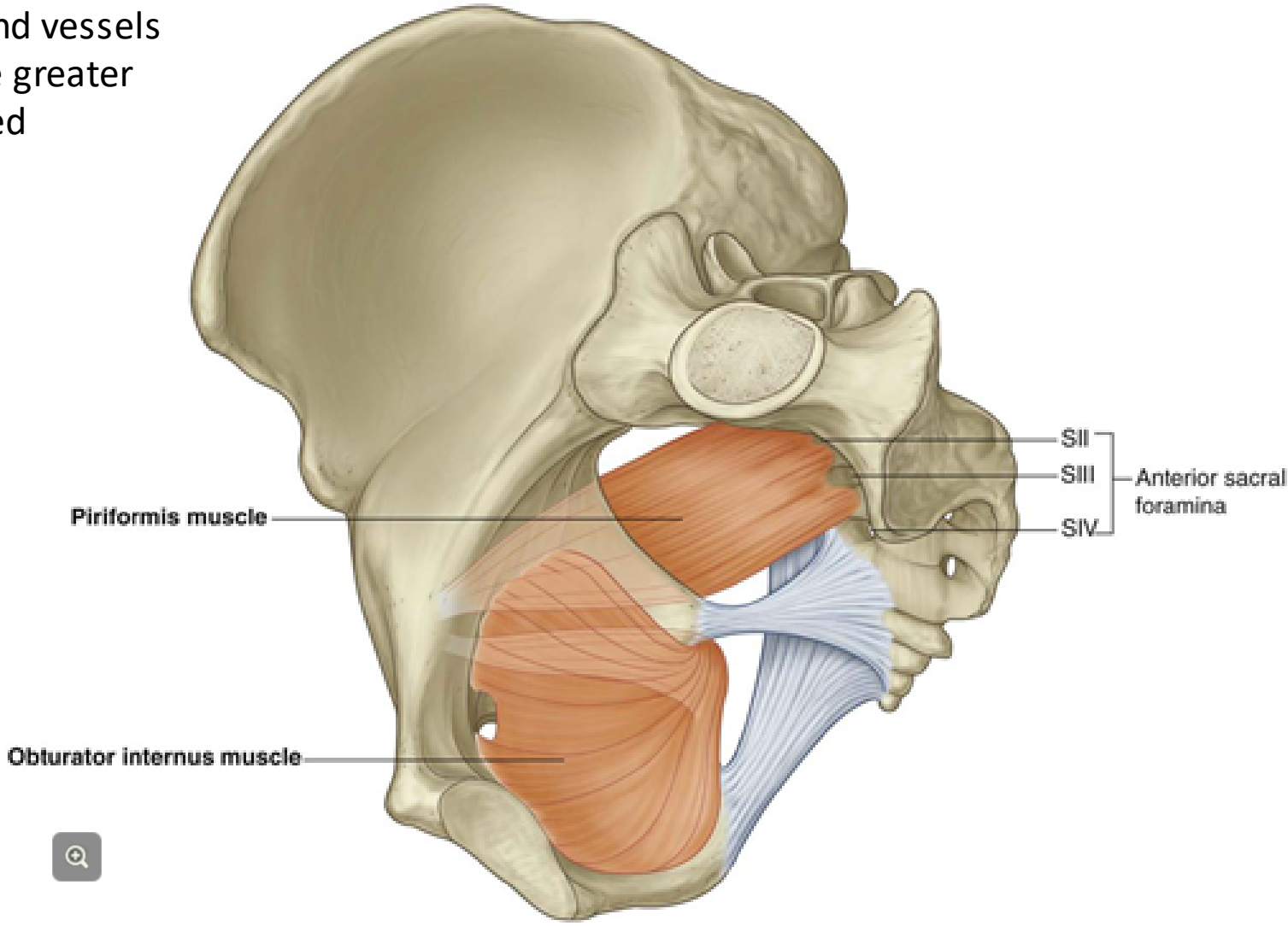


Coronal section from Grant's Atlas of Anatomy, ©LWW

The walls of the pelvis are clothed by two muscles that **originate within the pelvis**, then **exit** to insert in the region of the greater trochanter. These muscles act on the hip and provide padding to the bony pelvic wall.

The **piriformis** originates on the **anterior surface of the sacrum** and exits the pelvis via the **greater sciatic foramen**. It therefore clothes the posterolateral wall of the pelvis. The piriformis is known as the "**key to the region**" because nerves and vessels that exit the pelvis through the greater sciatic foramen are land-marked according to their position **relative to this muscle**.

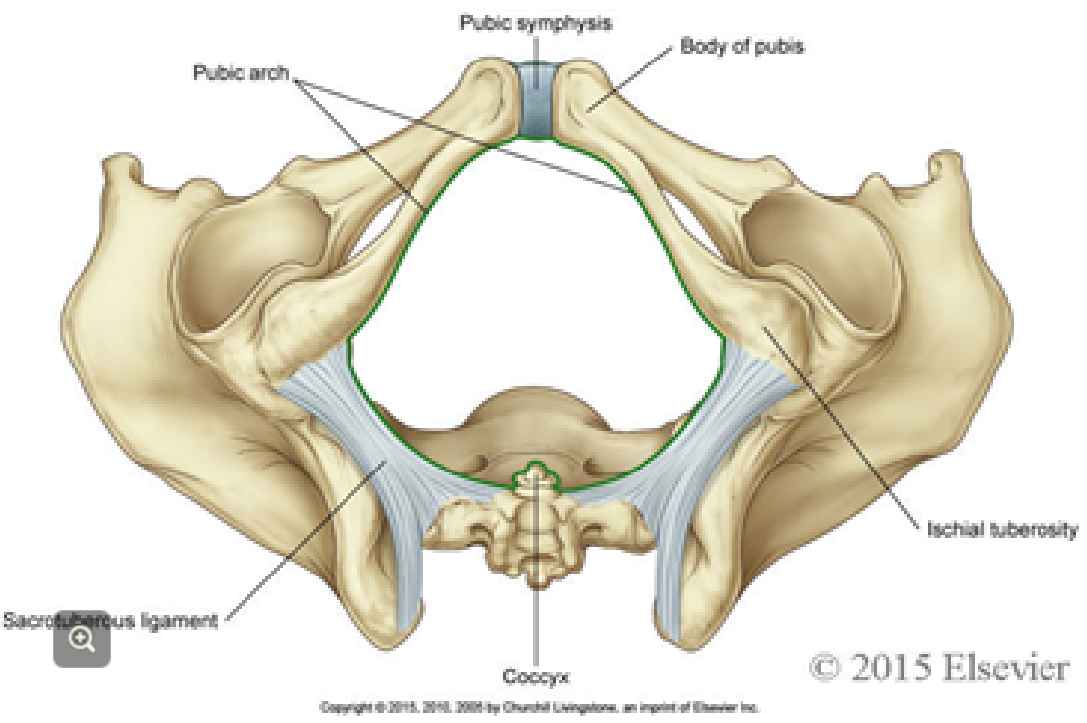
Recall that the **obturator membrane** covers over the obturator foramen and serves to provide surface area for muscular attachment. The **obturator internis muscle** originates on its internal surface and clothes the anterolateral wall of the pelvis. The obturator internis muscle exits the pelvis via the **lesser sciatic foramen**.

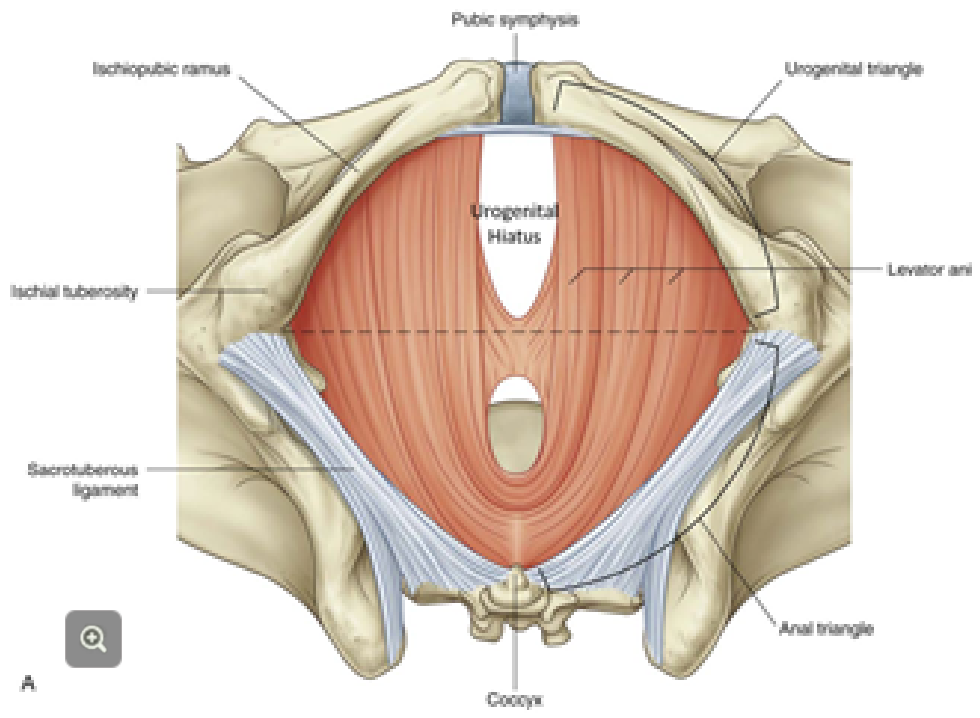


The **sacrotuberous ligaments** contribute to the margins of the **pelvic outlet**, along with the **ischiopubic rami**, the **pubic symphysis** and the **coccyx**. **Identify these landmarks** in the illustration below.

Most of the pelvic outlet is enclosed by the **pelvic diaphragm**, a sheet of skeletal muscle comprised largely of the levator ani that **separates the true pelvis from the perineum**. Recall that the **perineum** is defined as the region **between the thighs**, and **inferior to** the **pelvic diaphragm**.

A gap in the pelvic diaphragm, the **urogenital hiatus**, permits the passage of the genitourinary tract from the pelvis to the perineum. Other fibres loop around the anorectal junction, permitting its passage, as well.



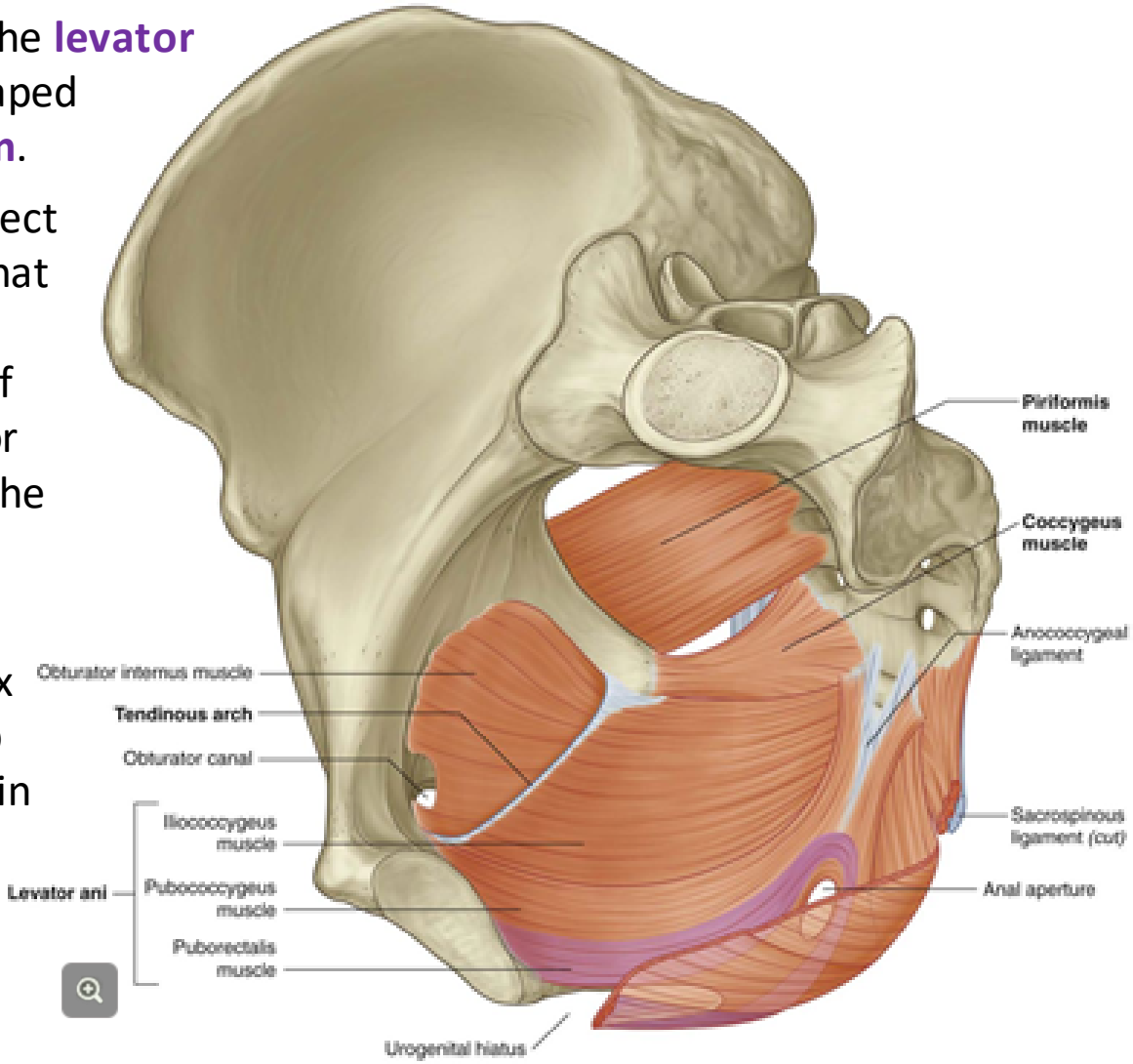


The relationship of the pelvic diaphragm to the pelvic wall is shown here.

The **pelvic diaphragm** consists of two muscles: the **levator ani** and the **coccygeus**, which form a bowl-shaped partition separating the **pelvis** from the **perineum**.

The **levator ani** originates from the posterior aspect of the **pubic bone** and along a **tendinous arch** that extends to the ischial spine, thus **bisecting the obturator internis**. Because of the attachment of the levator ani to this tendinous arch, the superior portion of the **obturator internis** contributes to the **lateral wall of the pelvis** and the inferior portion contributes to the **lateral wall of the perineum**.

Some fibres of the levator ani attach to the coccyx via the **anococcygeal ligament** while others loop around the **anal aperture**. Still other fibres meet in the midline anterior to the anal aperture, leaving a midline gap, the **urogenital hiatus**, through which the **urethra** passes in both sexes, and through which the **vagina** passes in females.



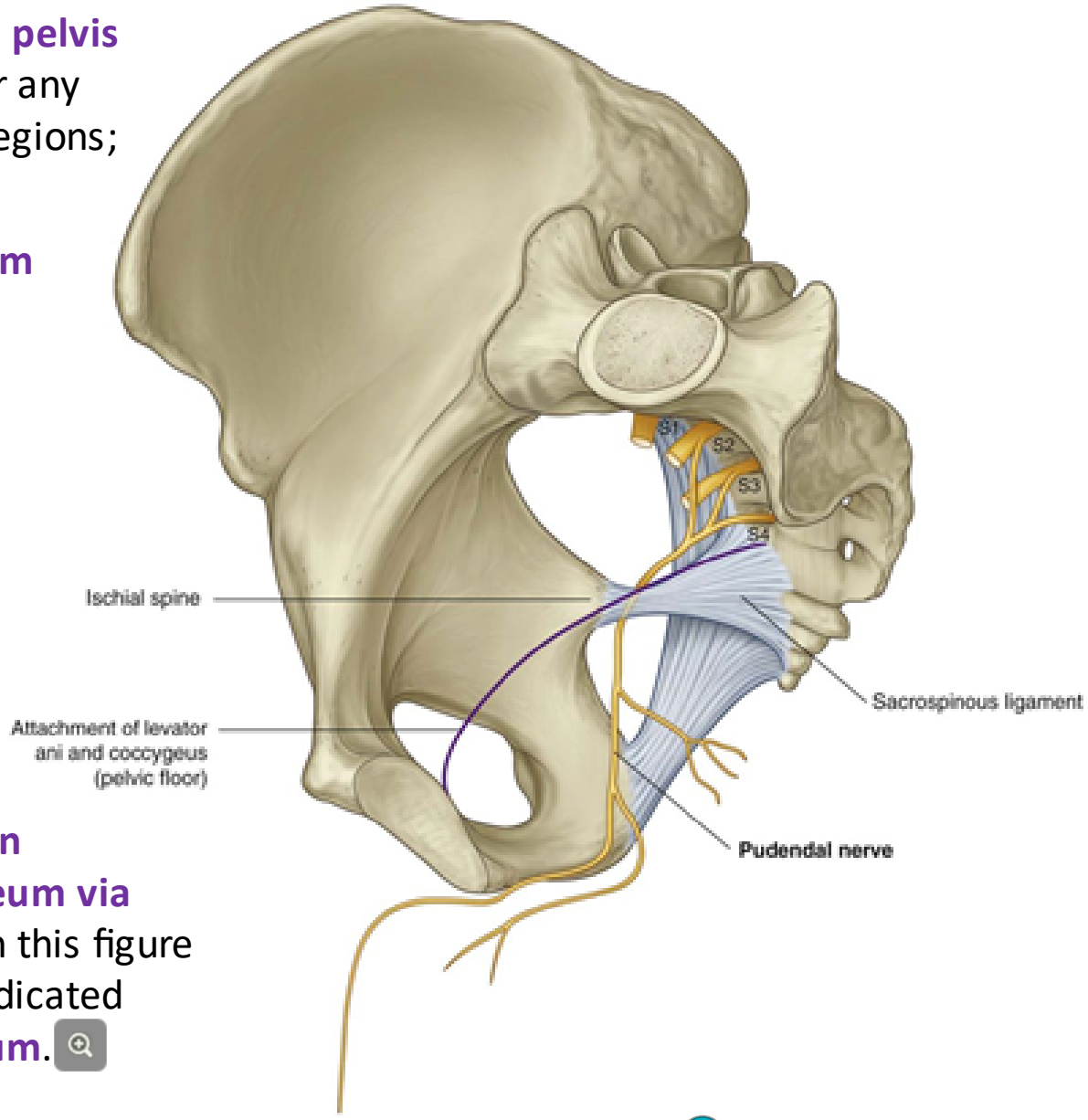
The levator ani muscles **support pelvic viscera** and **contribute to fecal and urinary continence**.

The coccygeus muscles complete the pelvic diaphragm, posteriorly. They are triangular, extending from a broad base on the anterior surface of the coccyx to the ischial spine. They overly the sacrospinous ligament.

The pelvic diaphragm **physically separates the pelvis from the perineum**. This creates a problem for any structures that must pass between these two regions; **the pelvic diaphragm is in the way**!

The **line of attachment** of the **pelvic diaphragm** is illustrated in this figure. Notice that this line crosses the **ischial spine** and **sacrospinous ligament**. Because of this:

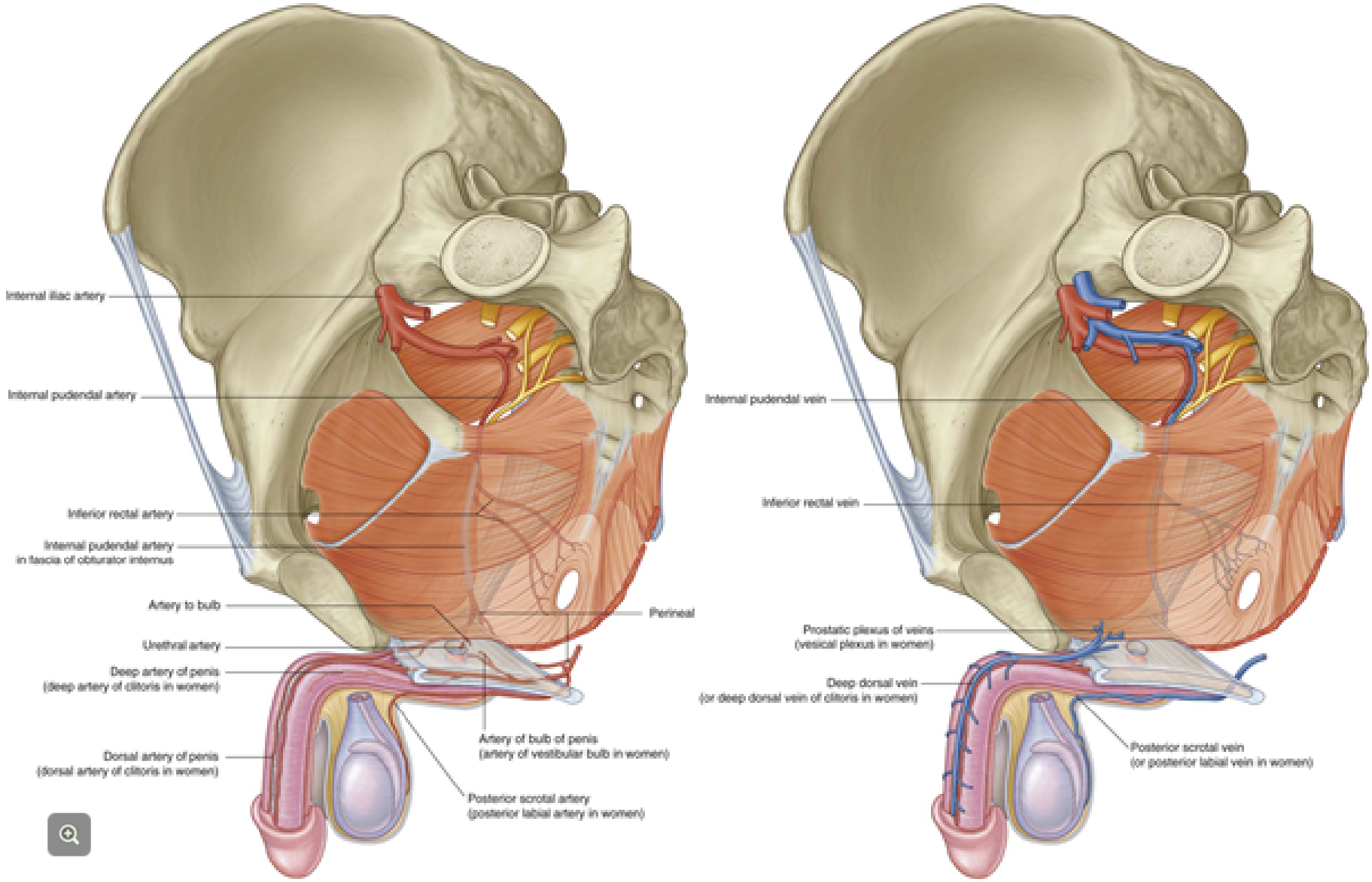
- the **greater sciatic foramen** connects the **pelvis** with the **gluteal region**, and
- the **lesser sciatic foramen** connects the **gluteal region** with the **perineum**.



Structures that **originate in the pelvis**, but are destined to **enter the perineum**, pass **out of the pelvis through the greater sciatic foramen inferior to the piriformis, and into the perineum via the lesser sciatic foramen**. This is illustrated in this figure using the **pudendal nerve**, a somatic nerve dedicated to the **skeletal muscle and skin of the perineum**.

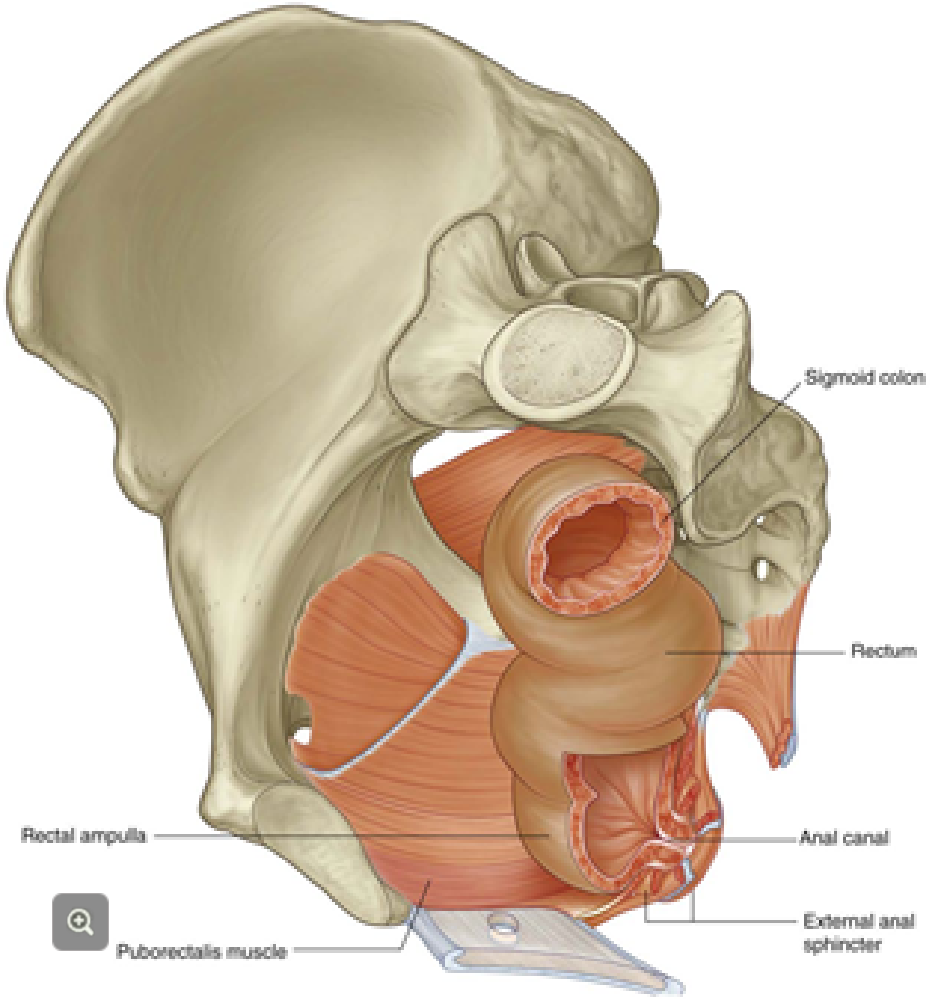
Examples of vessels solving the same conundrum in a similar manner are shown here, but with the pelvic diaphragm, obturator internis and the piriformis in place.

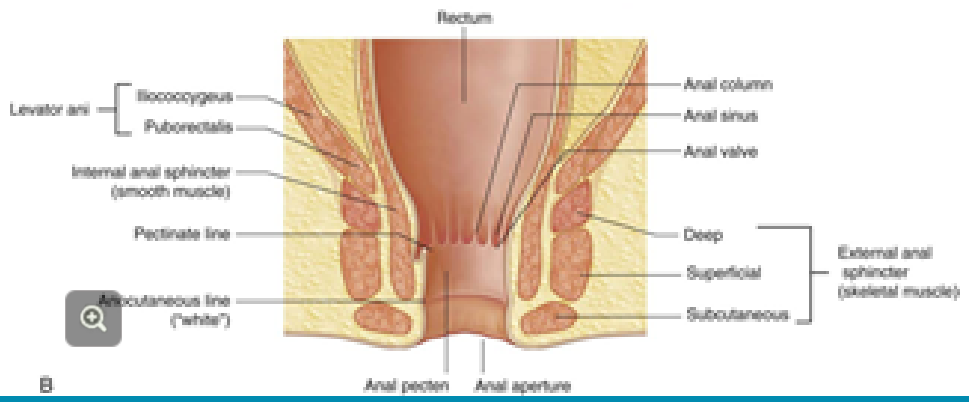
The Internal Pudendal Artery and Vein Travel with the Pudendal Nerve



In both sexes, in the posterior midline of the **pelvis**, are the distal portions of the digestive tract: the **terminal sigmoid colon** and the **rectum**. The **rectum**, and in particular its ampulla, functions to **store feces prior to evacuation**. The **anal canal** passes through the **anal aperture** of the levator ani.

The puborectal subdivision of the **levator ani** wraps around the **anorectal junction**, pulling it forward and imposing a **90° bend** at this point in the digestive tract. This creates a **pinch valve** that assists in the **maintenance of fecal continence**. During **defecation**, the **levator ani relaxes**, and the **rectoanal junction straightens**, to facilitate evacuation. Another consequence of the normal tone in the levator ani is that the anal canal is **oriented posteriorly** as it passes into the perineum.





The anal canal is surrounded by the **internal** and **external anal sphincters**. The internal anal sphincter is **smooth, involuntary muscle** integral to the wall of the anal canal. The external anal sphincter is a ring of **striated, voluntary muscle** located within the perineum.

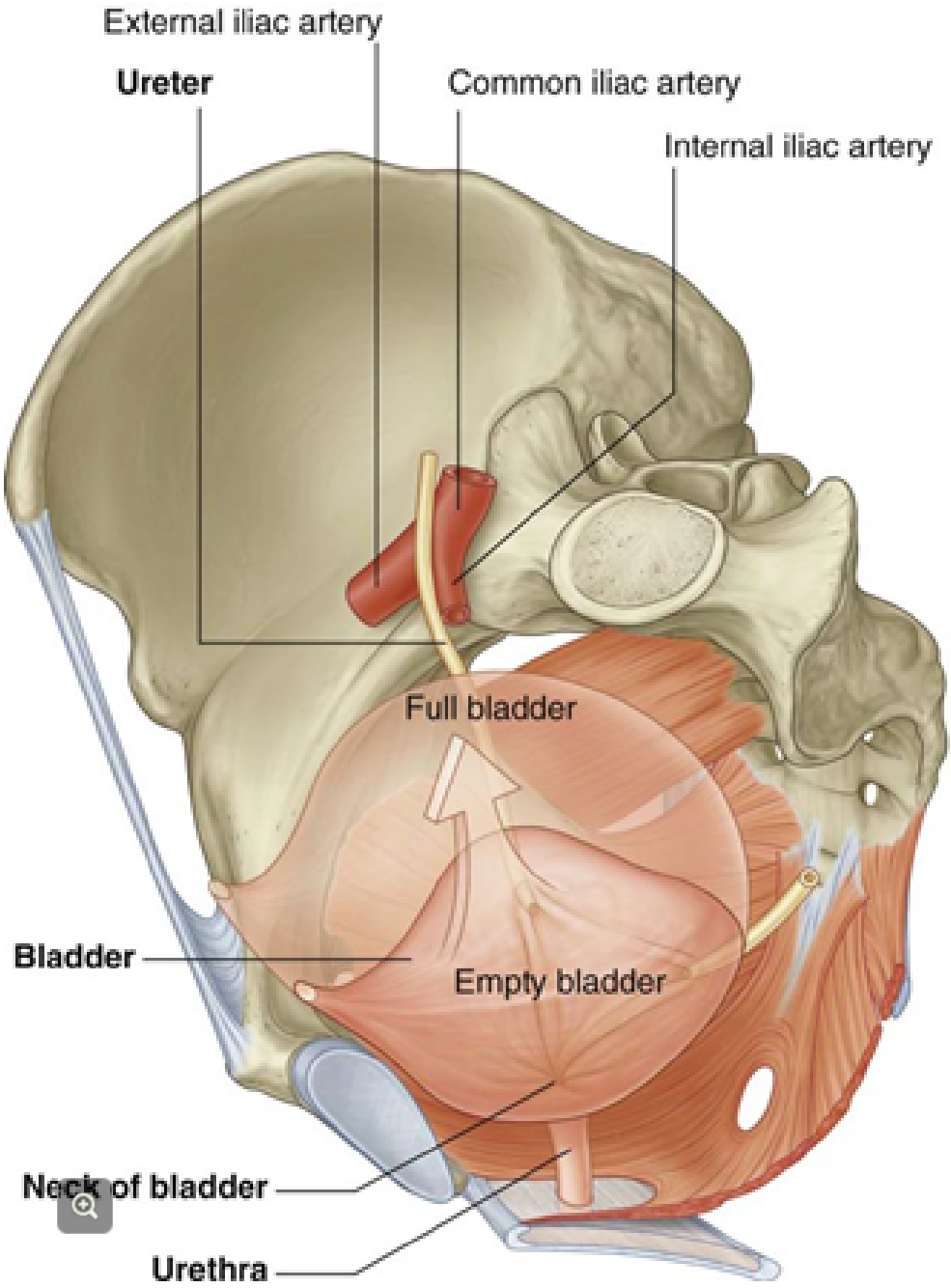
In both sexes, the pelvic portions of the urinary system are the terminal parts of the **ureters**, the **urinary bladder** and the **proximal portions of the urethra**.

The **ureter** enters the pelvic inlet by crossing **anterior to the bifurcation of the common iliac artery**. The ureters continue along the posterior wall of the pelvis to pierce the base of the urinary bladder.

In both sexes, the urinary bladder takes the most anterior position in the pelvis, being located **immediately posterior to the pubic symphysis**. The bladder, when empty, is located in the true pelvis. When full, however, it expands into the abdomen.

Recall that the urinary bladder is a **triangular pyramid**, with its base oriented posteriorly and its apex oriented anteriorly. It has a superior surface and two inferolateral surfaces.

The **neck of the bladder** surrounds the **origin of the urethra**, and contains the **internal urethral sphincter**, composed of smooth, **involuntary** muscle.



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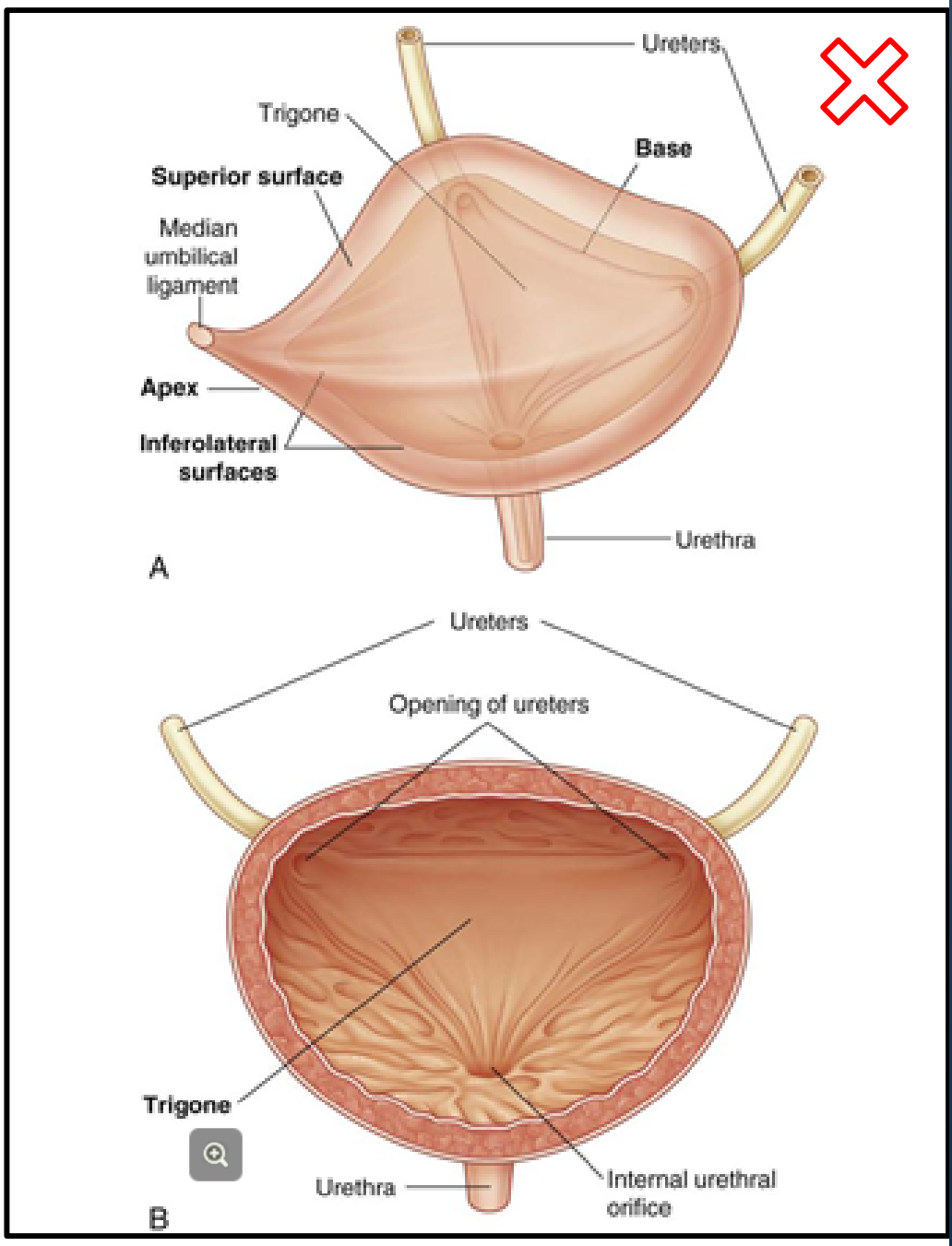
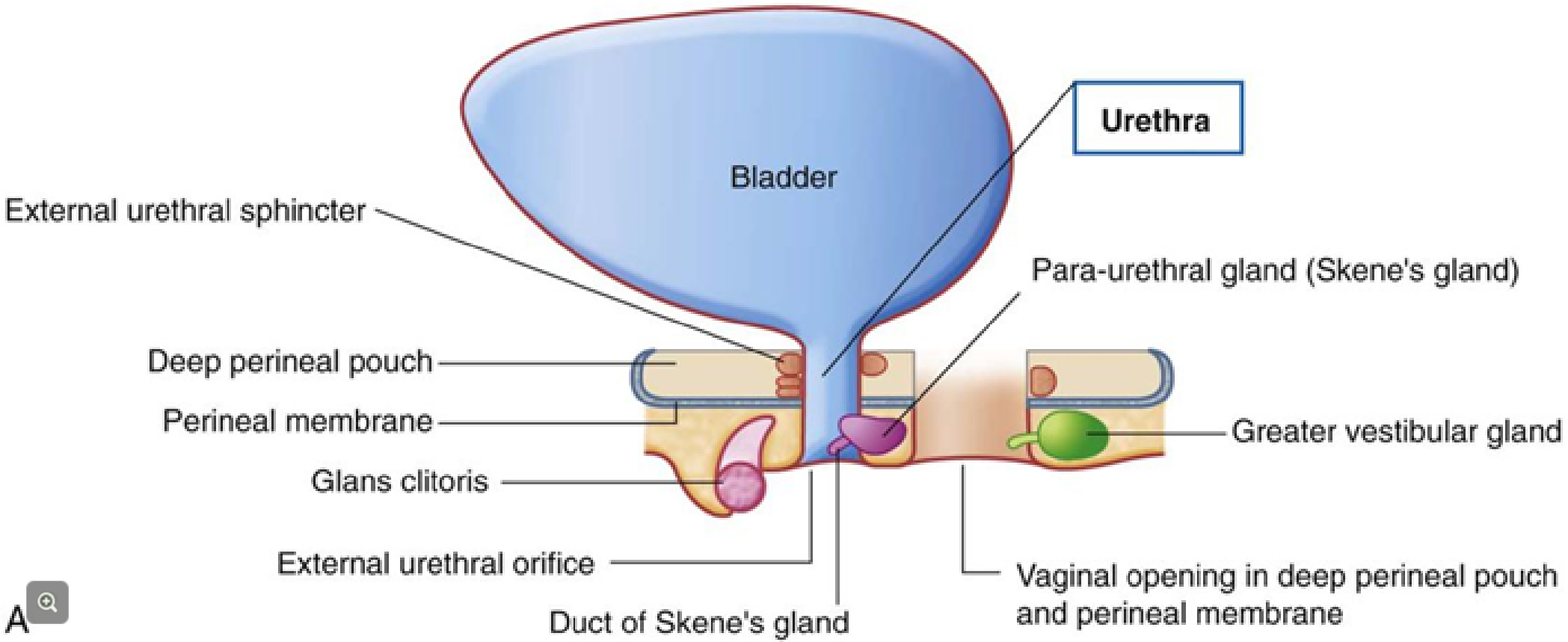


In the female, the urethra extends from **internal urethral orifice** at the neck of the bladder, through the **pelvic floor**, to open at the **external urethral orifice**. As the urethra passes through the **pelvic floor** it is surrounded by the striated, voluntary **external urethral sphincter**. The space into which the urethra and vagina open is the **vestibule**. The vestibule is bordered by the **labia minora**. Notice the relatively short length of the urethra in the female; at 4 cm, it is significantly shorter than the male urethra. The urethra is anterior to the vagina, and that the two are joined by CT. The para-urethral (Skene's) glands are paired, mucus-secreting glands that open into the terminal urethra.



In the male, the urethra extends from the **internal urethral orifice**, at the neck of the bladder, through the **prostate gland, pelvic floor**, and **corpus spongiosum** of the penis to open at the **external urethral orifice** of the glans. This subdivides the male urethra into the **prostatic**, **membranous** and **spongy (penile) parts**.

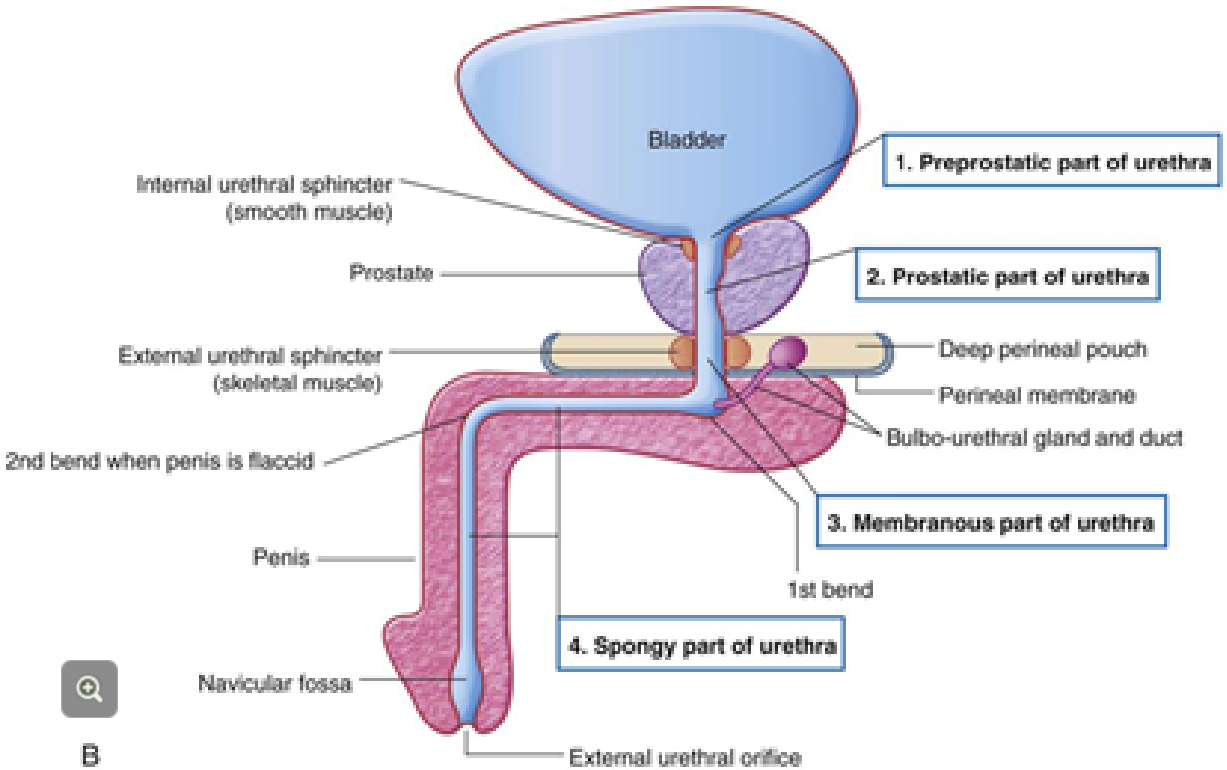
Notice that the **prostate gland surrounds the neck of the bladder**, which contains the **internal urethral sphincter**. Contraction of this sphincter in **emission** prevents the passage of semen into the bladder. This sphincter **may be compromised in prostatectomy**.

In the **prostatic urethra** are the openings of the roughly 50 **ducts of the prostate gland**. Also in the prostatic urethra are the bilaterally-paired openings of the **ejaculatory ducts**. Thus, it is in the prostatic urethra that the **urinary and reproductive systems of the male unite**.

As with the female urethra, as the male urethra passes through the **pelvic floor** it is surrounded by the striated, voluntary **external urethral sphincter**.

Located in the pelvic floor are the mucus-secreting **bulbo-urethral glands**, the ducts of which opens into the proximal portion of the penile (spongy) urethra.

In total, the male urethra is roughly 20 cm in length



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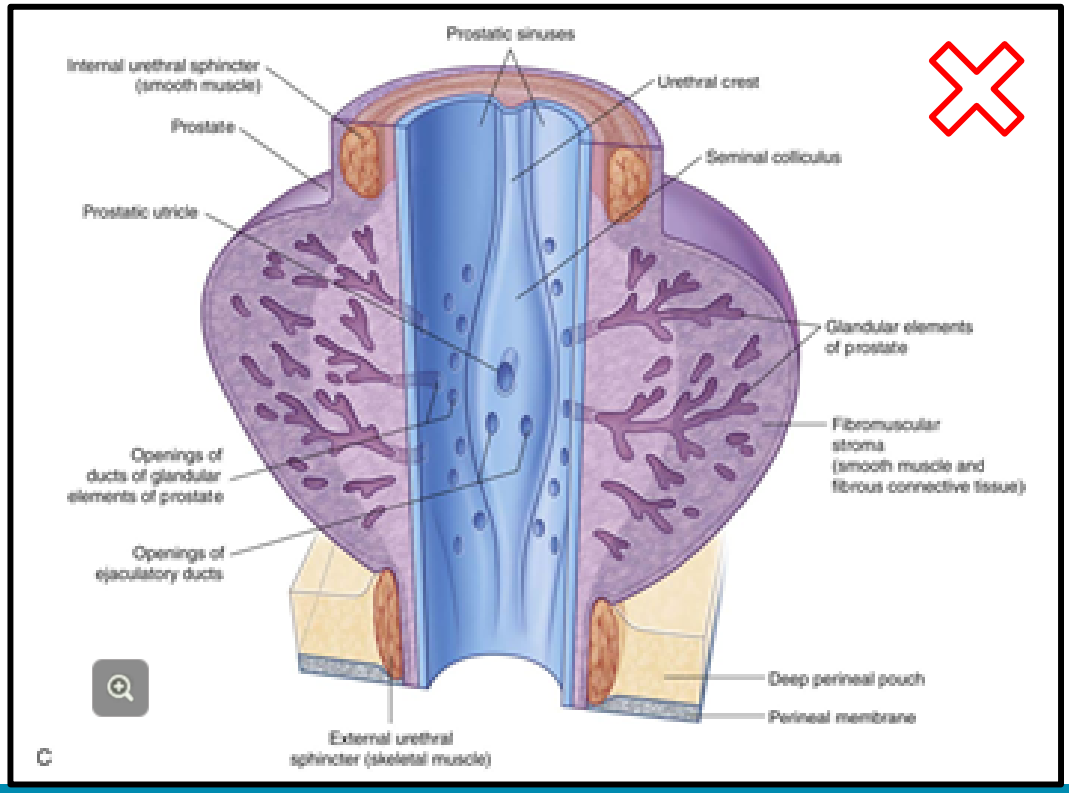


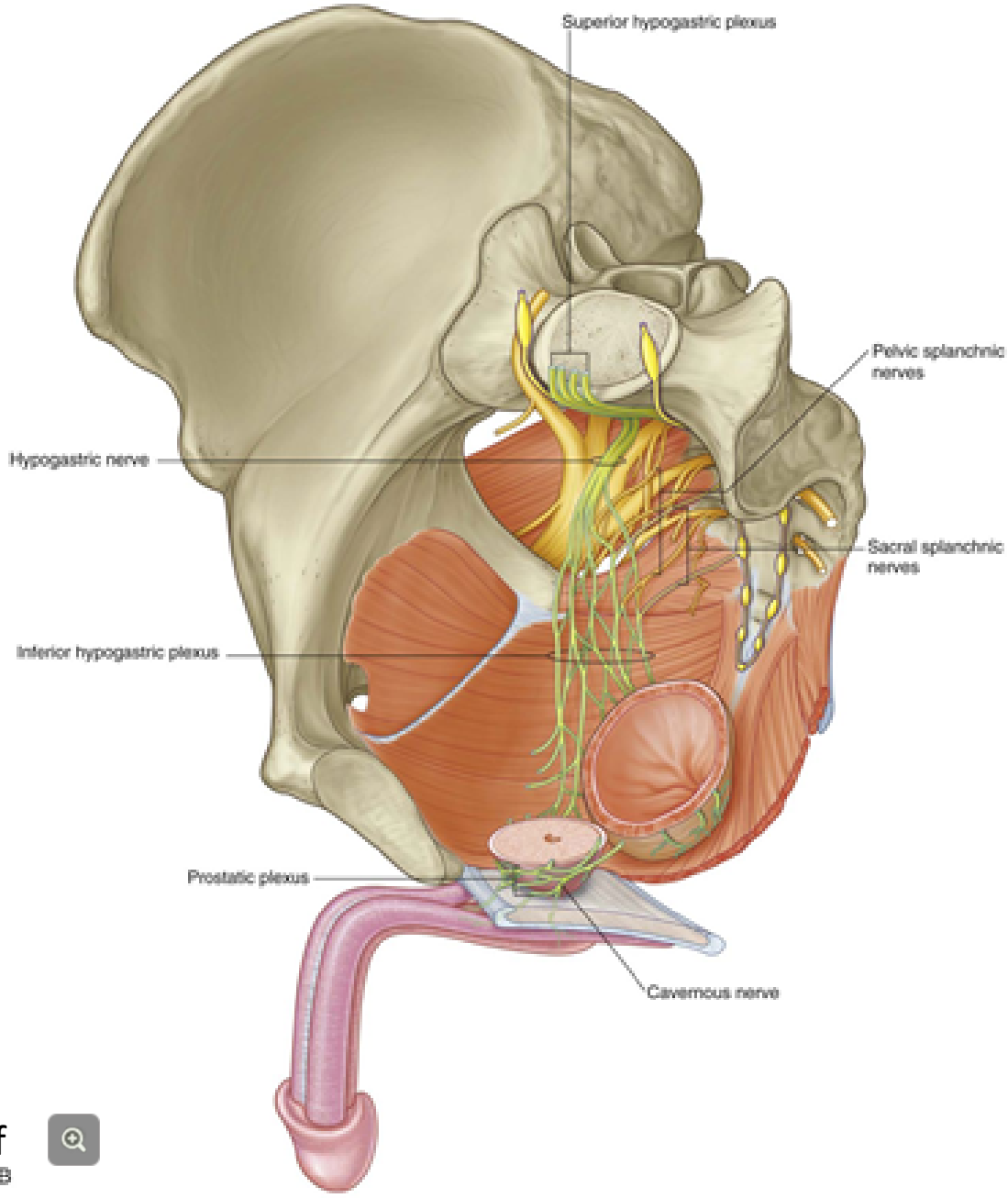
Pelvic portions of the **prevertebral plexus** provide **sympathetic, parasympathetic and visceral afferent** fibres to **pelvic structures**. The pelvic portions of the prevertebral plexus are **bilaterally paired** and are referred to, variably, as the **pelvic plexuses** or the **inferior hypogastric plexuses**.

The inferior hypogastric plexuses receive **sympathetic** fibres from the **sacral splanchnic nerves**, and parasympathetic fibres from the **pelvic splanchnic nerves**.

The inferior hypogastric plexuses give rise to the **rectal, uterovaginal / prostatic** and **vesical plexuses**.

Sympathetic fibres in these plexuses are responsible for vascular tone, contraction of smooth muscle sphincters of the anus and urethra, contraction of smooth muscle in the walls of the reproductive tracts and their accessory glands, including during emission in males.

Parasympathetic fibres in these plexuses are responsible for contraction of the detrusor muscle of the bladder and motility of the distal digestive tract.[B]



13A The Internal Iliac Artery

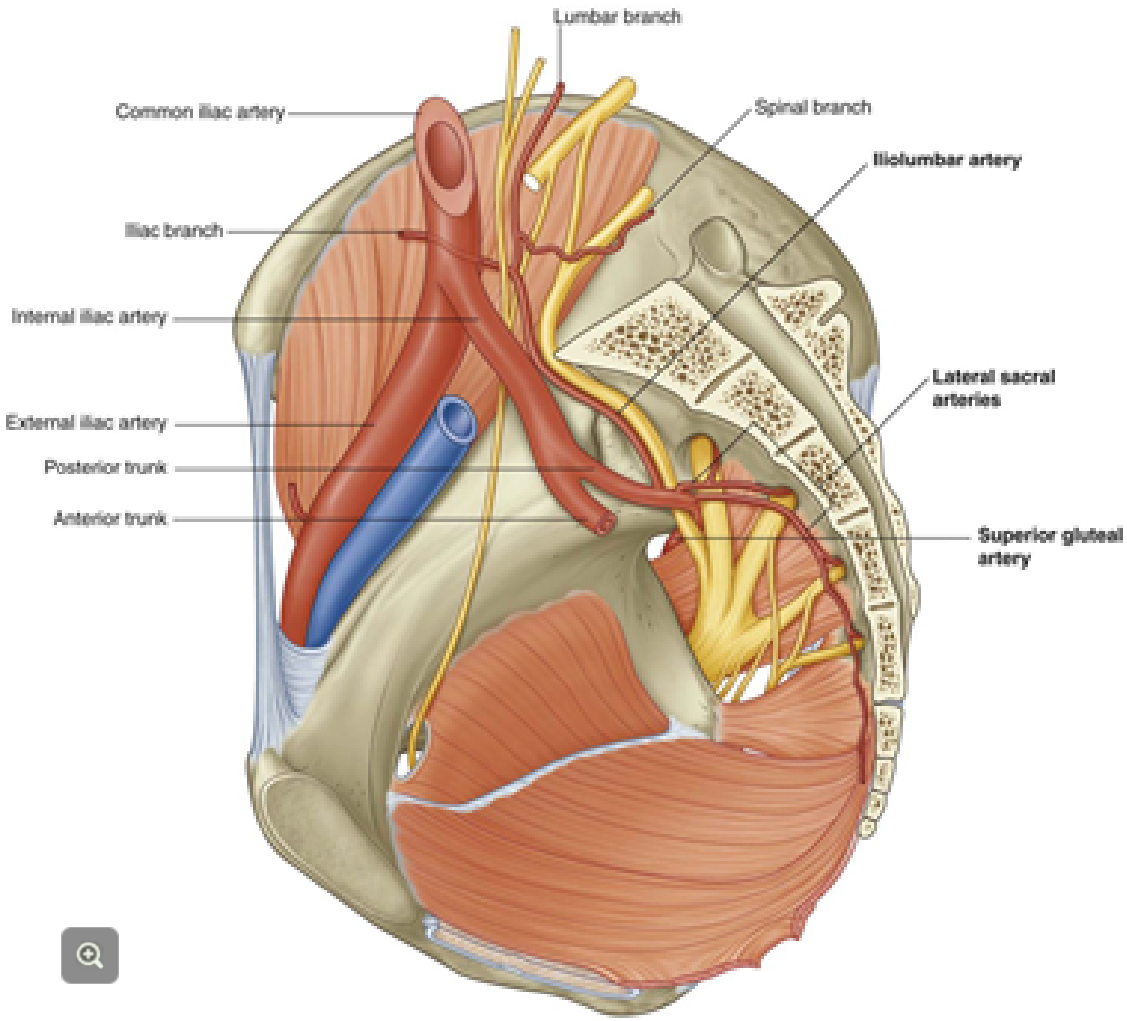
The **internal iliac artery** supplies blood to the **pelvis and perineum**, as well as sending branches to the gluteal region and medial thigh. Recall, however, that in both sexes, the **gonadal arteries** are derived from the **abdominal aorta**.

The internal iliac artery arises at the bifurcation of the common iliac artery at the level of the L5-S1 disc. It enters the pelvic inlet and itself bifurcates into **anterior and posterior trunks**.

The **posterior trunk** gives rise to branches that supply the posterior abdominal and pelvic walls, and the gluteal region, as seen in this figure.

The **anterior trunk**, shown here, gives rise to arteries that supply the pelvic viscera. These include **vesical** arteries and the **middle rectal** artery in both sexes, and **uterine** and **vaginal** arteries in the female.

In both sexes, it also gives rise to the **internal pudendal artery**, which supplies the **perineum**. It leaves the pelvis **with the pudendal nerve** via the greater sciatic foramen, inferior to the piriformis. These structures then enter the perineum via the lesser sciatic foramen.



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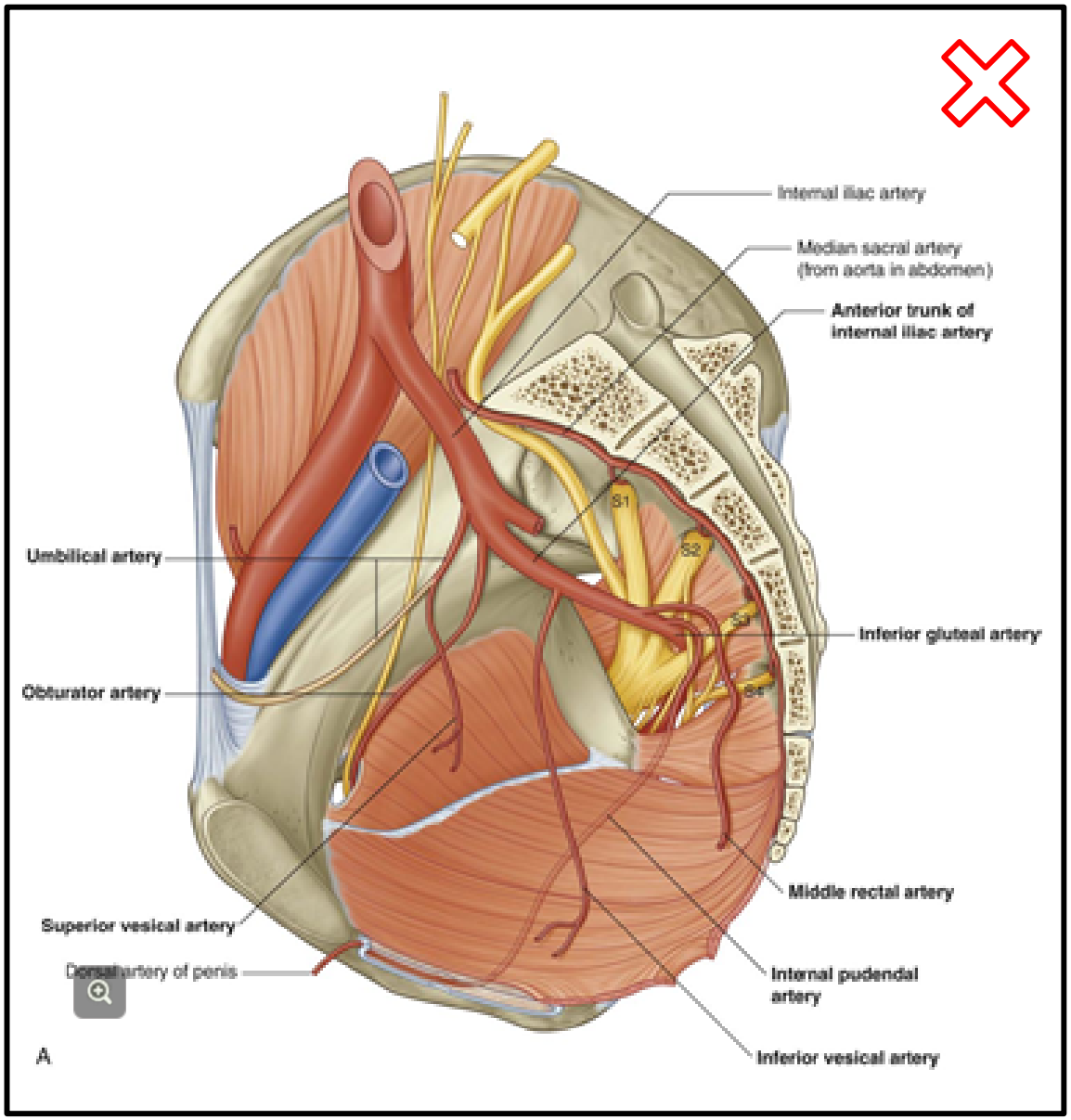
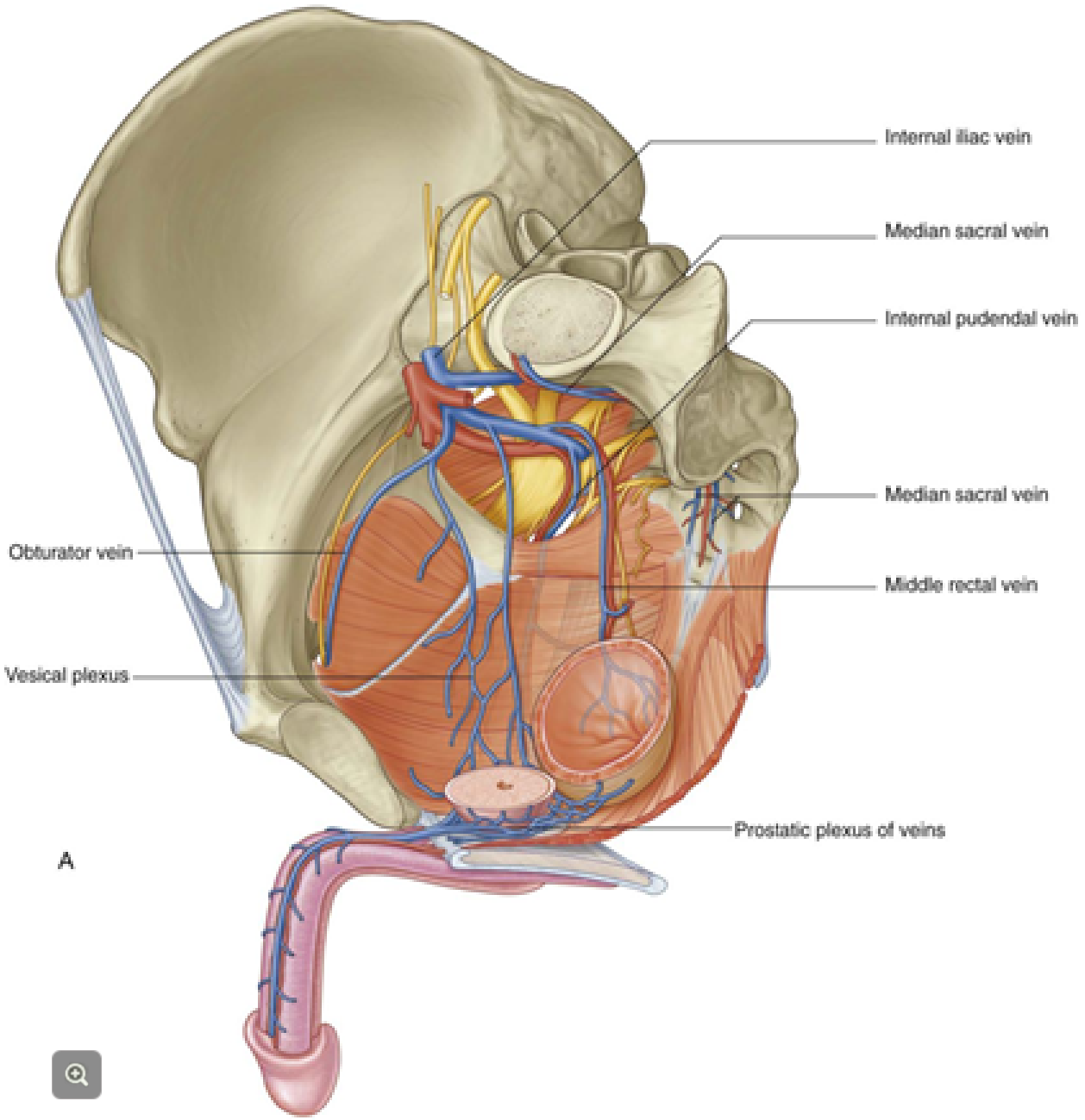


In general, **pelvic veins follow their companion arteries and take the same names**. Pelvic veins drain into the internal iliac vein, which ascends over the pelvic brim and joins the external iliac vein to form the common iliac vein.

Interconnecting networks of **venous plexuses** surround the pelvic viscera, forming the **vesical, rectal, uterine, vaginal** and **prostatic plexuses**.

A tributary of the prostatic plexus in males, and of the vesical plexus in females, is the **deep dorsal vein of the penis / clitoris**. It drains venous blood from these erectile tissues directly into the pelvis by passing between the posterior margin of the pubic symphysis and the anterior margin of the perineal membrane.

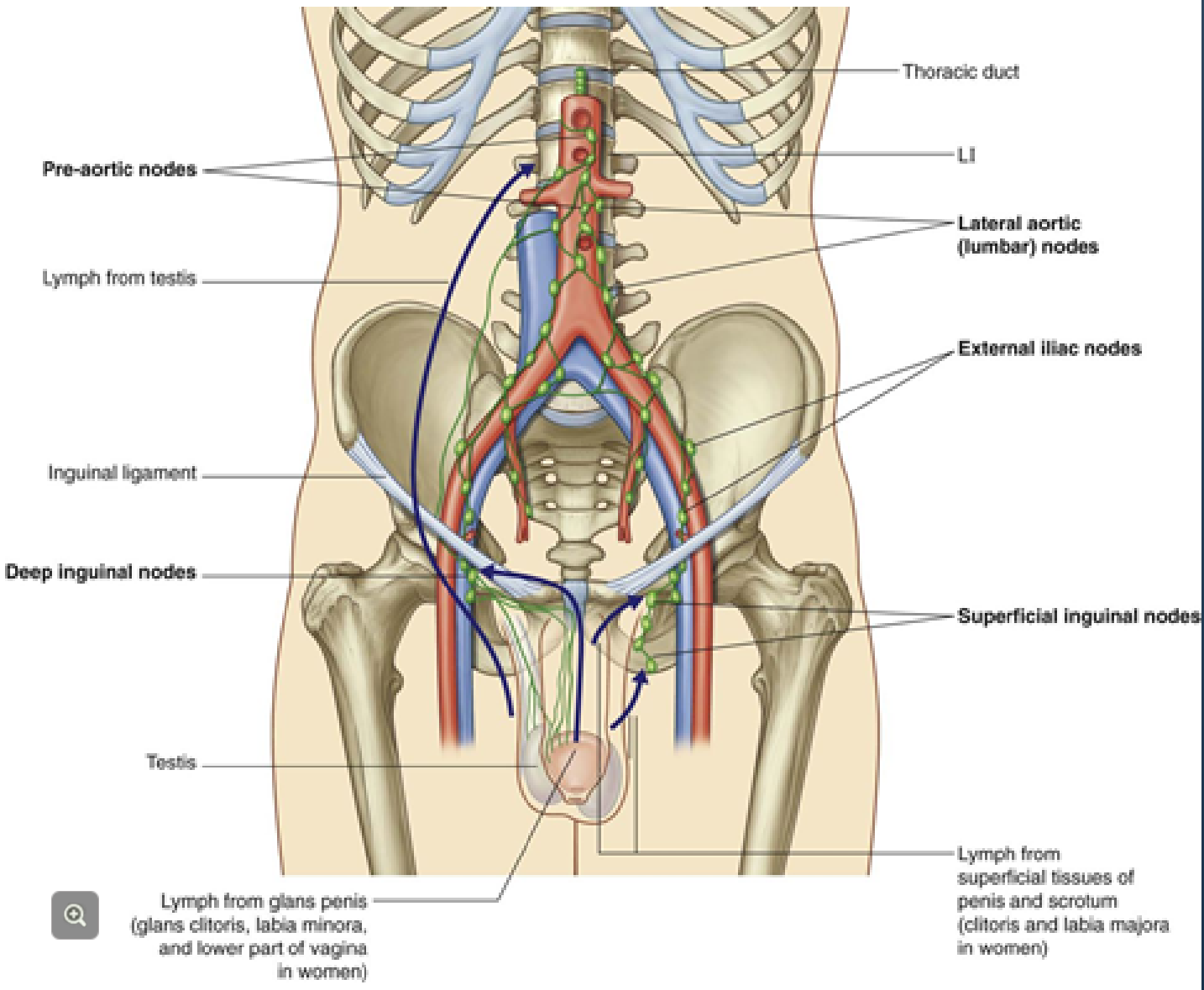


Lymph nodes associated with the **internal iliac vessels** receive lymph from pelvic and deep perineal structures.

Lymph nodes associated with the **external iliac vessels** receive lymph from the superficial and deep inguinal nodes.

Lymph nodes associated with the **common iliac vessels** receive lymph from both these groups of nodes, and convey it superiorly into the **lateral aortic / lumbar nodes**.

These drain into the **lumbar trunks**, which empty into the **cisterna chyle.** It continues superiorly as the **thoracic duct**.



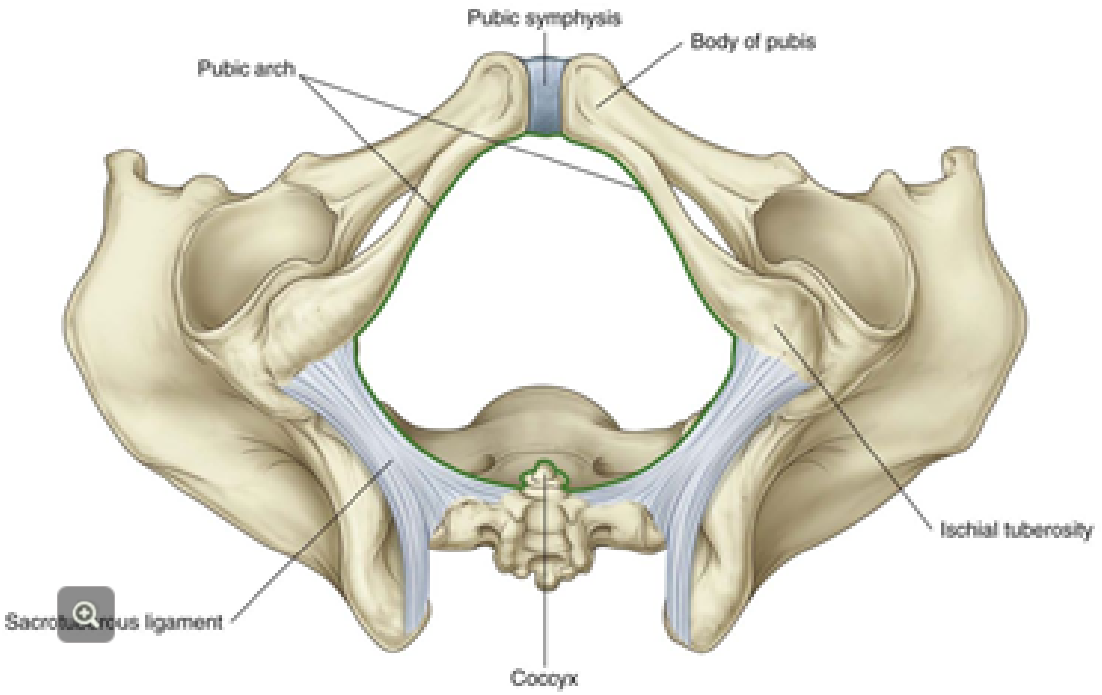
The landmarks that define the pelvic outlet and perineum are the inferior border of the **pubic symphysis**, the **tip of the coccyx** and the left and right **ischial tuberosities.** The **conjoint rami** are formed by the fused **inferior pubic ramus** and **ischial ramus.** The **pubic arch** is formed by the left and right conjoint rami and defines the **anterolateral borders of the perineum**. The sacrotuberous ligaments, bilaterally, form the **posterolateral borders of the perineum**.

For the **purposes of description**, the perineum is divided into the **urogenital (UG)** and **anal triangles** by the **transtubercular line**, an **imaginary line** that passes through the **ischial tuberosities**.

The **UG triangle** is bordered by the transtubercular line, posteriorly, and the pubic arch anterolaterally. In **both sexes**, the **UG triangle** serves to **anchor the external genitalia** and accommodates the passage of the **urethra**. In women, it also accommodates the opening of the vagina.

The **anal triangle** is defined by this imaginary line anteriorly and the sacrotuberous ligaments, posterolaterally. The anal triangle contains the **anal canal**.

The two triangles are not in the same plane. The **UG triangle** is in a **horizontal plane**, while the **anal triangle faces almost posteriorly**. The angle of flexion between the two triangles occurs along the transtubercular line.



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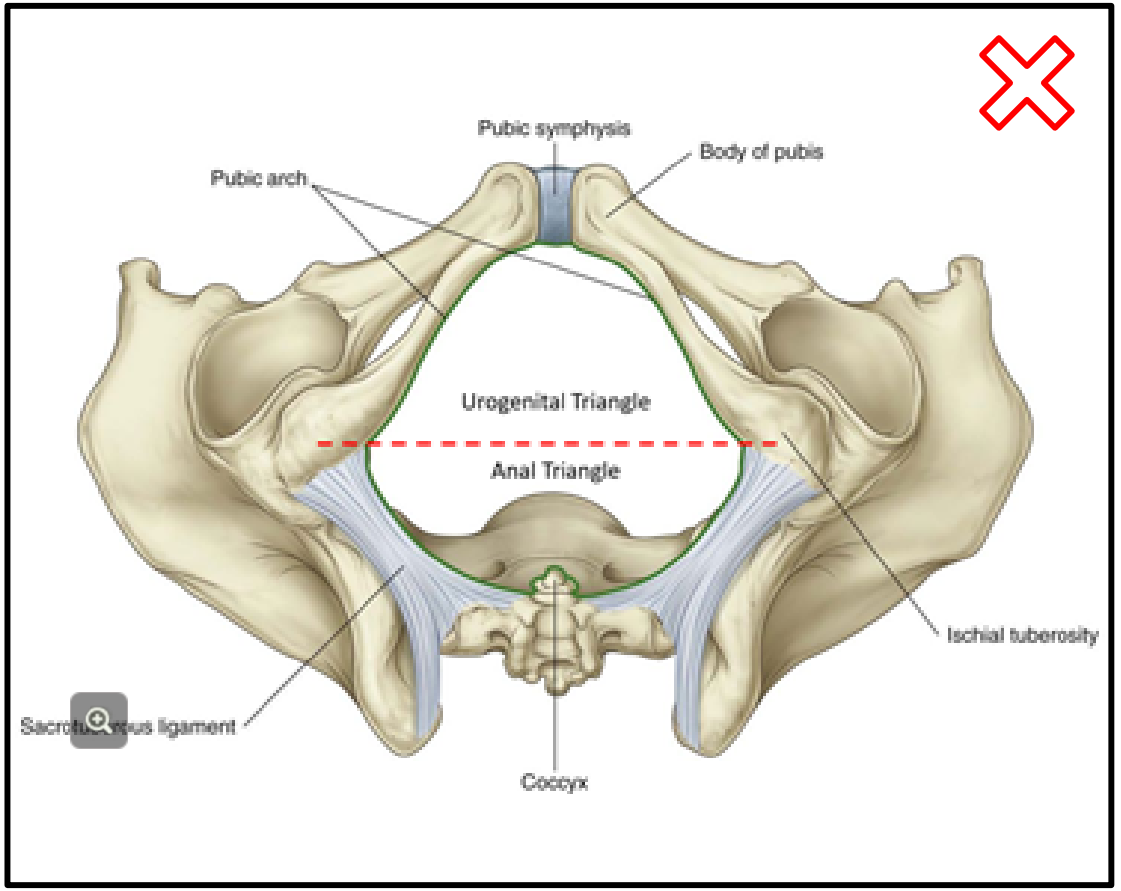
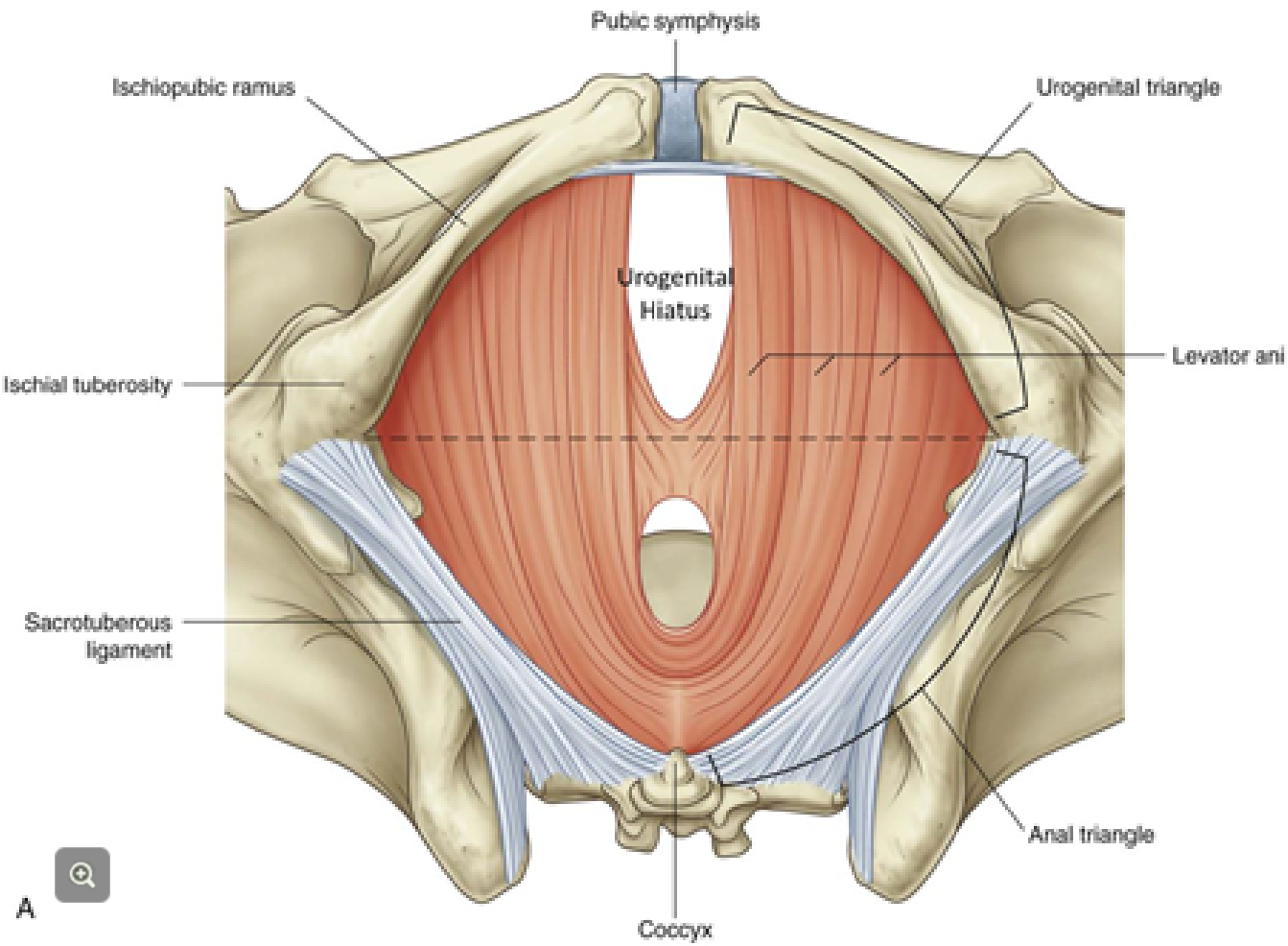


Because the pelvic diaphragm separates the pelvis, above, from the perineum below, **the pelvic diaphragm is the roof of the perineum**. The **pelvic diaphragm** consists largely of the **levator ani**, although the **coccygeus** completes it posteriorly.

Recall that the **UG triangle** contains the terminus of the **urogenital tract** and the **anal triangle** contains the terminus of the **digestive tract**. The transtubercular line separates the openings in the pelvic diaphragm that accommodate their passage, these being the **urogenital hiatus** and the **anal aperture**, respectively.

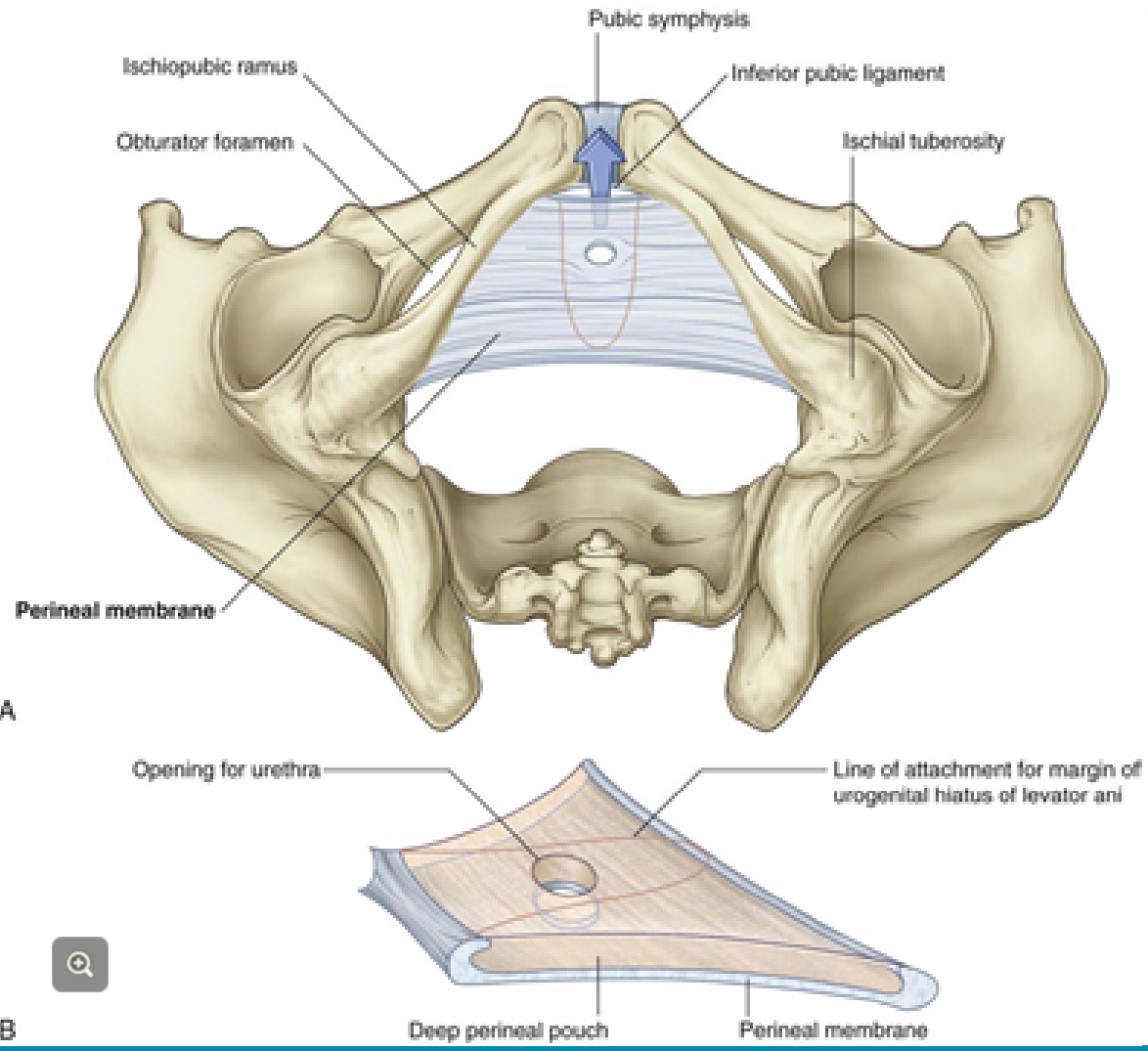
The urethra (and vagina) pass through the urogenital hiatus. The anal canal passes through the anal aperture.

The portions of the levator ani bordering these apertures assist the function of the **external urethral** and **anal sphincters** in maintaining urinary and fecal continence, respectively.



The **perineal membrane** extends between the conjoint rami within the **UG triangle**. It is a sheet of tough, dense, inextensible CT. Its free **posterior border** extends between the ischial tuberosities.

Superior to the perineal membrane is the **deep perineal pouch**. It consists largely of skeletal muscle and neurovascular bundles. The **superficial perineal pouch** is inferior to the perineal membrane.



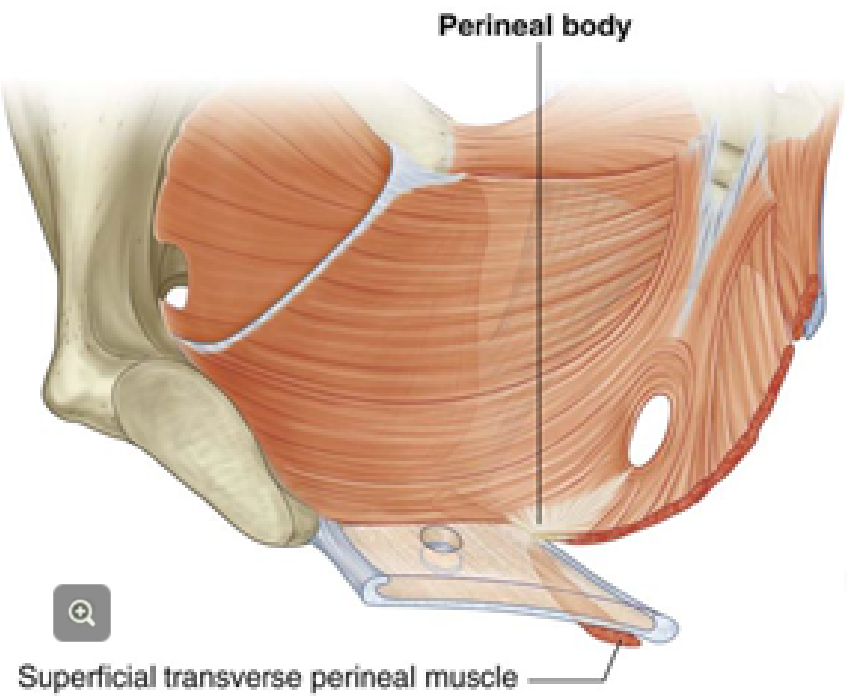
The perineal membrane and deep perineal pouch **close over the urogenital hiatus** of the pelvic diaphragm, thereby **completing the pelvic floor**. In both sexes, an **opening** in the perineal membrane permits the passage of the **urethra**. In females, a second opening permits the passage of the **vagina**.

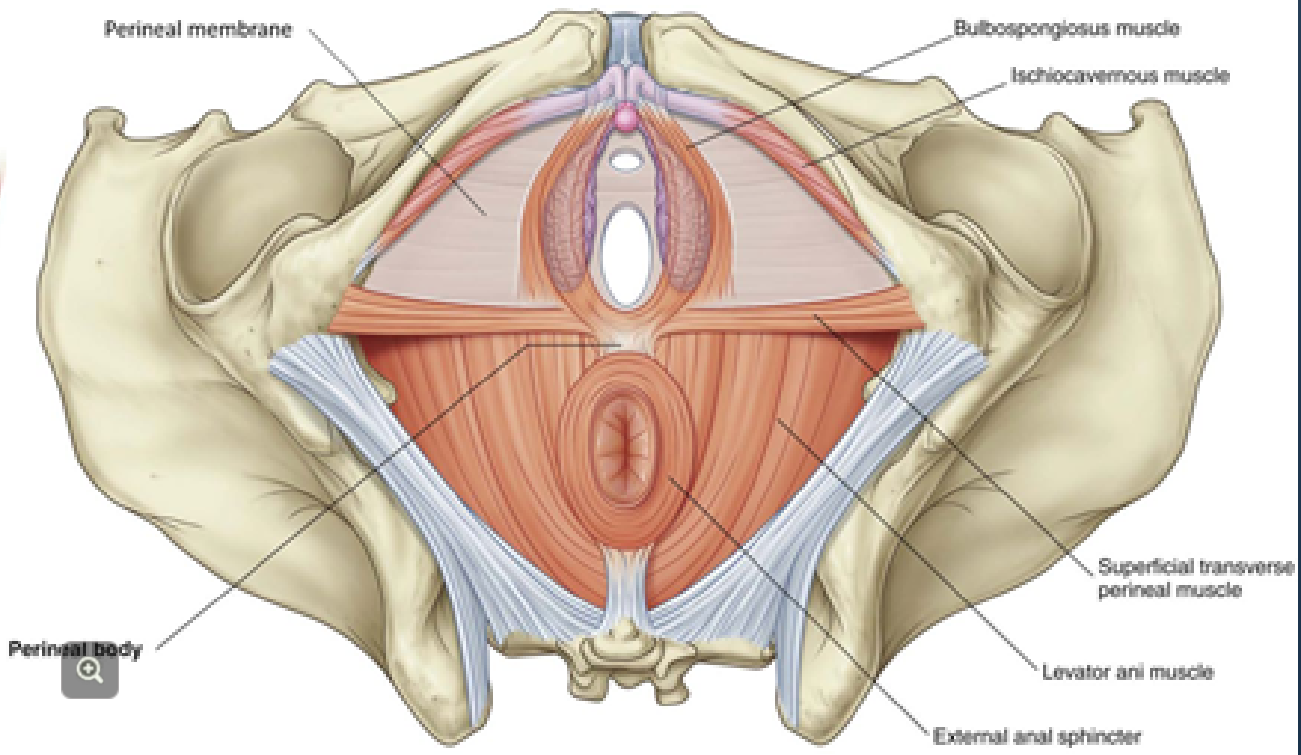
In both sexes, the skeletal muscle of the deep perineal pouch includes the **external urethral sphincter** which provides voluntary control over micturition.

External genitalia are tightly attached to the inferior surface of the **perineal membrane** and to the **bony pubic arch**. A hiatus between the anterior border of the perineal membrane and the pubic symphysis (blue arrow) **permits the passage of neurovascular bundles from the deep perineal pouch to the clitoris and penis**.

The **perineal body** is a **knot of CT** that acts as an important point of attachment for muscles and connective tissue structures of both the pelvic floor (left) and the perineum (right). It is located in the midline between the posterior border of the perineal membrane and the opening for the anal canal.

Amongst other muscles, the **levator ani** attaches here, specifically the portion that forms the posterior border of urogenital hiatus. It also provides attachment for muscles of the perineum in both the deep and superficial pouches.





In the accompanying graphic, the **funnel** represents the **pelvic diaphragm**. The **cylinder** that it rests in represents the bony pelvis. The inferior opening of the cylinder represents the **pelvic outlet**. The mouth of the funnel represents the line of attachment of the pelvic diaphragm to the wall of the pelvis. The space within and above the funnel represents the pelvic cavity. Notice the space **outside the funnel**, but **inside the cylinder**. This represents a part of the perineum called the the **ischioanal fossae**.

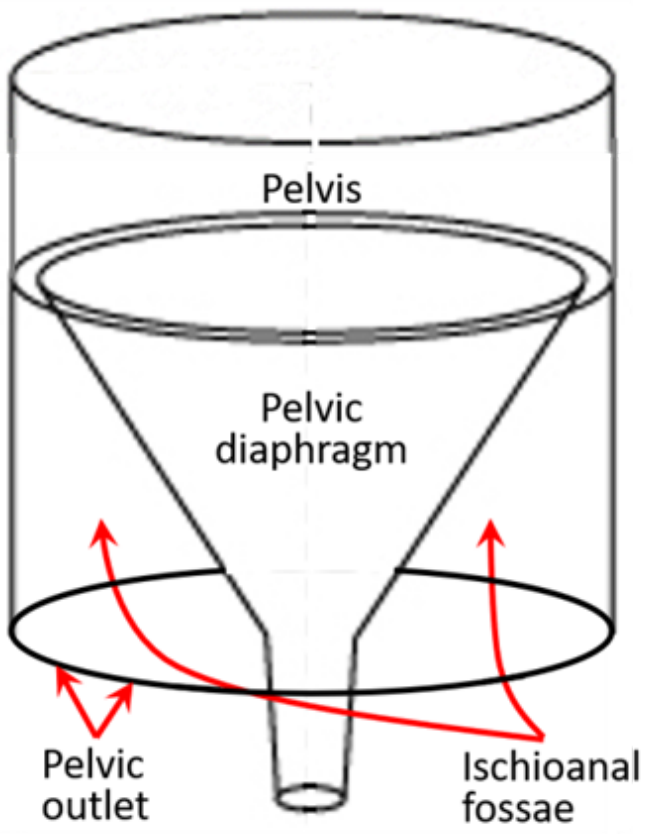
The ischioanal fossae are fat-filled spaces that permit the expansion of the anal canal during defecation. They also contains important nerves, including those to the **external anal** and **external urethral sphincters**.

The pelvic diaphragm consists of the **levator ani** and the **coccygeus** muscles, seen here: .

Notice, in this illustration, that the **coccygeus** extends from the sacrum to the ischial spine, forming the **posterior portions of the pelvic diaphragm.**

The remainder of the pelvic diaphragm is made up of the **levator ani** muscle. Look closely at the **line of attachment of the levator ani**, via a **tendinous** arch, across the internal surface of the **obturator internis** muscle.

The line of attachment of the levator ani, via this tendinous arch, bisects the obturator internis muscle such that **the superior half of the obturator internis is in the true pelvis and the inferior half is in the perineum. THIS IS VERY IMPORTANT TO UNDERSTAND!**



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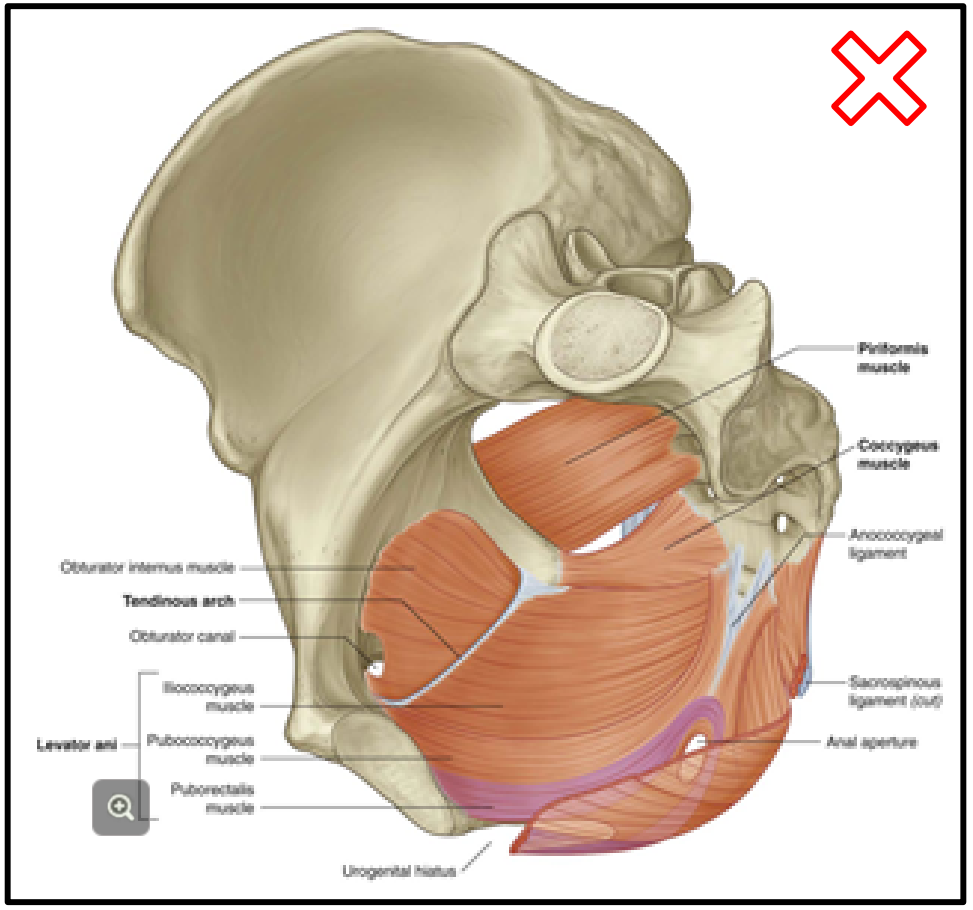

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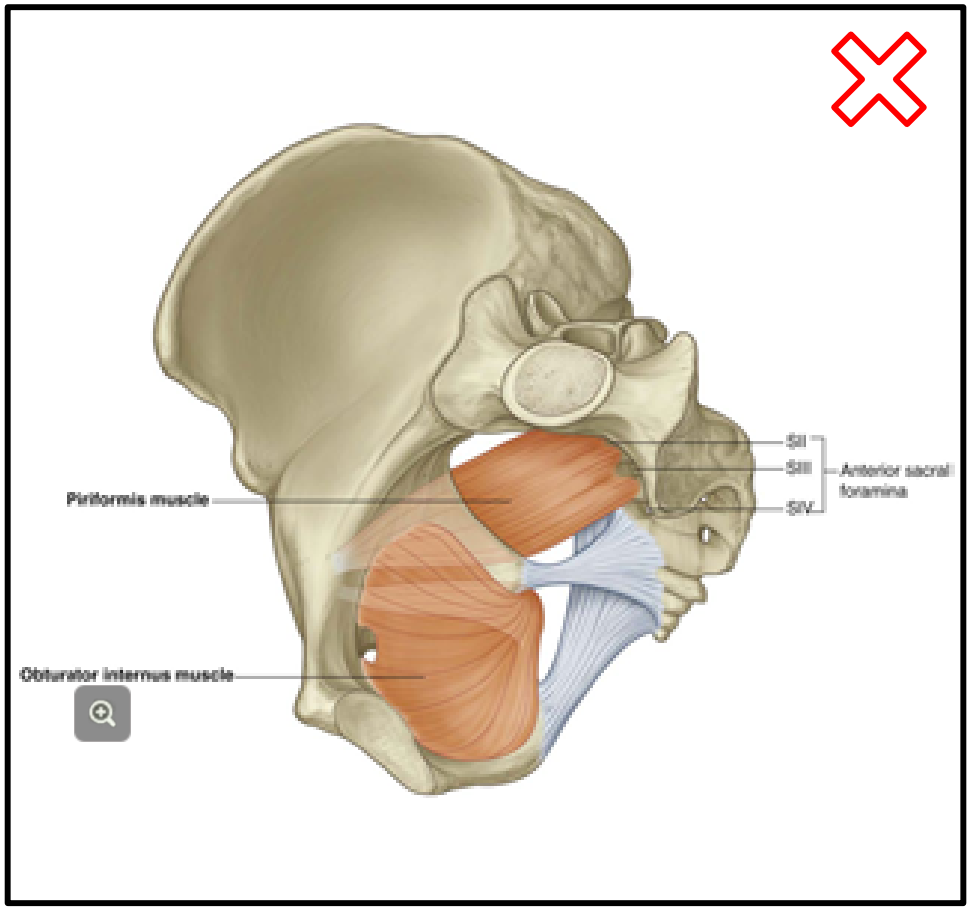


The ischioanal fossae of the anal triangle extend into the urogenital triangle **superior to the deep perineal pouch and perineal membrane**. These are the **anterior recesses of the ischioanal fossae**.

Look at Figure C and confirm the following:

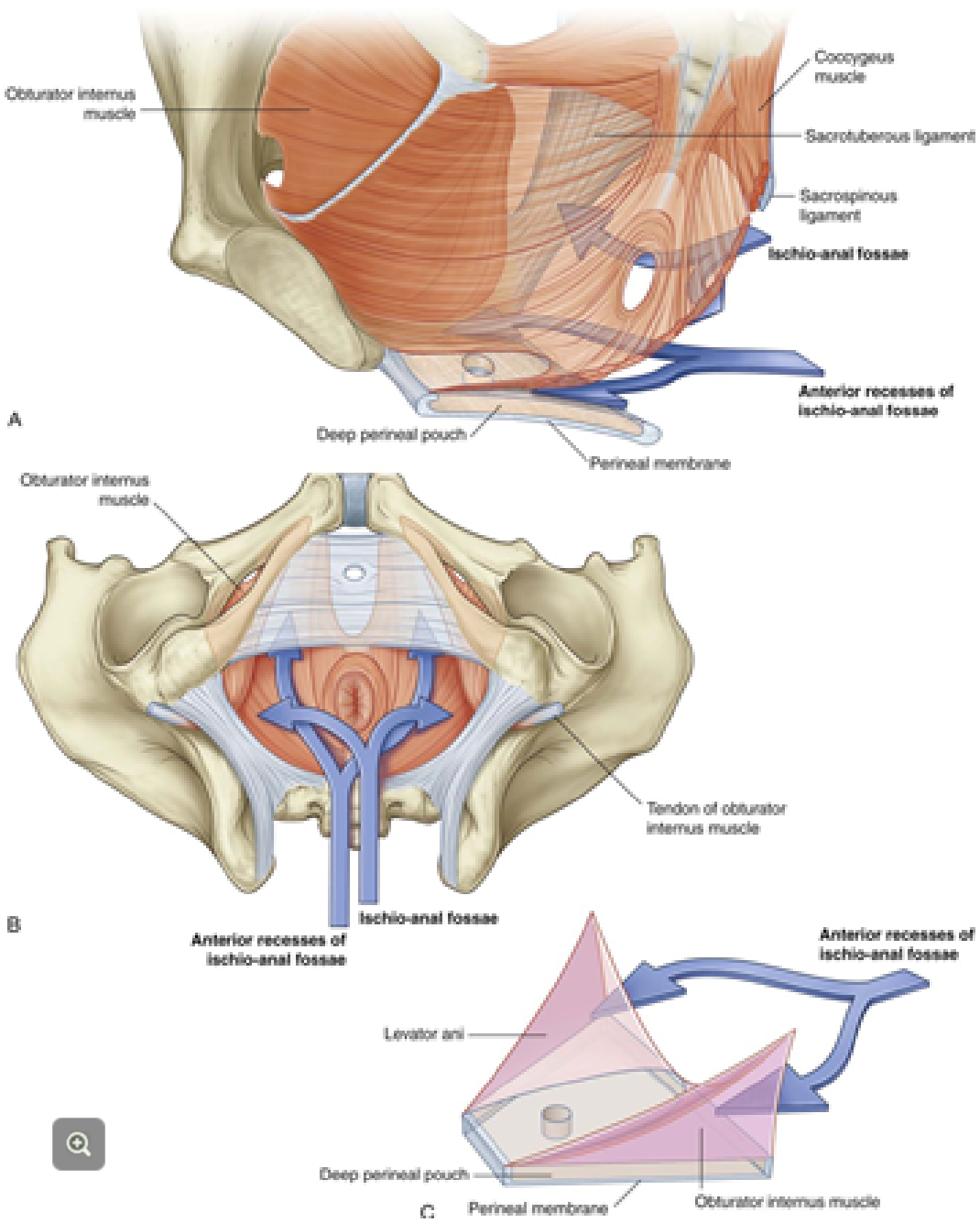
The **floors** of the anterior recesses are the **deep perineal pouch**.

The **lateral walls** of the anterior recesses are the **obturator internis** muscle.

The **medial walls** of the anterior recesses are the **levator ani**.

The anterior recesses of the ischioanal fossae are **dead-end spaces** that end at the **pubis**, where the **perineal membrane** and the **levator ani** attach.

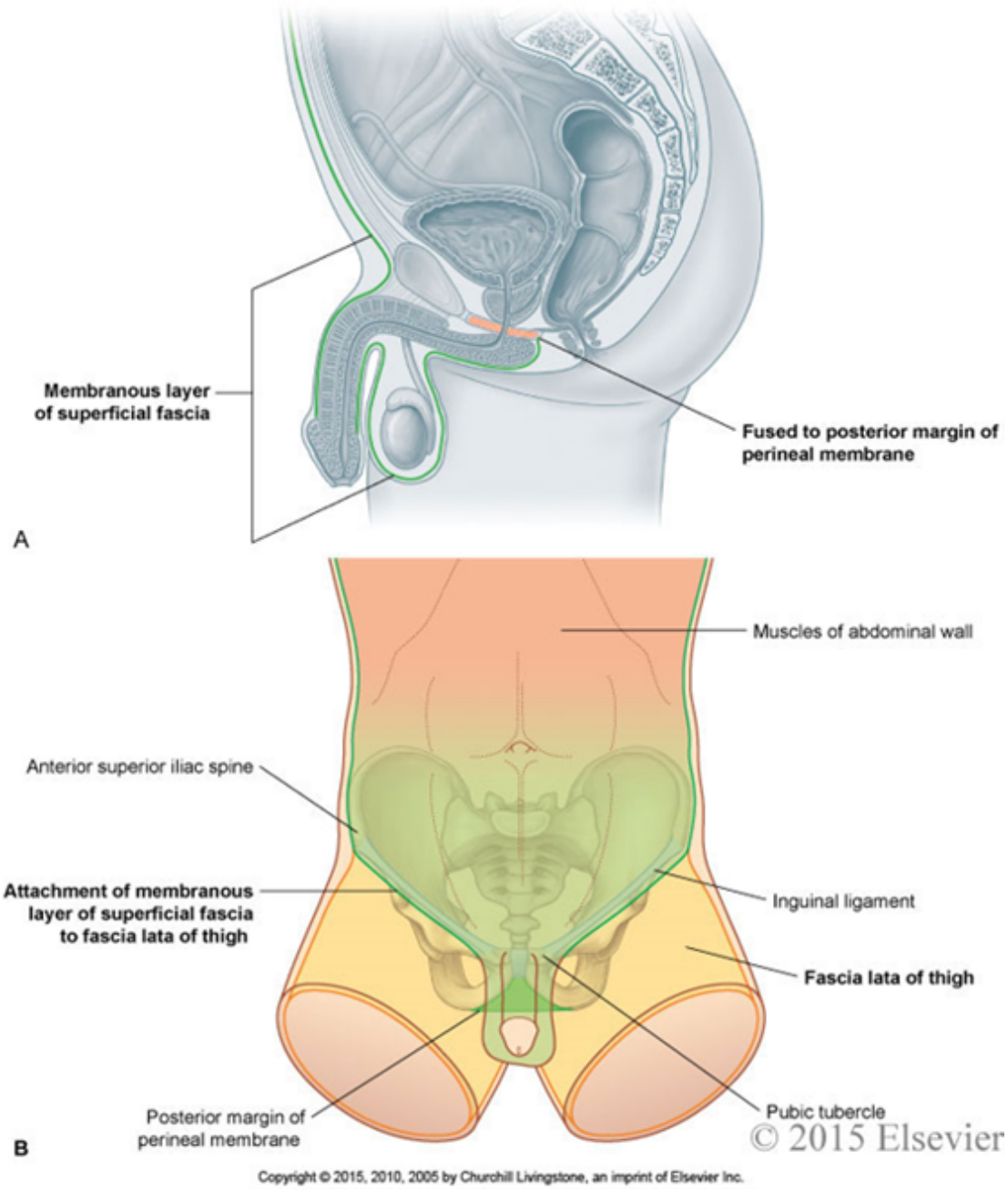
Realize that the anterior recesses are **extensions of the ischioanal fossae**; these spaces are **continuous with each other** and filled with fat. They also, however **contain important neurovascular elements that serve perineal structures**.



The portions of the **UG triangle** described thus far are the **perineal membrane**, **deep perineal pouch** and the **anterior recesses of the ischioanal fossa**. Next is the region **superficial to the perineal membrane**.

The region of the UG triangle between the **membranous layer of superficial fascia** and the **perineal membrane** is the **superficial perineal pouch**. This region contains the **erectile structures** of the external genitalia and associated **skeletal muscles**.

In both sexes, bilaterally-paired erectile bodies, the **corpora cavernosa**, are fused to the ischiopubic rami, proximally. Their distal, unfixed ends form the **body of the clitoris** in women, and contribute to the **body of the penis** in men. The proximal, attached ends of these erectile structures are called the **crura of the clitoris** or **crura of the penis**.



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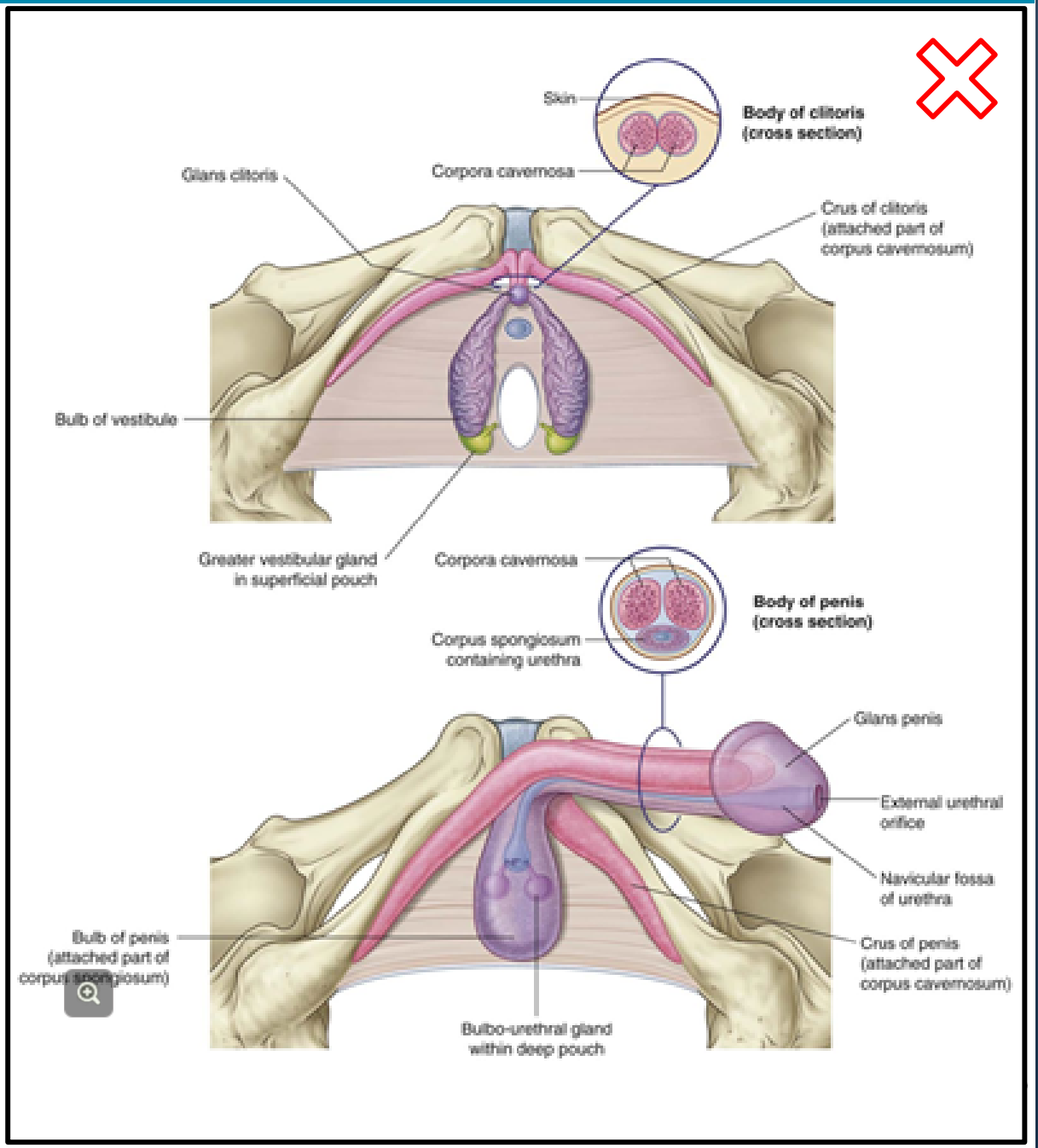
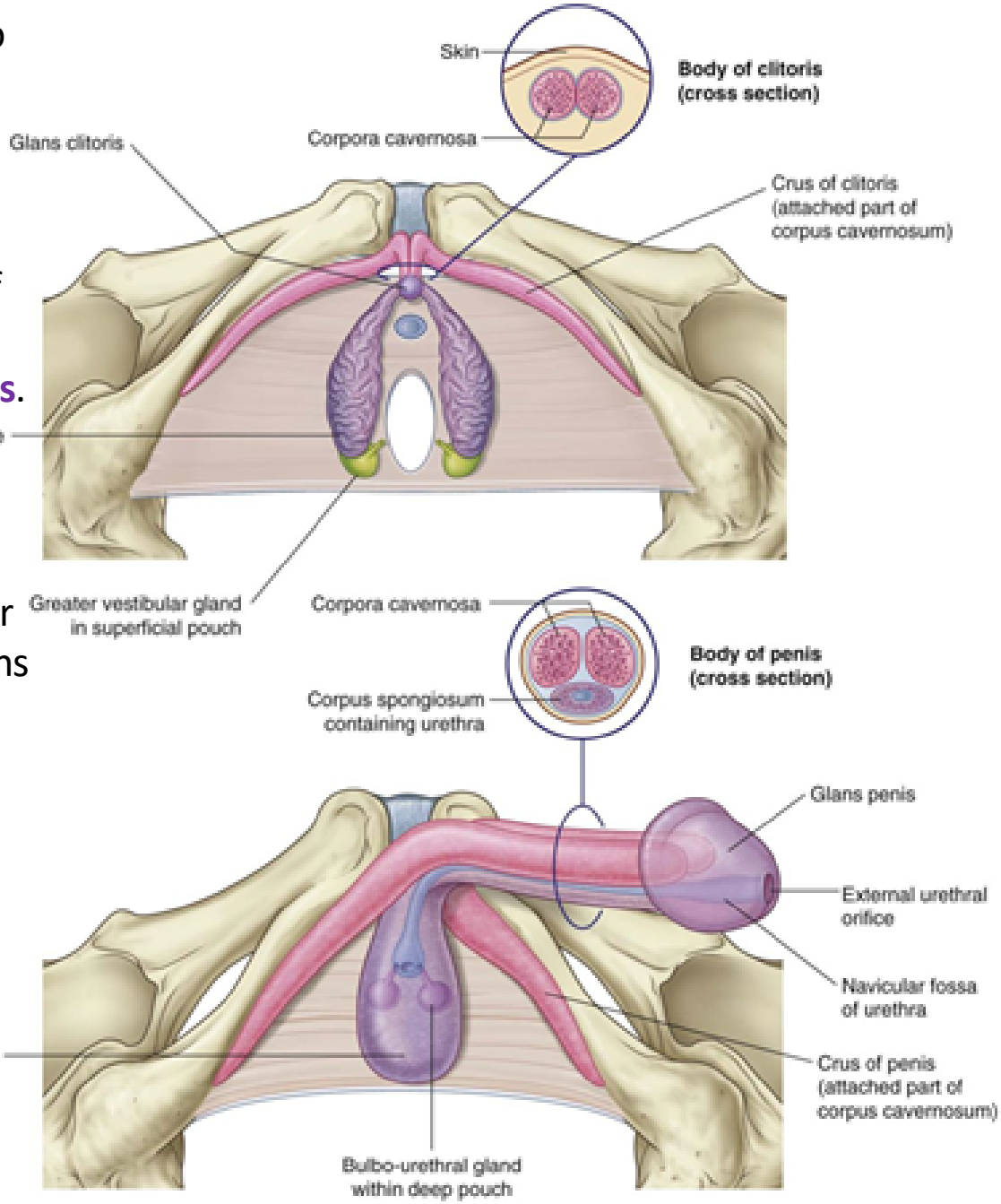


In women, the **space** between the labia minora, into which the urethra and vagina open, is called the **vestibule**. A second pair of erectile bodies, the **bulbs of the vestibule**, surround this space bilaterally, fused to the inferior surface of the perineal membrane. Tapered, anterior extensions of the bulbs of the vestibule meet in the midline, anterior to the urethral opening, as the **glans clitoris**.

The male homologue of the bulbs of the vestibule is the **corpus spongiosum**, a single midline erectile body. It's proximal end is enlarged as the **bulb of the penis**, and is fused to the inferior surface of the perineal membrane. Its distal end joins the corpora cavernosa to complete the **body of the penis**, and expands to cover their distal ends as the **glans penis**. The **male urethra** extends through the corpus spongiosum to open at the tip of the glans penis at the **external urethral orifice**.

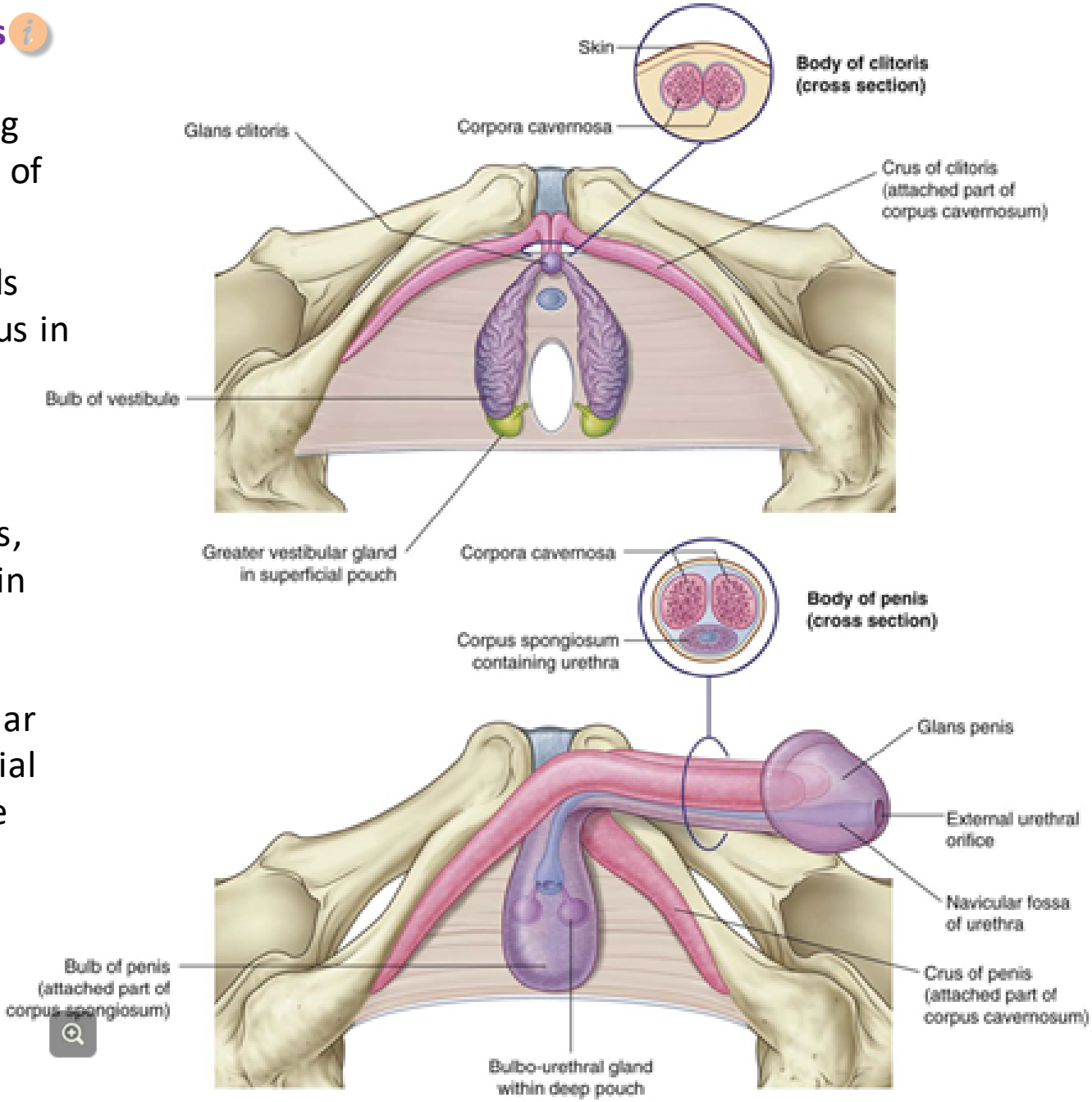
By convention, in anatomical position, **the penis is erect**. Therefore, **the corpus spongiosum is described as being ventral to the corpora cavernosa**, although their relationships are the opposite in the flaccid penis.



In women, the **greater vestibular glands** are located in the **superficial perineal pouch**. These pea-sized, mucus-secreting glands are located posterior to the bulbs of the vestibule.

The ducts of the greater vestibular glands open into the vestibule and secrete mucus in response to sexual arousal.

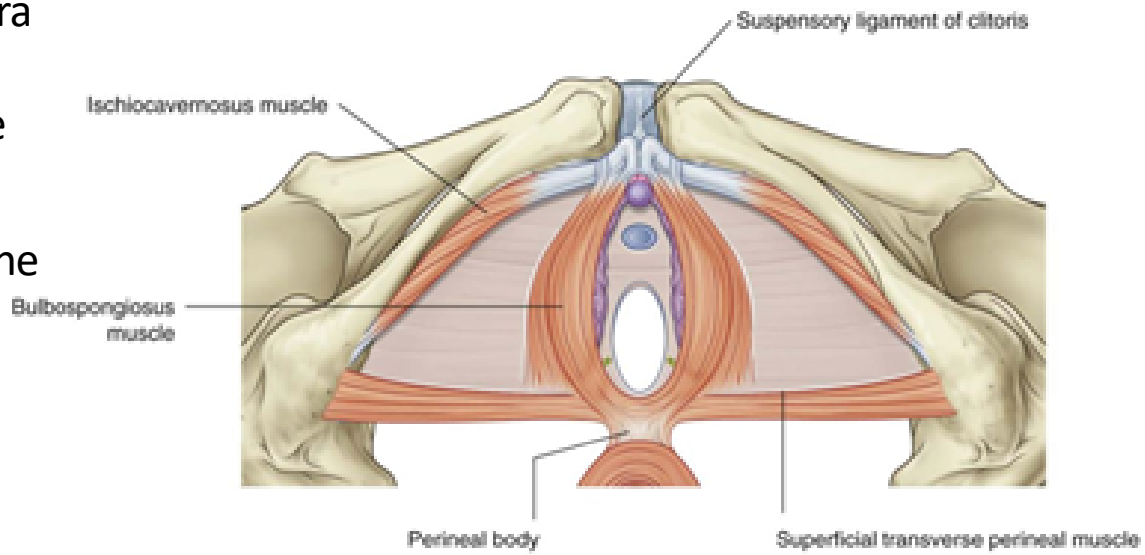
The male homologue of the greater vestibular glands are the **bulbourethral glands**. Like the greater vestibular glands, the bulbourethral glands secrete mucus in response to sexual arousal. They are, however, located in the **deep perineal pouch** in contrast to the greater vestibular glands, which are located in the superficial perineal pouch. Their ducts open into the urethra as it passes through the perineal membrane.



Three paired skeletal muscles occupy the superficial perineal pouch. Two will be described.

The **ischiocavernosus** muscles overly the crura of the clitoris and penis. On contraction, they propel blood from the crura to the body of the clitoris or penis.

The **bulbospongiosus muscles** extend from the perineal body to overlie the **bulb(s) of the vestibule and penis**.

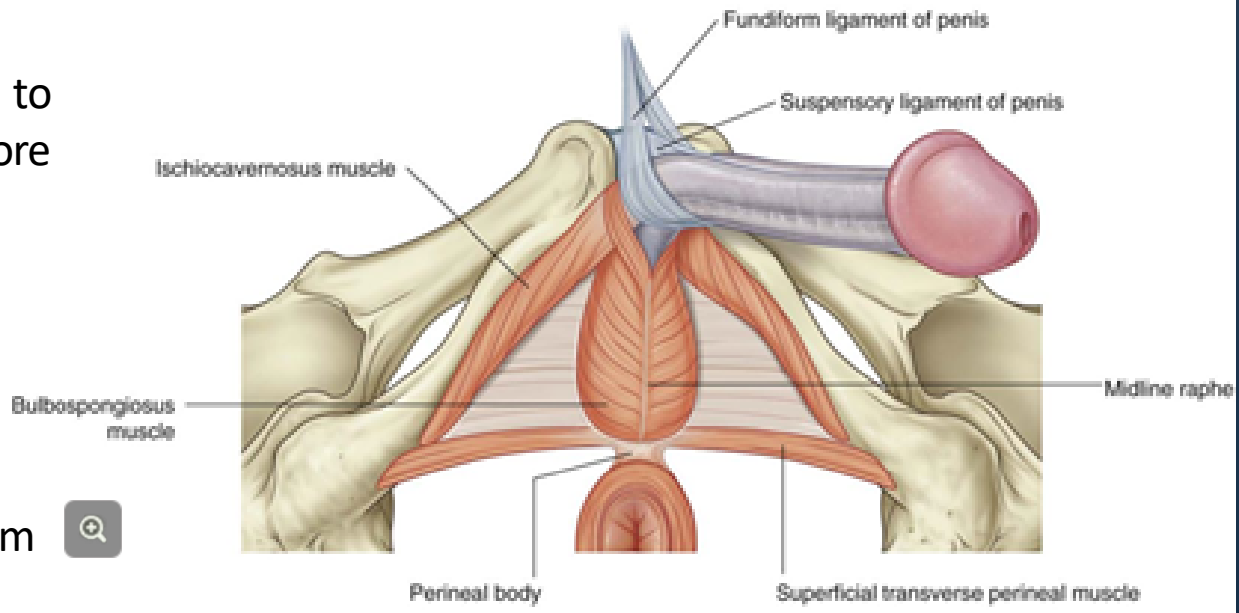


In females, the bulbospongiosus are **two separate muscles**. In males, the two bulbospongiosus muscles are **fused in a midline raphe** to cover over the bulb of the penis.

In **both sexes**, the bulbospongiosus contracts to **propel blood** from the engorged bulb into more distal parts, including the **glans**. In **men**, the bulbospongiosus also:

i) assists with **emptying the penile urethra** following micturition, and

ii) contracts **reflexively** during **ejaculation**, causing the **pulsatile expulsion of semen** from the penis.



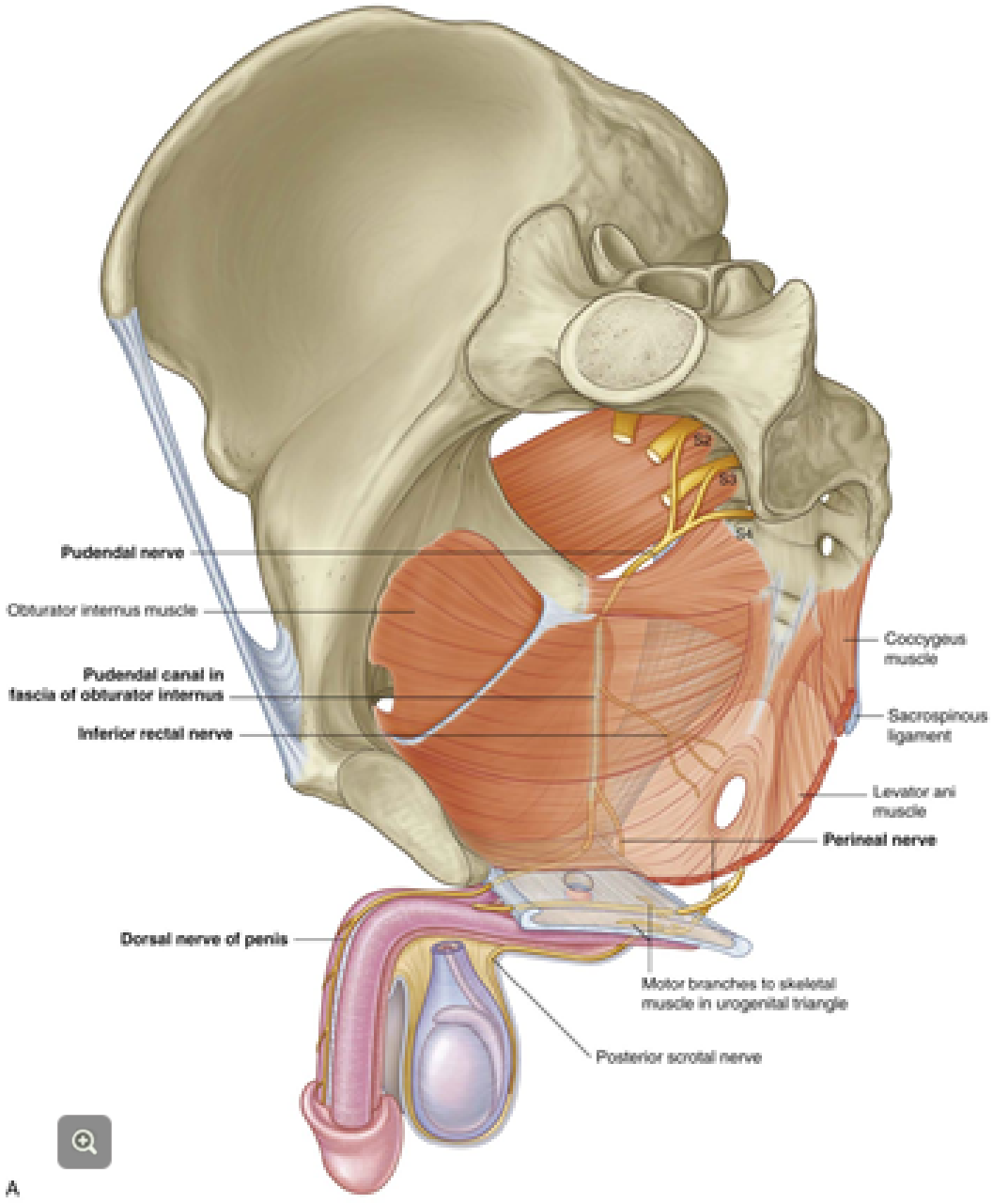
The pudendal nerve is formed on the posterior wall of the pelvis in the sacral plexus, by contributions from the **S2, S3** and **S4 ventral rami**.

While the pudendal nerve is formed in the pelvis, it innervates targets in the perineum. To bypass the pelvic diaphragm and access the perineum, the pudendal nerve exits the pelvis though the **greater sciatic foramen**, inferior to the piriformis, passes **outside the sacrospinous ligament**, and then enters the anal triangle through the **lesser sciatic foramen**.

The **pudendal nerve** gives rise to the three major somatic nerves of the perineum, the **inferior rectal nerve**, the **perineal nerve** and the **dorsal nerve of the penis / clitoris**.

This is shown clearly here:

The pudendal nerve travels along the lateral wall of the ischioanal fossa, deep to the obturator fascia, in what is referred to as the **pudendal canal**.



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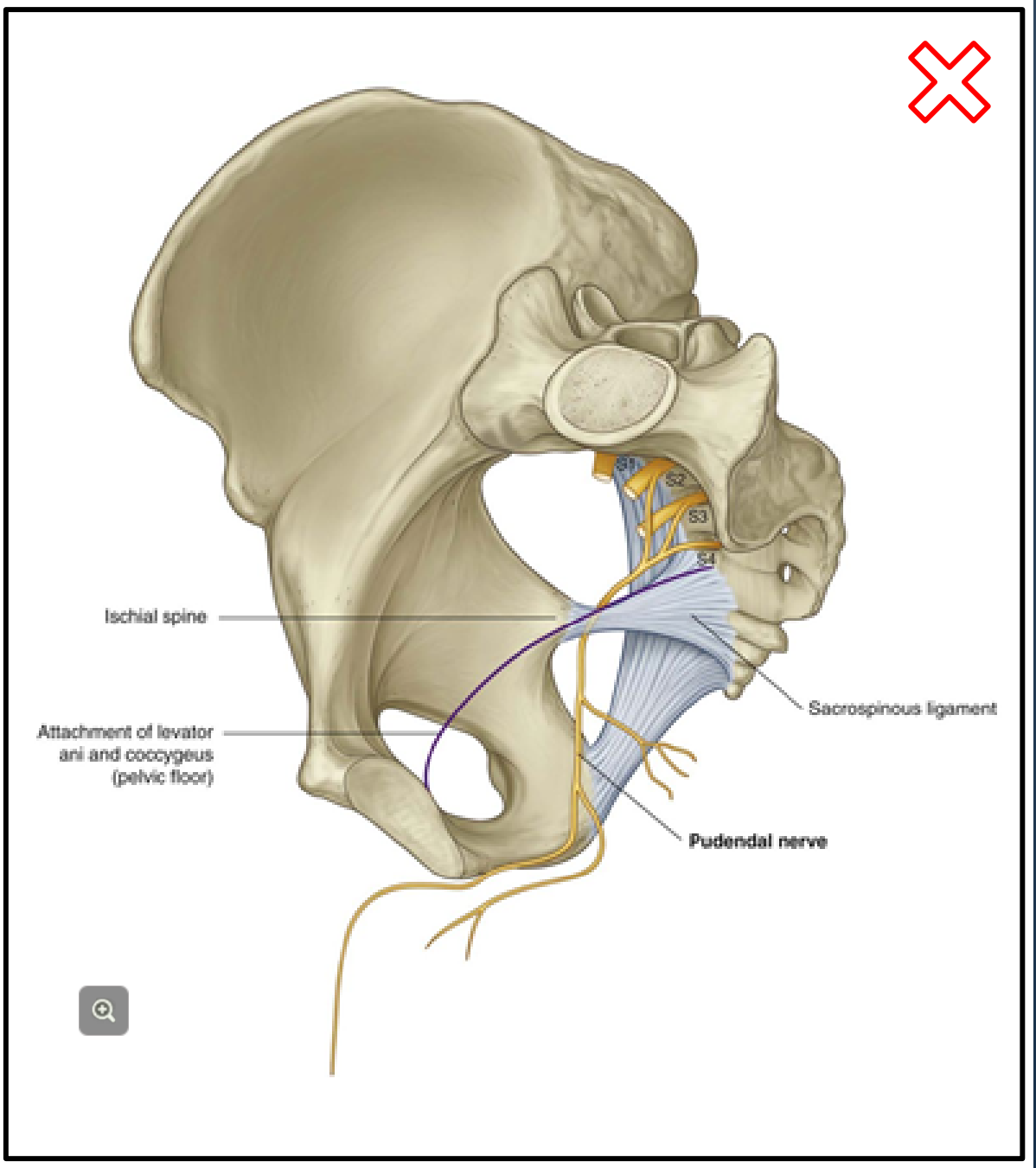
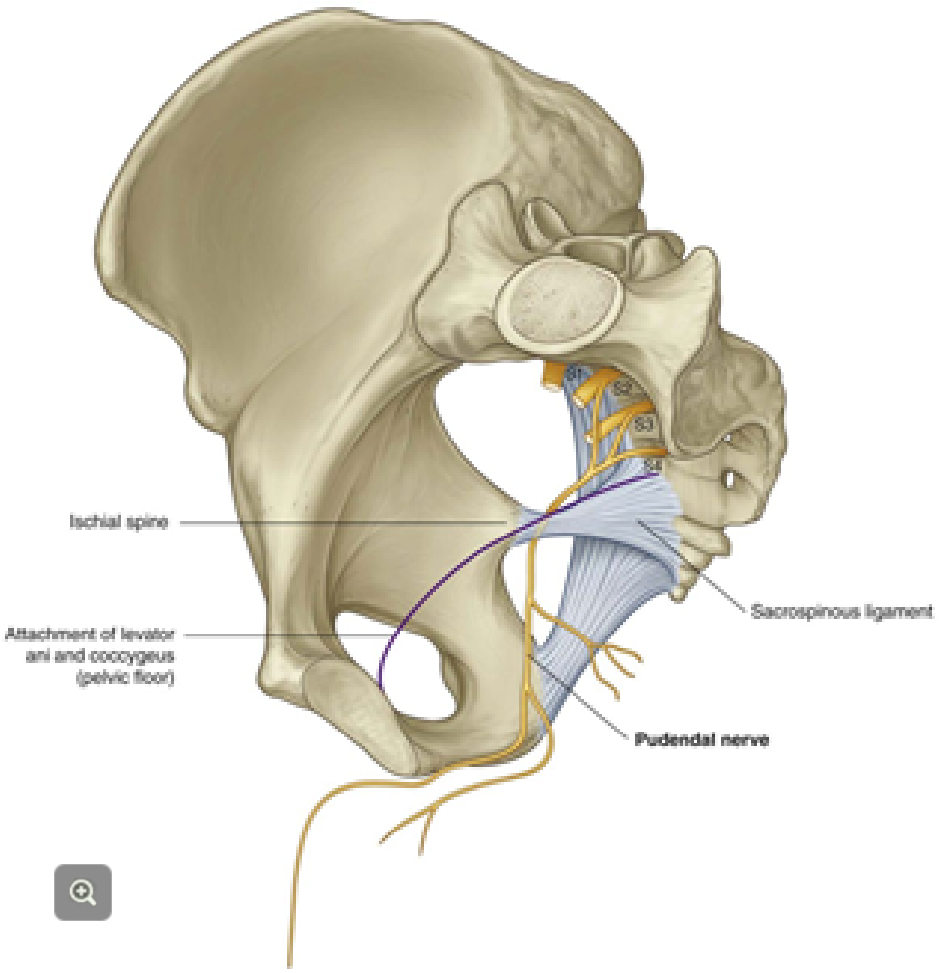


Because the **pudendal nerves** arise from the **same spinal levels** as the **pelvic splanchnic nerves**, students confuse them.

The **pudendal** nerve is a **somatic nerve**. It contains the axons of **lower motor neurons**, the cell bodies of which are located in the **ventral horns** of the spinal cord at the **S2-S4 levels**. These axons are destined to innervate **skeletal muscle of the perineum**. It contains **sensory fibres** being distributed to the **skin** of the perineum and **sympathetic postganglionic fibres** that innervate vascular smooth muscle, as well as glands and erector pili muscle of the skin of the perineum.

The **pelvic splanchnic nerves** contain **parasympathetic preganglionic fibres**, the cell bodies of which are located in the **intermediolateral cell column** of the sacral spinal cord at the **S2-S4 levels**. The pelvic splanchnic nerves form on the posterior wall of the sacrum and feed into the inferior hypogastric plexus, from which their axons are distributed to the viscera of the distal digestive tract and pelvis. From the prostatic / uterovaginal plexus, axons pass through the urogenital hiatus with the urethra to access the **vascular smooth muscle of the erectile tissues of the penis and clitoris**. These parasympathetic nerves are responsible for erection.



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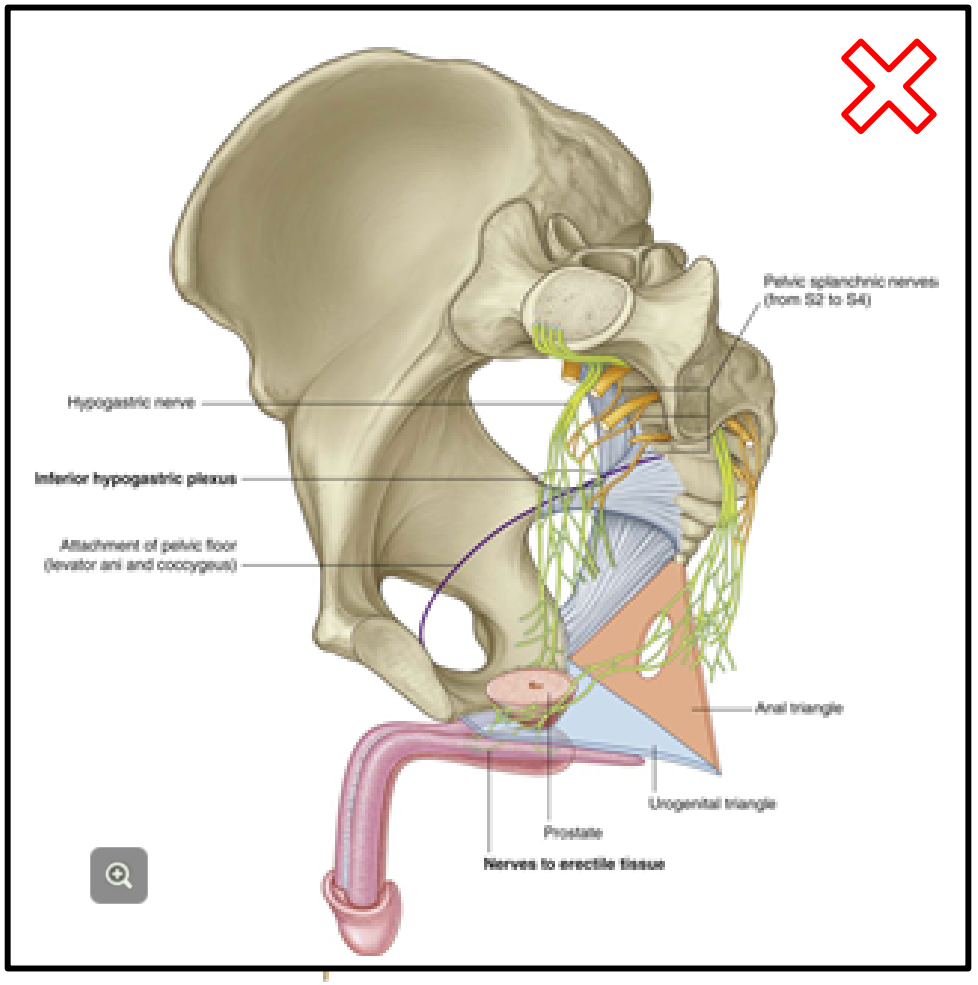
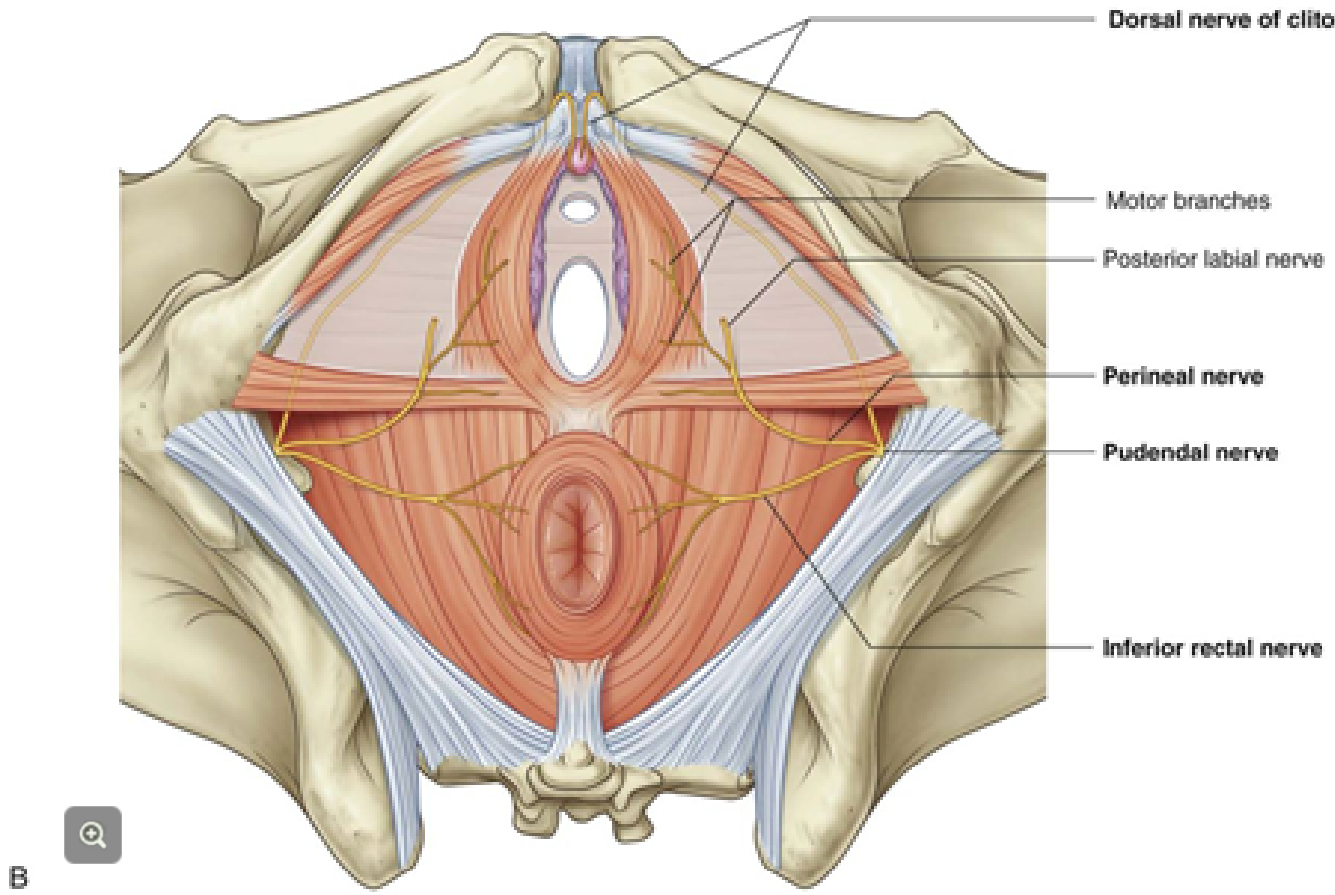


The pudendal nerve has three major branches:

The **inferior rectal nerve** crosses the ischioanal fossa to innervate the **external anal sphincter** and portions of the **levator ani** and the **skin of the anal triangle**.

The **perineal nerve** enters the superficial perineal pouch to innervate its **skeletal muscle**, the **skin of the urogenital triangle** and ends as the cutaneous **posterior scrotal / labial nerves**.

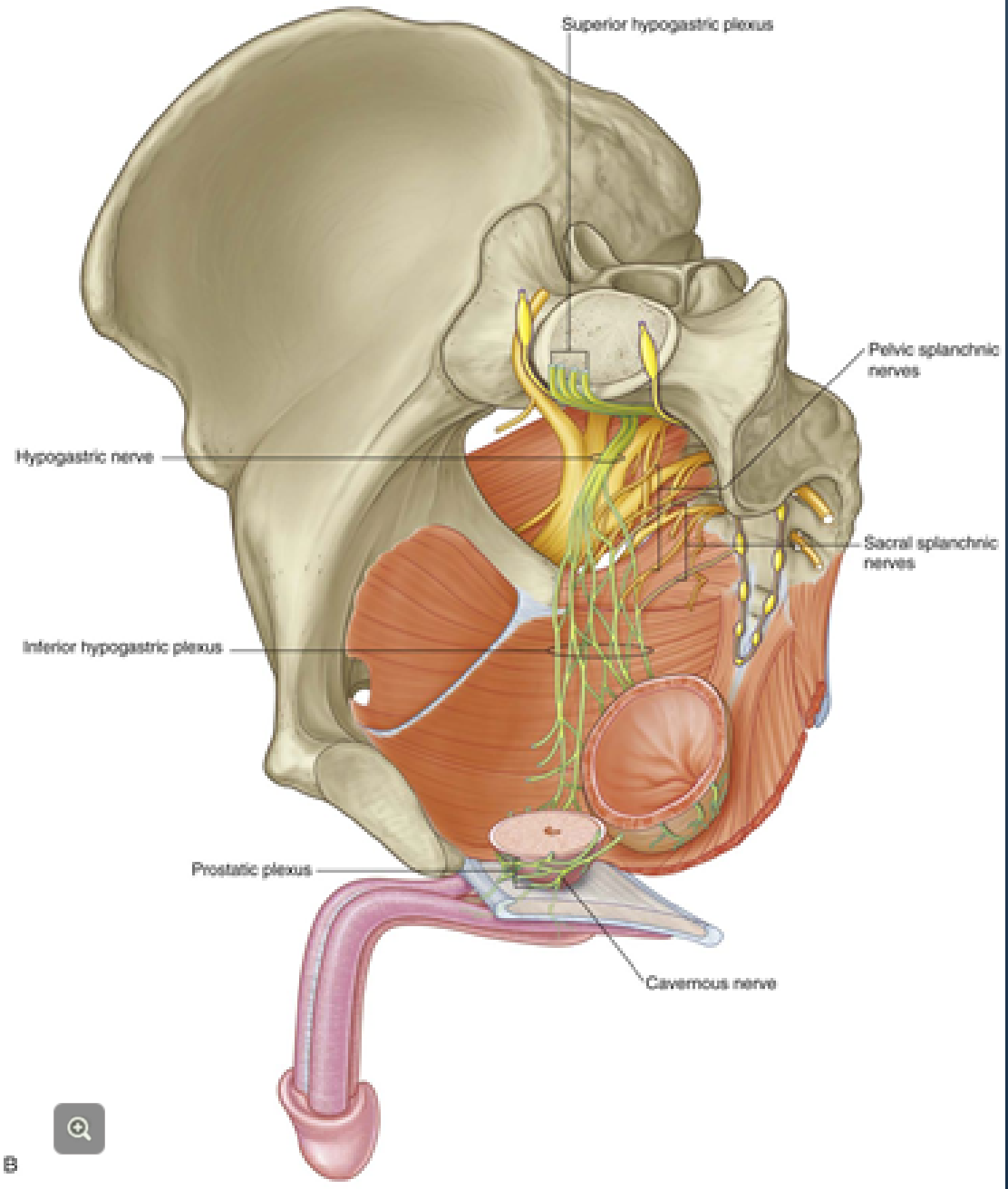
The third branch traverses the **deep perineal pouch** to end as the **dorsal nerve of the penis / clitoris**.



Recall that the **inferior hypogastric (pelvic) plexuses** provide **sympathetic, parasympathetic and visceral afferent** fibres to **pelvic structures**. The inferior hypogastric plexuses receive **sympathetic** fibres from the **sacral splanchnic nerves** and parasympathetic fibres from the **pelvic splanchnic nerves**. The inferior hypogastric plexuses give rise to the **rectal, uterovaginal / prostatic** and **vesical plexuses**.

The **erectile tissues of the perineum** are innervated by terminal branches of the inferior hypogastric plexuses that pass through the **deep perineal pouch**. In men, these are the **cavernous nerves**, derived from the **prostatic plexus**. In women these nerves are likely derived from the **uterovaginal plexus**.

Because of the close association of the cavernous nerves with the prostate, **impotence** can be a complication of **prostatectomy**. Similarly, **sexual dysfunction** can be a complication in **hysterectomy**.



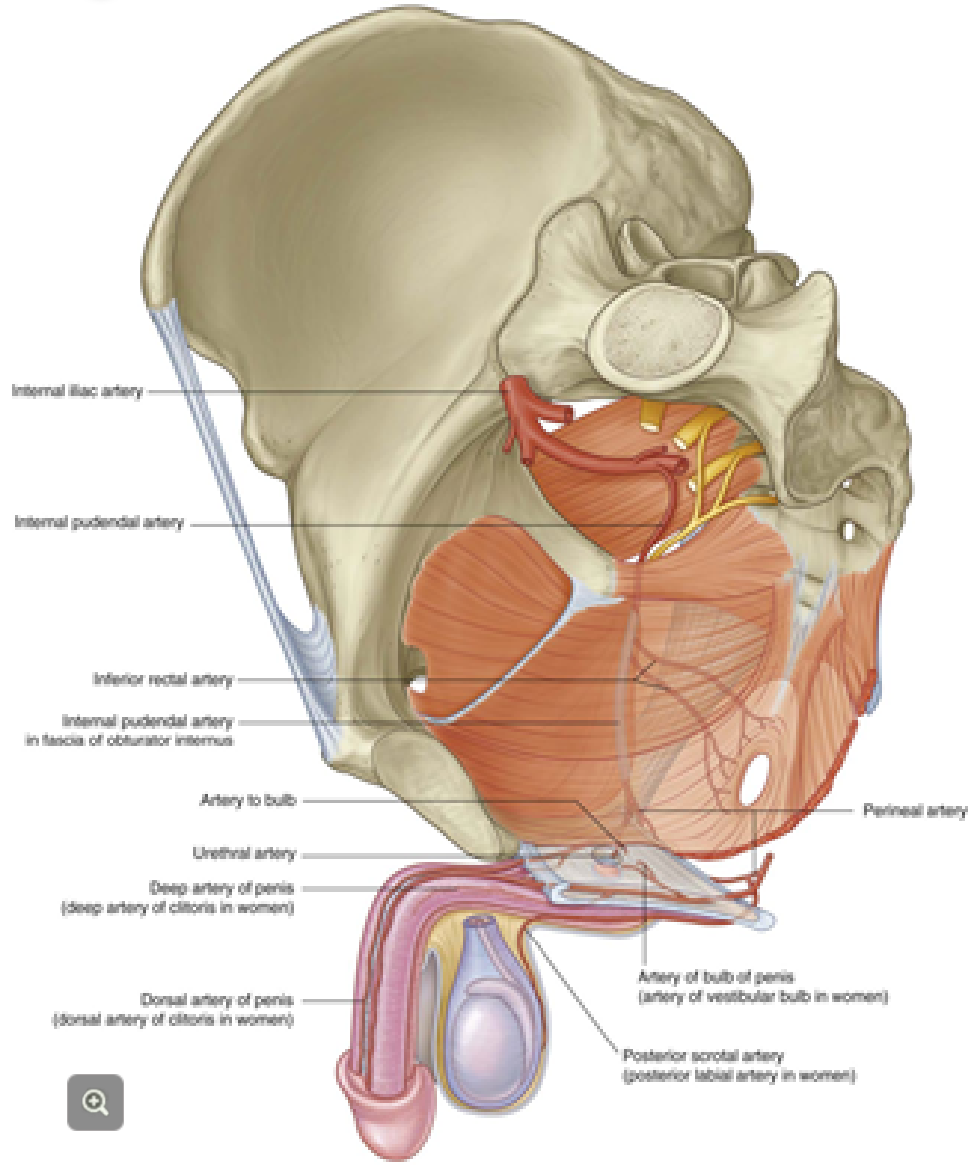
The **internal pudendal artery** arises in the pelvis as a branch of the **internal iliac artery**. It, and its branches, have **companion veins** of the same name.

The internal pudendal artery and vein, with the **pudendal nerve**, pass through the **greater sciatic foramen**, around the **ischial spine**, and through the **lesser sciatic foramen** into the **anal triangle**. Notice in the figure that, at the ischial spine, the **pudendal nerve** is **most medial**.

The internal pudendal artery and vein branch with the pudendal nerve.

They thus form the **inferior rectal arteries** / **veins**, which accompany the inferior rectal nerves across the ischioanal fossa to the rectum. These vessels anastomose with the **middle rectal** arteries and veins from the **internal iliac**, and the **superior rectal** arteries and veins from the **inferior mesenteric**. The venous anastomosis is a significant site of portocaval anastomosis.

Perineal arteries and **veins** accompany the perineal nerves into the superficial pouch. The internal pudendal artery and vein end by supplying the structures of the deep pouch and erectile tissue.



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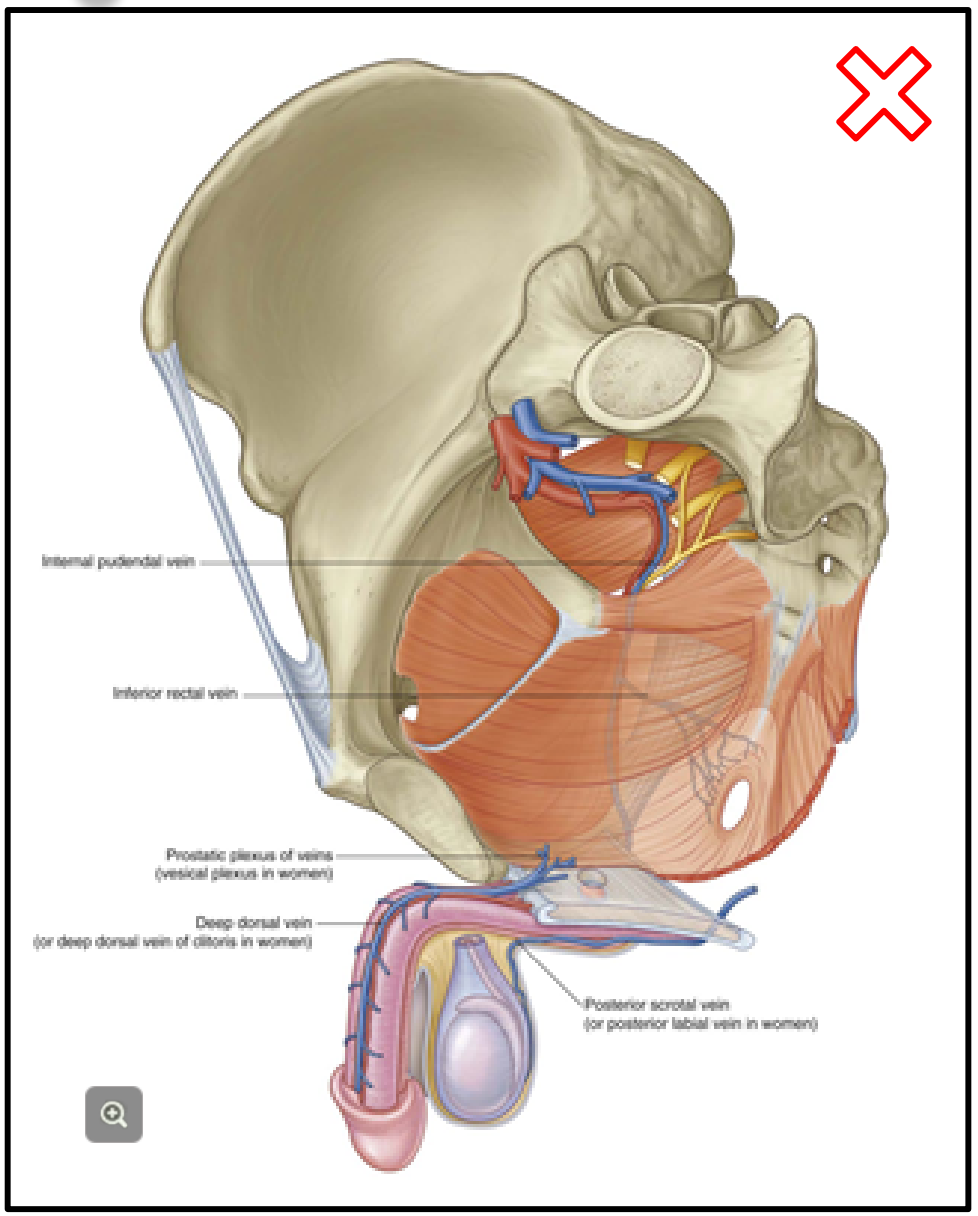

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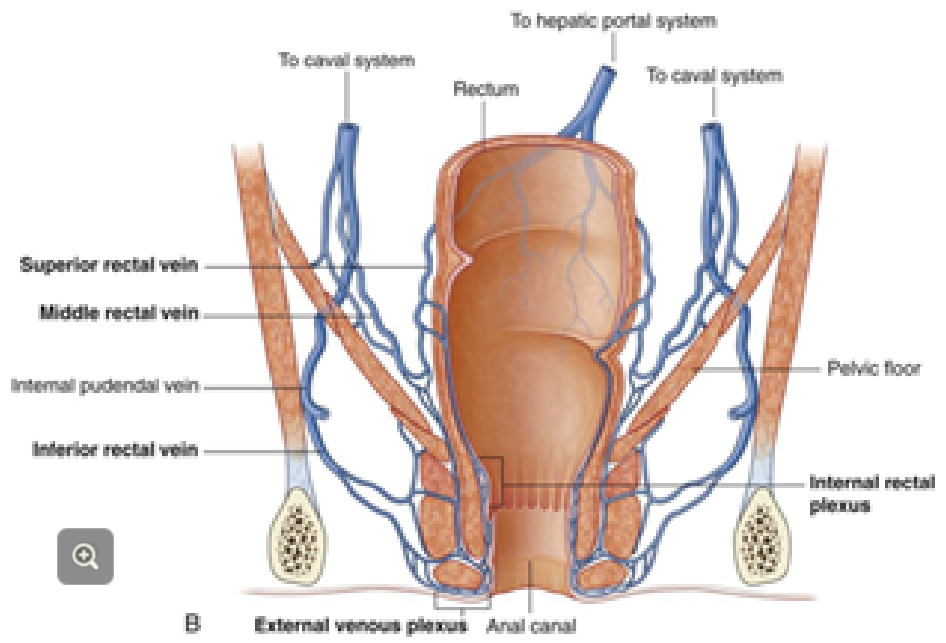
Perineal arteries and **veins** accompany the perineal nerves into the superficial pouch. The internal pudendal artery and vein end by supplying the structures of the deep pouch and erectile tissue.

In **portal hypertension**, as might occur in cirrhosis of the liver, venous pressure in portocaval anastomoses is elevated, causing venous engorgement and increased likelihood of bleeding.



13.1 The Retroperitoneum

What you'll need:

SPECIMENS

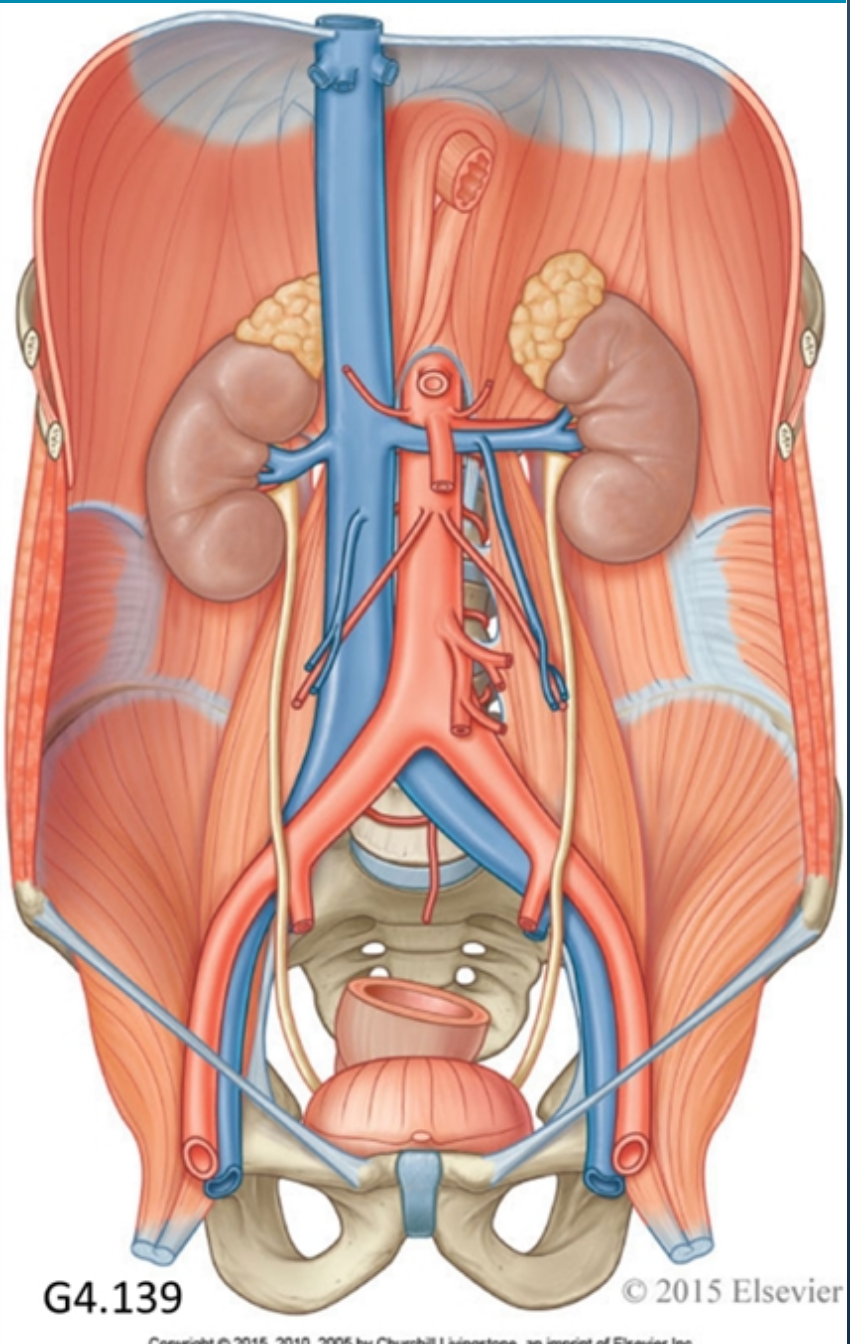
- One cadaver as chosen by your TA.
- Abdomen Organs Teaching Bin

INSTRUCTIONS

If your cadaver has been chosen by your TA for dissection of the retroperitoneum you will embark upon Exercise 13.1, The Retroperitoneum, during Week 31. You'll likely only get as far as Progress Check 2 during week 31, leaving some of this dissection for your colleagues to complete during Week 32. You will complete Exercise 13.2, The Perineum, during Week 32, and have time to go back and study the completed dissection. Those students coming to this exercise during week 32 must review the entire dissection from the start before starting to dissect further.

When you have completed this dissection, you will be able to identify and/ or describe:

- the gross relationships of the kidneys, including their CT coverings, and the viscera, muscles and bones that are adjacent to them.
- the blood supply and venous drainage of the kidneys
- the gross internal structure of the kidney and the formation and path of the ureters within the retroperitoneum.
- the gross relationships of the adrenal glands, their blood supply and venous drainage
- the branches of the abdominal aorta and the tributaries of the inferior vena cava (IVC).
- the muscles that make up the posterior abdominal wall.
- the nerves that populate the posterior abdominal wall and their distribution.
- the groups of lymph nodes that populate the posterior abdominal wall.

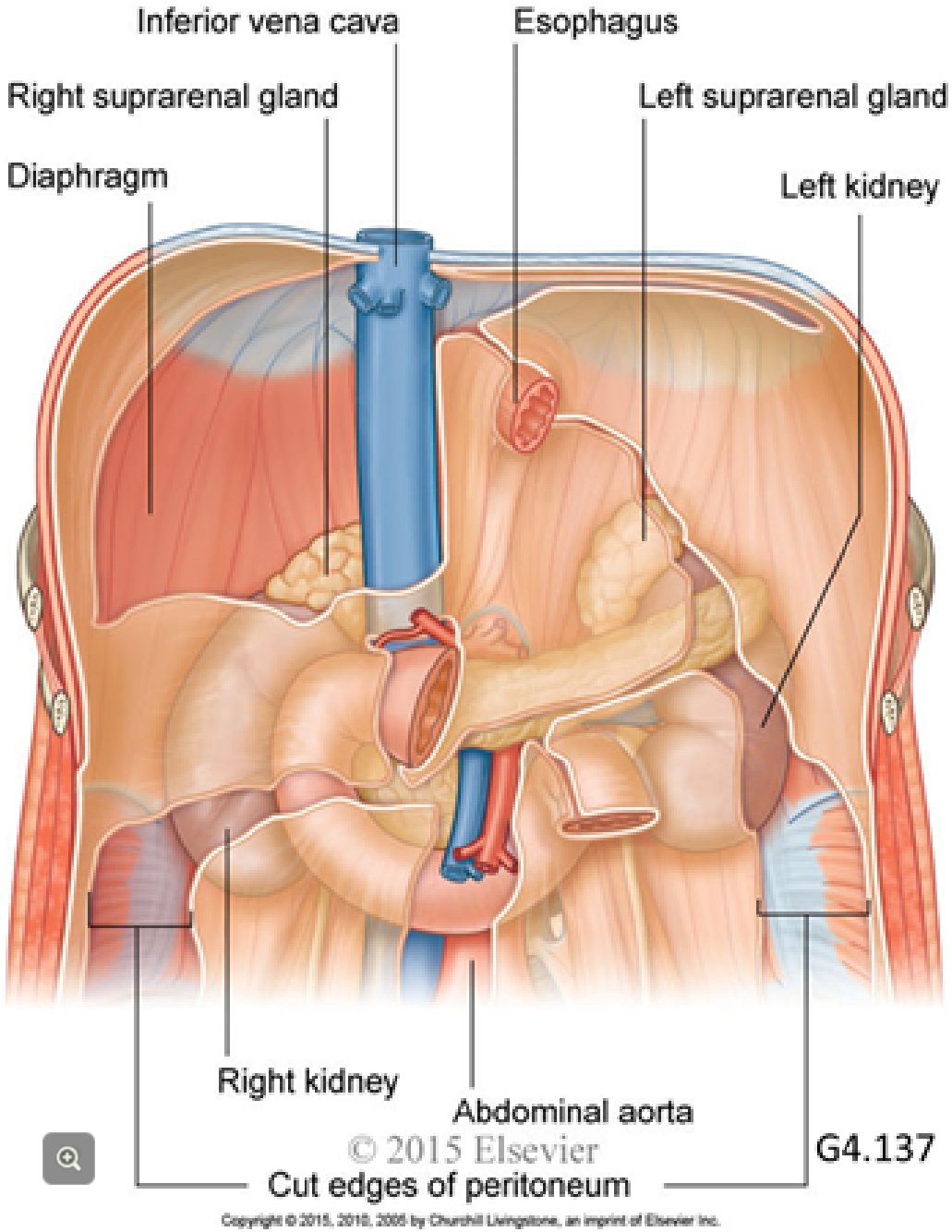


Your TA will have chosen four cadavers in your lab that will **NOT** be dissected any further, so that they can be **used for review of the digestive tract and its blood supply** in preparation for the Unit 4 bell-ringer. You will remove the GI tract from the remaining cadavers in order to dissect and understand the **anatomy of the retroperitoneum**.

Currently, the GI tract is attached:

- proximally and distally, by the **esophagus and rectum**, respectively
- **to the aorta** by the celiac trunk, superior mesenteric artery and inferior mesenteric artery
- by the structures contained within the porta hepatis **to the liver**, which itself is attached **to the underside of the diaphragm**, with the IVC embedded in its posterior aspect.

Order of this dissection: first you will cut these structures, and remove the digestive tract and liver. Then you will then dissect the retroperitoneum in order to understand its anatomy.

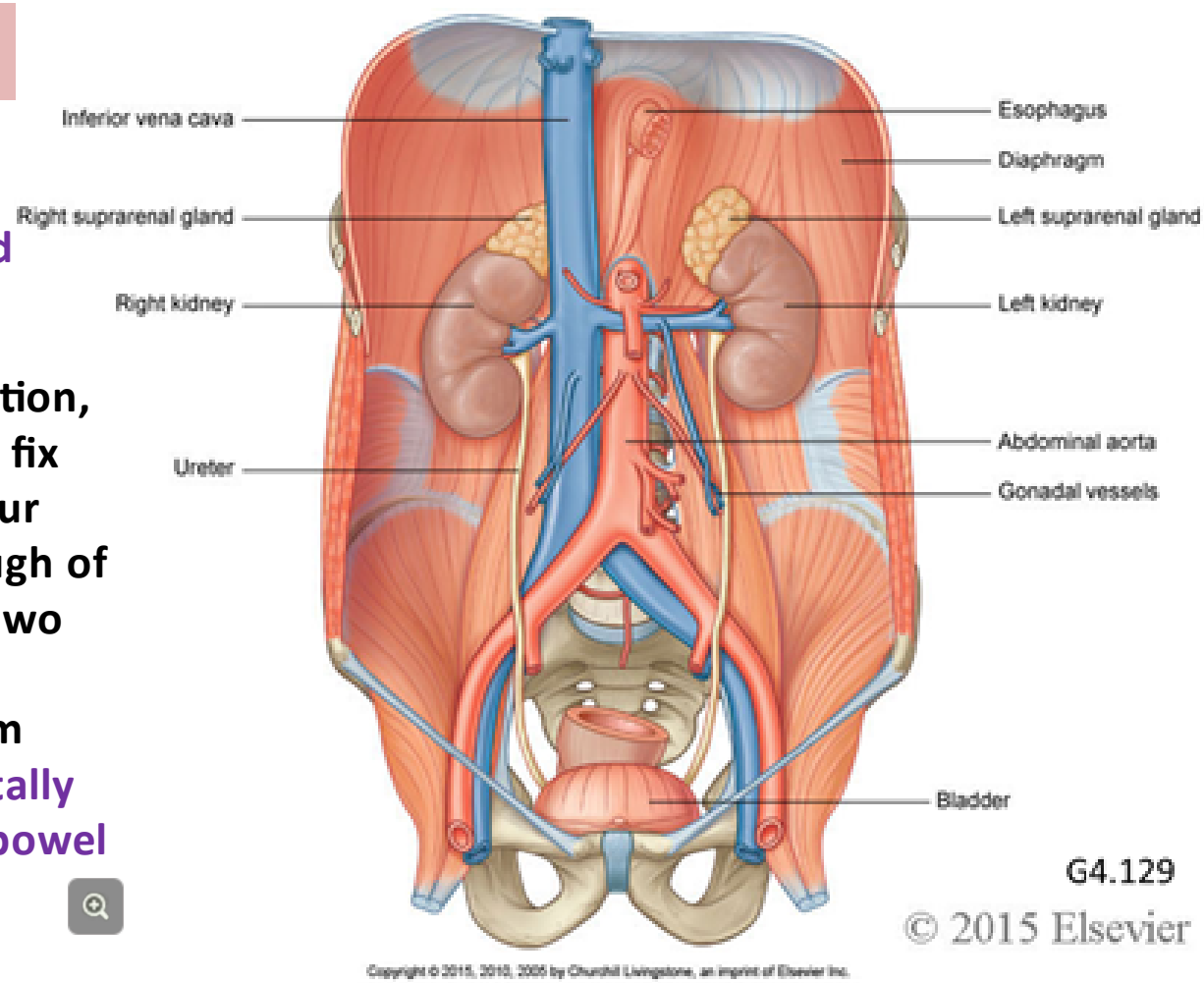


TASK

LOCATE the junction between

the sigmoid colon and the rectum, at the point where the sigmoid colon loses its mesentery and becomes fixed to the posterior wall of the pelvis.

Using your fingers, or at most, blunt dissection, break through the serous membranes that fix the rectum in place so that you can get your fingers behind it. Loosen, in this way, enough of a length of bowel that you are able to tie two strings tightly around it, about 4 cm apart. Using large scissors, cut through the rectum between the two strings. Do this as far distally as possible; i.e. you want to leave as little bowel in the pelvis as you can.



TASK

TURN your attention to the esophagus.

Just at the point where it passes through the diaphragm, tie a string tightly around the esophagus. Because the esophagus will be empty, you need not tie two strings. Cut through the esophagus and the vagal trunks superior to the string.

First, remind yourself of the ligamentous attachments of the liver.

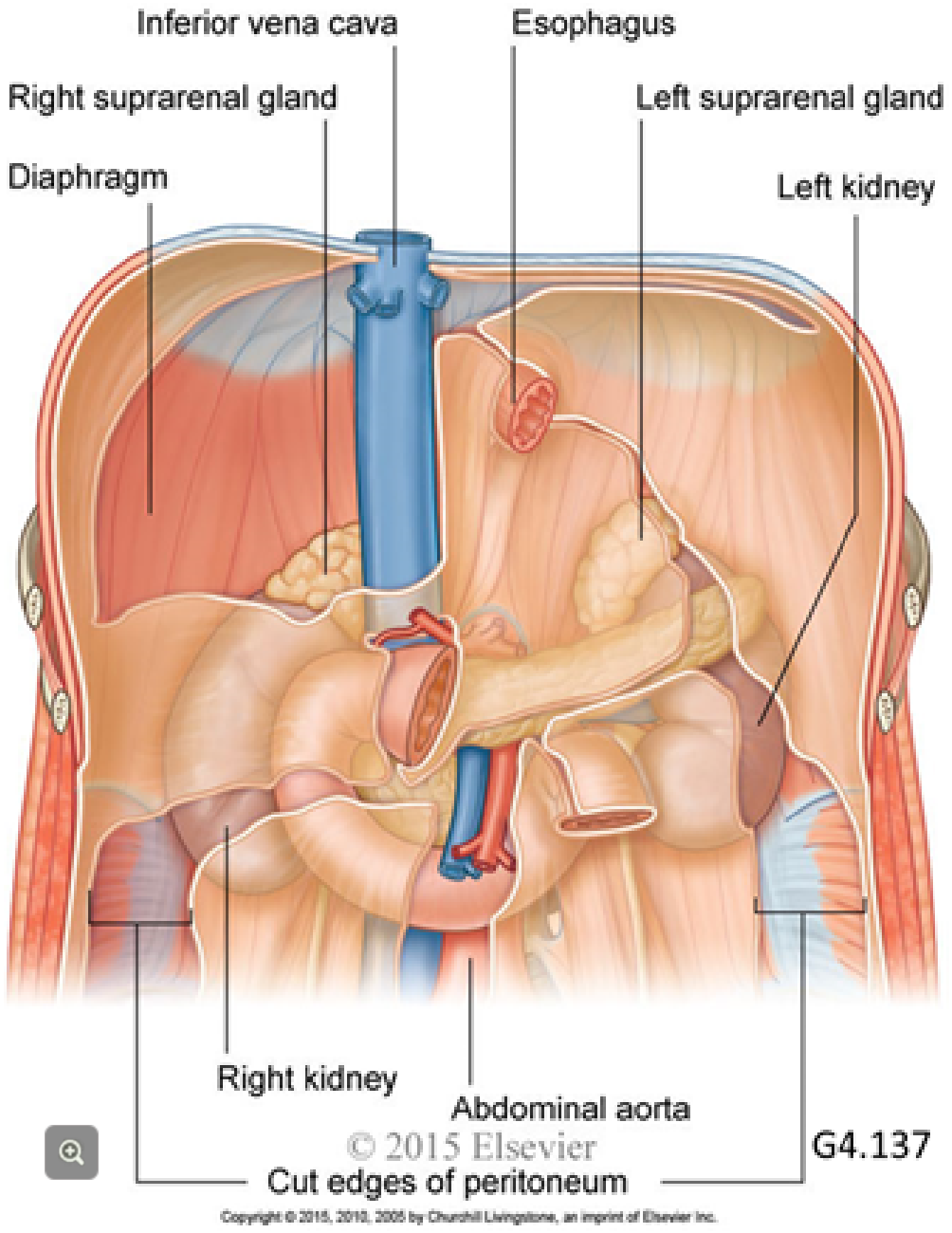
TASK

USE LARGE SCISSORS

to cut the falciform ligament free from the falciform flap. Extend this cut bilaterally through the anterior lamina of the coronary and triangular ligaments. Insert your fingers between the liver and diaphragm, and tear the CT that fixes the liver in place at its bare area. Feel for the posterior lamina of the coronary ligament and cut it.

Use your scissors to cut through the inferior vena cava between the liver and the diaphragm. Tip the liver upward and cut the inferior vena cava a second time, as close to the inferior surface of the liver as possible. This will leave a short segment of IVC embedded in the posterior border of the liver, just like in the diagram on the previous slide.

At this point, the liver is attached only to the GI tract via the structures in the porta hepatis. The GI tract itself is attached only by the branches of the abdominal aorta that supply it.



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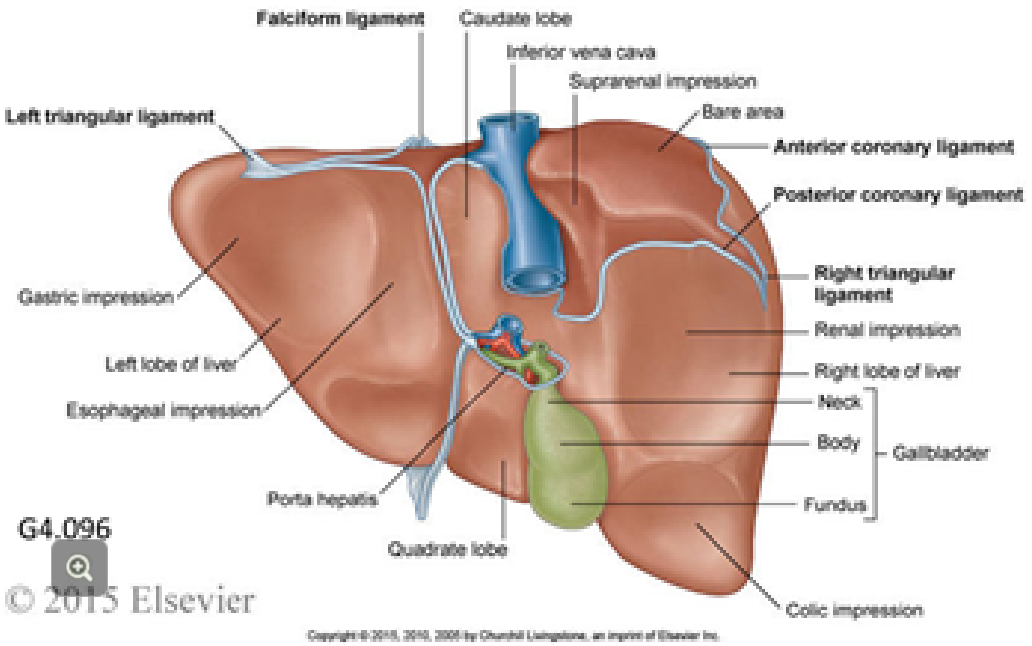
You will next **detach the liver from the diaphragm** and **transect the IVC**, leaving only a short stump of the vessel embedded in the liver.

Using the accompanying diagram, remind yourself of the **peritoneal attachments of the liver** that form the **falciform**, **coronary** and **triangular ligaments**.



TASK

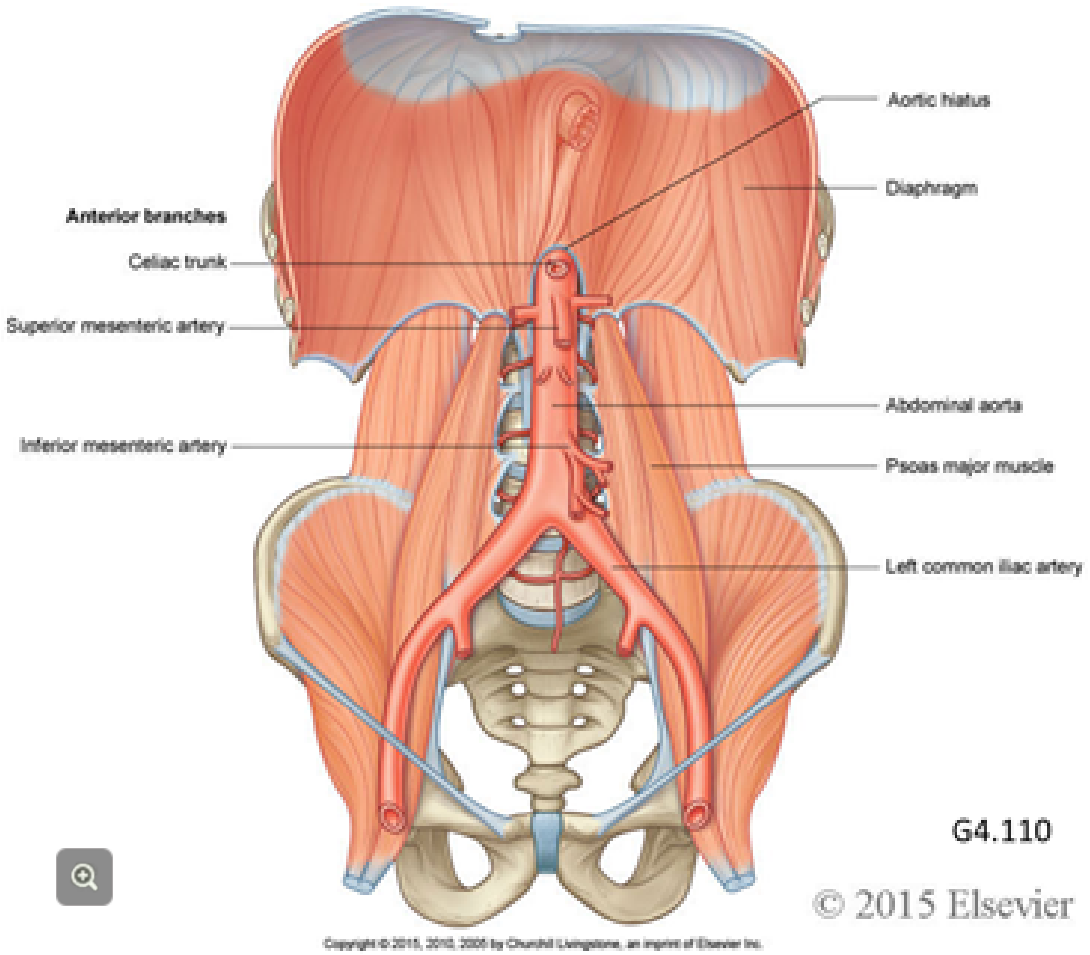
USE large scissors to cut the celiac trunk close to the aorta.

Because this vessel is so short, you will not leave a stump on the aorta, but a hole in it. **Cut through the SMA and IMA, leaving a 1-cm stump. Now the GI tract is held in the abdomen only by peritoneal remnants. Starting with the stomach, you will cut these before lifting the GI tract out of the abdominal cavity.**

START with the stomach and, using your fingers or a blunt instrument, free it from any peritoneal attachments it may still have to the posterior abdominal wall.

Grasp the spleen and gently roll it anteriorly and to the right. With your other hand, carefully free the splenic vessels and the tail, then body of the pancreas from the posterior abdominal wall. Lay these structures back down in position.

Now, approaching the curve of the duodenum from the right side, slide your fingers posterior to the duodenum and free it and the head of the pancreas from the posterior abdominal wall. Again, lay this portion of the gut back down in position.



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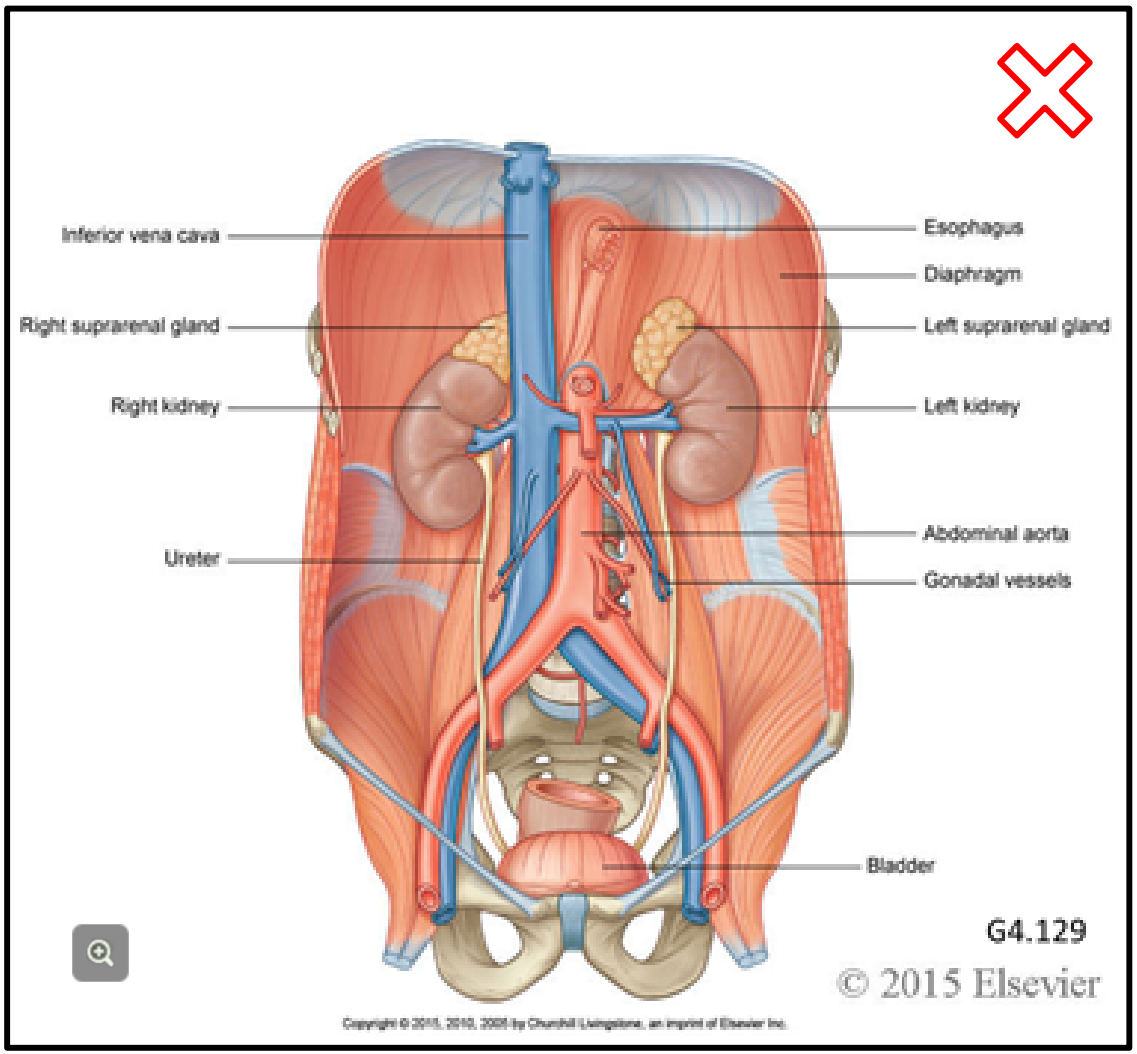


TASK

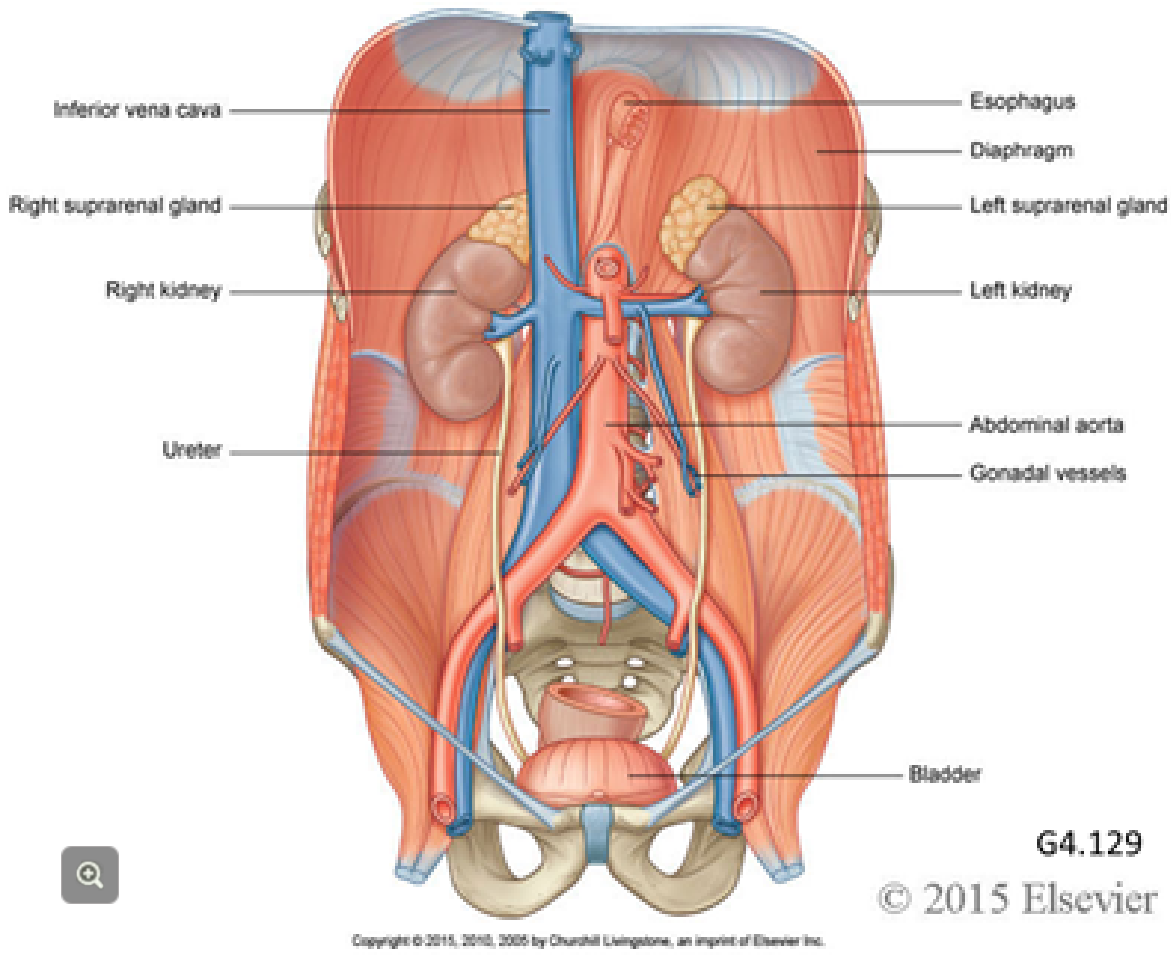
USING large scissors, cut the parietal peritoneum lateral to the ascending colon, along the right paracolic gutter. Use your fingers to tear any CT holding the ascending colon to the posterior abdominal wall. Roll the ascending colon to the left and, using your fingers, free its vessels from the posterior abdominal wall.

In a similar way, cut the parietal peritoneum lateral to the descending colon, along the left paracolic gutter. Using your fingers, free the descending colon from the posterior abdominal wall. Roll the descending colon to the right, and using your fingers, free its vessels from the posterior abdominal wall.

The GI tract, liver, pancreas and spleen are now free from the posterior abdominal wall.

Lift the GI tract, liver, pancreas and spleen out of the abdominal cavity. Place the viscera in a plastic bag and tie it with a length of string.

Place the bag at the foot of the table, between the cadaver's feet, inside the body bag. It can be stored here for the time being.



The body region posterior to the peritoneal cavity is know as the **retroperitoneum**. It is **bordered anteriorly by** the **parietal peritoneum** lining the peritoneal cavity and **posteriorly by** the **muscles and bones** that make up the **posterior abdominal wall**.

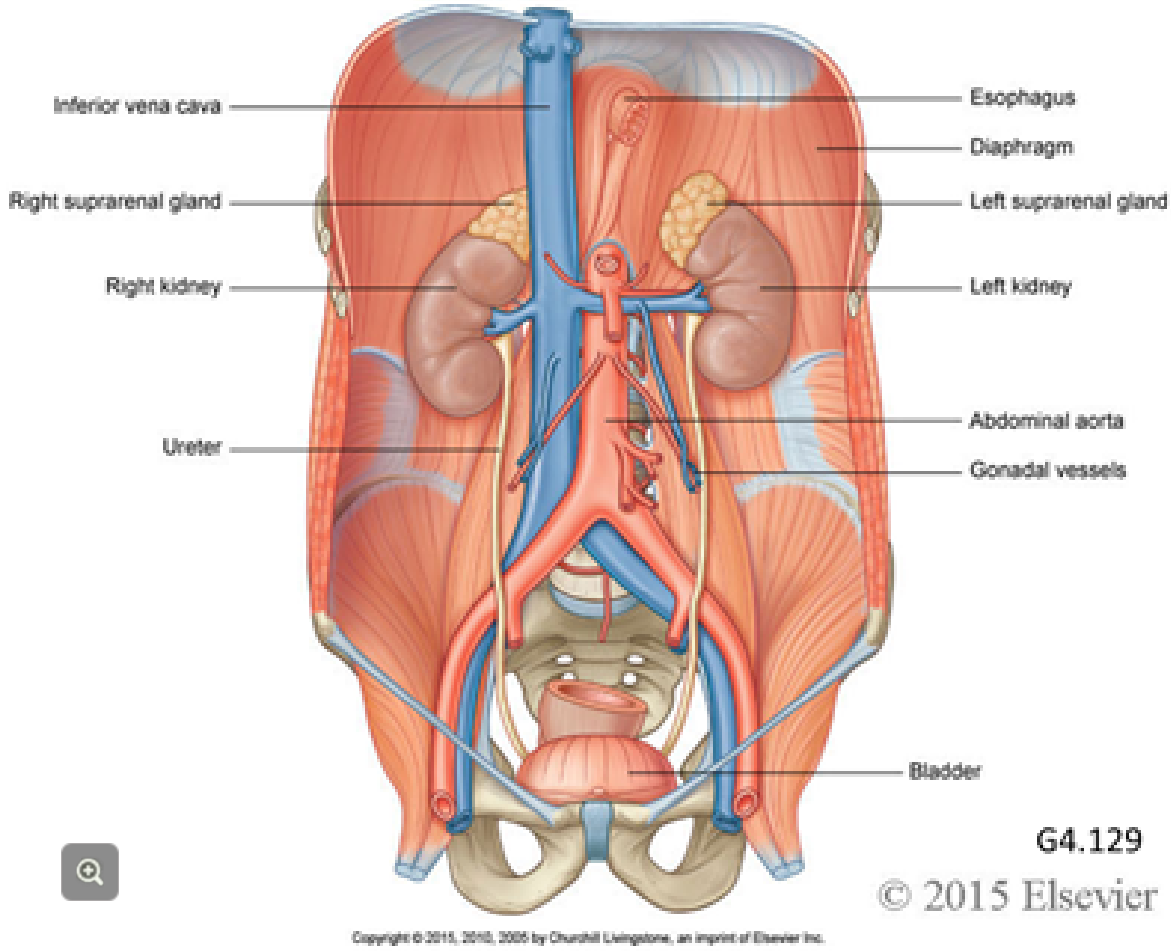
Structures of the retroperitoneum are embedded in loose CT and adipose. These are the **kidneys, ureters, suprarenal glands, aorta, inferior vena cava,** various **nerves** and the **abdominal portions of the sympathetic trunks**. You will dissect each of these structures in turn, and finish by studying the diaphragm.

TASK

REMOVE excess fluid from the posterior abdominal wall using either a syringe, rags or paper towel. Before dissecting, get your bearings by palpating the major viscera of the retroperitoneum.

Palpate, through the remaining parietal peritoneum and underlying adipose, the kidneys and adrenal glands. They lie roughly between vertebral levels T12 and L3. Palpate the abdominal aorta and, to the right of it, the inferior vena cava.

Now, remove any remaining parietal peritoneum.



If you are working on a **male cadaver**, start with the testicular vessels at the **deep inguinal ring**.

If you are working on a **female cadaver**, start with the ovarian vessels at the **suspensory ligament of the ovary**.

Be warned that the gonadal vessels are small, delicate and easily broken. **Take the utmost care**.

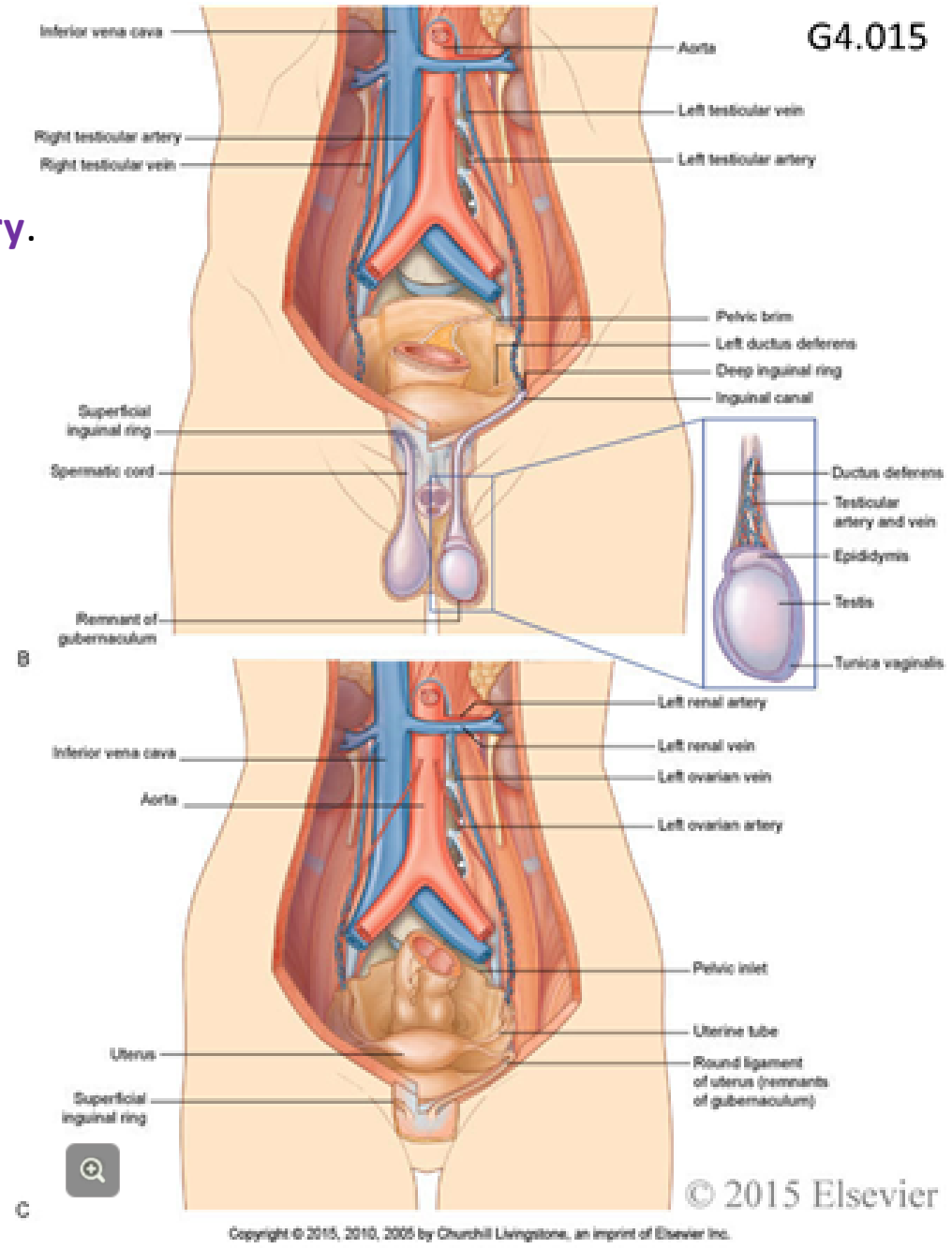
TASK

TRACE the gonadal vessels superiorly

and take note of their course anterior to the ureter. Be careful not to damage the ureter as you dissect the gonadal vessels.

Trace the gonadal arteries to their origin from the abdominal aorta at roughly vertebral level L2, inferior to the origin of the renal arteries.

Trace the gonadal veins and notice that while the right gonadal vein drains directly into the IVC, the left gonadal vein drains into the left renal vein, which crosses the midline to empty into the IVC.



Note in the accompanying diagrammatic cross-section of the abdomen that the kidneys are **embedded in layers of adipose and fascia**. They are cradled in the curve of the posterior body wall with the **vertebrae medially** and the **musculature of the back posteriorly and laterally**. They are thus **well protected from mechanical injury**.

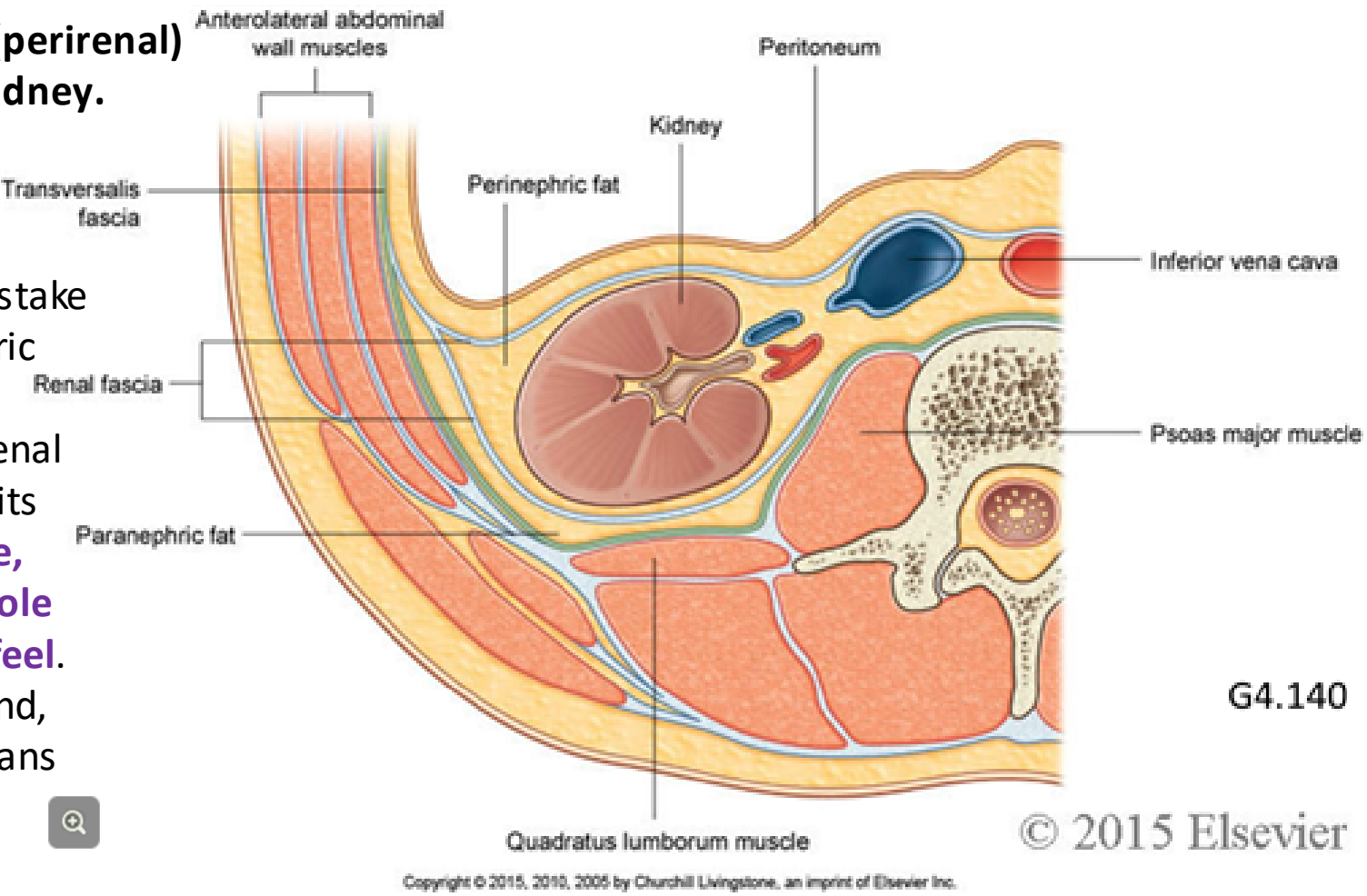
TASK

BREAK THROUGH the renal fascia using your fingers.

Within the perinephric (perirenal) fat locate, by feel, the kidney.

Work the kidney free from the perinephric fat.

Be warned that it is easy to mistake the adrenal gland for perinephric fat because they are both lobular and yellowish. The adrenal gland can be differentiated by its **smaller lobules, its pinker hue, its location on the superior pole of the kidney and its denser feel**. Do not remove the adrenal gland, but do gently work the two organs apart, leaving their blood supplies intact.



TASK

LOCATE the left renal vein and trace it from where it emerges from the hilum of the kidney, across the anterior aspect of the left renal artery and aorta, to where it merges with the IVC. Notice its relationship to the SMA: it passes between the SMA and the aorta.

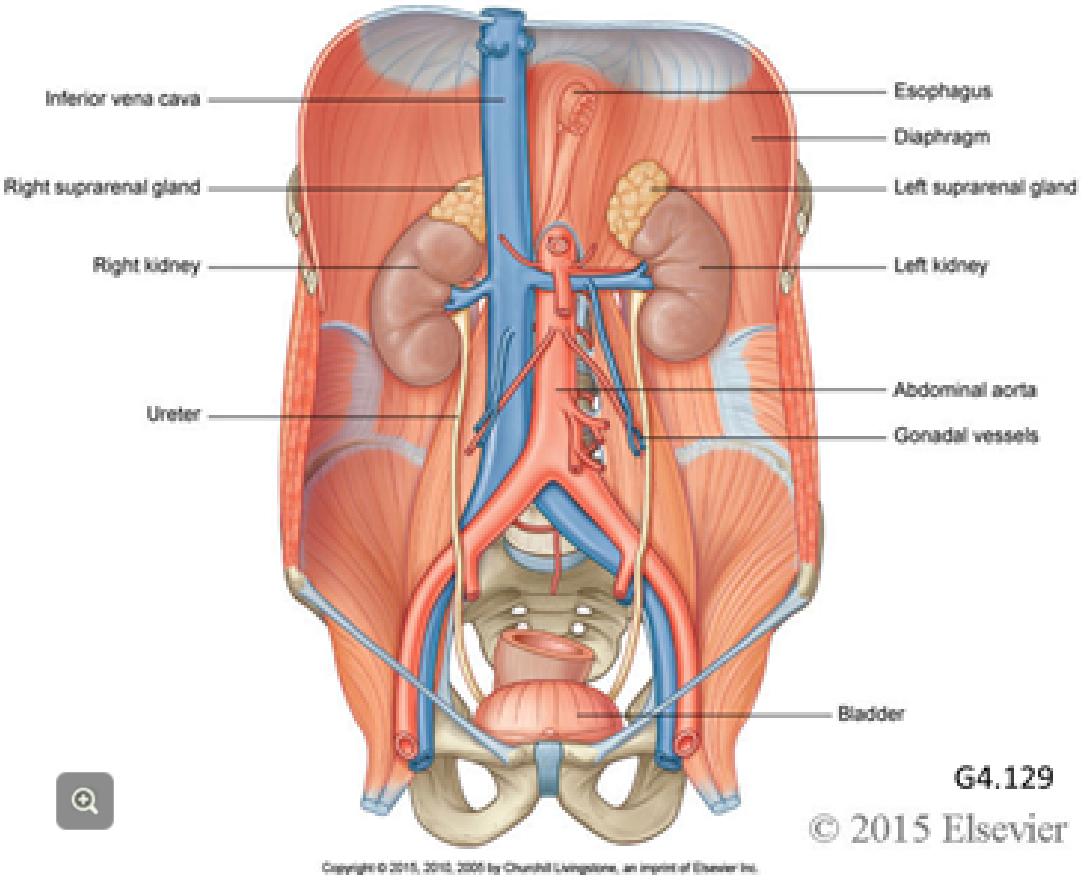
The left adrenal vein and the left gonadal vein empty into the left renal vein. **Ensure that the juncture of the left gonadal vein with the left renal vein is clearly demonstrated in your dissection.**

Using large scissors, cut the left renal vein where it meets the IVC, and reflect it to the left. Preserve the attachments of its tributaries.

Identify the left renal artery posterior to the left renal vein. Clean the length of the left renal artery from the aorta to the hilum of the kidney. It is common for there to be one or more **accessory renal arteries**.

Notice that the renal artery branches to form several segmental arteries as it approaches the kidney.

The left renal artery gives branches that contribute to the blood supply the **adrenal gland and the ureter**. It is not necessary to identify these branches in the cadaver, although do know of their existence and origin.



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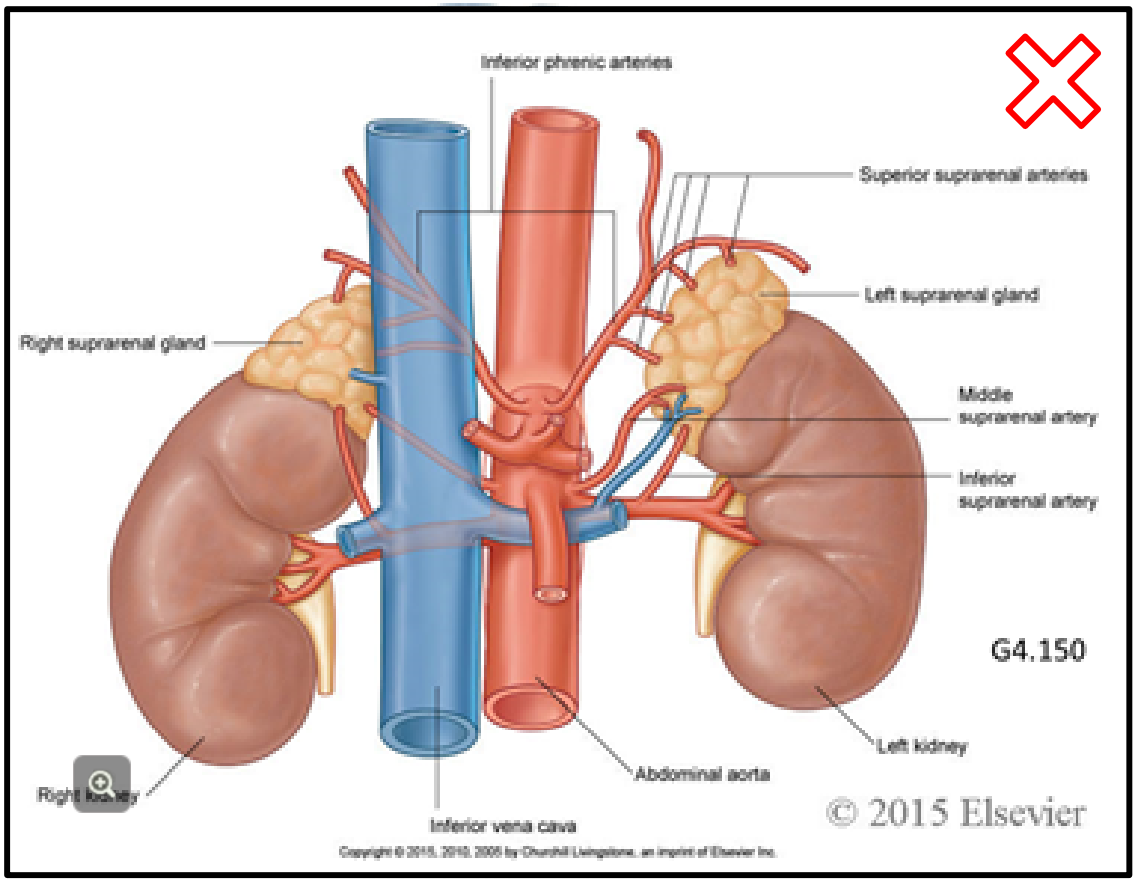


TASK

REFLECT the left kidney to the right using the left renal artery as a hinge

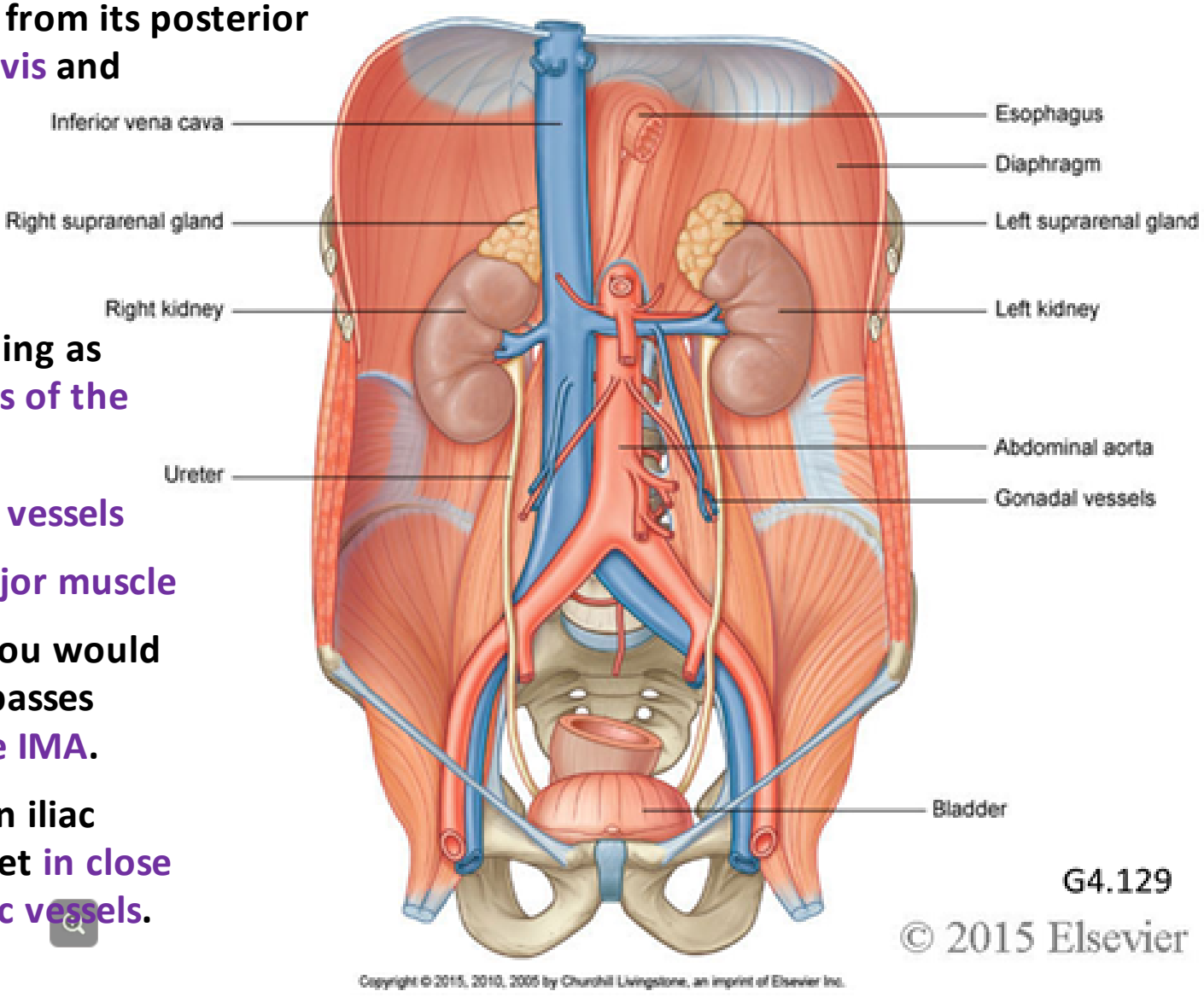
in order to study the kidney from its posterior aspect. Identify the renal pelvis and its continuation, the ureter.

Notice that in anatomical position, the renal pelvis is posterior to the renal artery.

Follow the ureter inferiorly, cleaning as you work. Notice the relationships of the ureter to surrounding structures:

- it runs posterior to the gonadal vessels
- it runs anterior to the psoas major muscle
- were the GI tract still in place, you would have observed that the ureter passes posterior to the branches of the IMA.

Trace the ureter over the common iliac vessels and through the pelvic inlet in close approximation to the internal iliac vessels.



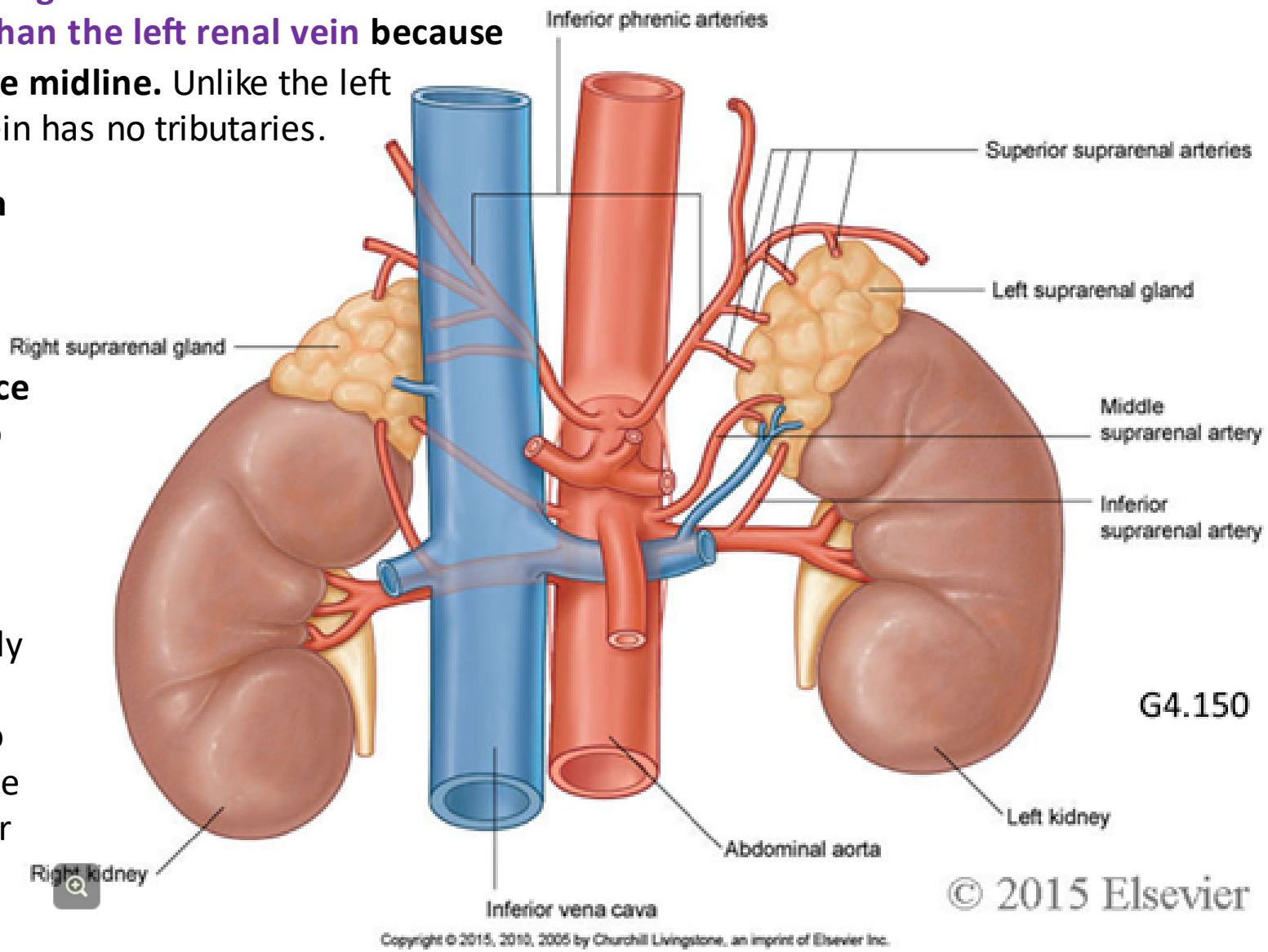
TASK

REPLACE the left kidney to its original position.

Identify and clean the right renal vein. Notice that it is significantly shorter than the left renal vein because the IVC is to the right of the midline. Unlike the left renal vein, the right renal vein has no tributaries.

Leaving the right renal vein intact, reflect the IVC inferiorly and toward the right in order to expose the right renal artery. Notice its longer length relative to the left renal artery.

The right renal artery gives rise to branches that contribute to the blood supply the **adrenal gland and the ureter**. It is not necessary to identify these branches in the cadaver, but do know of their existence and origin.



TASK

REFLECT the right kidney to the left,

using the right renal artery as a hinge, in order to study the kidney from its posterior aspect. Identify the renal pelvis and its continuation, the ureter. Notice that in anatomical position, the renal pelvis is posterior to the renal artery.

Follow the ureter inferiorly, cleaning as you work. Notice the relationships of the ureter to surrounding structures:

- it runs posterior to the gonadal vessels
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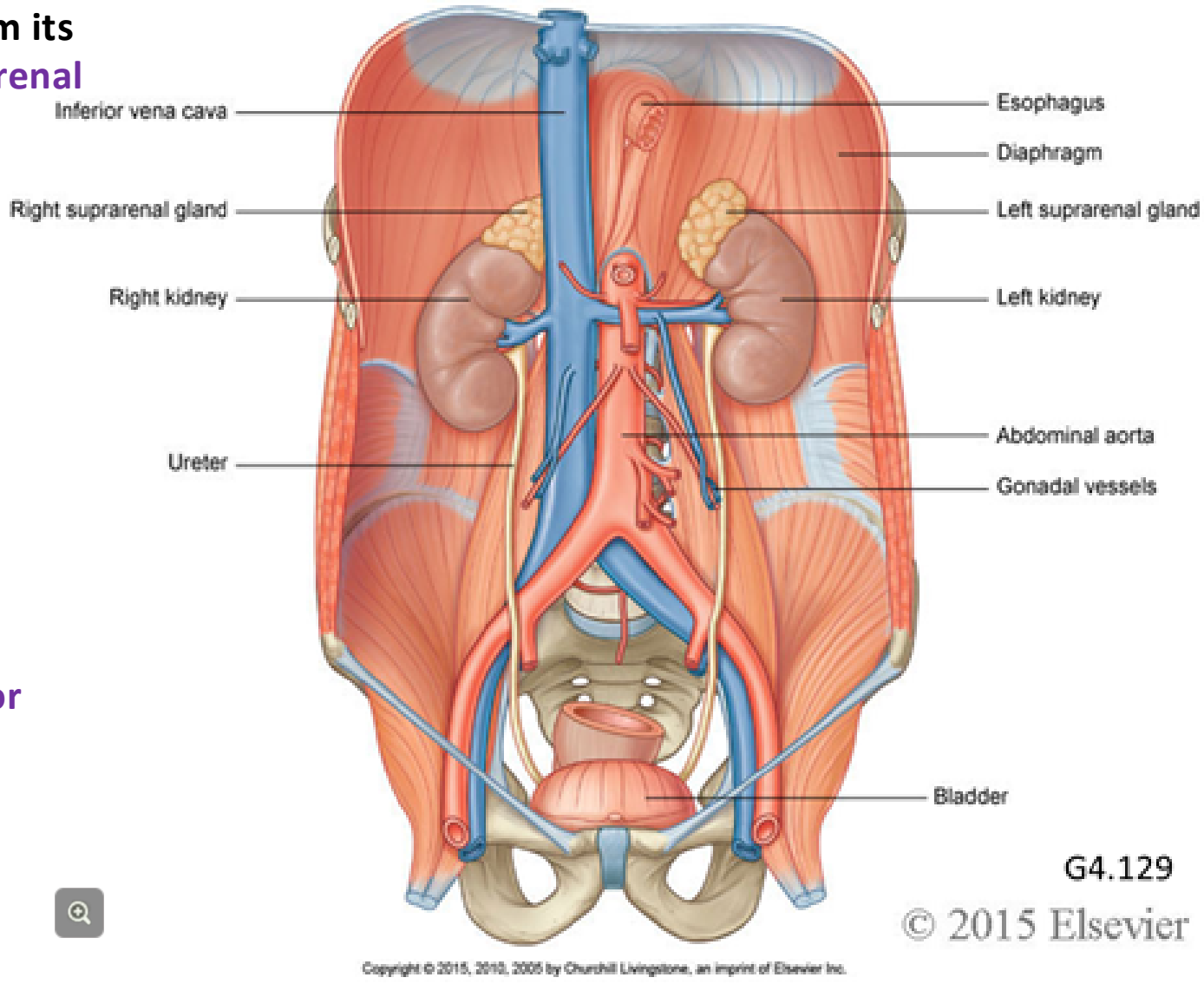
Trace the ureter over the common iliac vessels and through the pelvic inlet in close approximation to the internal iliac vessels.

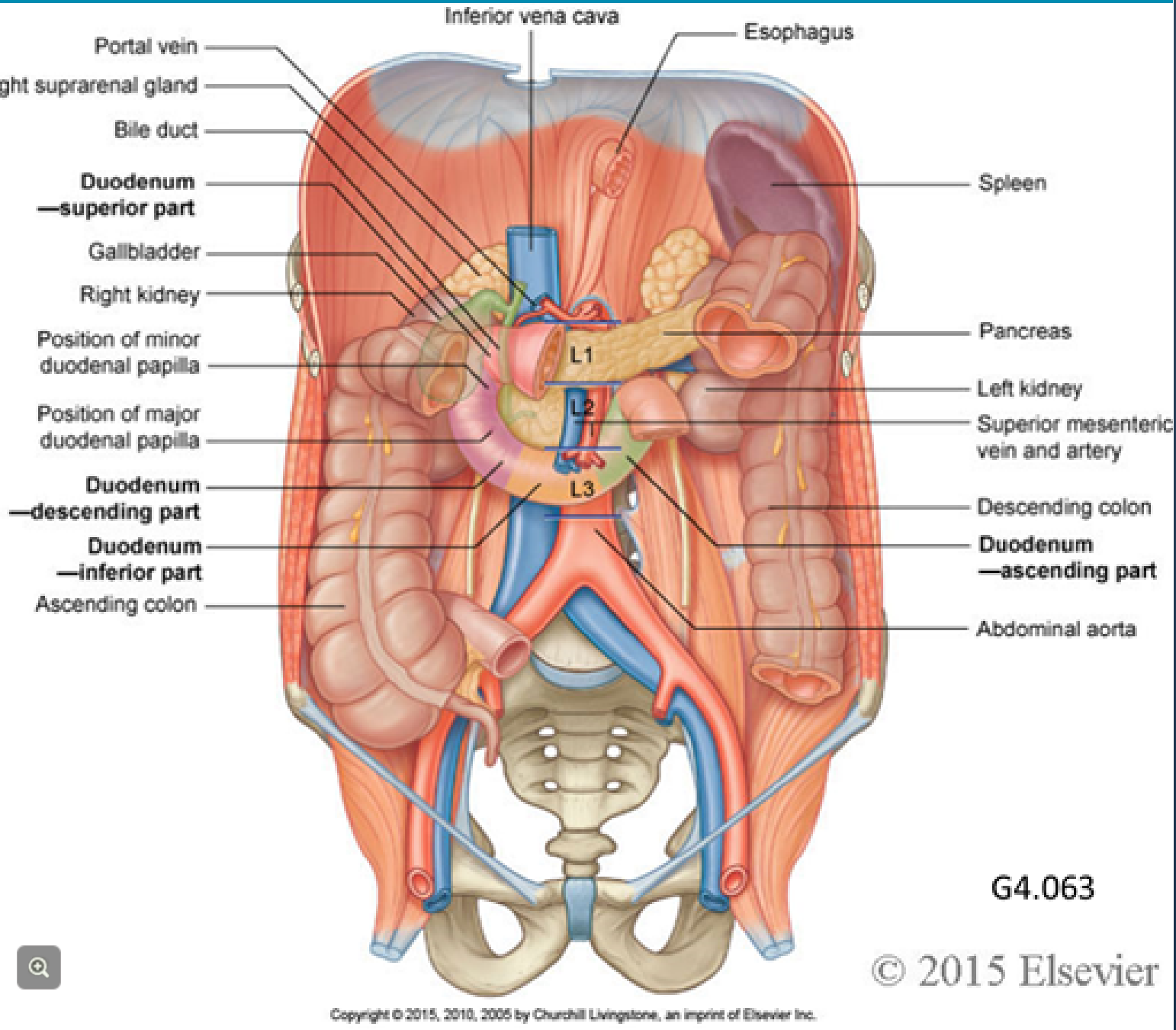


Use the accompanying diagram to recall the following **relationships**:

An adrenal gland is superior to each kidney.

The **right kidney** is posterior to the second part of the duodenum and the right colic flexure. The hepatorenal recess separates it from the visceral surface of the liver.

The **left kidney** is posterior to the tail of the pancreas, the left colic flexure, the spleen and the stomach.



Since embarking upon your dissection of the retroperitoneum, you have **dissected** and **clearly exposed** the following structures:

- testicular / ovarian BVs; Are there any differences between the right and left sides?
- R & L kidneys and adrenal glands
- R & L renal veins; What is the relationship of the left renal vein to the SMA and aorta?
- R & L renal arteries and segmental arteries; Are there accessory renal arteries in your cadaver?
- What two organs are supplied by the renal arteries, besides the kidney?
- R & L renal pelvis and ureter; With what major vessels do the ureters pass into the pelvis?
- What is most posterior in the renal hilum, the renal artery, vein or pelvis? What is most anterior?
- Which is shorter, the R or L renal vein, and why? Which is shorter, the R or L renal artery, and why?
- Describe the relationship of the right kidney to four adjacent structures or spaces.
- Describe the relationship of the left kidney to four adjacent structures.

Quiz each other thoroughly. If you are satisfied with the **quality of your dissection**, and your **ability to identify these structures** and **answer these questions**, move on to the next stage of the dissection.

TASK

USING a scalpel, make a coronal cut through one kidney,

starting at its lateral border. Do not cut entirely through the kidney; leave the anterior and posterior halves attached at the renal pelvis.

Open the kidney like a book, using the renal pelvis as a hinge. Identify the following features:

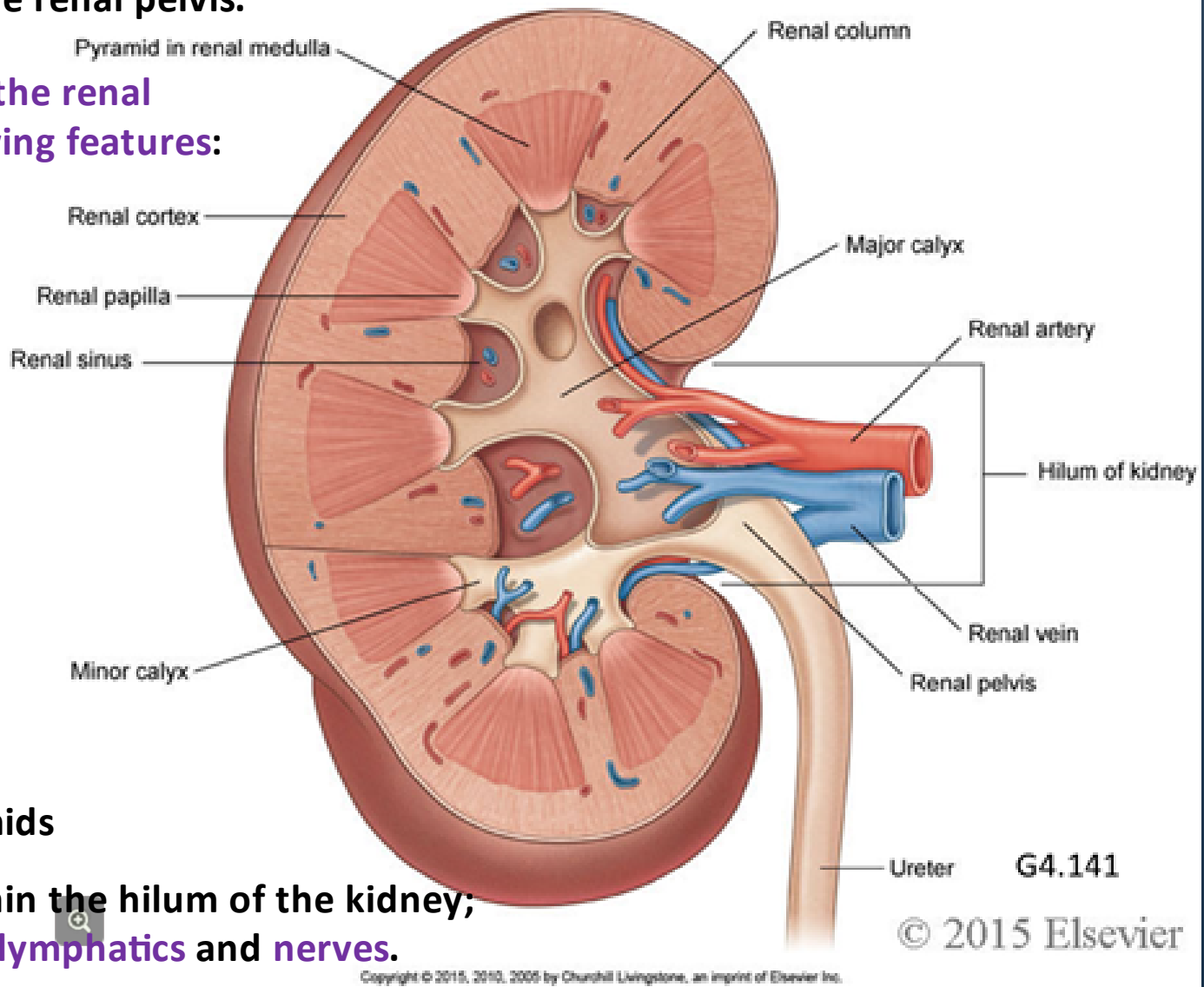
Renal capsule: the fibrous organ capsule of the kidney, tightly adhered to its surface.

Renal cortex: the paler, superficial renal tissue

Renal medulla: the deeper region of the kidney, subdivided into the:

- **Renal pyramids: darker, wedge-shaped subdivisions**
- **Renal columns: paler "cortical" tissue separating the renal pyramids**

Renal sinus: the fat-filled space within the hilum of the kidney; it contains the renal pelvis, vessels, lymphatics and nerves.



TASK

IDENTIFY the following features:

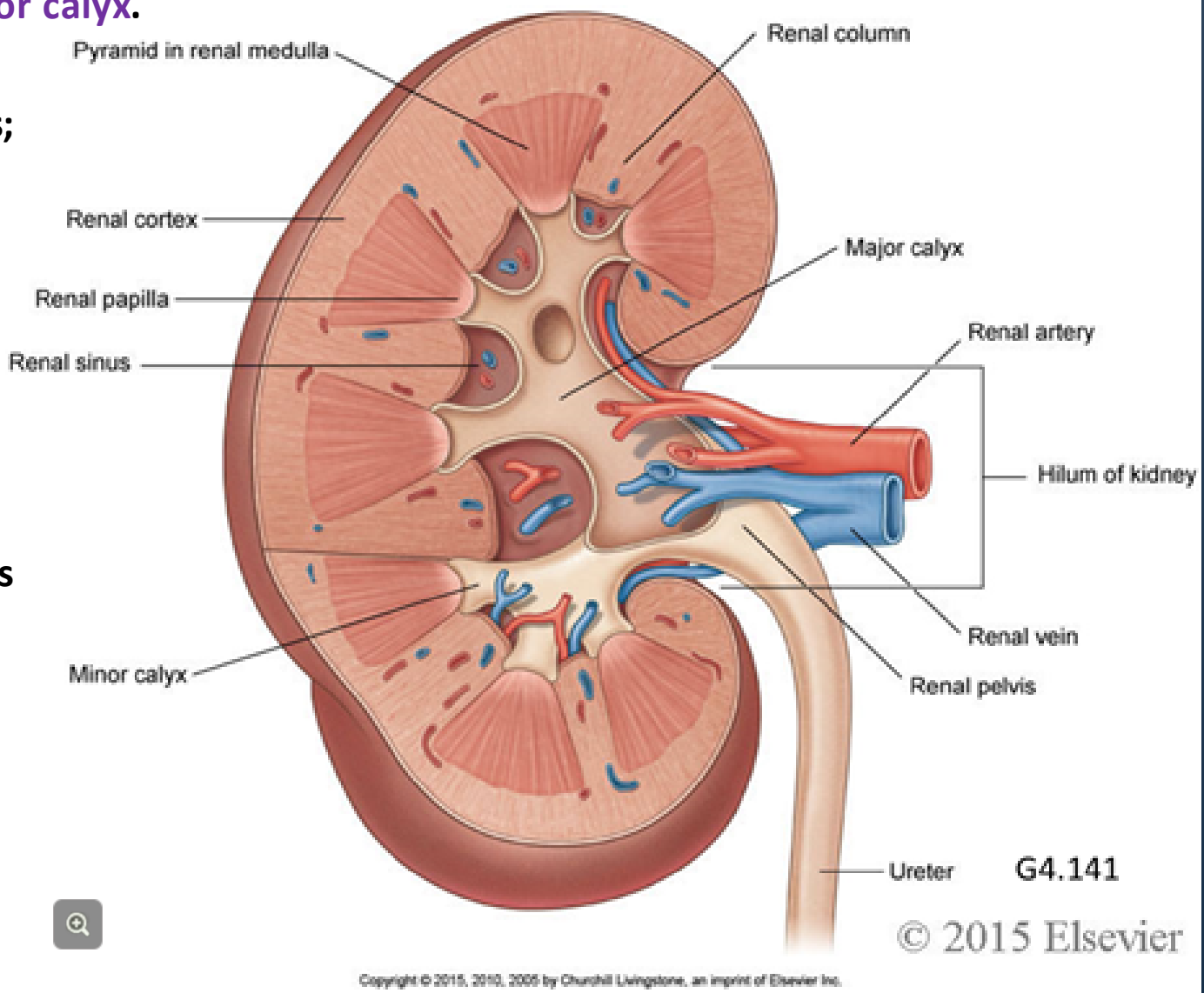
Renal papilla: the **apex** of the renal pyramid; it projects into a **minor calyx**.

Minor calyx: a cup-like structure into which the renal papilla extends; **formed urine drips from the renal papilla into a minor calyx**.

Major calyx: formed by the union of minor calyces; it collects urine produced by a number of renal pyramids.

Renal pelvis: formed by the union of the major calyces; the renal pelvis thus collects the urine created by the entire kidney. The renal pelvis tapers to form the **ureter** which emerges from the renal hilum.

Ureter: the **muscular tube** that transports urine from the kidney to the urinary bladder.



Care must be taken in dissecting the adrenal glands due to their **delicate structure**. As they are endocrine glands, they have a particularly **rich blood supply**. Since the adrenal medulla is, developmentally, a modified sympathetic ganglion, the adrenal glands are **richly endowed with sympathetic preganglionic fibres**.

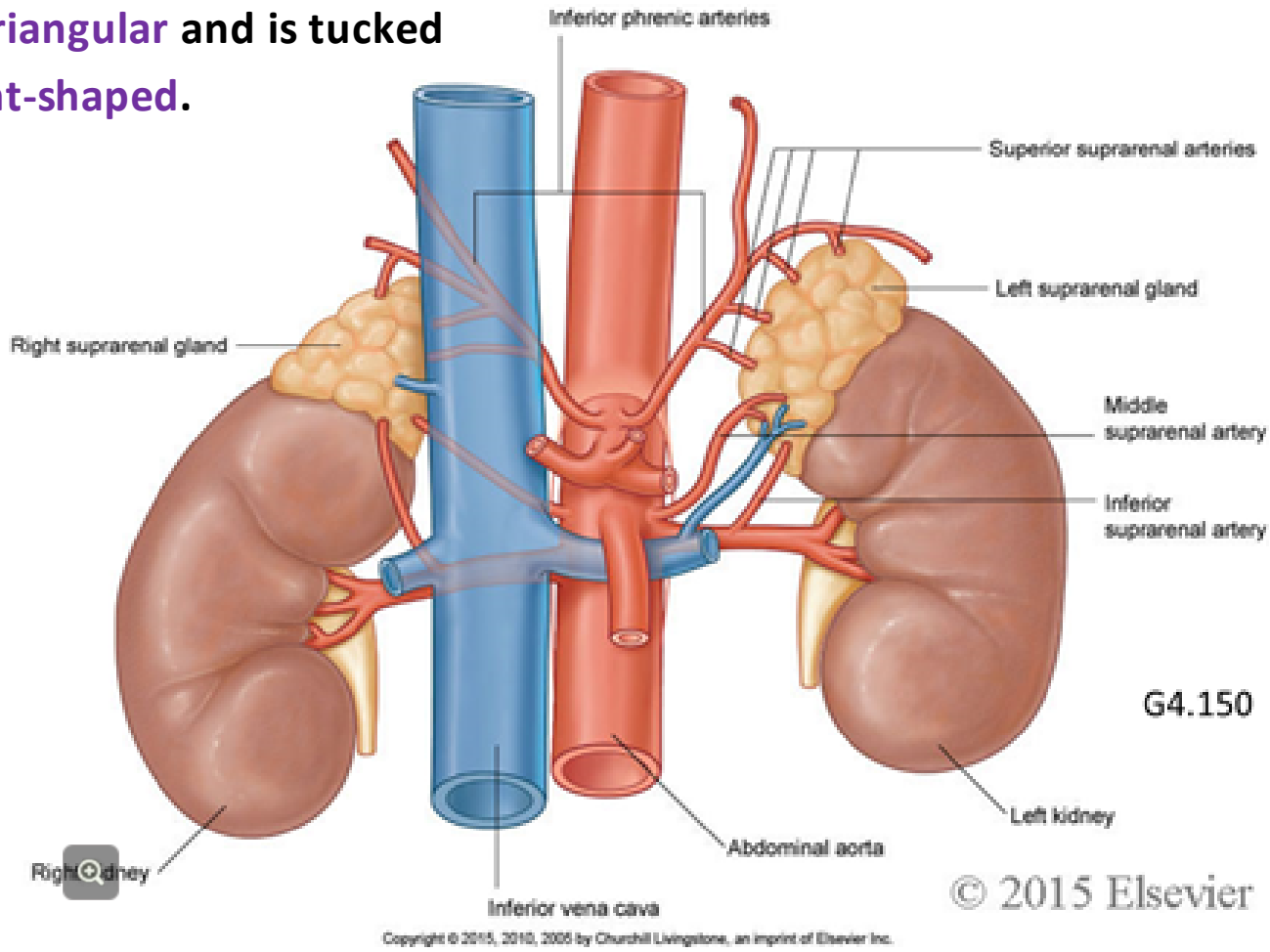
TASK

USING your fingers, identify the suprarenal gland.

Clean the fat from the surface of each gland and notice the shape of each: The right gland is triangular and is tucked behind the IVC. The left gland is crescent-shaped.

Do not attempt to isolate their blood supply, but use the accompanying diagram to realize that each gland is supplied by branches of the inferior phrenic artery, the abdominal aorta, and the renal artery.

Regarding their venous drainage, notice that, like the gonadal veins, the left adrenal vein drains into the left renal vein, while the right adrenal vein empties directly into the IVC.



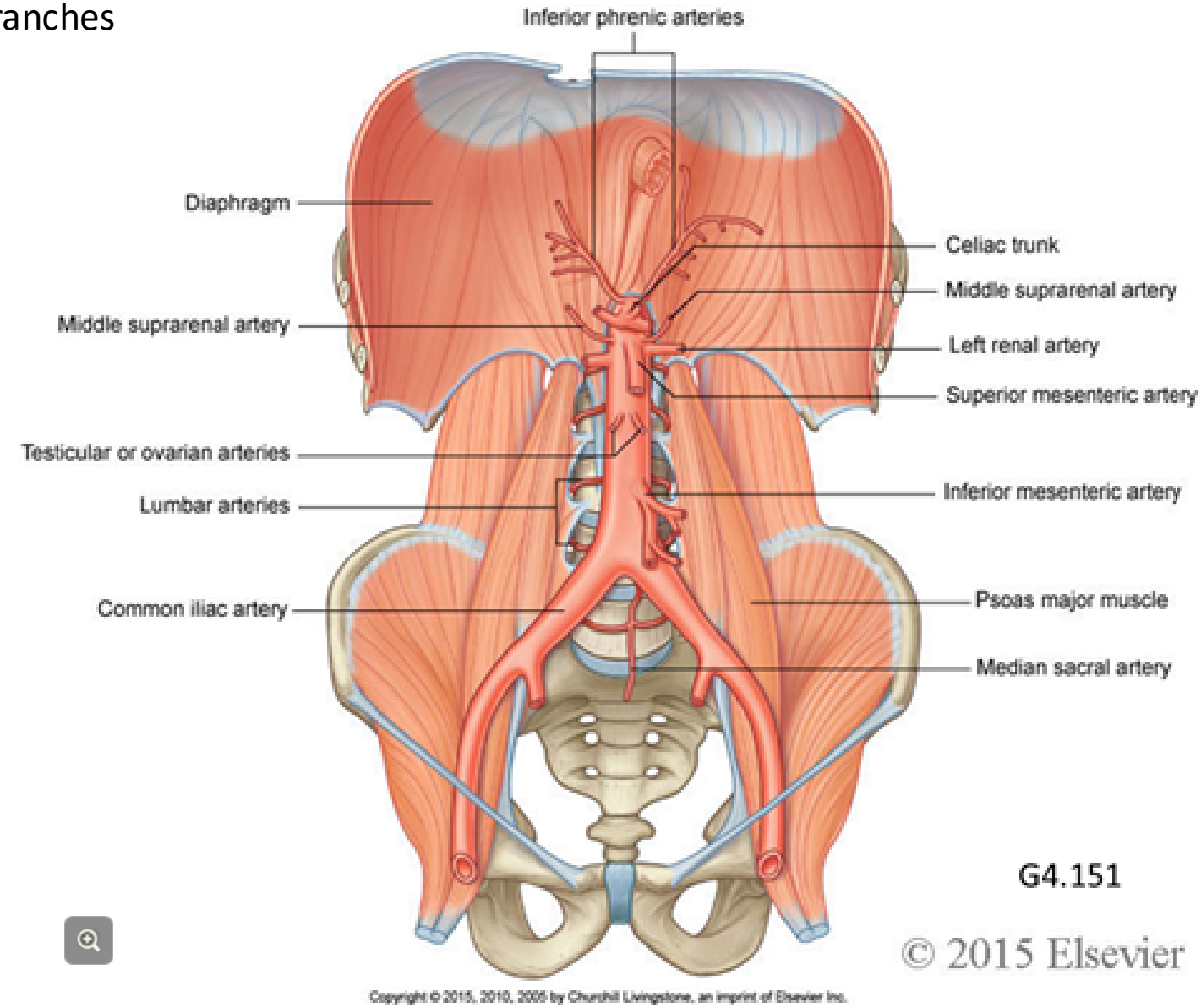
The abdominal aorta extends from the aortic hiatus of the diaphragm at vertebral level T12 to its bifurcation anterior to the L4 vertebral body. Here it forms the **right and left common iliac arteries**.

Organize your thinking about the branches of the abdominal aorta as follows:

It has **three unpaired visceral branches**, which you've previously studied: the celiac trunk, superior mesenteric artery and the inferior mesenteric artery.

It has **three paired visceral branches** that supply retroperitoneal organs: the adrenal arteries, the renal arteries and the gonadal arteries. These, too, you have already dissected.

It has **paired parietal branches that supply the body wall**: the inferior phrenic arteries and the lumbar arteries. Next, you will dissect these branches.



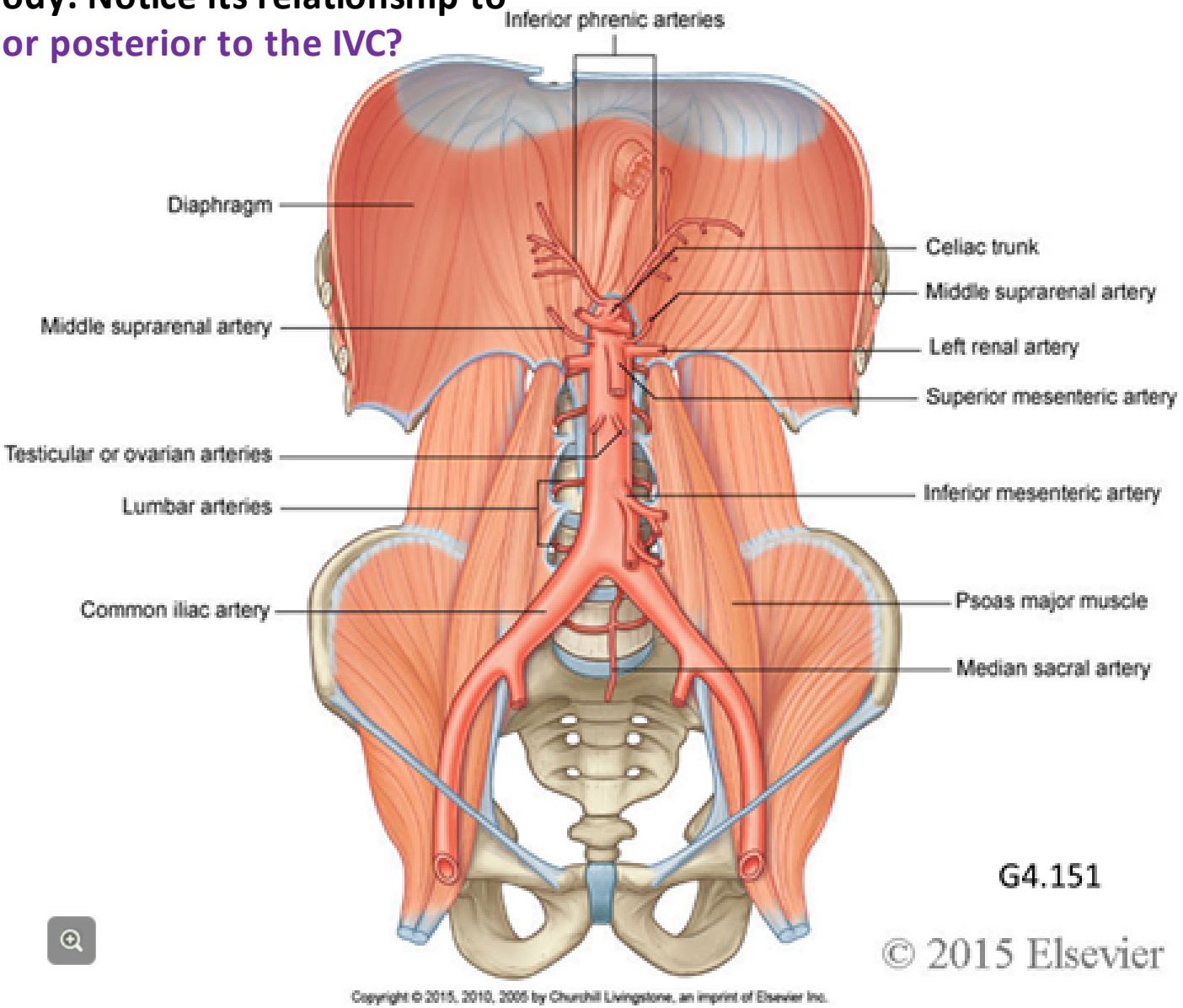
TASK

IDENTIFY at least one lumbar artery on the right side,

crossing a lumbar vertebral body. Notice its relationship to the IVC. Does it pass anterior or posterior to the IVC?

Identify the first branches of the abdominal aorta, the inferior phrenic arteries, where they ramify over the inferior surface of the diaphragm. You will recall that the inferior phrenic arteries contribute to the blood supply of the adrenal arteries.

Identify and clean the common iliac arteries to their bifurcation forming the internal iliac arteries, which supply pelvic structures, and the external iliac arteries, which supply the lower limbs.

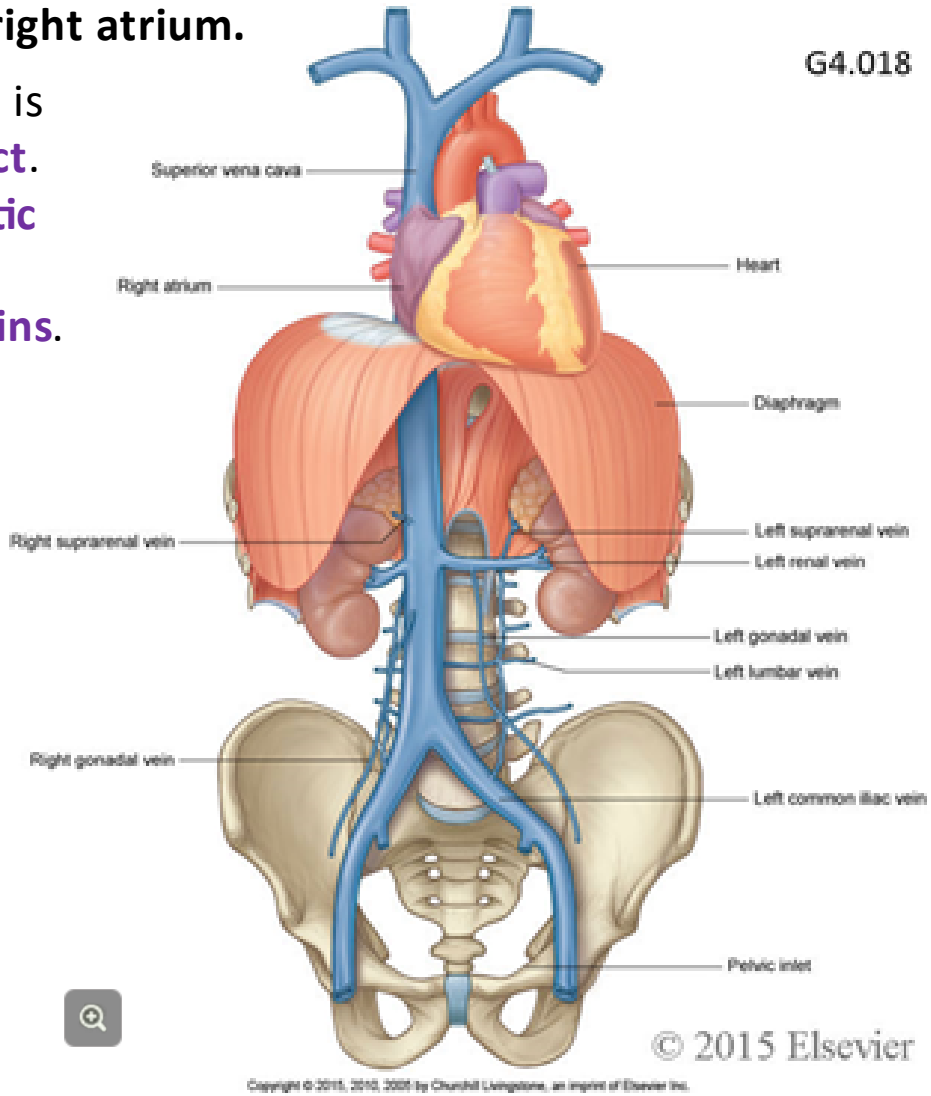


TASK

NOTE the following in the cadaver:

The IVC forms anterior to the fifth lumbar vertebra with the union of the right and left common iliac veins. It ends at the caval opening of the diaphragm at the level of the T_8 vertebral body, where it passes through the diaphragm to open into the right atrium.

A major difference between the IVC and the abdominal aorta is the **absence of branches associated with the digestive tract**. Venous blood from the digestive tract is carried by the **hepatic portal system** to the **liver**. After processing in the hepatic sinusoids, this blood empties into the IVC via the **hepatic veins**.



TASK

NOTE the following in the cadaver:

Like the abdominal aorta, paired branches connect the IVC to the adrenal glands, kidneys and gonads. Identify these veins and note that on the right side, these are direct tributaries of the IVC, while on the left side these are indirect tributaries that empty first into the left renal vein.

Like the aorta, paired branches connect the IVC to the posterior body wall and drain the inferior surface of the diaphragm. Identify at least one pair of lumbar veins, as well as the inferior phrenic veins.

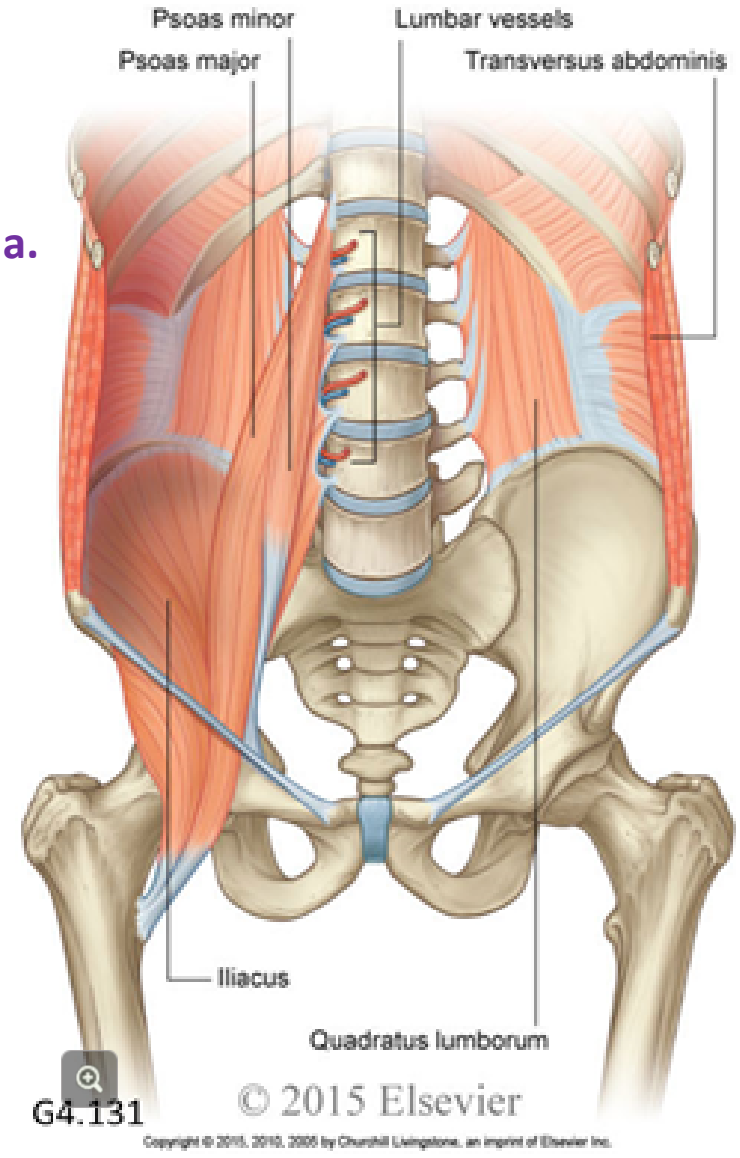
The posterior abdominal wall is composed of the **vertebral column and associated muscles**. These muscles **act on the vertebral column and lower limb**, and **form the thoracic diaphragm**. Nerves coursing through the posterior abdominal wall innervate its muscles and those of the lower limb. These, too, will be dissected.

TASK

LEAVING their vessels intact, reflect both kidneys and adrenal glands toward the midline to improve your access to the posterior abdominal wall, bilaterally. Using your hands, remove the remaining subserous (extraperitoneal) fat and fascia.

Locate the psoas major muscle arising from the lateral aspect of the lumbar vertebrae and passing into the false pelvis. In the false pelvis, lateral to the psoas major muscle, identify the iliacus arising from the iliac fossa. Observe that the two muscles unite and pass across the anterior aspect of the hip joint to attach to the lesser trochanter of the femur. They form a functional unit that acts to flex the hip joint.

Between rib 12 and the iliac crest, lateral to the psoas major, identify the quadratus lumborum muscle. With unilateral contraction, the quadratus lumborum laterally flexes the vertebral column. Lateral to the quadratus lumborum, identify the transversus abdominis muscle. It extends from behind the quadratus lumborum to line the lateral aspect of the abdominal wall.

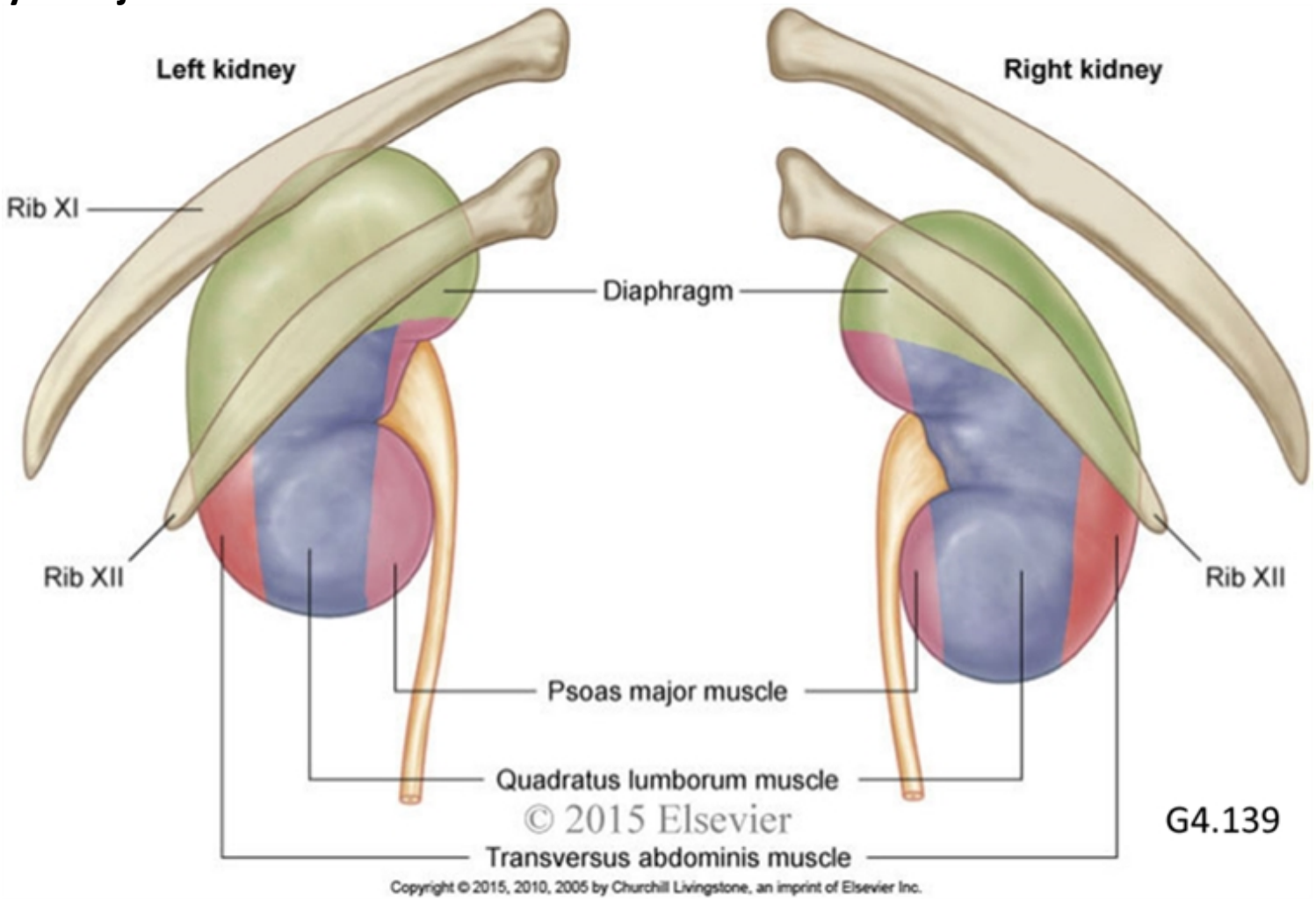


G4.131

TASK

PLACE the kidneys back in their correct position

and notice their relationships to these muscles. Each is related, posteriorly, to the diaphragm, psoas major, quadratus lumborum and transversus abdominis muscles. The superior pole of the left kidney is adjacent to the 11th rib, while due to the bulk of the liver, the superior pole of the right kidney is adjacent to the 12th rib.



Since the last Progress Check, you have **dissected** and **clearly exposed** the following structures:

- renal capsule, renal cortex, renal medulla (inc. the renal pyramids and renal columns), and renal sinus.
- Trace the flow of urine from the renal papilla, thru the minor calyx, major calyx, renal pelvis, and ureter.
- adrenal glands, their relationships to the kidneys; What three arteries contribute to the blood supply of the adrenal glands? Describe the venous drainage of the R and L adrenal glands and their asymmetry
- What are the three, **unpaired**, visceral branches of the abdominal aorta? What are the three **paired** visceral branches of the abdominal aorta? What are the **paired parietal** branches of the abdominal aorta?
- Identify the inferior phrenic arteries and veins and a lumbar artery and vein. What is the relationship of the right lumbar arteries to the IVC?
- Identify the common, internal and external iliac arteries. What body region does the internal iliac artery supply? What body region does the external iliac artery supply?
- Identify the internal, external and common iliac veins, and the formation of the IVC. Through what opening in the diaphragm does the IVC pass? At what vertebral level is this opening located? Describe the asymmetry of the paired visceral veins draining the three retroperitoneal organs
- Identify the psoas major, iliacus, quadratus lumborum and transversus abdominis muscles.
- Which rib is adjacent to the superior pole of the right kidney? of the left kidney?

Quiz each other thoroughly. If you are satisfied with the **quality of your dissection**, and your **ability to identify these structures** and **answer these questions**, call your TA over to confirm and get permission to move on to the next stage of the exercise.

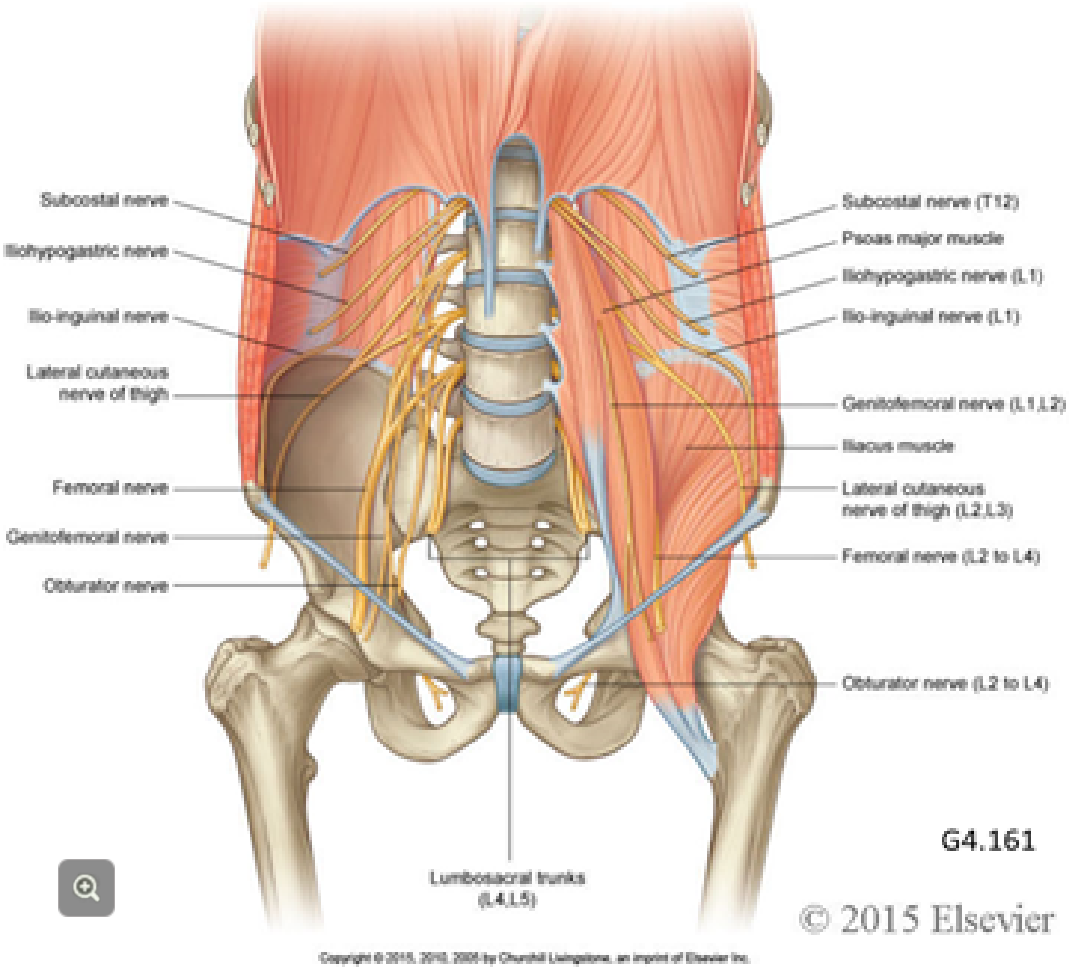
Nerves arising from the ventral rami of the T12 to L4 spinal nerves supply the thickness of the lower abdominal wall with somatic motor fibres, sensory fibres, and sympathetic postganglionic fibres. The ventral rami of L1 to L4 feed, initially, into the **lumbar plexus** within the substance of the psoas major. The peripheral branches of the lumbar plexus arise from the lateral aspect of the psoas major. These nerves travel initially in the extraperitoneal (subserous) fascia of the posterior abdominal wall. **The most reliable way to identify these nerves is to start with relevant landmarks**, which you have just learned.

TASK

IDENTIFY the genitofemoral nerve

where it arises from the substance of the psoas major muscle to run on its anterior surface. Find its bifurcation where it forms a genital branch and a femoral branch. The genital branch passes through the inguinal canal and is motor to the cremaster muscle. The femoral branch passes under the inguinal ligament with the femoral artery and is cutaneous to the skin inferior to the inguinal ligament.

Remove the remaining extraperitoneal (subserous) fascia from the musculature of the posterior abdominal wall using your fingers. Move your fingers horizontally, in line with the nerves that you are trying to find to maximize your chances of keeping these nerves intact.



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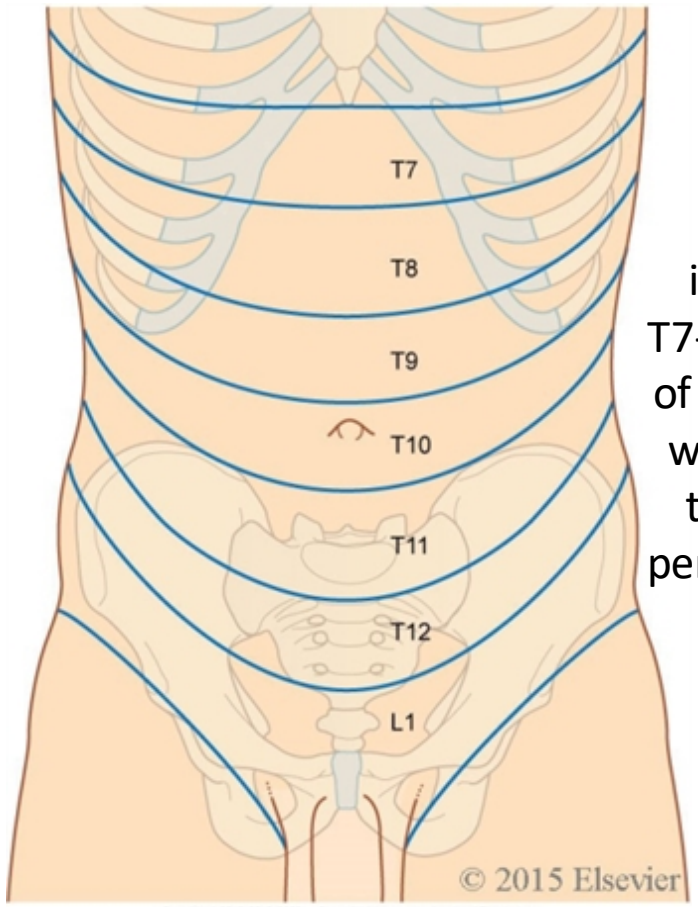


Remember, extensions of intercostal nerves T7-T11 supply much of the anterior body wall, specifically in the epigastric and periumbilical levels.

The next three nerves course over the internal surface of the quadratus lumborum and transversus abdominis. **These are the nerves responsible for innervating the lower abdominal musculature**.

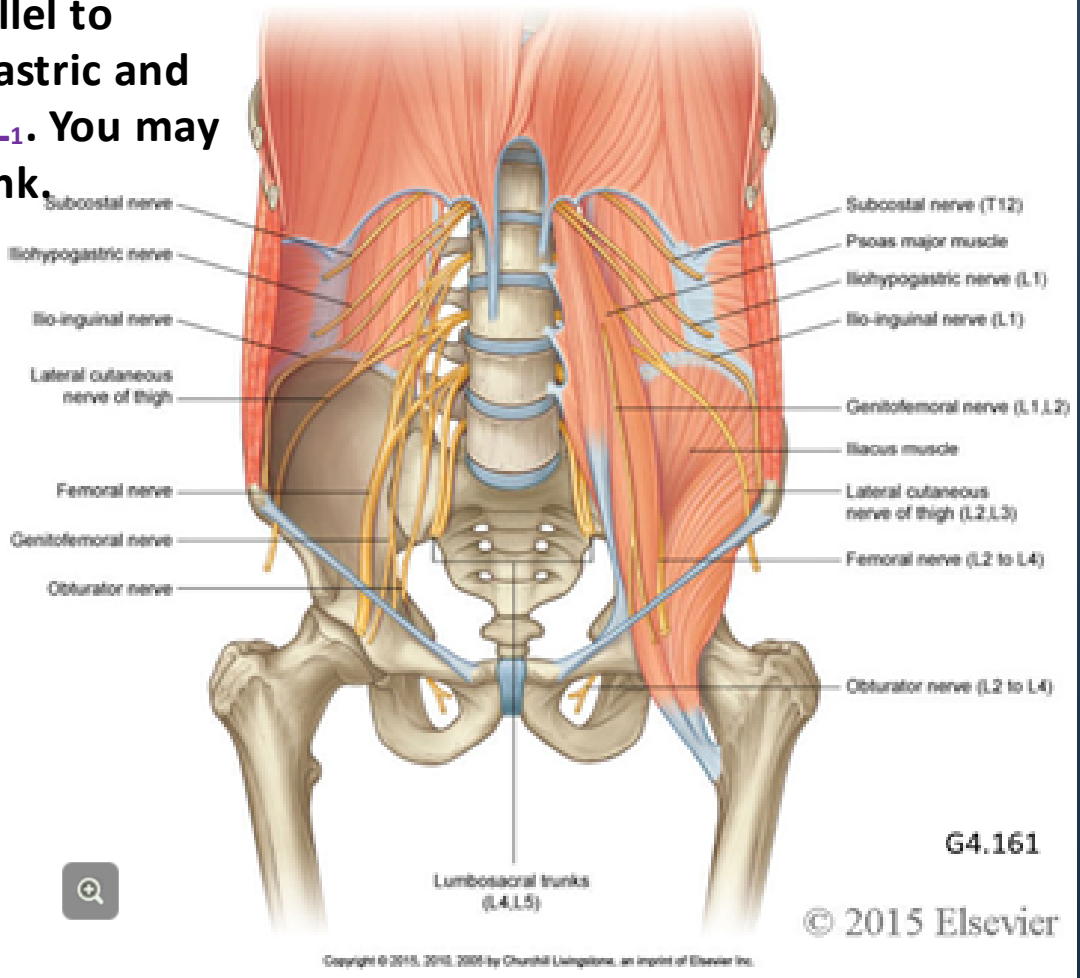
TASK

USE your fingers to identify the 12th rib.

Use the 12th rib to locate the subcostal nerve running inferior to it. Identify, by feel, the iliac crest. Find the ilioinguinal nerve crossing the quadratus lumborum, then running along the iliac crest. Between these two nerves, and running parallel to them, find the iliohypogastric nerve. The iliohypogastric and ilioinguinal nerves arise from the ventral ramus of L_1. You may or may not see them originate from a common trunk.

Identify the lateral cutaneous nerve of the thigh as follows: it passes under the inguinal ligament just medial to the ASIS. It is a cutaneous nerve that supplies the skin of the lateral thigh.

Identify a major branch of the lumbar plexus, the femoral nerve, by running your finger between the psoas major and the iliacus. It is formed by contributions from L_2 - L_4. In addition to supplying the iliacus with motor fibres, the femoral nerve is important in that it supplies the quadriceps, the knee extensors of the anterior thigh. It is also sensory to the anterior thigh.

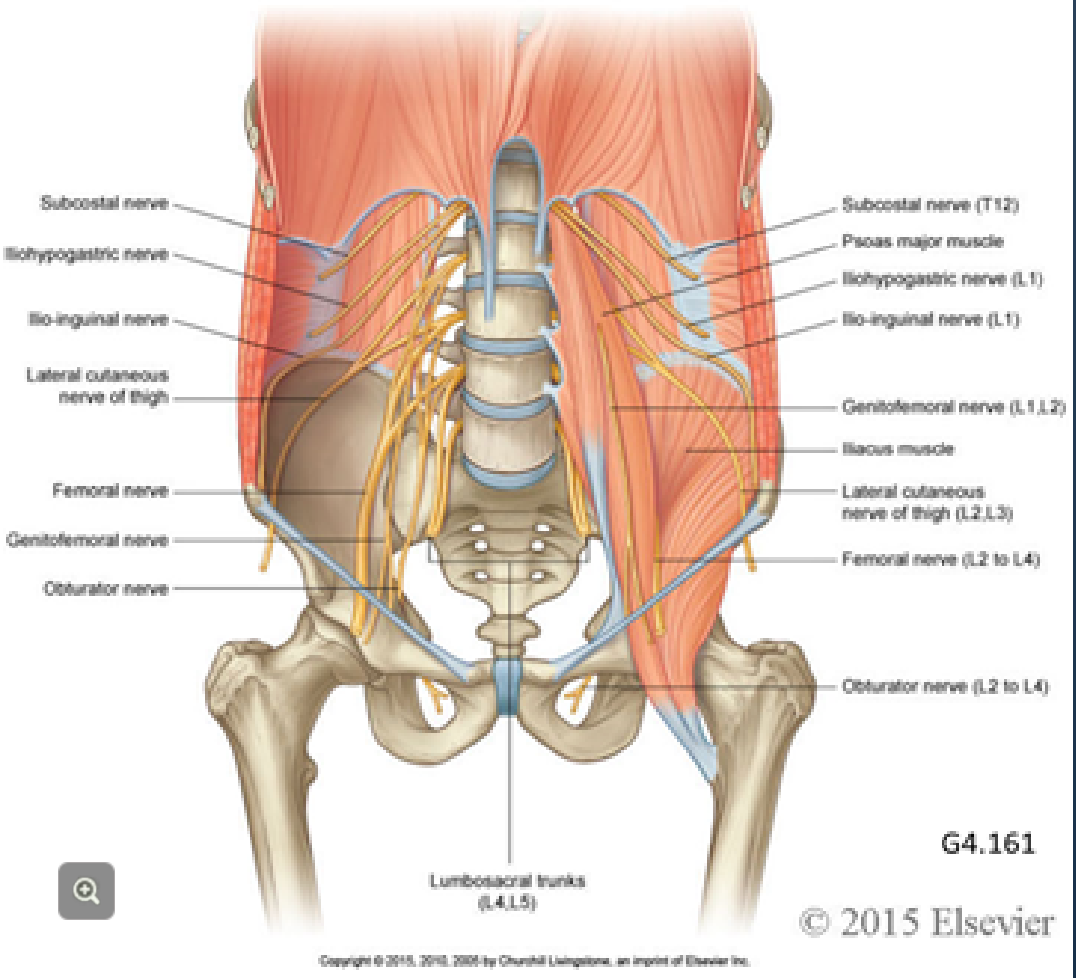


TASK

IDENTIFY the obturator nerve

by running your finger between the psoas major and the common iliac vessels. Like the femoral nerve, it is formed by contributions from L_2 - L_4. Trace the obturator nerve to where it passes through the obturator canal to provide motor and sensory fibres to the medial thigh.

Deep and medial to the obturator nerve, identify the lumbosacral trunk, which is formed by contributions from the L_4 and L_5 ventral rami. It passes anterior to the ala of the sacrum and into the pelvis to join the sacral plexus. It thereby contributes L_4 and L_5 fibres to the nerves formed by the sacral plexus, such as the sciatic nerve, the largest peripheral nerve in the body



You first studied the diaphragm in Unit 3 when it was described as **the floor of the thoracic cavity**.
We now study the diaphragm **in the context of the abdominal cavity, where it forms the roof**.

TASK

USING blunt dissection techniques,

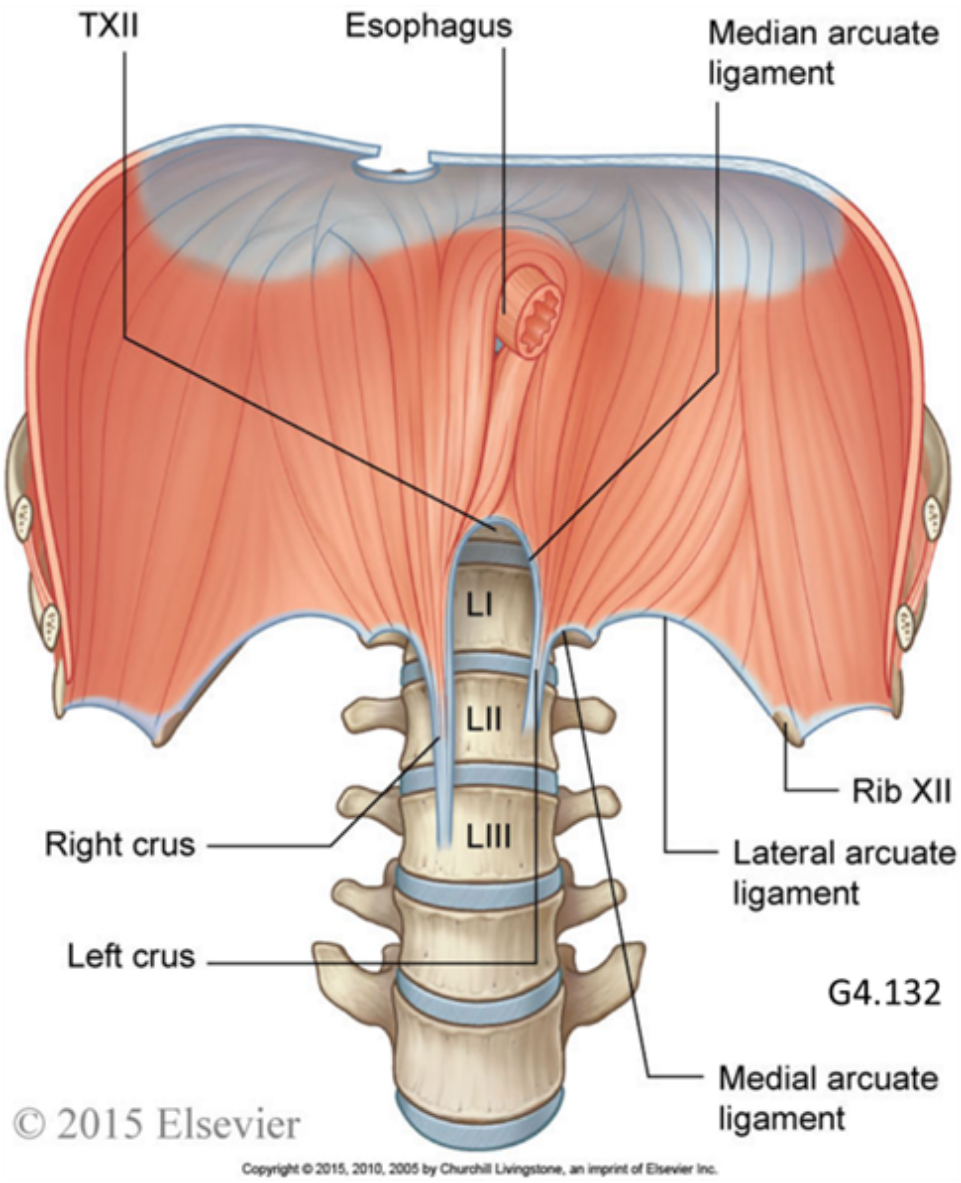
remove any remaining parietal peritoneum and extraperitoneal fascia from the underside of the diaphragm. Identify its following parts:

The median arcuate ligament, a fascial arch which curves over the aorta to form the aortic hiatus.

The right and left crura of the diaphragm, on either side of the median arcuate ligament. These anchor the diaphragm to the lumbar vertebral bodies. The right crus extends down to L3 and the left crus extends down to L2. The esophageal hiatus is an opening in the right crus.

The medial arcuate ligaments are bilaterally-paired fascial arches that curve over the psoas major muscles.

The lateral arcuate ligaments are bilaterally -paired fascial arches that curve over the quadratus lumborum.



TASK

IDENTIFY the features of the diaphragm from its inferior aspect:

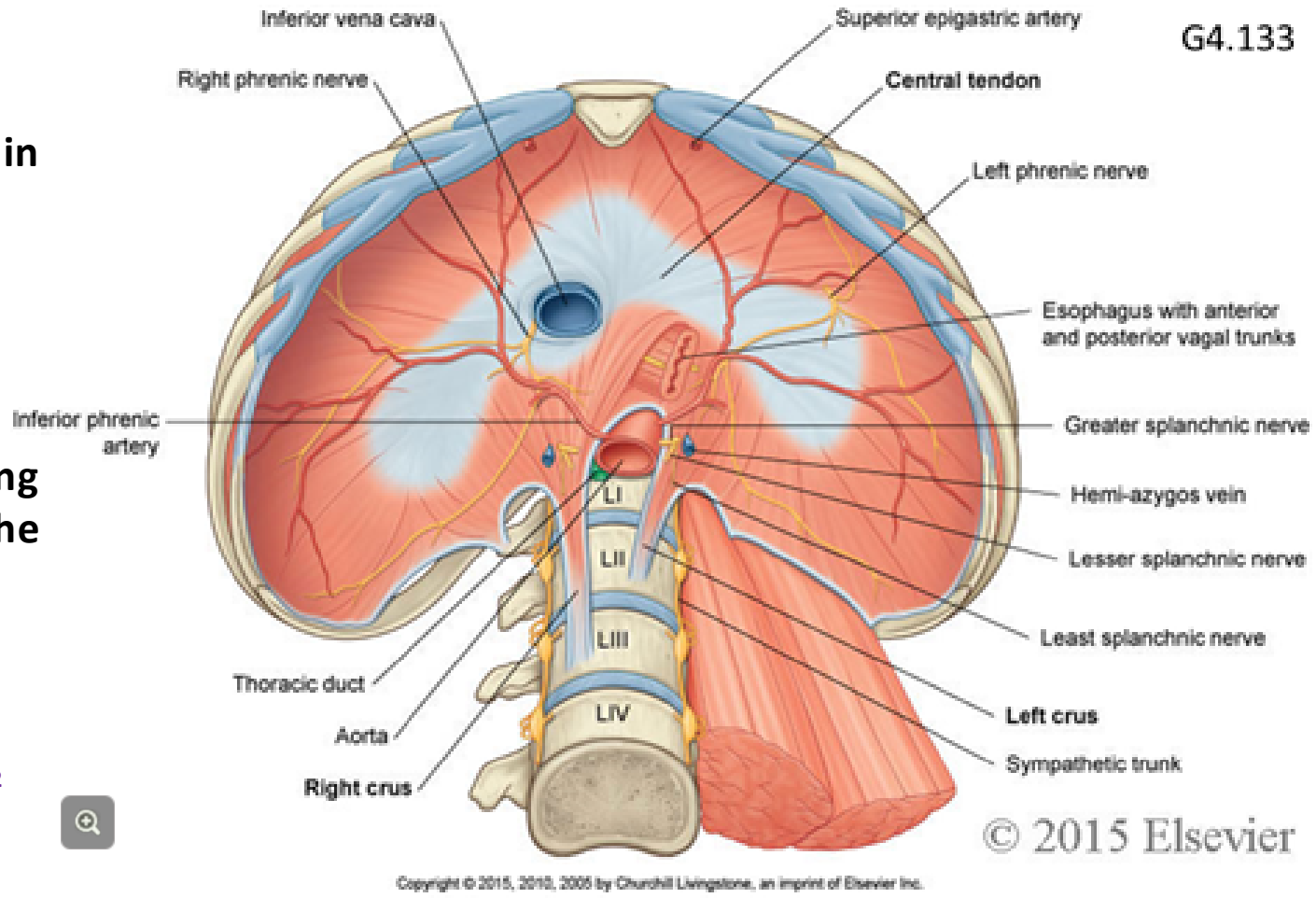
Central tendon: the aponeurotic center of the diaphragm, into which its muscle fibres insert and which descends with muscular contraction to increase thoracic volume.

Costal part: the muscle fibers that arise from the lower six ribs and their costal cartilages.

Lumbar part: formed by two crura (right and left) and the muscle fibers that arise from the medial and lateral arcuate ligaments.

Identify the three major openings in the diaphragm:

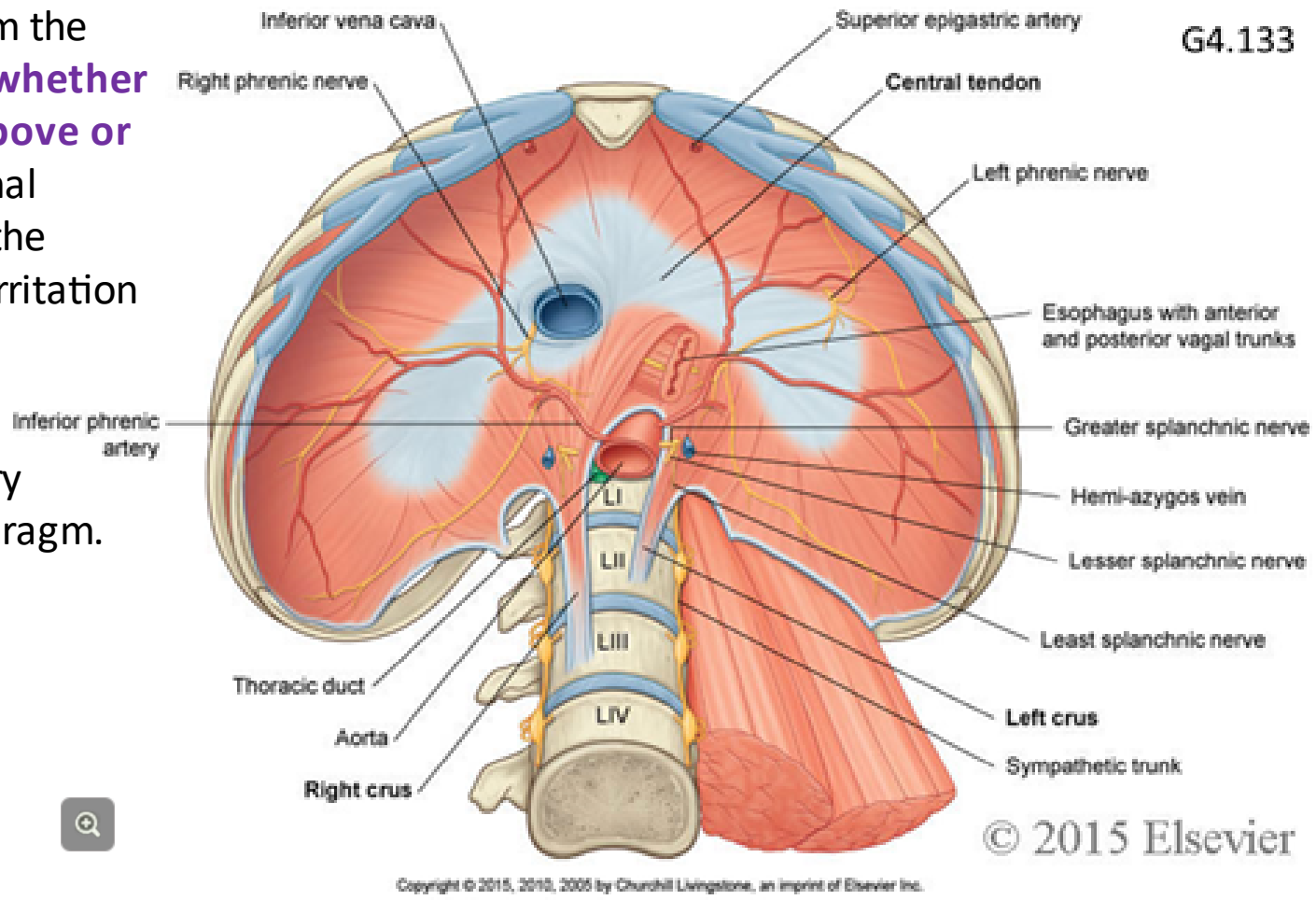
- **the caval foramen in the central tendon at the level of the T_8 vertebral body,**
- **the esophageal hiatus, an opening in the right crus at the level of the T_{10} vertebral body, and**
- **the aortic hiatus, an opening in the posterior margin of the diaphragm at the level of the T_{12} vertebral body.**



The thoracic diaphragm is **skeletal muscle**, and is therefore innervated by the **somatic nervous system**. The diaphragm is, in fact, composed of **two hemi-diaphragms**, which are controlled independently by the **right and left phrenic nerves**. The phrenic nerves also contribute **sensory fibres** to the **parietal pleura and parietal peritoneum** covering the **superior and inferior surfaces of the central diaphragm**, respectively.

You learned in Unit 3 that irritation of the diaphragm refers to the shoulder owing to the origin of the phrenic nerves from the ventral rami of C_3 - C_5. **This is true whether the diaphragm is irritated from above or below**. i.e. irritation of the abdominal surface of the diaphragm refers to the shoulder for the same reason that irritation of its thoracic surface does.

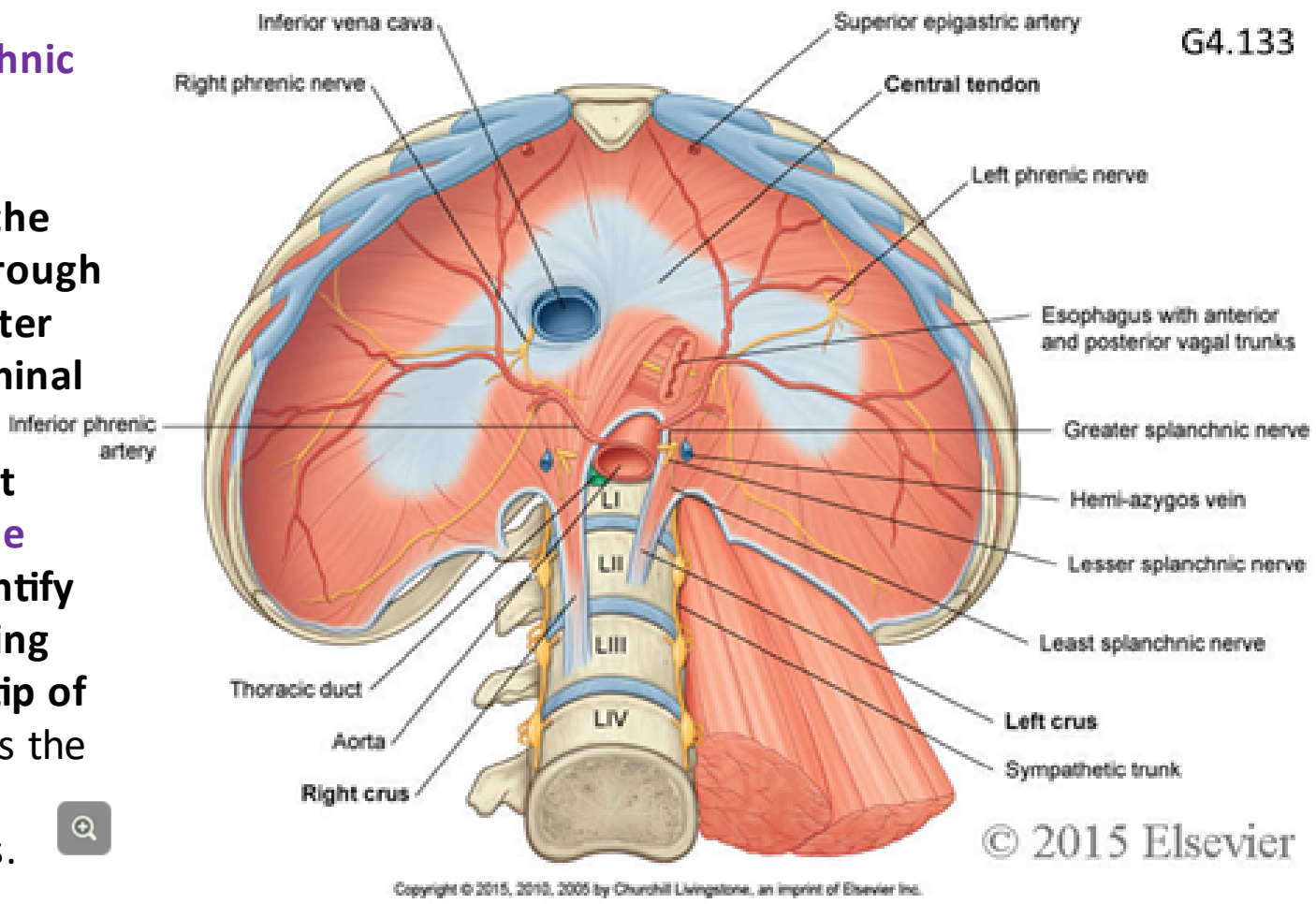
Intercostal nerves **T5 to T11** and the **subcostal nerves** supply sensory fibres to the **periphery** of the diaphragm.



TASK

IDENTIFY the sympathetic trunk on the lumbar vertebral bodies between the crura of the diaphragm and the psoas major muscle. Lumbar sympathetic ganglia give rise to i) **grey rami communicantes**, which pass posteriorly to contribute **sympathetic postganglionic fibres** to the **lumbar ventral rami**, and therefore to the **body wall and legs**, and ii) **lumbar splanchnic nerves**, which pass anteriorly to contribute **sympathetic preganglionic fibres** to the **aortic plexus**.

From the superior aspect of the diaphragm, trace a greater splanchnic nerve from the sympathetic chain adjacent to the thoracic vertebral bodies to the superior surface of the diaphragm. Pass a blunt probe through the diaphragm alongside the greater splanchnic nerve. From the abdominal aspect of the diaphragm, find the tip of your probe and observe that your probe has passed through the crus of the diaphragm. Try to identify the greater splanchnic nerve passing through the diaphragm near the tip of your probe. In the abdomen, it joins the **celiac ganglion** to synapse onto sympathetic postganglionic neurons.



Since the last Progress Check, you have **dissected** and **clearly exposed** the following structures:

- genitofemoral nerve and its genital and femoral branches. What muscle does the genital branch supply? What reflex would be affected by damage to this nerve?
- subcostal, iliohypogastric and ilioinguinal nerves, lateral cutaneous nerve of the thigh, femoral and obturator nerves, lumbosacral trunk. What movement would be affected by a lesion of the femoral nerve? What area of skin would be affected by damage to the obturator nerve?
- median arcuate ligament, medial arcuate ligaments, lateral arcuate ligaments. Over what structure does each of these ligaments arch?
- aortic hiatus, L& R crura, esophageal hiatus, caval opening
- central tendon, costal and lumbar parts of the diaphragm
- sympathetic trunk in the abdomen. Grey rami arising from the sympathetic trunks here contribute sympathetic postganglionic fibres to what body region? Lumbar splanchnic nerves contribute sympathetic fibres to what plexus? Are these fibres pre- or postganglionic?
- The spleen ruptures, spilling blood against the underside of the diaphragm. Pain is felt in the ipsilateral shoulder. Explain.

If you are satisfied with the **quality of your dissection**, and your **ability to identify these structures** and **answer these questions**, call you TA over for confirmation and for permission to clean up.

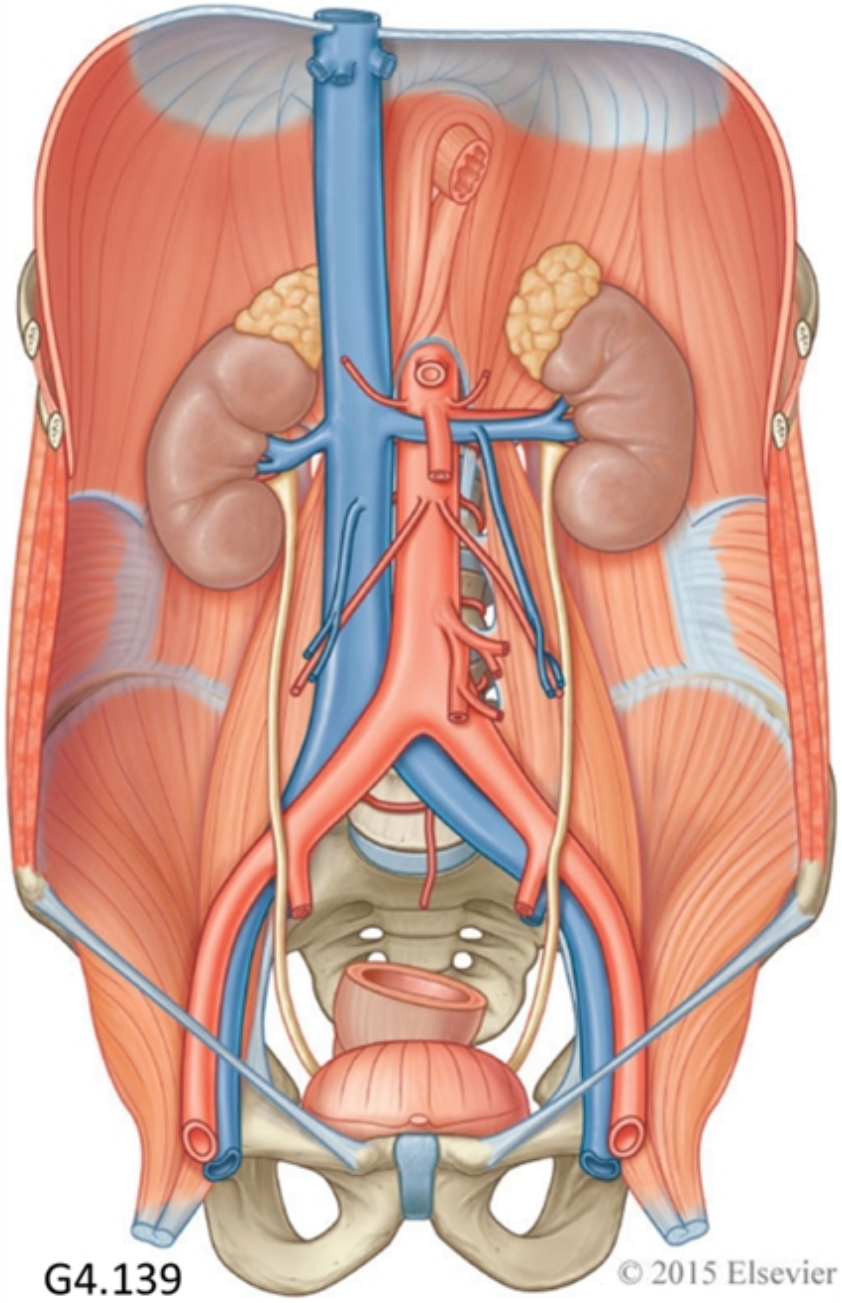
TASK

CLEAN UP BEFORE YOU LEAVE.

Put all tissue into the appropriate tissue container. Gloves and paper towel go in regular garbage.

Fluid goes in the carboy in the corner of the lab.

Moisten your dissection and place moist cloths on the posterior body wall. Close the flaps of skin over your cadaver and cover it with moist cloths. Close the body bag and wipe its external surface in order to keep the lab presentable for other groups.



13.2 The Perineum

What you'll need:

SPECIMENS

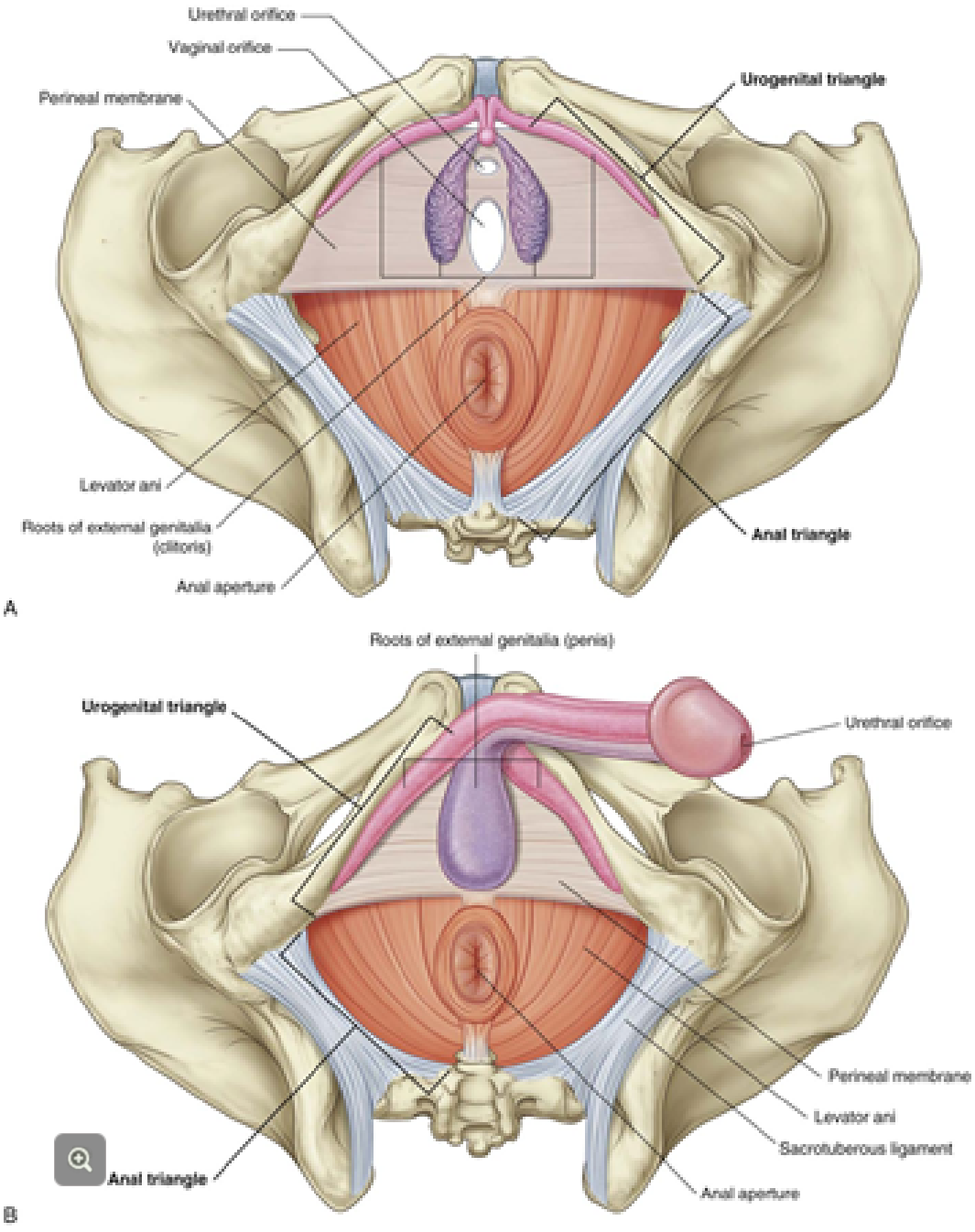
- two models of the pelvis, one with viscera and one without
- a set of three silicone funnels and 3 pipe cleaners
- prosected male and female perinea

INSTRUCTIONS

If your TA has decided that your cadaver will not be dissected any further, you will start Lab 13 studying the prosections of the male and female perinea during Week 32. Students are responsible for retrieving the prosected perinea from the bin in which they are stored. The prosections must be kept moist by students throughout the lab period. Students must **moisten, wrap, bag and tag** each specimen, and return it to the bin.

When you have learned the content of this eModule, you will be able to identify and describe the:

- boundaries and subdivisions of the perineum.
- contents of the anal triangle.
- contents of the deep and superficial pouches of the urogenital triangle in the male and female.



The **perineum** is the body region **between the thighs** and **inferior to the pelvic floor**.

The **pelvic floor** is composed of skeletal muscle, the **pelvic diaphragm**, and a connective tissue structure, the **perineal membrane**. The pelvic diaphragm consists of the **levator ani** and **coccygeus muscles**.

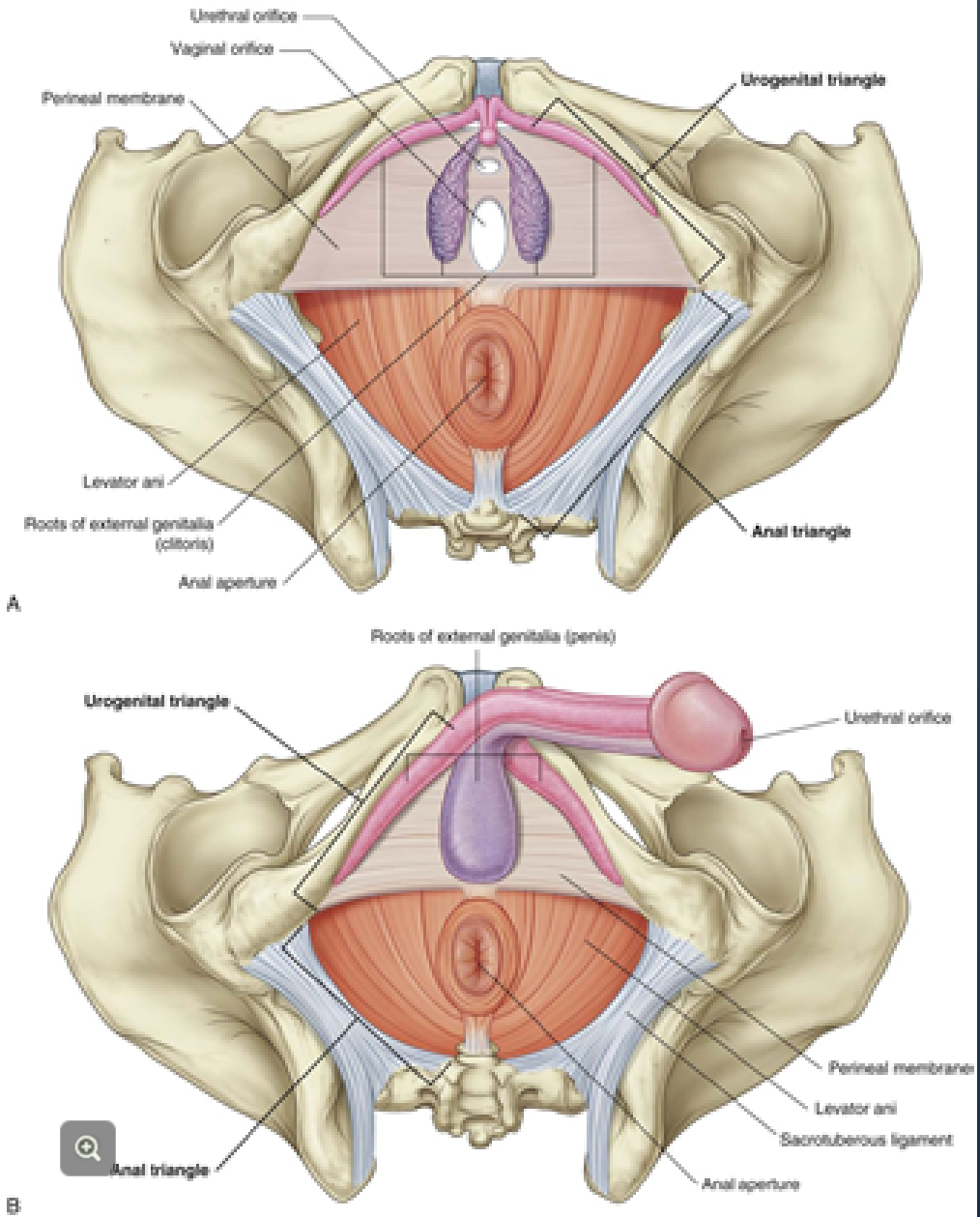
The pelvic floor separates the **pelvis**, superiorly, from the **perineum**, inferiorly. Components of the **genitourinary** and **digestive tracts** pass through the pelvic floor, from the pelvis into the perineum.

The **perineum** includes the **pelvic outlet**, defined by the **pubic symphysis**, anteriorly, the **coccyx**, posteriorly and the **ischial tuberosities**, laterally.

For descriptive purposes, the **transtubercular line** divides the perineum into a **urogenital (UG) triangle**, anteriorly, and an **anal triangle**, posteriorly.

In **both sexes**, the **UG triangle** serves to **anchor the external genitalia** and accommodates the passage of the **urethra**. In women, it also accommodates the opening of the **vagina**.

The anal triangle contains the **anal canal**.



You have been provided with a model of a bony pelvis and a model of a bony pelvis with ligaments, muscles, viscera, nerves and vessels.

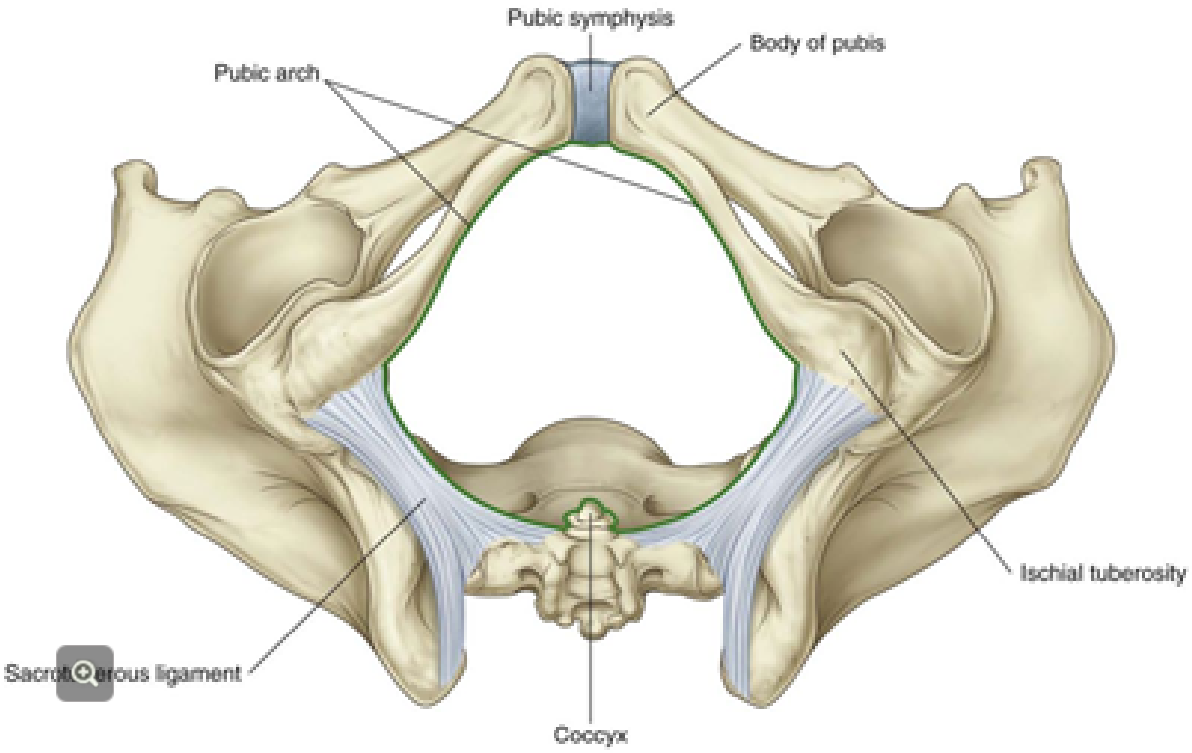
TASK

ORIENT the bony pelvis dorsal down and look at it from the inferior aspect, as illustrated. Identify the landmarks that define the pelvic outlet. These are the inferior border of the pubic symphysis, the tip of the coccyx and the left and right ischial tuberosities. Identify the conjoint rami, formed by the inferior pubic and ischial rami. The pubic arch is formed by the left and right conjoint rami and defines the anterolateral borders of the perineum.

Turn your attention to the model of the pelvis with viscera. You must reassemble it as you found it when you are finished.

On the right side of the model, from the posterior aspect, identify the sacrotuberous and sacrospinous ligaments. Identify the greater and lesser sciatic foramina. Identify the piriformis muscle passing through the greater sciatic foramen. Identify the obturator foramen covered over by the obturator membrane. Close this layer.

Now, orient the model as in the original illustration and recognize that the postero-lateral borders of the perineum are formed by the sacrotuberous ligaments, bilaterally.



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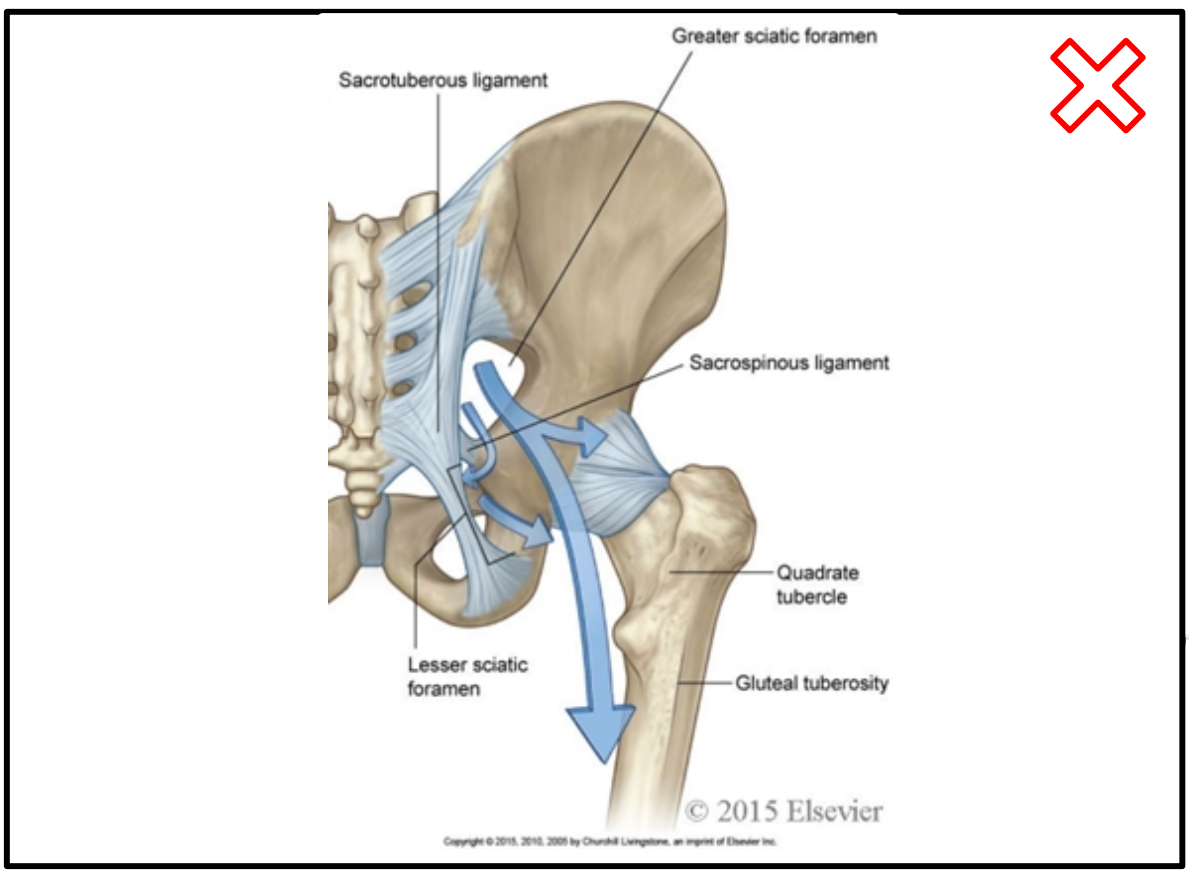

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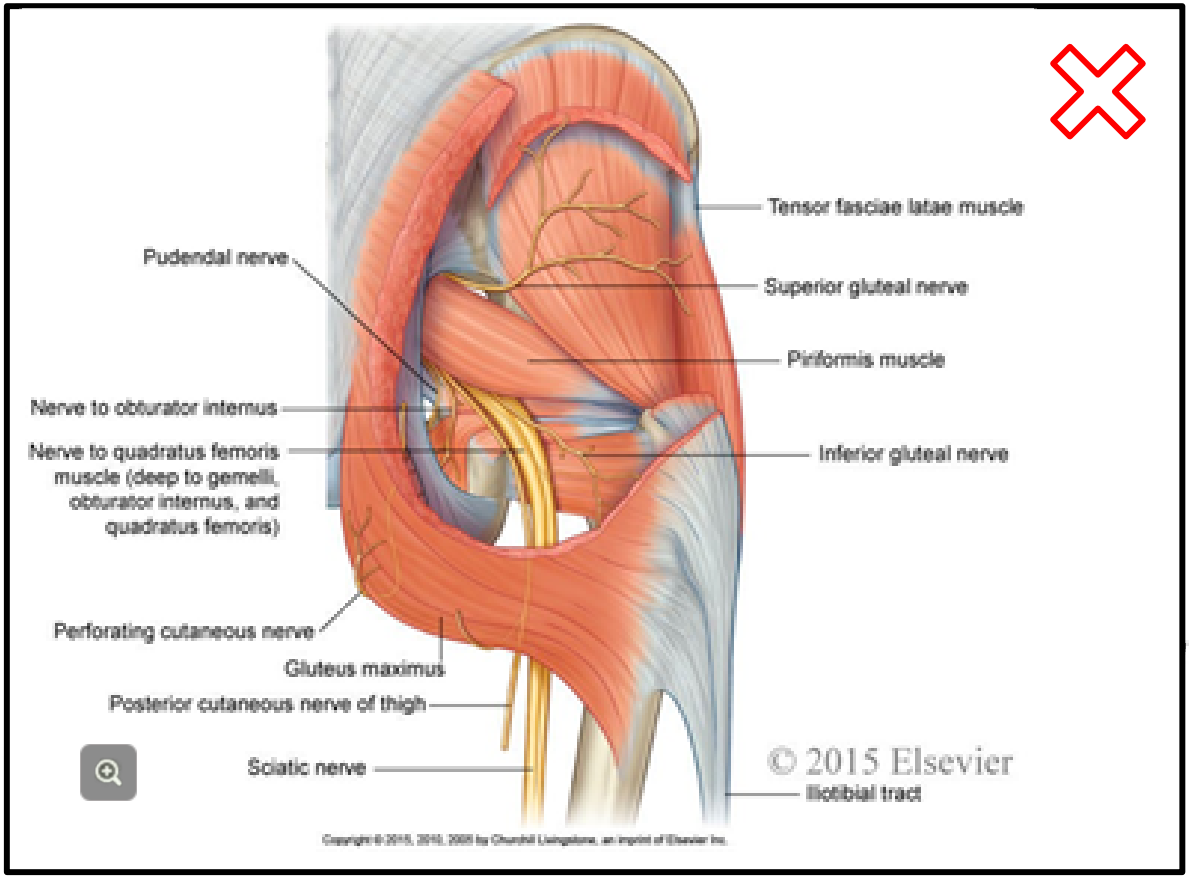

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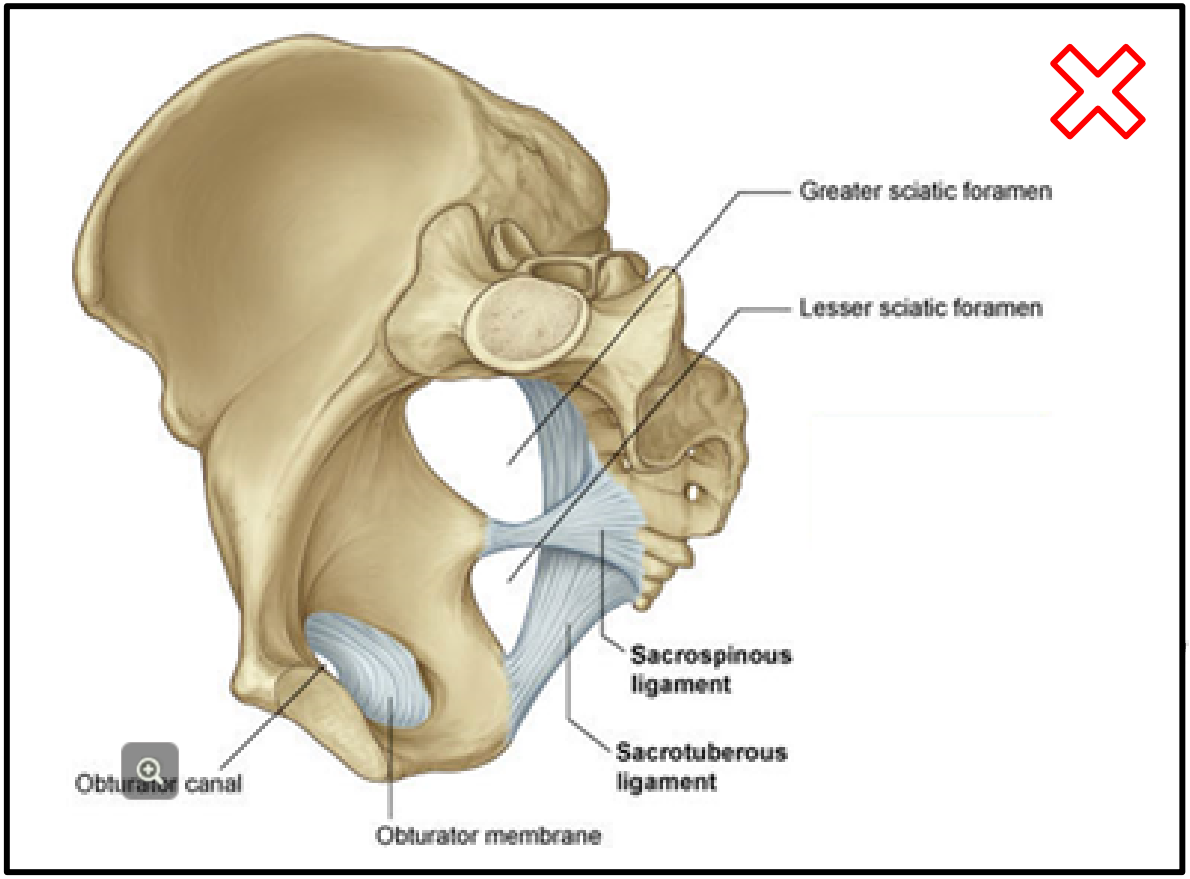
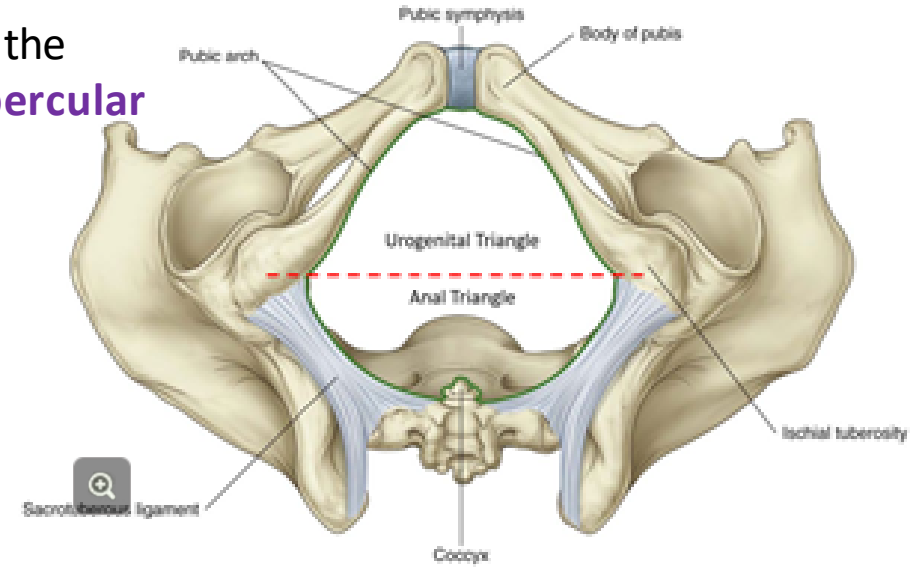


For the **purposes of description**, the perineum is divided into the **urogenital (UG)** and **anal** triangles by the imaginary **transtubercular line** which **passes through the ischial tuberosities**.

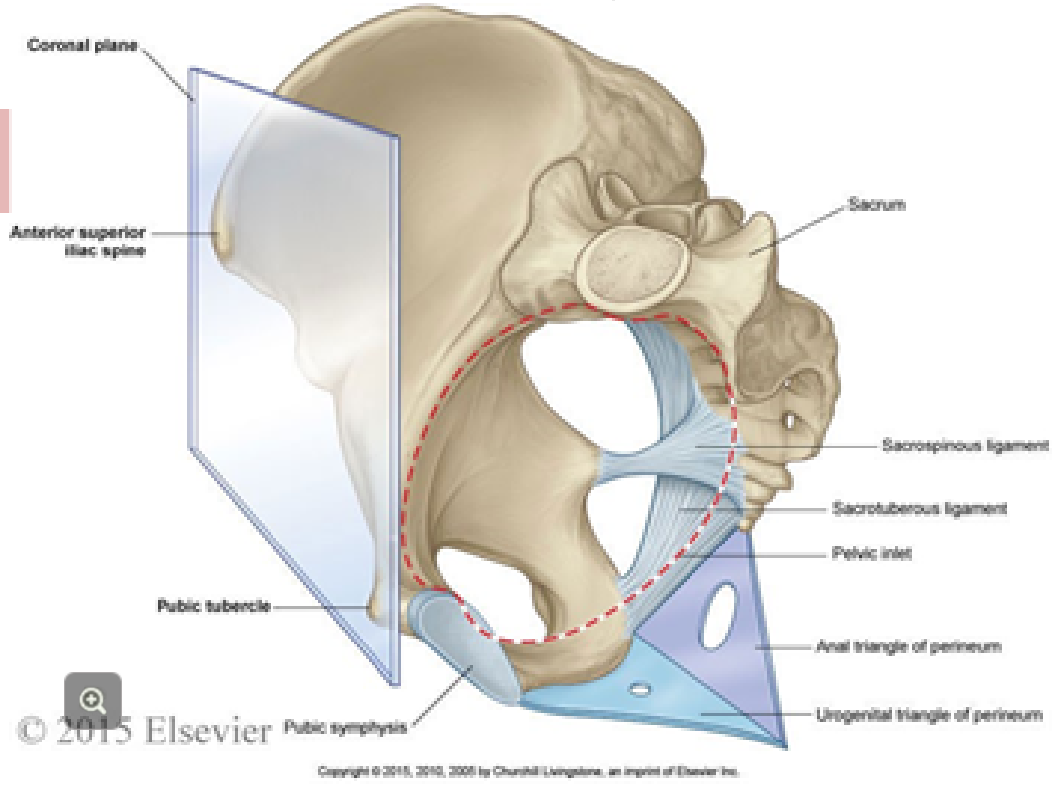


TASK

LOOK AT the pelvis model from below, and define the three sides of these triangles. The UG triangle is defined by the transtubercular line, posteriorly, and the pubic arch anterolaterally. The anal triangle is defined by the transtubercular line anteriorly and the sacrotuberous ligaments, posterolaterally.

TASK

ORIENT the pelvis in the anatomical position, with the ASISs and the pubic tubercles in the coronal plane. Look at the pelvis from the side and realize that the two triangles are not in the same plane.



The **UG triangle** is in a **horizontal plane**, while the **anal triangle faces almost posteriorly**. The angle of flexion between the two triangles is at the imaginary **transtubercular line**.

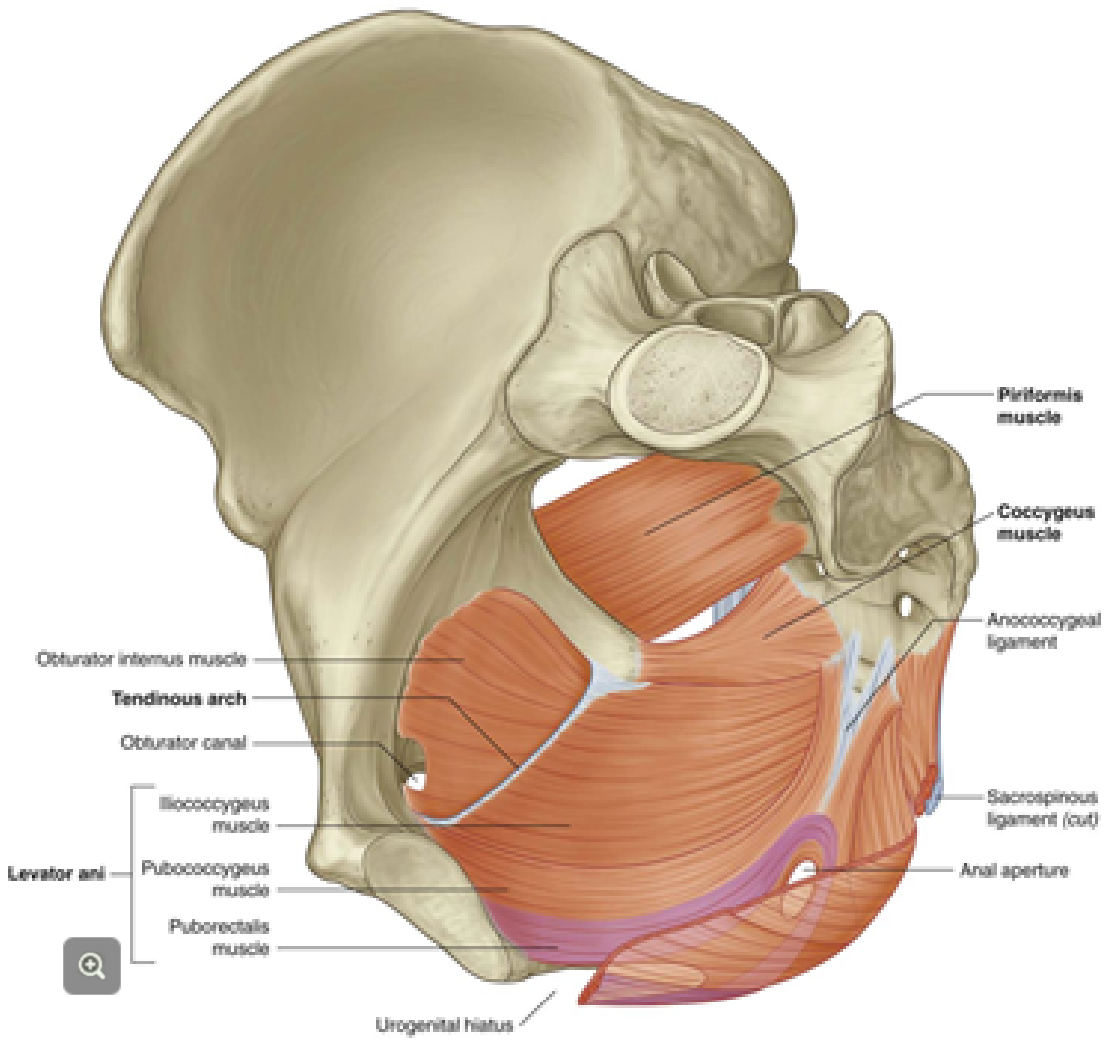
The **pelvic diaphragm** consists largely of the **levator ani**, although another muscle, the **coccygeus**, completes the pelvic diaphragm posteriorly. The fibres of the levator ani loop around the termini of the urogenital and digestive tracts, leaving a gap called the **urogenital hiatus**.

TASK

LOOK into the model pelvis through the pelvic inlet. With reference to the illustration, identify the levator ani, coccygeus and obturator internis muscles. Next identify the piriformis muscle, partially obscured by the roots of the sacral plexus. Now close this slide layer.

In the model, identify the most medial fibres of the levator ani forming the anal aperture and urogenital hiatus. As this is a model of the female pelvis, notice that the urogenital hiatus is subdivided to allow passage of the urethra and the vagina.

Confirm in the model that since the pelvic diaphragm separates the pelvis, above, from the perineum below, the pelvic diaphragm contributes to both the floor of the pelvis and the roof of the perineum.



The **pelvic diaphragm** consists largely of the **levator ani**, although another muscle, the **coccygeus**, completes the pelvic diaphragm posteriorly. The fibres of the levator ani loop around the termini of the urogenital and digestive tracts, leaving a gap called the **urogenital hiatus**.

TASK

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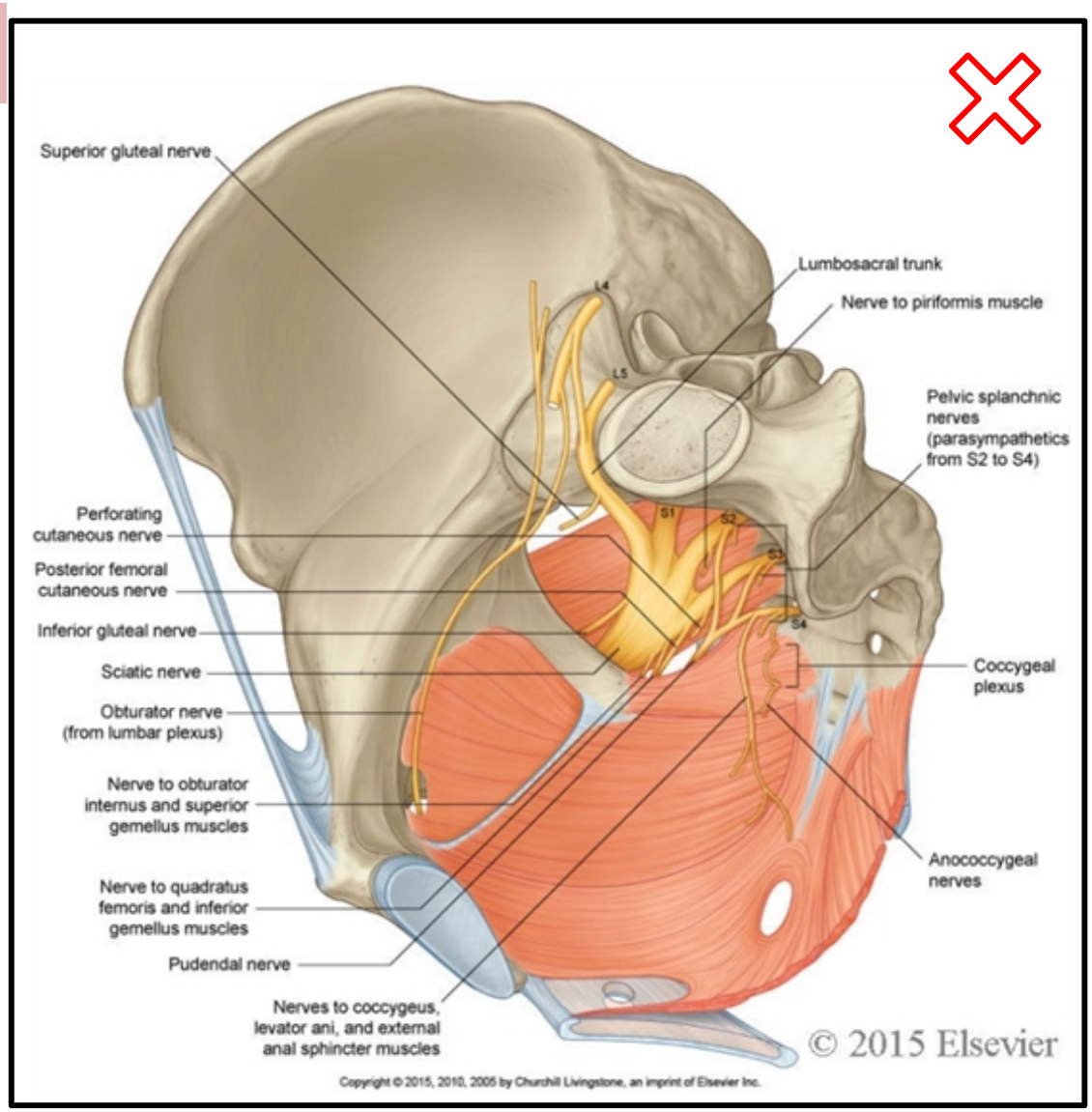


TASK

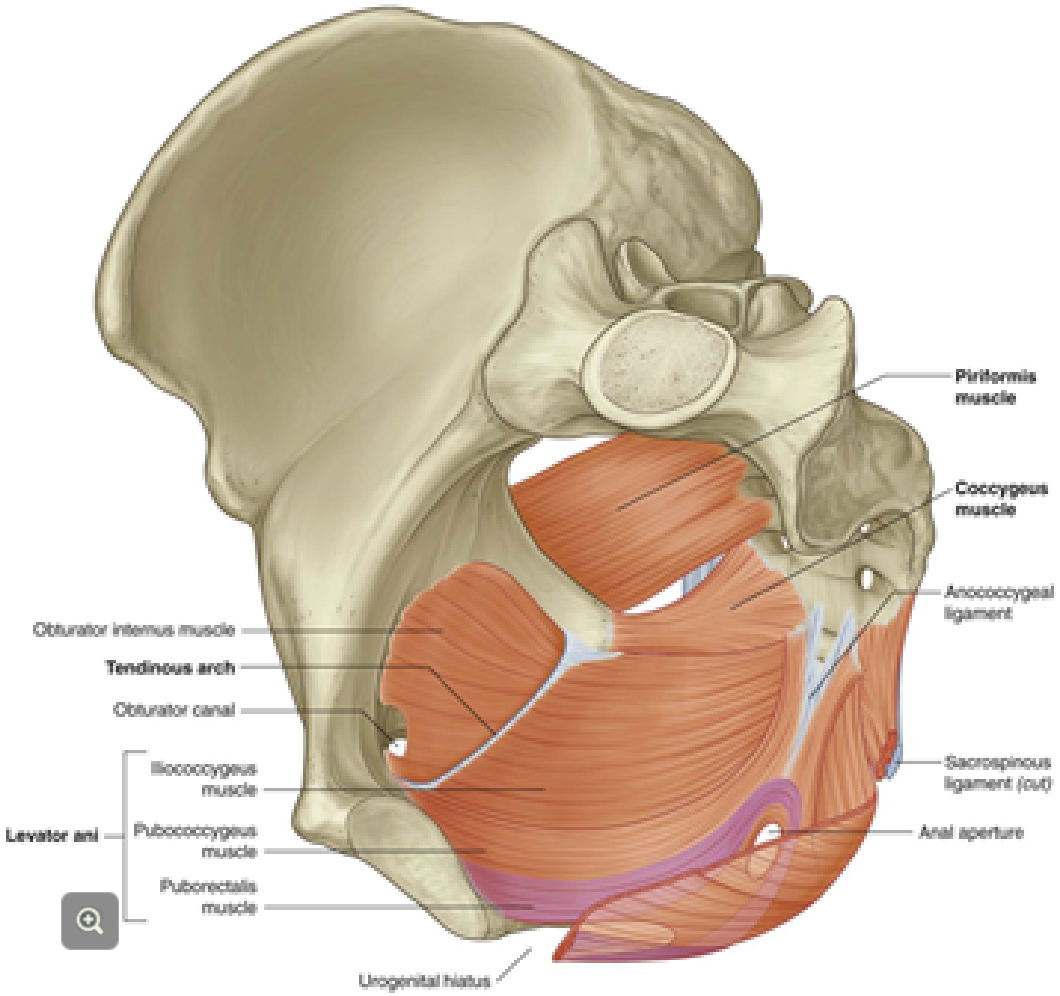
TRACE the line of attachment of the pelvic diaphragm in the model.

Note that the coccygeus extends from the anterior aspect of the S5 vertebral body to the ischial spine. Note that the levator ani arises from i) a tendinous arch that bisects the obturator internis and ii) from the posterior aspect of the pubic bone.

Because the pelvic diaphragm **separates the pelvis from the perineum**, neurovascular structures passing between these regions must take a circuitous route.

Turn the model over and again identify the piriformis muscle passing out of the greater sciatic foramen. This time, identify also the sciatic nerve passing through the greater sciatic foramen inferior to the piriformis. Identify also the much smaller pudendal nerve crossing over the sacrospinous ligament and through the lesser sciatic foramen to enter the perineum.

This circuitous route, taken by vessels and nerves passing between the pelvis and perineum, is very important to understand!



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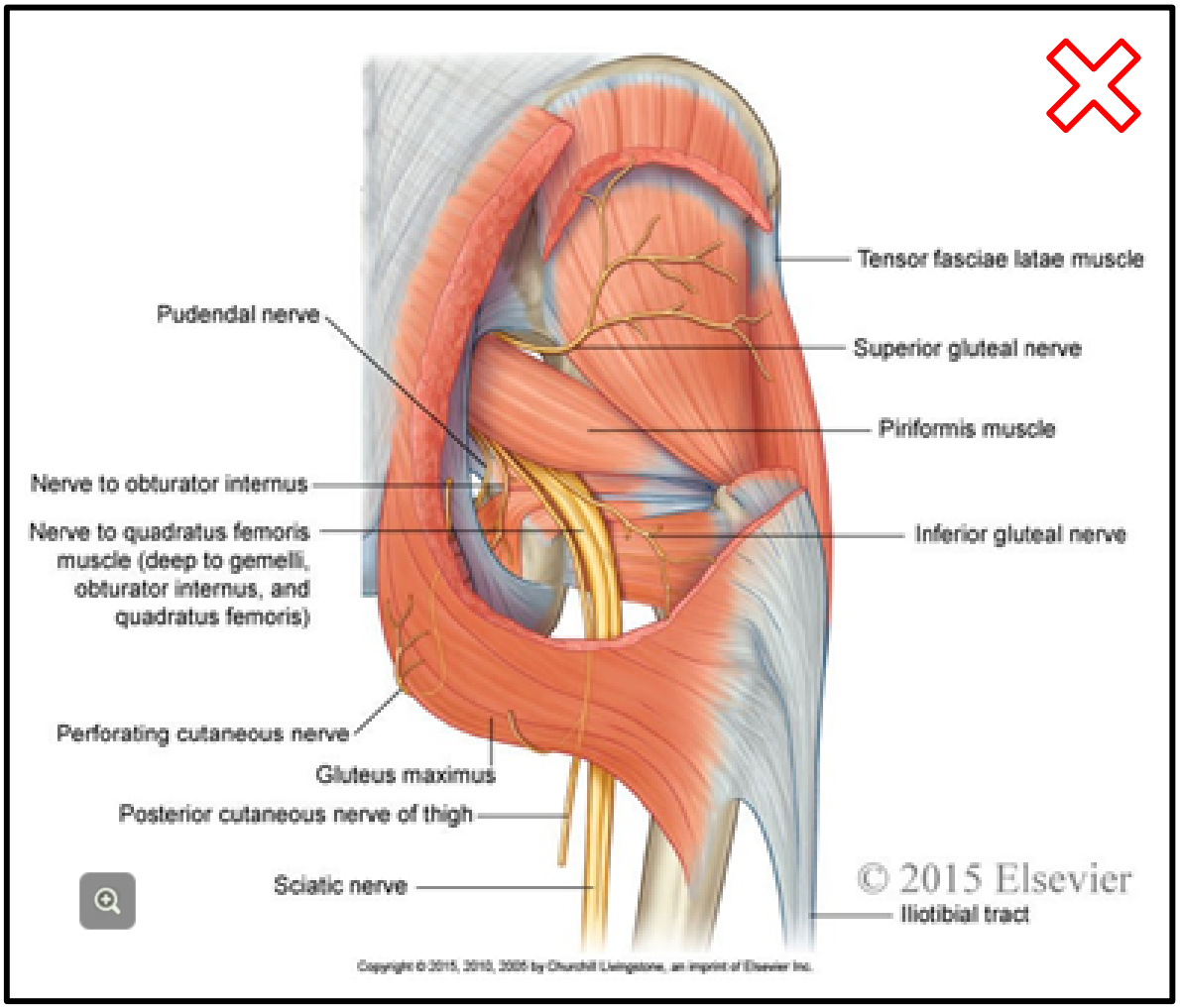
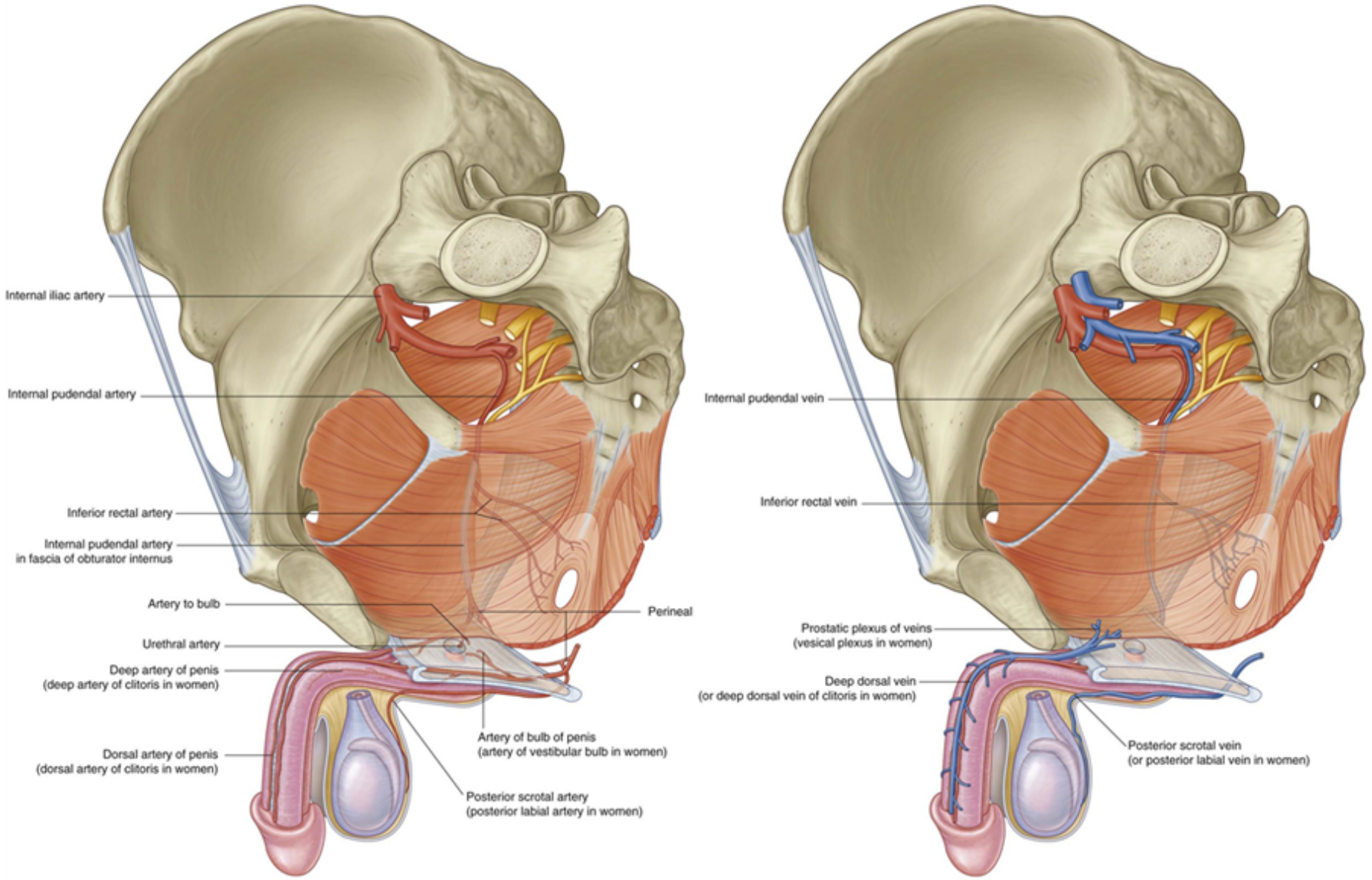


The internal pudendal artery and vein take the same route as the pudendal nerve.



Since embarking upon this exercise, you have learned the answers to the following questions:

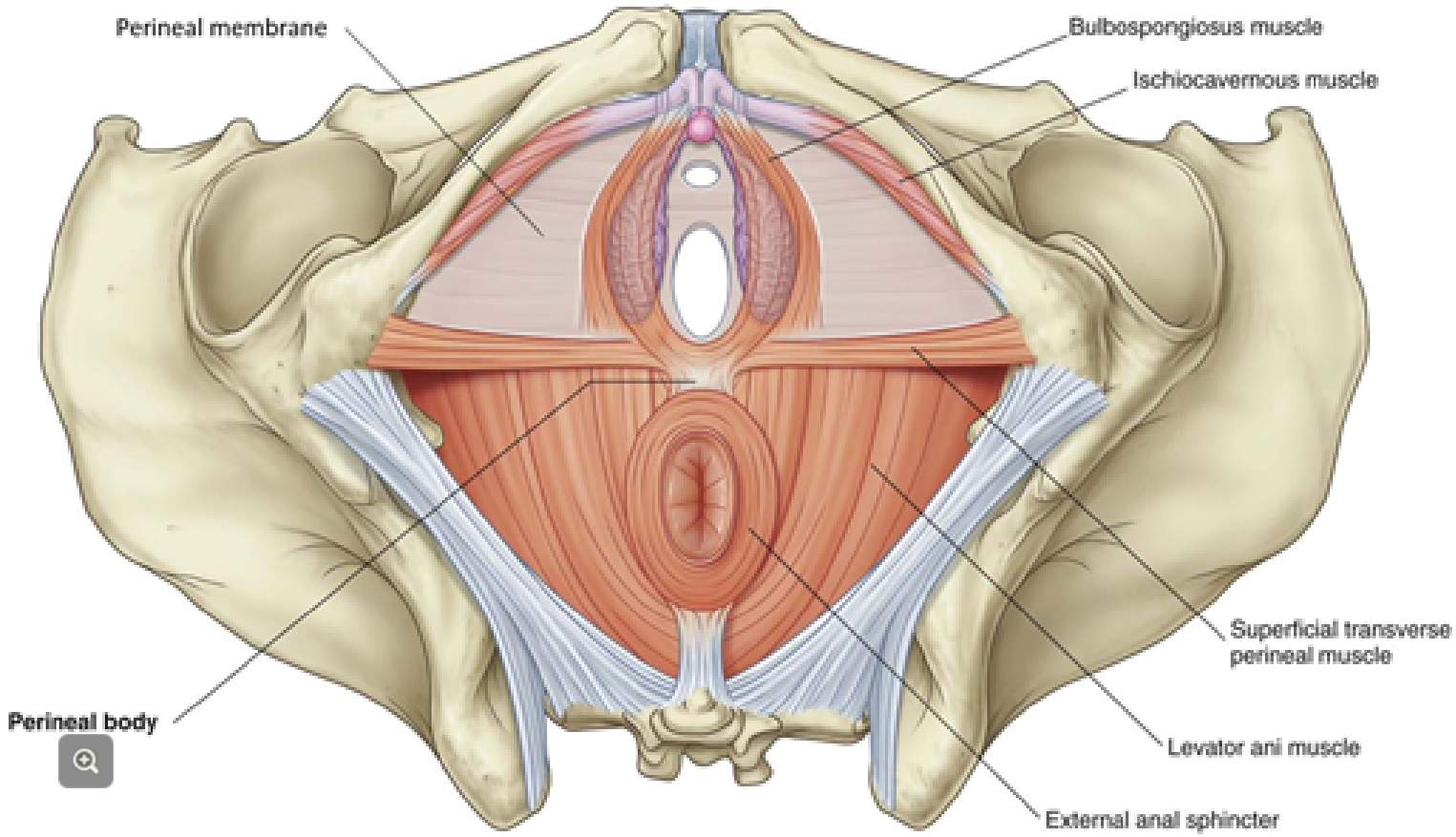
- What two structures from the pelvic diaphragm? what two structures form the pelvic floor?
- What structure separates the pelvis from the perineum?
- What structures form the anterior, posterior and lateral boundaries of the perineum? what structures form its roof and floor?
- What are the boundaries of the urogenital triangle? what are the boundaries of the anal triangle?
- What is the urogenital hiatus? What is the anal aperture?
- How is it that the obturator internis muscle forms the lateral wall of both the pelvis and perineum?
- Describe the route by which the pudendal nerve and internal pudendal vessels pass from the pelvis to the perineum.

Quiz each other thoroughly. If you are satisfied with your **ability to identify these structures** and **answer these questions**, move on to the next stage of the exercise.

TASK

UNWRAP the prosected perinea.

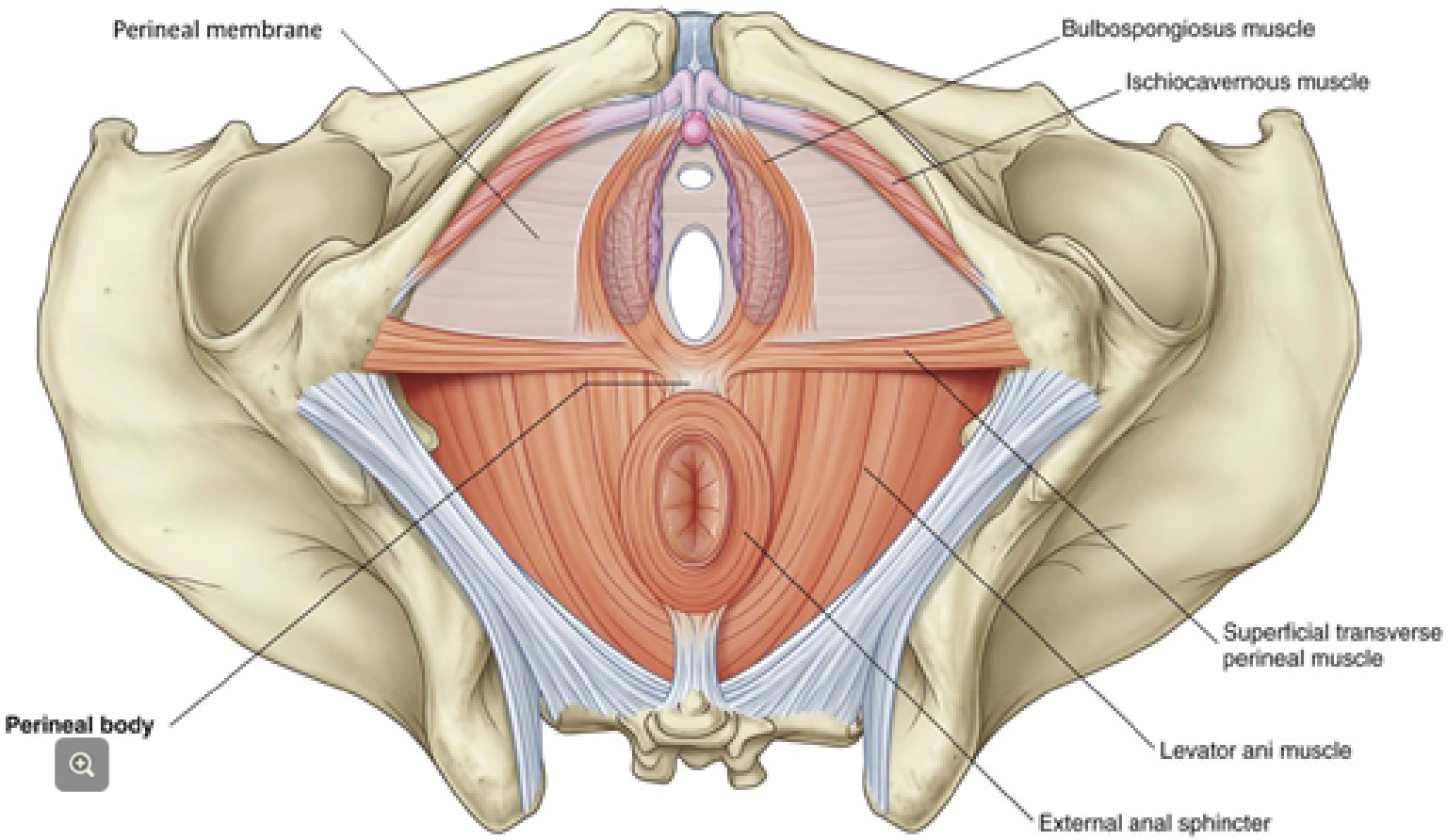
Sit them upside down on the table and study them from the posterior aspect. In both, start by identifying the landmarks that define the pelvic outlet and perineum: the inferior border of the pubic symphysis, the coccyx, and the ischial tuberosities. Now, identify the pelvic diaphragm, which from this aspect, is seen to consist of the levator ani. Observe that it is, indeed, shaped like a funnel, tapering to the anus. Note the fibres of the pelvic diaphragm surrounding the anus; they assist the the external anal sphincter in maintaining fecal continence.



For a review of the perineal membrane, its attachments and relationship to the pelvic floor, deep perineal pouch, superficial perineal pouch and external genitalia, click here: .

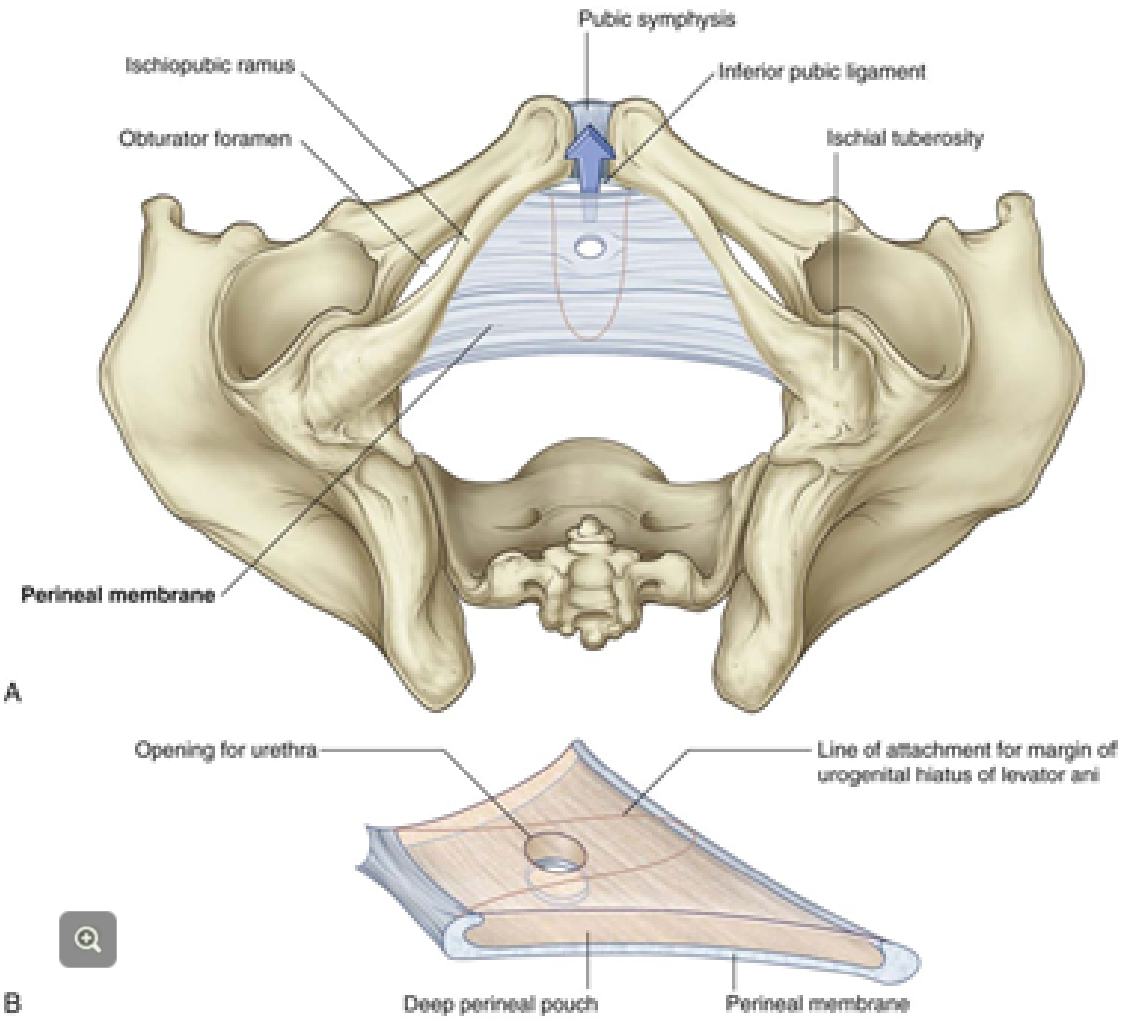
TASK

IDENTIFY, in the prosection, stretching between the ischial tuberosities, anterior to the anus, the posterior border of the perineal membrane. Pinch the perineal membrane with your thumbs and index fingers, bilaterally. Between your fingers is the skeletal muscle and neurovascular bundles of the deep perineal pouch, as well as the perineal membrane.



The **perineal membrane** is a sheet of tough, dense, inextensible CT that extends between the conjoint rami within the **UG triangle**. Its free **posterior border** extends between the ischial tuberosities.

The region superior to the perineal membrane is the **deep perineal pouch**. It largely consists of skeletal muscle and neurovascular bundles. The **superficial perineal pouch** is inferior to the perineal membrane.



The perineal membrane and deep perineal pouch **close over the urogenital hiatus** of the pelvic diaphragm, thereby **completing the pelvic floor**. In both sexes, an **opening** permits the passage of the **urethra**. In females, a second opening permits the passage of the **vagina**.

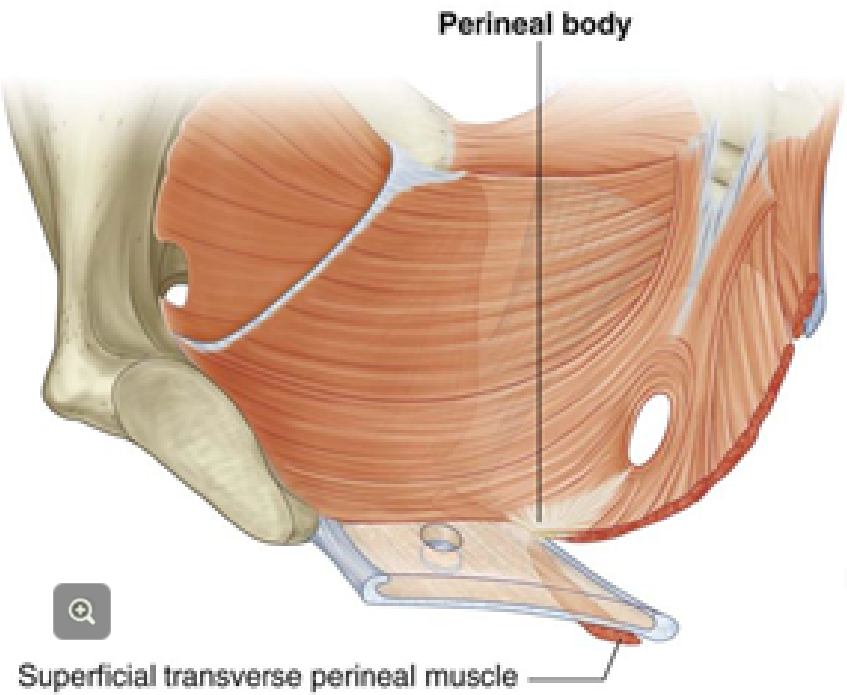
In both sexes, the skeletal muscle of the deep perineal pouch includes the **external urethral sphincter** which provides voluntary control over micturition.

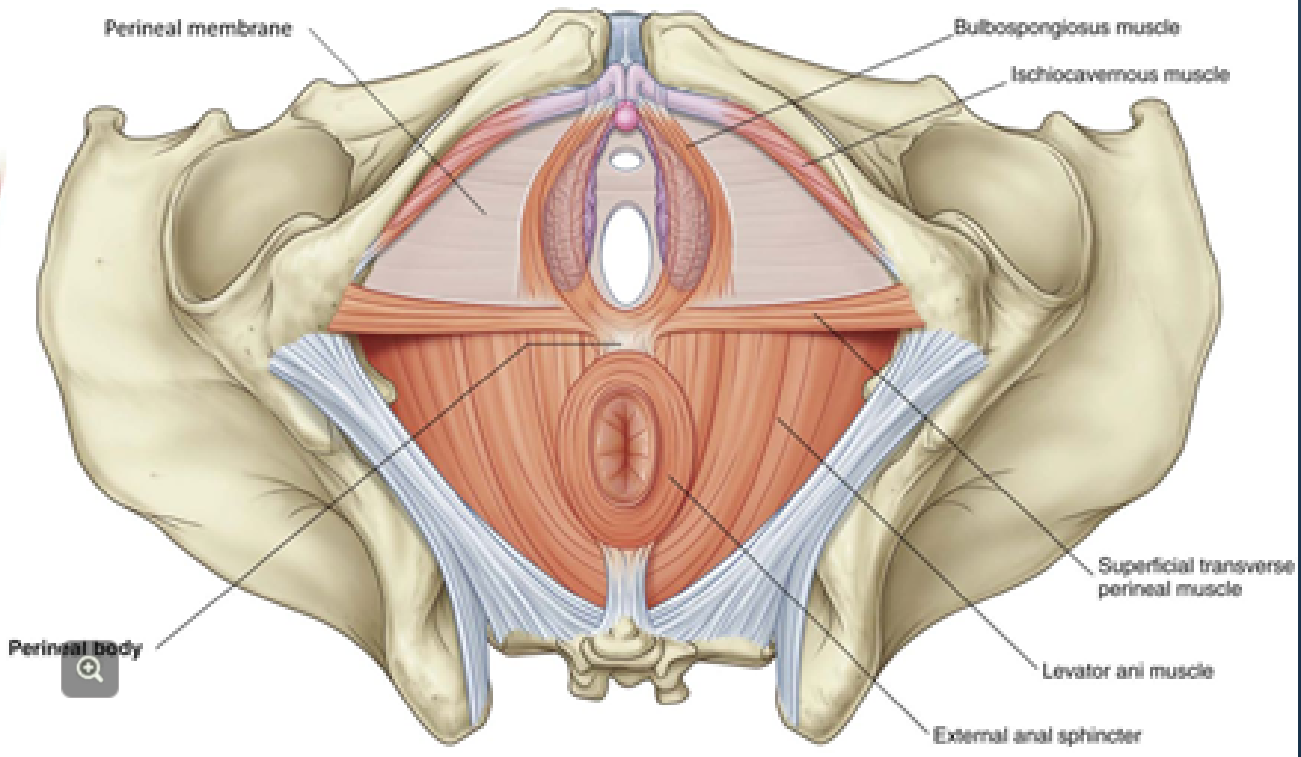
External genitalia are tightly attached to the inferior surface of the **perineal membrane** and to the **bony pubic arch**. A hiatus between the anterior border of the perineal membrane and the pubic symphysis (blue arrow) **permits the passage of neurovascular bundles from the deep perineal pouch to the clitoris and penis**.

The **perineal body** is a **knot of CT** that acts as an important point of attachment for muscles and connective tissue structures of both the pelvic floor (left) and the perineum (right).

TASK

IDENTIFY the perineal body at the midpoint of the posterior edge of the perineal membrane. Amongst other muscles, the **levator ani** attaches here, specifically the fibres forming the posterior border of urogenital hiatus. It also provides attachment for muscles of the perineum in both the deep and superficial pouches.



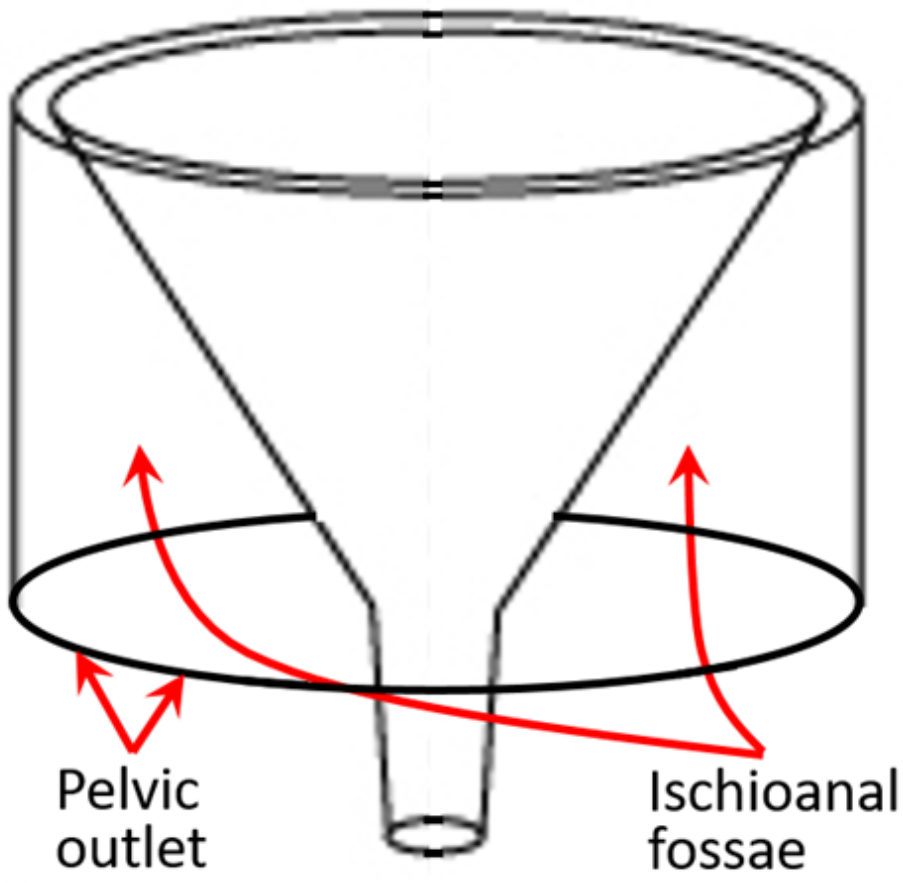


In the accompanying graphic, the **funnel** again represents the **pelvic diaphragm**. The **cylinder** that it rests in represents the part of the bony pelvis **below the line of attachment of the pelvic diaphragm**. The inferior opening of the cylinder represents the **pelvic outlet**. The space **outside the funnel**, but **inside the cylinder** represents the **ischioanal fossae**. In life, the ischioanal fossae are fat-filled spaces that permit the expansion of the anal canal during defecation. As you will learn, it also contains important nerves that innervate perineal structures, including the **external anal sphincter** and the **external urethral sphincter**.

Before you identify the ischioanal fossae in the prosection, notice, in this illustration that the coccygeus extends from the sacrum to the ischial spine, forming the posterior portions of the pelvic diaphragm.

The remainder of the pelvic diaphragm is made up of the **levator ani** muscle. **Look closely at the line of attachment of the levator ani, via a tendinous arch, across the internal surface of the obturator internis muscle (below).**

The line of attachment of the levator ani, via this tendinous arch, bisects the obturator internis muscle such that the superior half of the obturator internis lines the lateral wall of the true pelvis and the inferior half of the obturator internis lines the lateral wall of the perineum .



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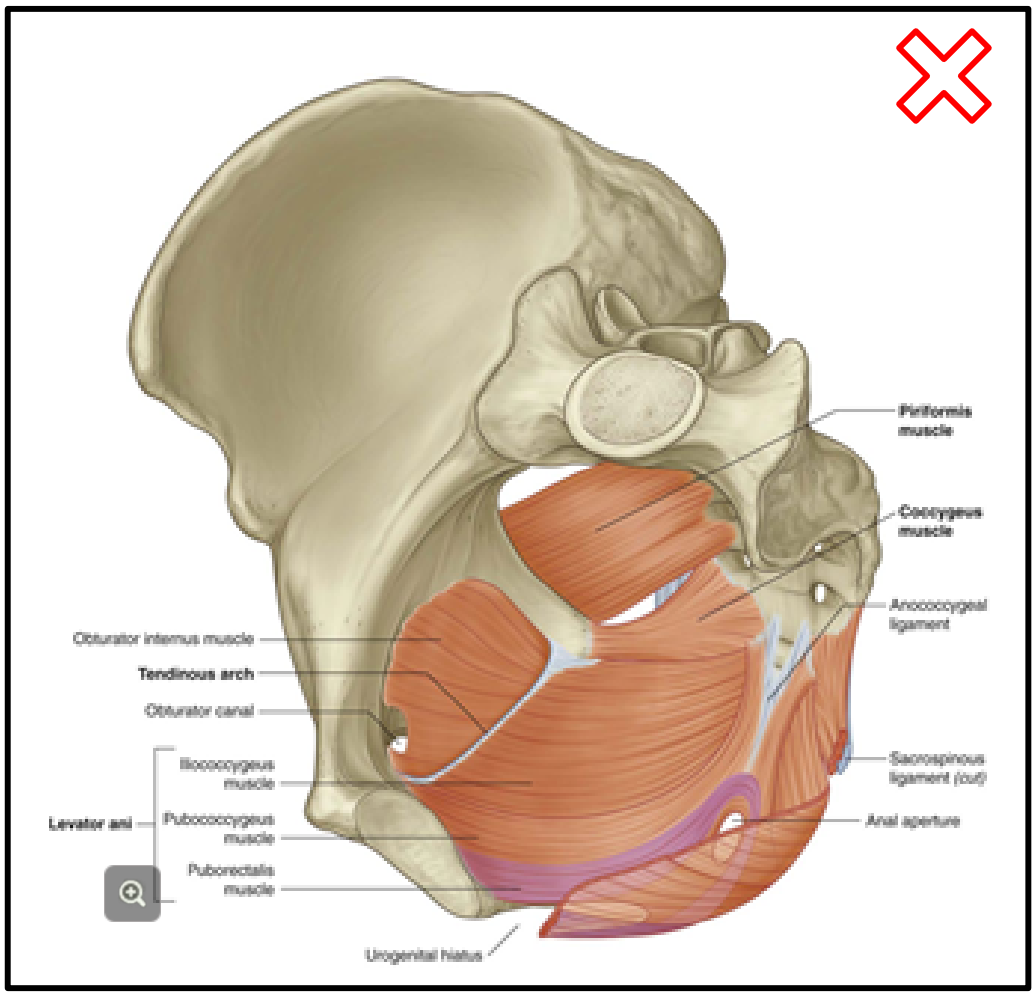

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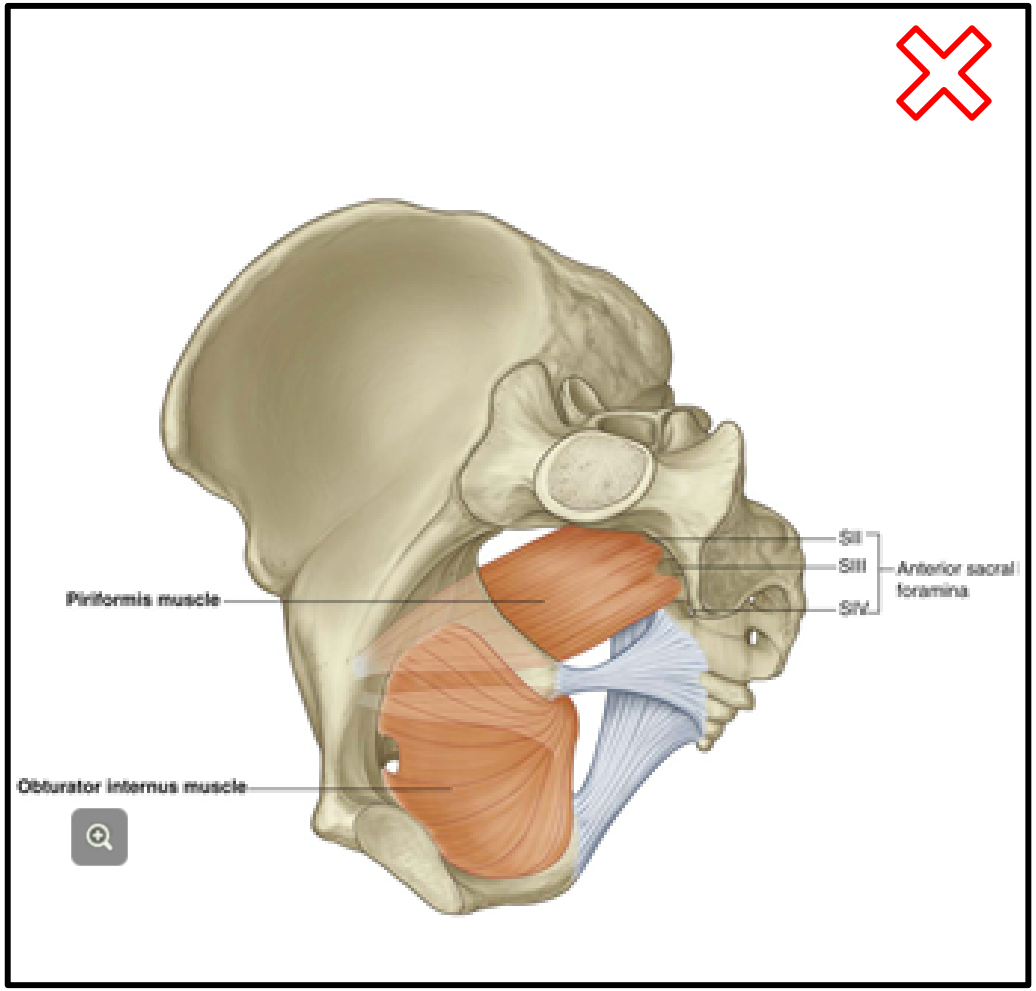


TASK

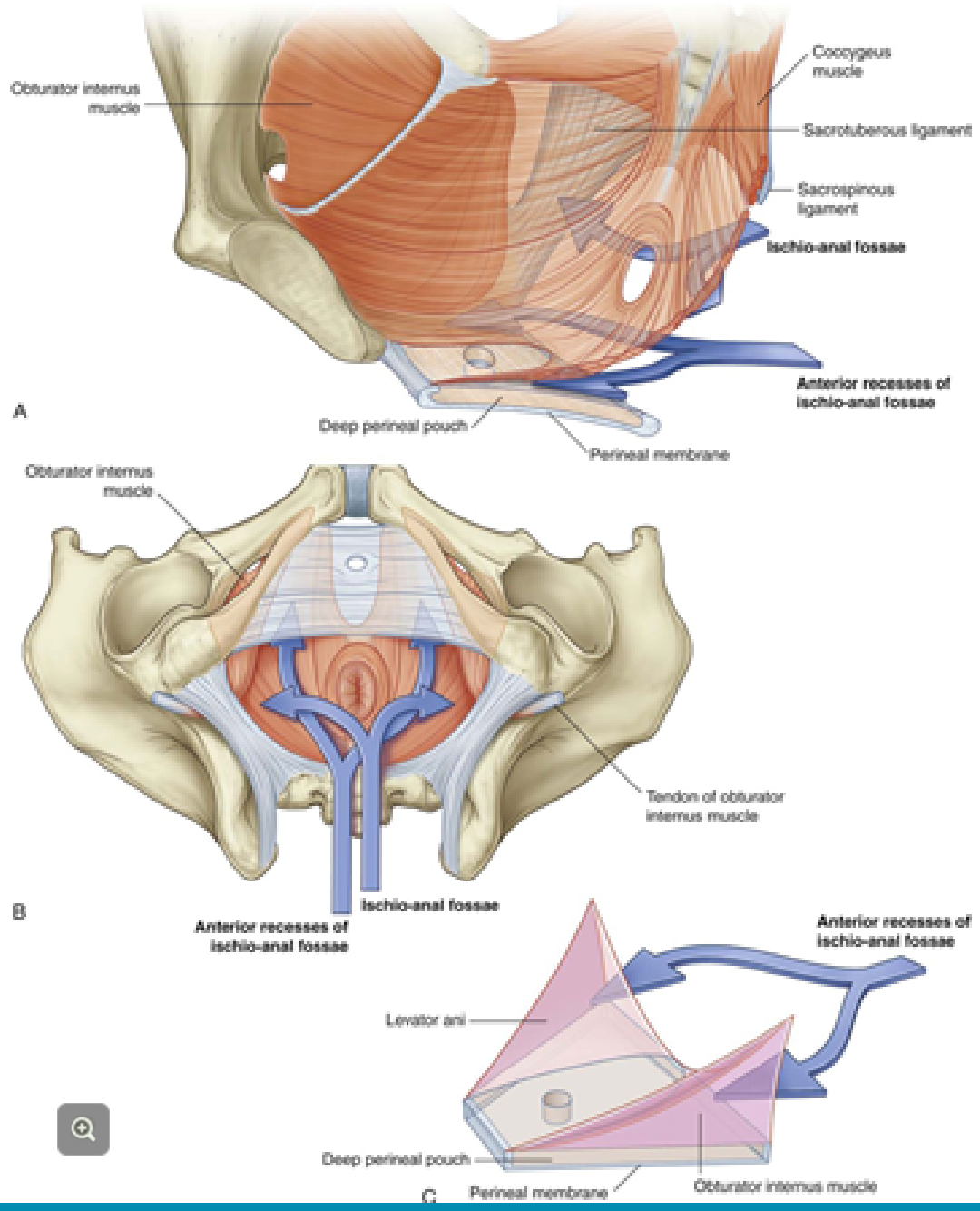
TURN your attention back to the prosections. From the posterior aspect, insert your hands through the pelvic outlet, into the spaces on either side of the levator ani. Your hands are in the ischioanal fossae of the anal triangle.

Feel the medial wall of the ischioanal fossa; it is the levator ani.

Feel the lateral wall of the ischioanal fossa; you are touching the obturator internis muscle.

Feel the apex of the ischioanal fossa, where the medial wall (levator ani) meets the lateral wall (obturator internis), is at the tendinous arch of attachment of the levator ani to the obturator internis.

Appreciate that what is an empty space in the prosection is filled with fat in life.



TASK

SLIDE your fingers anteriorly, from the ischioanal fossae of the anal triangle into the urogenital triangle superior to the deep perineal pouch and perineal membrane. Your fingers are in the anterior recesses of the ischioanal fossae.

Look at Figure C. and perform the following exercise:

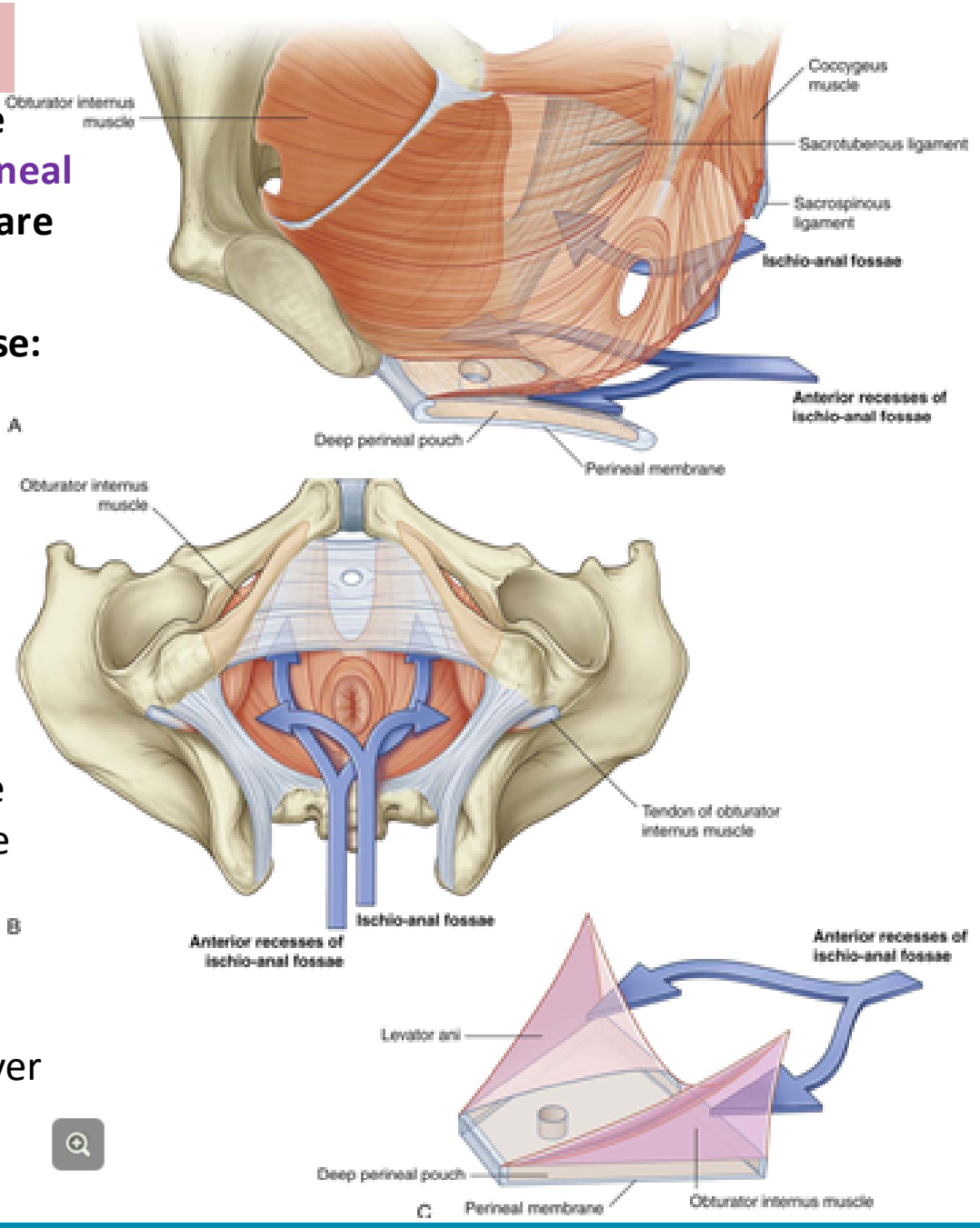
Touch the floor of the anterior recesses; you are touching the deep perineal pouch.

Touch the lateral walls of the anterior recesses; you are touching the obturator internis muscle.

Touch the medial wall of the anterior recesses; you are touching the levator ani.

Your fingers are in a **dead-end space** that ends at the **pubis**, to which both the **perineal membrane** and the **levator ani** attach.

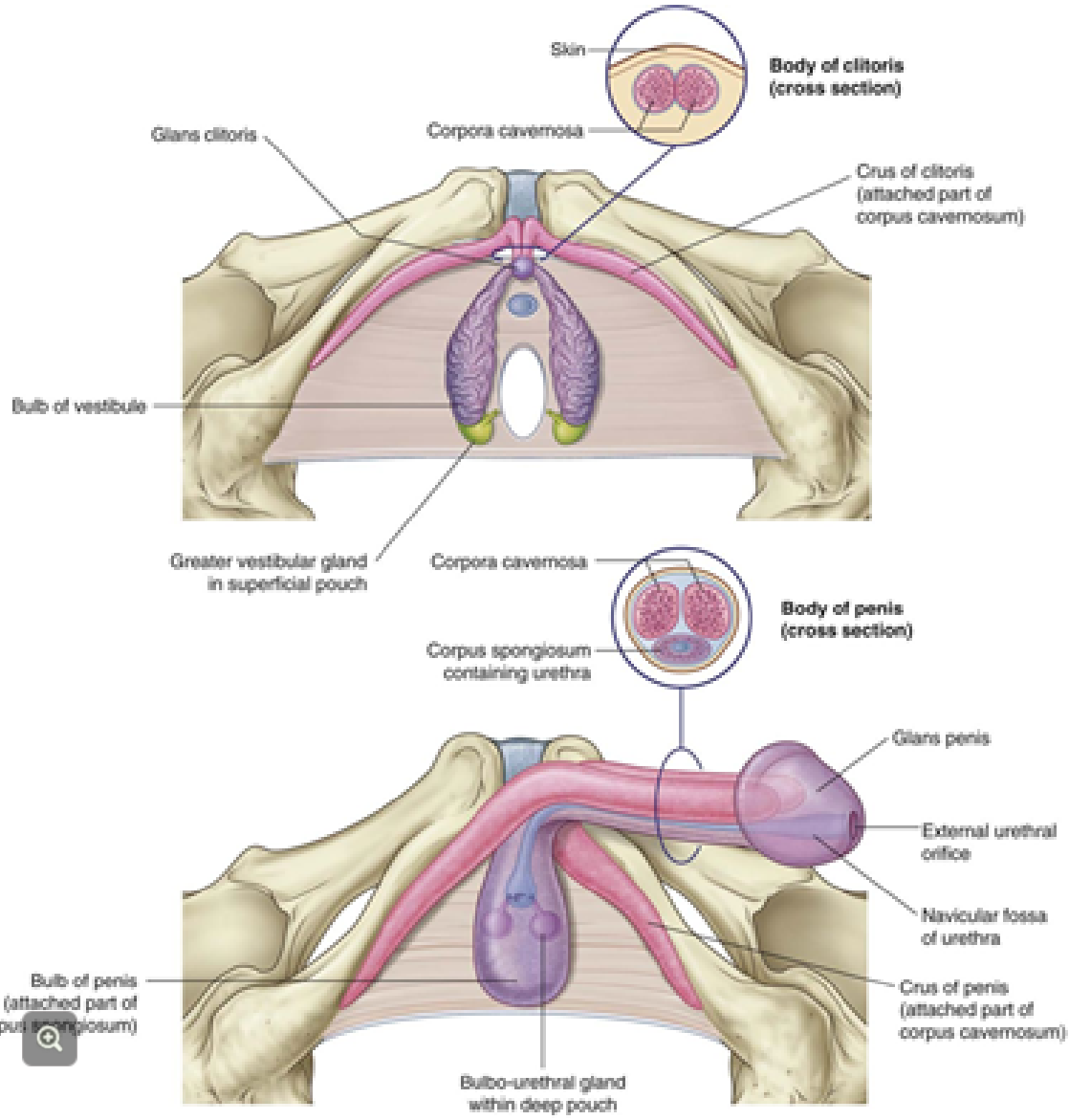
Realize that the anterior recesses are **extensions of the ischioanal fossae**; these spaces are **continuous with each other** and filled with fat. They also, however **contain important neurovascular elements that serve perineal structures**, as you will see.



The region of the UG triangle superficial to the **perineal membrane**, limited by the **membranous layer of superficial fascia** is the **superficial perineal pouch**. This region contains the **erectile structures** of the external genitalia and associated **skeletal muscles**.

In both sexes, bilaterally-paired erectile bodies, the **corpora cavernosa**, are fused to the ischiopubic rami, proximally. Their distal, unfixed ends form the **body of the clitoris** in women, and contribute to the **body of the penis** in men. The proximal, attached ends of these erectile structures are called the **crura of the clitoris** or **crura of the penis**.

In women, the **space** between the labia minora, into which the urethra and vagina open, is called the **vestibule**. A second pair of erectile bodies, the **bulbs of the vestibule**, surround this space bilaterally, fused to the inferior surface of the perineal membrane. Tapered anterior extensions of the bulbs of the vestibule meet in the midline, anterior to the urethral opening, as the **glans clitoris**.



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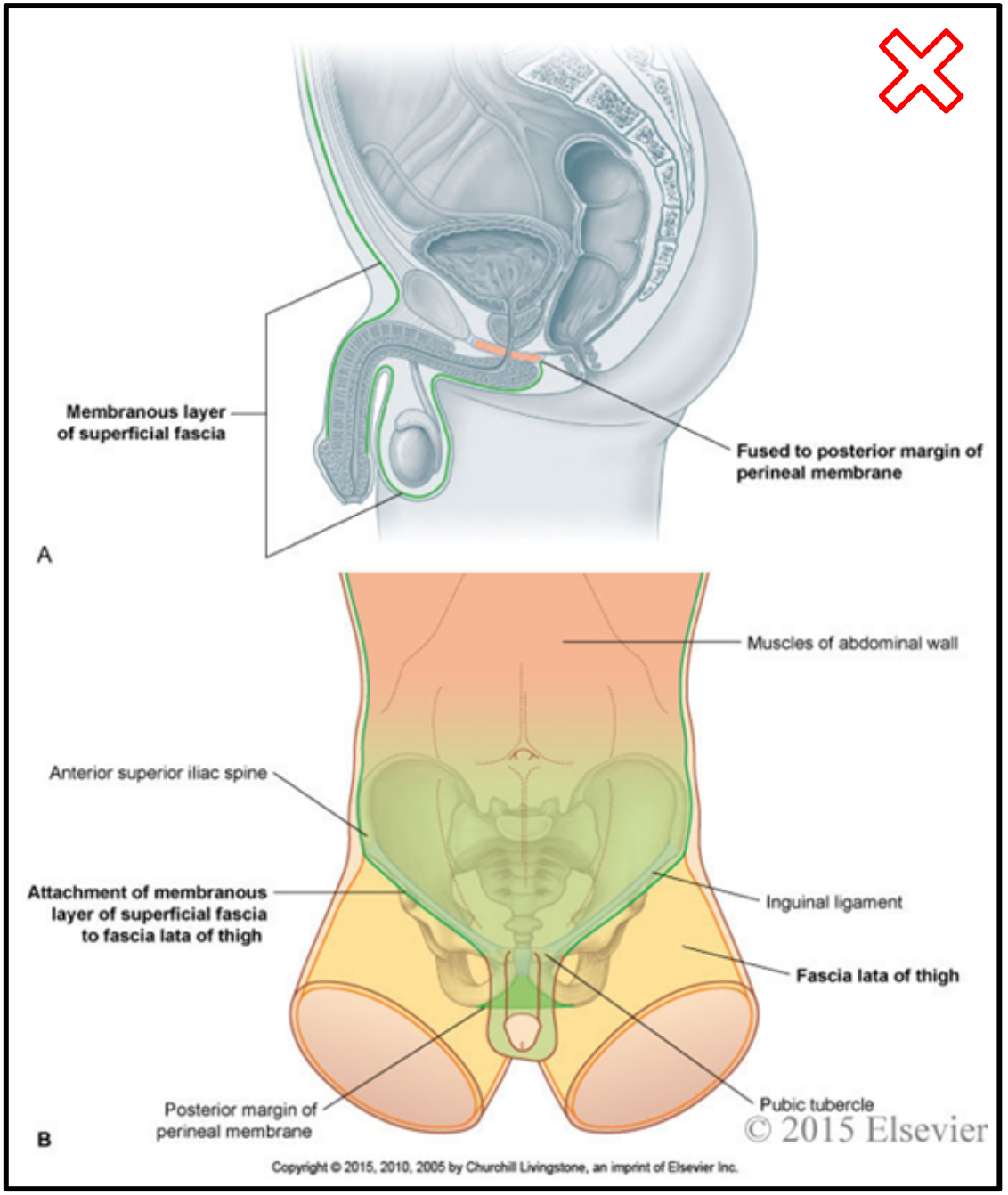
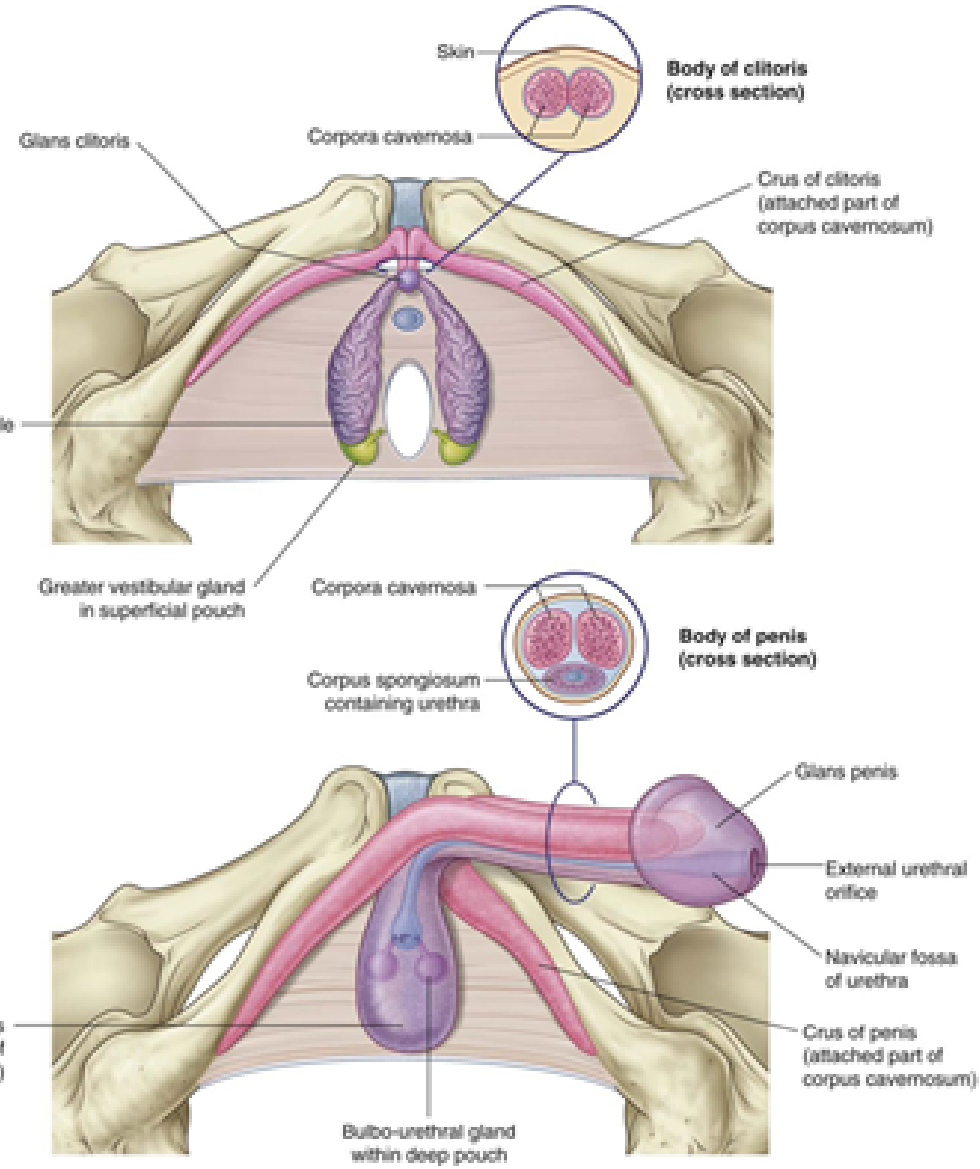


The **male homologue** of the bulbs of the vestibule is the **corpus spongiosum**, a single, midline erectile body. Its proximal end is enlarged as the **bulb of the penis**, and is fused to the inferior surface of the perineal membrane. Its distal end joins the corpora cavernosa to complete the **body of the penis** and expands to cover their distal ends as the **glans penis**. The **spongy urethra** extends through the corpus spongiosum to open at the tip of the glans penis at the **external urethral orifice**.

In women, the **greater vestibular glands** are located in the **superficial perineal pouch**. These pea-sized, mucus-secreting glands are located posterior to the bulbs of the vestibule. The ducts of the greater vestibular glands open into the vestibule and secrete mucus in response to sexual arousal.

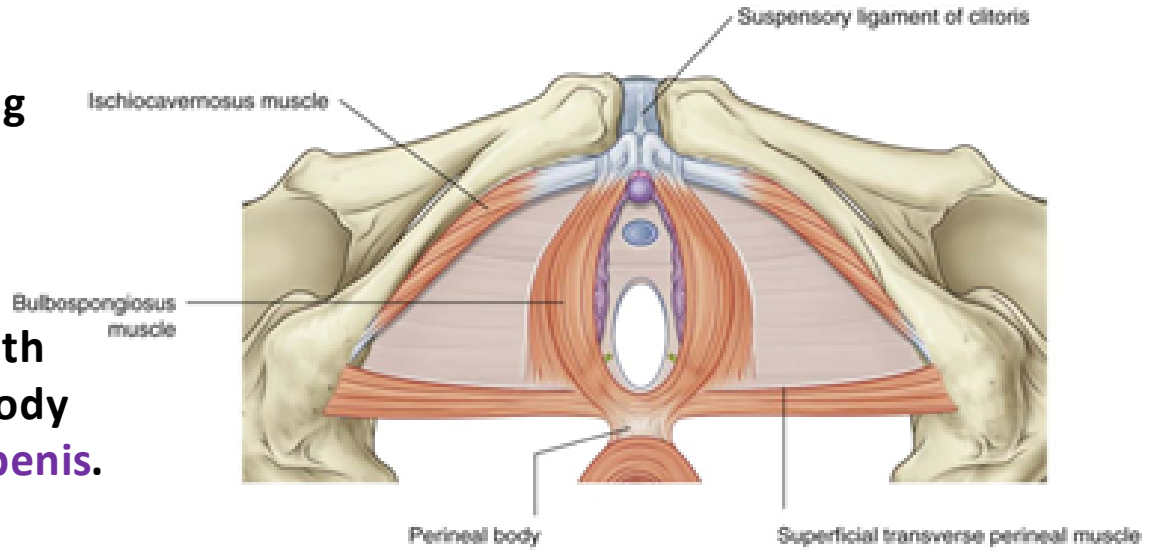
The male homologue of the greater vestibular glands are the **bulbourethral glands**. Like the greater vestibular glands, the bulbourethral glands secrete mucus in response to sexual arousal. They are, however, located in the **deep perineal pouch** in contrast to the greater vestibular glands. Their ducts open into the urethra as it passes through the perineal membrane.



Three paired skeletal muscles occupy the superficial perineal pouch. Two will be described.

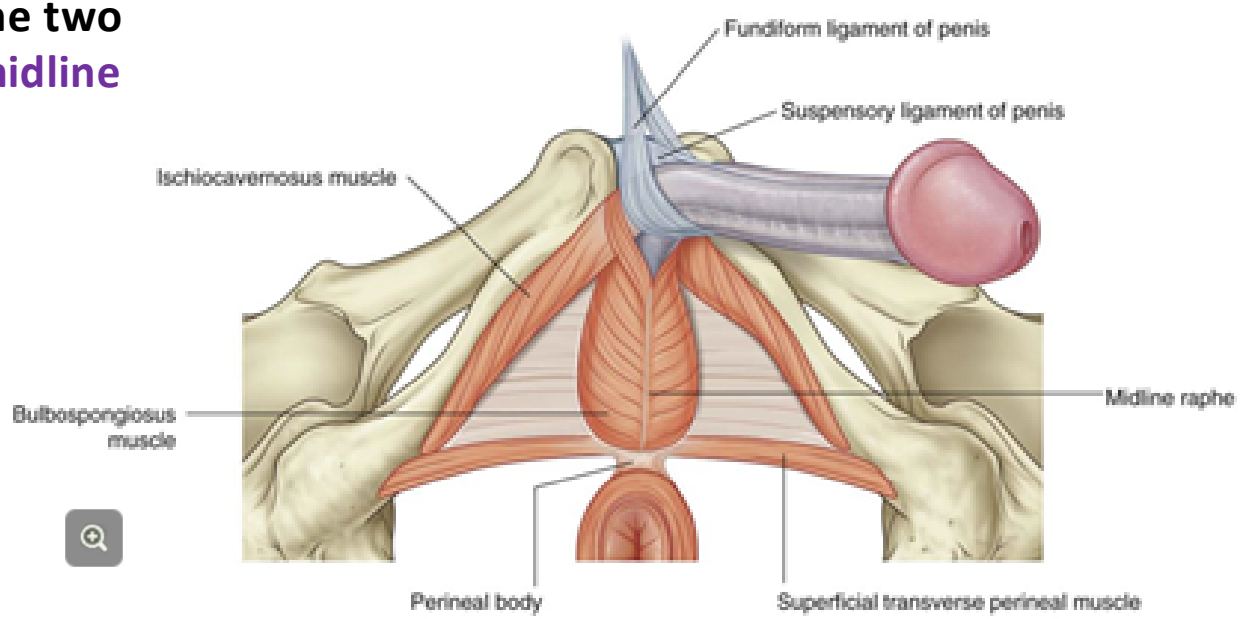
TASK

IDENTIFY the ischiocavernosus muscles on both prosections, overlying the crura of the clitoris and penis. On contraction, they propel blood from the crura to the body of the clitoris or penis.



Identify the **bulbospongiosus muscles on both prosections, extending from the perineal body to overlie the bulb(s) of the vestibule and penis.**

On the female prosection, note that the bulbospongiosus are two separate muscles. On the male prosection, however, note that the two bulbospongiosus muscles have fused in a midline raphe to cover over the bulb of the penis.



In **both sexes**, the bulbospongiosus contracts to **propel blood** from the engorged bulb into more distal parts, including the **glans**. In **men**, the bulbospongiosus also i) assists with **emptying the penile urethra** following micturition, and ii) contracts **reflexively** during **ejaculation**, causing the **pulsatile expulsion of semen** from the penis.

If you need reminding that the pudendal nerve is a somatic nerve, click here:. On one or both sides of the prosection, the gluteus maximus muscle will have been cut, allowing you to study the structures deep to in.

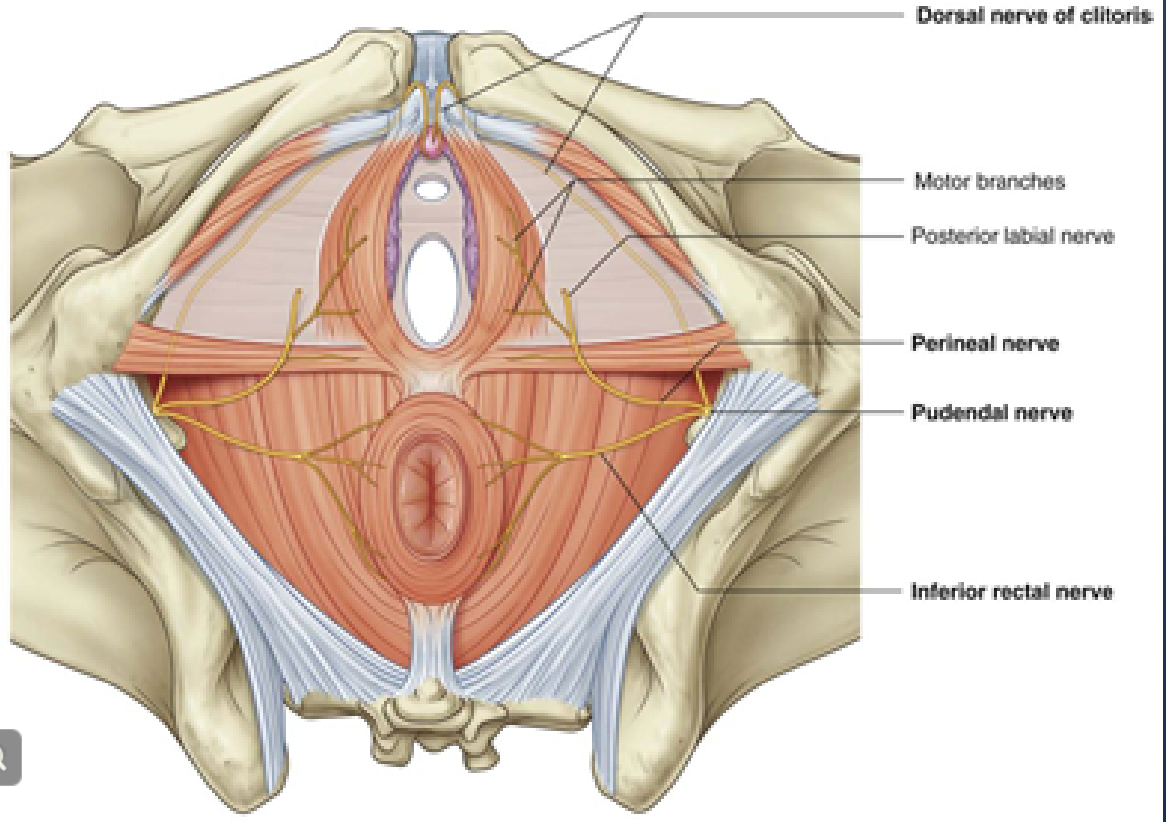
TASK

REFLECT the gluteus maximus muscle in both prosections. identify the pudendal nerve by its course: It exits the greater sciatic foramen inferior to the piriformis, but medial to the sciatic nerve. It crosses the ischial spine, and then enters the anal triangle through the lesser sciatic foramen. It has three major branches. Be able to identify the first two, and to describe the distribution of all three.

The inferior rectal nerve crosses the ischioanal fossa to innervate the external anal sphincter and portions of the levator ani and the skin of the anal triangle.

The perineal nerve enters the superficial perineal pouch to innervate its skeletal muscle, the skin of the urogenital triangle and ends as the cutaneous posterior scrotal / labial nerves.

The third branch traverses the deep perineal pouch to innervate the skeletal muscle of the external urethral sphincter, and ends as the dorsal nerve of the penis / clitoris.



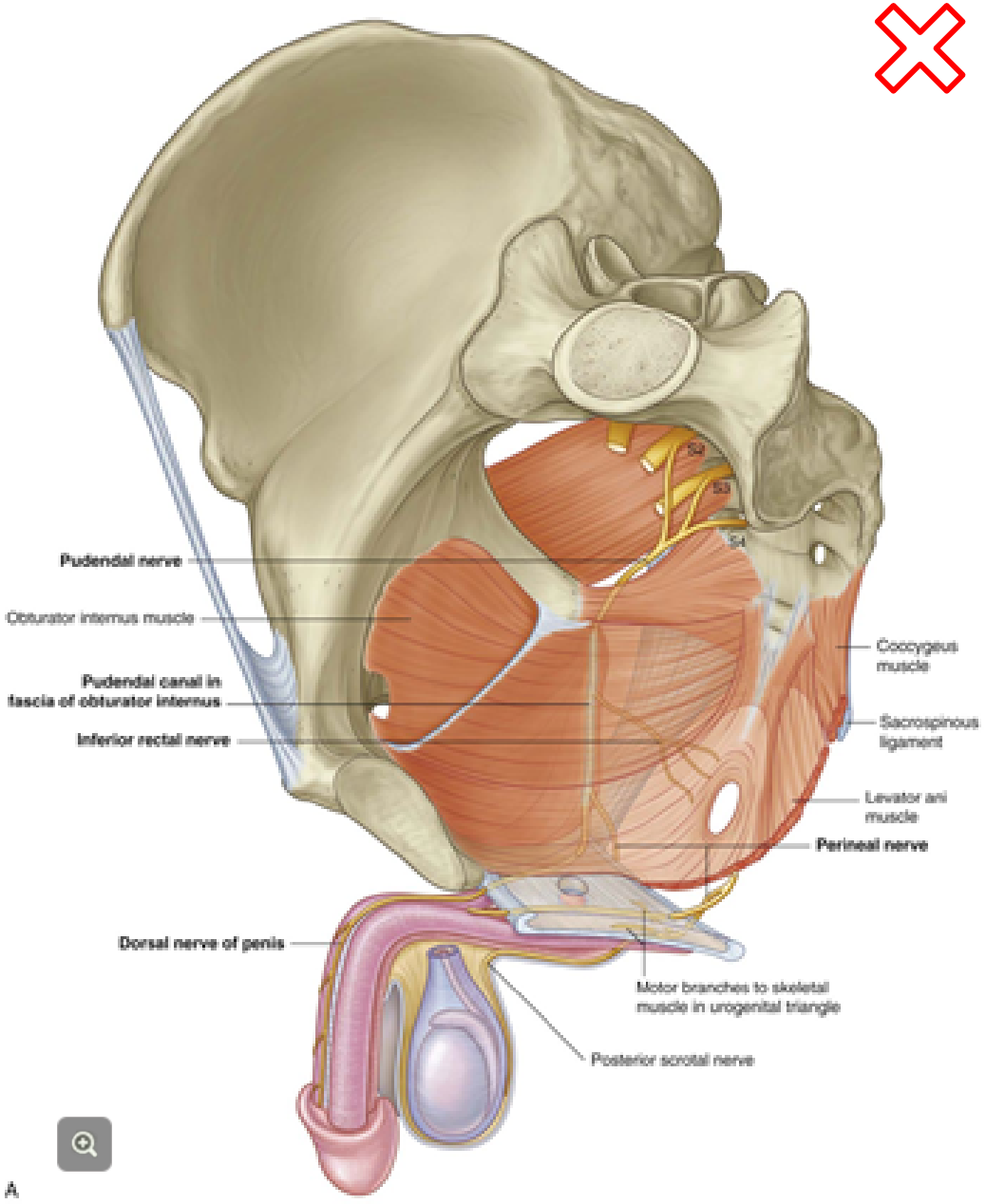
For a review of the autonomic nerves of the perineum, click here:.

Three major somatic nerves of the perineum are the **inferior rectal nerve**, the **perineal nerve** and the **dorsal nerve of the penis / clitoris**. These are all branches of the **pudendal nerve**. The pudendal nerve is formed on the posterior wall of the pelvis in the **sacral plexus**, by contributions from the **S2, S3** and **S4 ventral rami**.

The pudendal nerve is formed in the pelvis but innervates targets in the perineum. The pelvic diaphragm stands in its way, so the pudendal nerve exits the pelvis though the **greater sciatic foramen**, inferior to the piriformis, passes **outside the sacrospinous ligament**, and then enters the anal triangle through the **lesser sciatic foramen**.

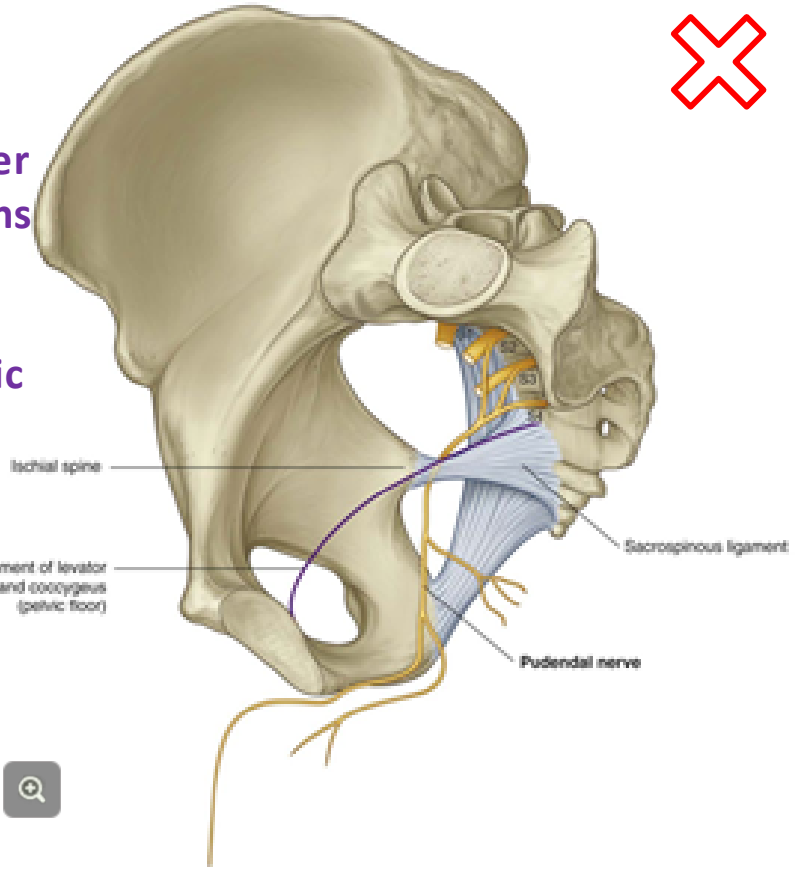
This is shown clearly here:

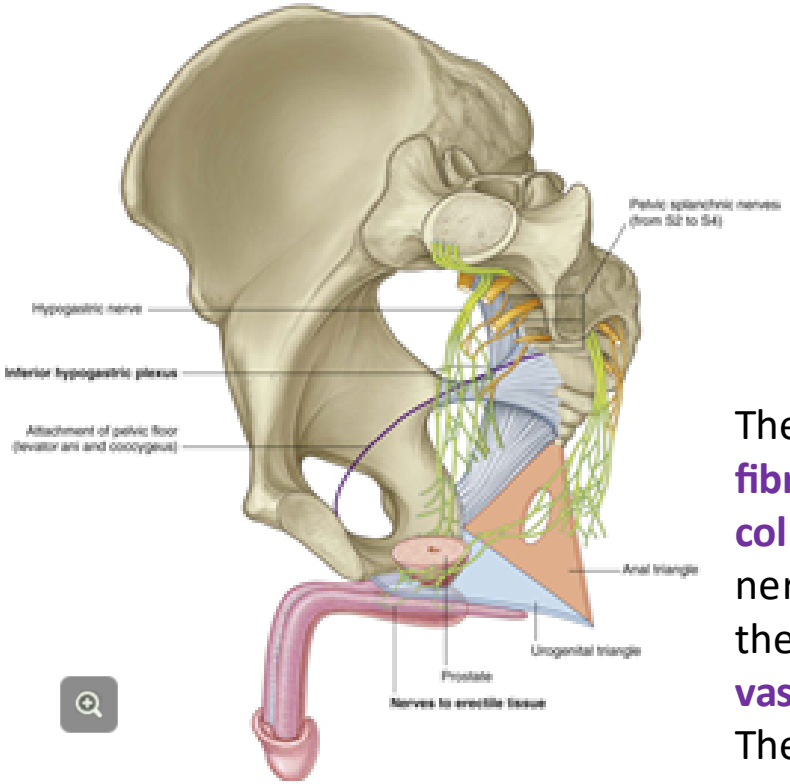
The pudendal nerve travels along the lateral wall of the ischioanal fossa, deep to the obturator fascia, in what is referred to as the **pudendal canal**.



Because the **pudendal nerves** arise from the **same spinal levels** as the **pelvic splanchnic nerves**, students confuse them.

The **pudendal** nerve is a **somatic nerve**. It contains the axons of **lower motor neurons**, the cell bodies of which are located in the **ventral horns** of the spinal cord at the **S2-S4 levels**. These axons are destined to innervate **skeletal muscle of the perineum**. It contains **sensory fibres** distributed to the **skin** of the perineum and **sympathetic postganglionic fibres** that innervate vascular smooth muscle, as well as glands and erector pili muscle of the skin of the perineum.





The **pelvic splanchnic nerves** contain **parasympathetic preganglionic fibres**, the cell bodies of which are located in the **intermediolateral cell column** of the sacral spinal cord at the **S2-S4 levels**. The pelvic splanchnic nerves form on the posterior wall of the sacrum and are distributed to the viscera of the distal digestive tract and pelvis. This includes the **vascular smooth muscle of the erectile tissues of the penis and clitoris**. The pelvic splanchnic nerves, therefore, are responsible for erection.

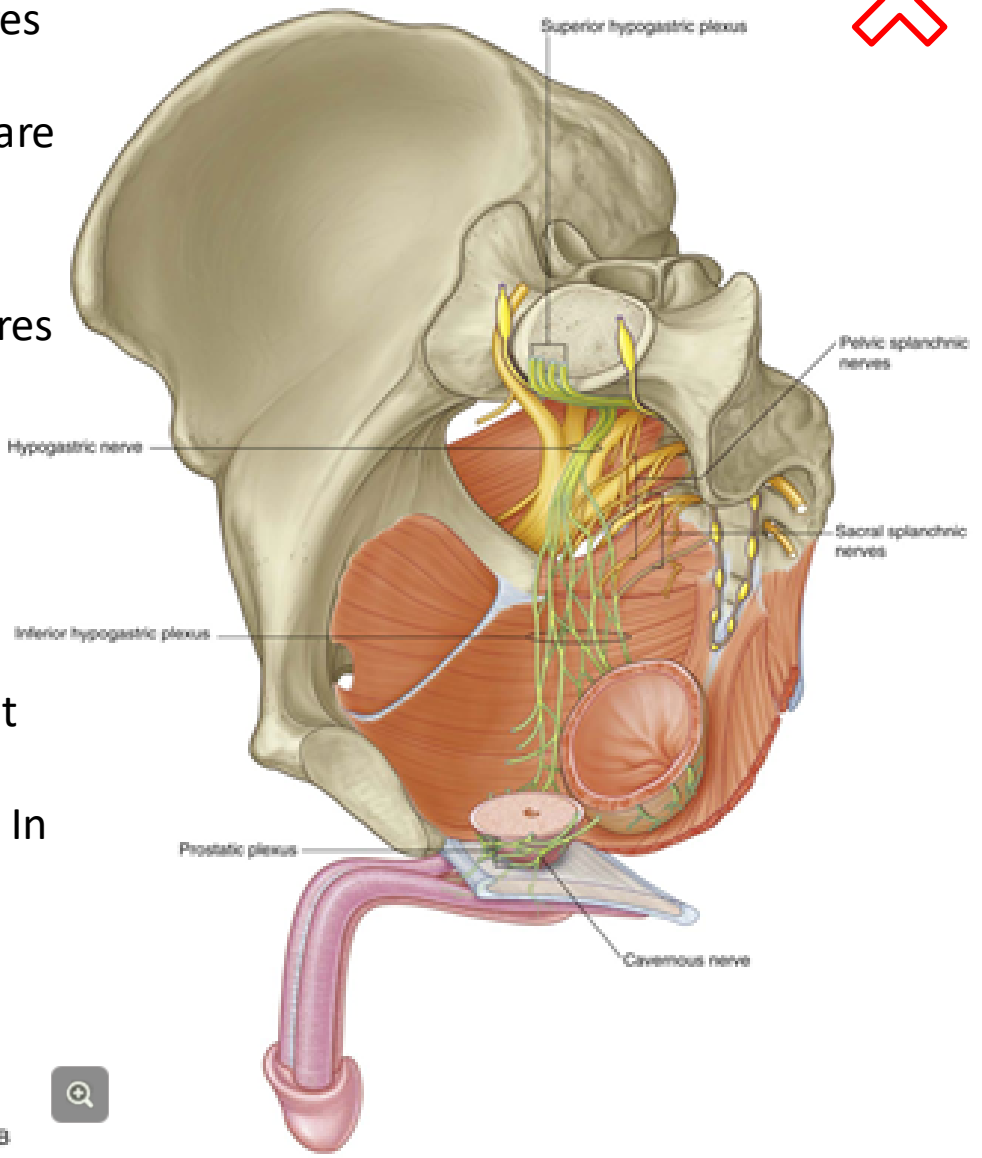
Pelvic portions of the **prevertebral plexus** provide **sympathetic, parasympathetic and visceral afferent** fibres to **pelvic structures** and to the **erectile tissues of the perineum**. The pelvic portions of the prevertebral plexus are **bilaterally paired** and are referred to, variably, as the **pelvic plexuses** or the **inferior hypogastric plexuses**.

The inferior hypogastric plexuses receive **sympathetic** fibres from the **sacral splanchnic nerves**, and parasympathetic fibres from the **pelvic splanchnic nerves**.

The inferior hypogastric plexuses give rise to the **rectal, uterovaginal, prostatic and vesical plexuses**.

The **erectile tissues of the perineum** are innervated by terminal branches of the inferior hypogastric plexuses that pass through the **deep perineal pouch**. In men, these are the **cavernous nerves**, derived from the **prostatic plexus**. In women these nerves are likely derived from the **uterovaginal plexus**.

Because of the close association of the cavernous nerves with the prostate, **impotence** can be a complication of **prostatectomy**. Similarly, **sexual dysfunction** can be a complication in **hysterectomy**.



The **internal pudendal artery** arises in the pelvis as a branch of the **internal iliac artery**. It, and its branches, have **companion veins** of the same name.

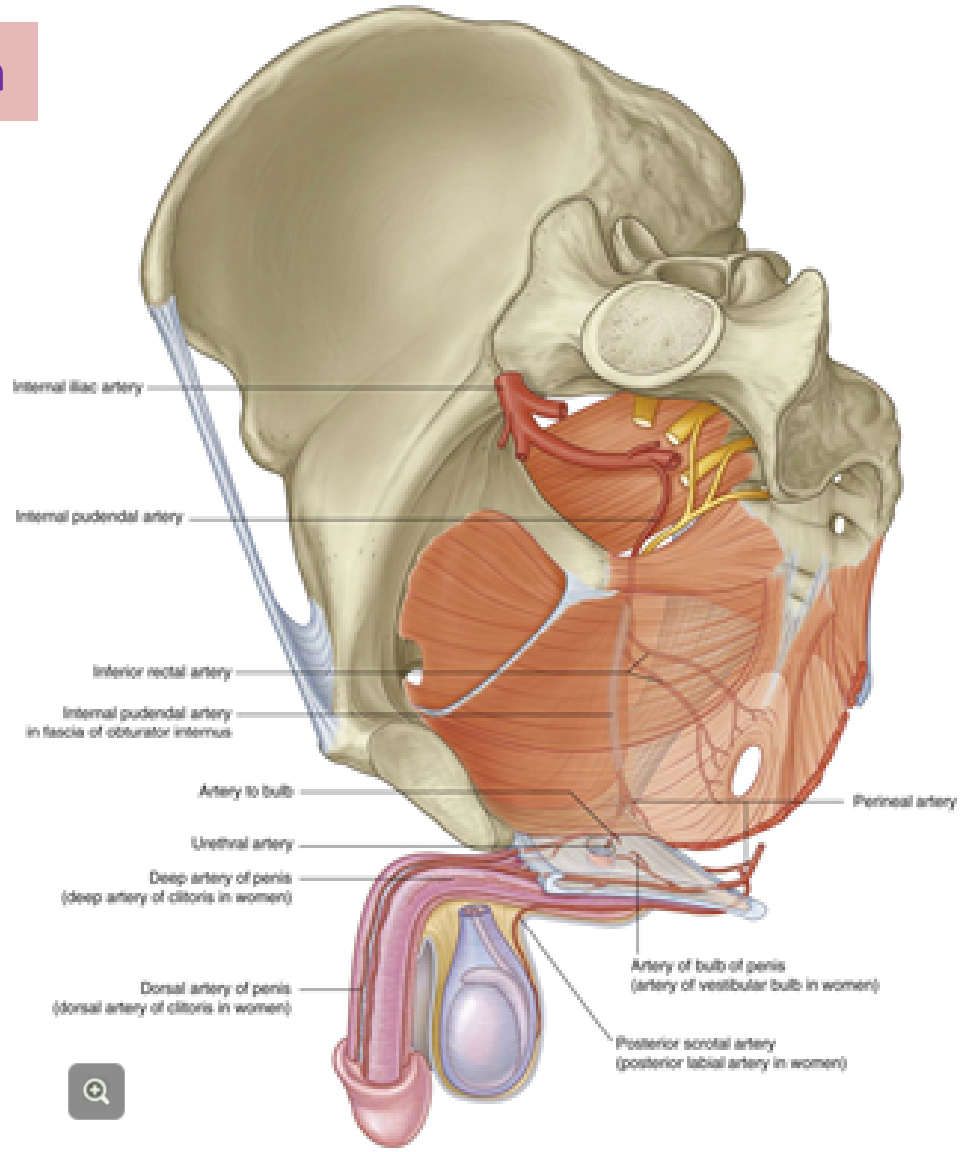
TASK

IDENTIFY the internal pudendal artery / vein in the companionship of the pudendal nerve, passing through the greater sciatic foramen, around the ischial spine, and through the lesser sciatic foramen into the anal triangle. Notice that at the ischial spine, the pudendal nerve is most medial. The internal pudendal artery and vein branch with the pudendal nerve.

Identify the inferior rectal arteries / veins accompanying the inferior rectal nerves across the ischioanal fossa to the rectum. These vessels anastomose with the middle rectal arteries and veins from the internal iliac, and the superior rectal arteries and veins from the inferior mesenteric. The venous anastomosis is a significant site of portocaval anastomosis .

Perineal arteries and veins accompany the perineal nerves into the superficial pouch.

The internal pudendal artery and vein end by supplying the structures of the deep pouch and erectile tissue.



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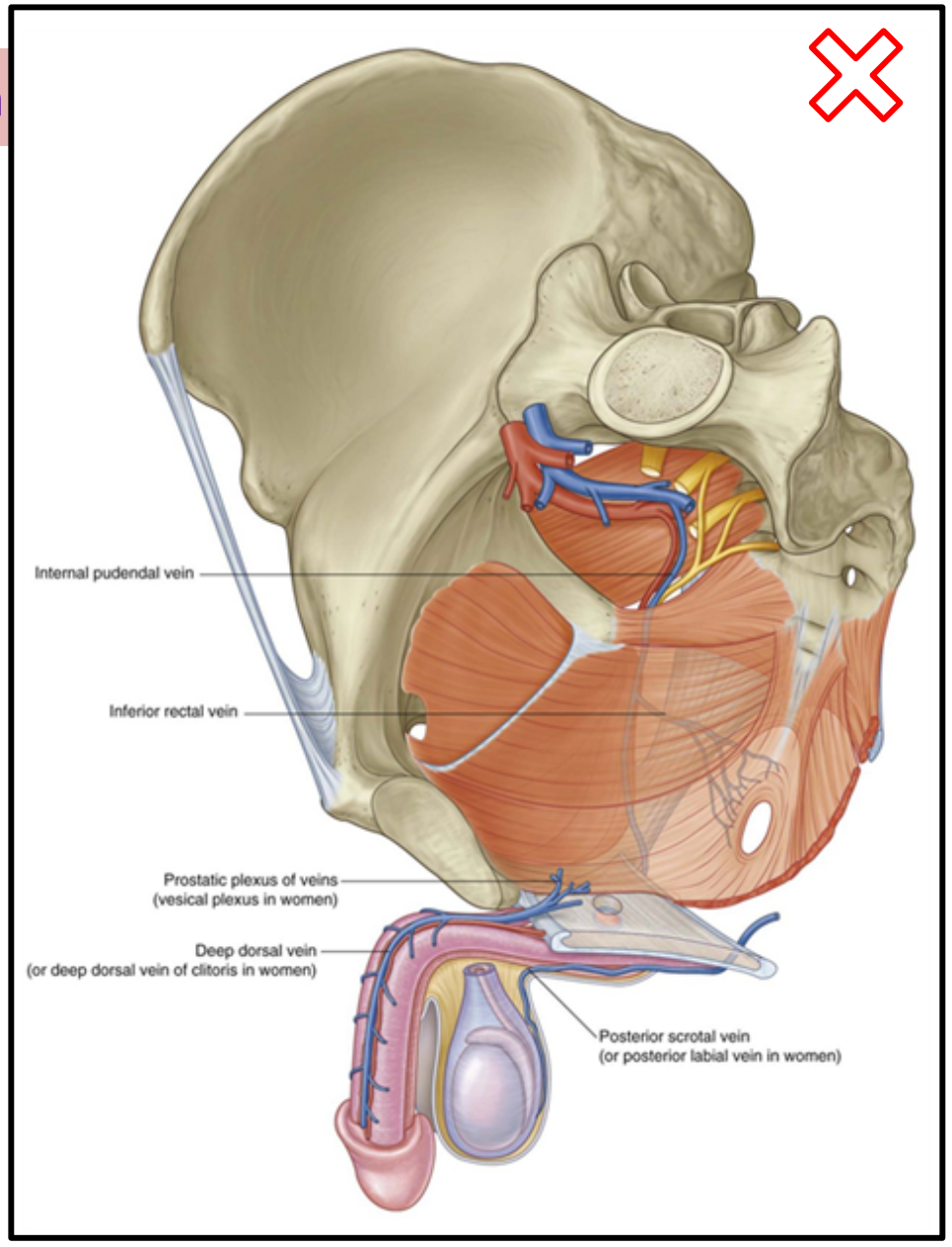

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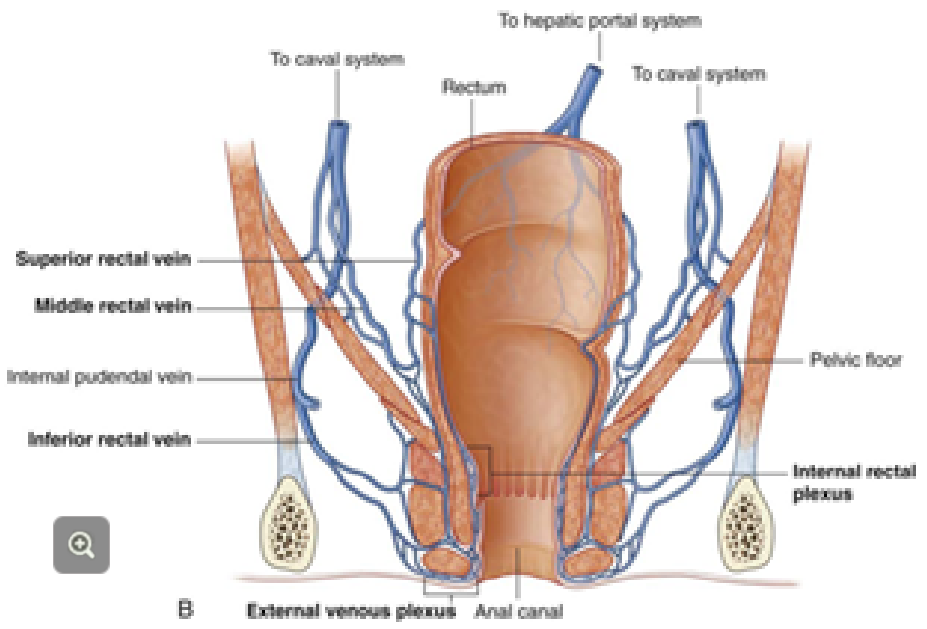
In **portal hypertension**, as might occur in cirrhosis of the liver, venous pressure in portocaval anastomoses is elevated, causing venous engorgement and increased likelihood of bleeding.



Since the last progress check, you have identified the following structures and learned the answers to the following questions:

- In the prosected perineum, identify the boundaries of the perineum, the pelvic diaphragm, the obturator internis, the ischioanal fossae and its anterior recesses, the perineal membrane, the perineal body,
- What structures form the medial and lateral walls, and apex of the ischioanal fossae? What forms the floor of the anterior recess of the ischioanal fossae? What fills the ischioanal fossae and its anterior recesses in life?
- what structures limit the superficial perineal pouch superiorly and inferiorly? Identify and describe the erectile bodies of the superficial perineal pouch in the male and female and the skeletal muscles associated with each.
- What are the greater vestibular glands? bulbourethral glands?
- identify and describe the distribution of the pudendal nerve and two of its branches, the inferior rectal and perineal nerves. Describe the distribution of the dorsal nerve of the penis / clitoris
- Identify and describe the distribution of the internal pudendal artery and its branches, the inferior rectal and perineal arteries.

If you are satisfied with your ability to answer these questions, call your TA over for confirmation and permission to move on.