1. Which statement is true regarding pelvic veins?
   
   A. The external iliac vein lies medial to the external iliac artery
   B. The external iliac veins join to form the inferior vena cava
   C. The inferior vena cava cannot be imaged
   D. Pelvic veins are usually imaged using an arteriogram

2. What bony landmark on the lateral pelvic wall may be used as a reference for localizing female pelvic anatomy or pain phenomena?
   
   A. Coccyx
   B. Ischial spine
   C. Ischial tuberosity
   D. Obturator canal
   E. Pectineal line

3. Which statement about the pelvic floor is NOT correct?
   
   A. Along with the pelvic brim, it defines the true pelvic cavity
   B. It is a funnel-shaped skeletal muscle
   C. It is referred to as the pelvic diaphragm
   D. It is tensed during defecation
   E. It projects into the anal triangle

4. Following pregnancy and delivery, a 32-year-old woman continued to have problems with urinary incontinence which developed during pregnancy. Her obstetrician counseled her to strengthen the muscle bordering the vagina and urethra, increasing its tone and exerting pressure on the urethra. This physical therapy was soon adequate to restore urinary continence. What muscle was strengthened?
   
   A. Coccygeus
   B. Ischiocavernosus
   C. Obturator Internus
5. Preganglionic parasympathetic nerve fibers within the pelvic (inferior hypogastric) plexus arise from S2, 3, 4 and enter the plexus via:

- gray rami communicantes
- hypogastric nerves
- pelvic splanchnic nerves
- sacral splanchnic nerves
- white rami communicantes

6. While performing a hysterectomy, the resident must ligate the uterine artery. To avoid iatrogenic injury to the ureters, she must be aware that the ureter passes ___________ the artery at the level of the ____________.

- Over; cervix
- Over; fundus of uterus
- Over; pelvic brim
- Under; cervix
- Under; pelvic brim

7. After giving birth, a patient complains of urinary stress incontinence characterized by dribbling of urine with an increase in intra-abdominal pressure. Her physician suspects injury to the pelvic floor during delivery which may have altered the position of the neck of bladder and the urethra. Which muscle was most likely damaged during the vaginal delivery?

- Bulbospongiosus
- Coccygeus
- Levator ani
Obturator internus
Piriformis

8. A caudal epidural block is a form of regional anesthetic used in childbirth. Within the sacral canal, the anesthetic agent bathes the sacral spinal nerve roots which would anesthetize all of the following nerves except:
A. Pelvic splanchnics
B. Pudendal
C. S2 dorsal root
D. Sacral splanchnics
E. S2 ventral primary ramus

9. After giving birth, a patient complains of dribbling of urine while coughing, sneezing, or laughing. Which muscle was most likely damaged during the vaginal delivery?
A. Coccygeus
B. Levator ani
C. Obturator internus
D. Piriformis
E. Transverse perineal

10. A patient presents complaining of blood-stained stools and the inability to completely empty his rectum. He also has pain along the back of his thigh and weakness of the posterior thigh muscles. Digital examination reveals a tumor in the posterolateral wall of the rectum. Pressure on what nerve plexus could cause the pain in his lower limb?
A. Inferior hypogastric
B. Inferior mesenteric
C. Lumbar
11. In a patient with rectal cancer located in the wall of the ampulla, you find that the cancer has spread to the muscle immediately lateral to the ampulla. This muscle is the:
   A. Piriformus
   B. Obturator internus
   C. Levator ani
   D. Sphincter urethrae
   E. Bulbospongiosus

12. Blood supply to the superior portions of the bladder typically arises from the ____________ arteries.
   A. Umbilical
   B. Middle rectal
   C. Obturator
   D. Inferior gluteal
   E. Uterine

13. The pelvic splanchnic nerves primarily carry ____________ to the ____________ plexus.
   A. Preganglionic parasympathetics--superior hypogastric
   B. Preganglionic parasympathetics--inferior hypogastric
   C. Postganglionic parasympathetics--superior hypogastric
   D. Postganglionic sympathetic--superior hypogastric
   E. Postganglionic sympathetic--superior hypogastric

14. The arcus tendineus levator ani is a thickening of fascia of the:
   A. Coccygeus
   B. Obturator externus
15. The sacral outflow of the parasympathetic (craniosacral) system enters the pelvic plexus via:

A. Hypogastric nerves
B. Pelvic splanchnic nerves
C. Pudendal nerves
D. Sacral splanchnic nerves

1. The correct answer is: A. The external iliac veins lie medial to the external iliac artery

The external iliac veins lie medial to the external iliac artery. The external iliac veins are not the veins that join to make the inferior vena cava. First, the external and internal iliac veins join to form a common iliac vein on each side. Then, the common iliacs join to form the inferior vena cava. The inferior vena cava can be imaged--it can be seen in axial CT scans or with a venogram. Veins are not imaged using an arteriogram--an arteriogram is for arteries! Instead, veins can be imaged with a venogram, a test where contrast is injected into the venous system.

2. The correct answer is: B. Ischial spine

The ischial spine is the only answer choice on the lateral pelvic wall. It arises just superior to the lesser sciatic notch and serves as the site of attachment of the sacrospinous ligament. The coccyx is the most inferior part of the vertebral column, resulting from the fusion of the four coccygeal vertebrae. It articulates with the sacrum, which means that it is associated with the posterior wall of the pelvis. The ischial tuberosity
protrudes posteroinferiorly, not laterally, from the body of the ischium. This is where weight rests when the body is in the sitting position. The ischial tuberosity also serves as the site of attachment for the sacrotuberous ligament. The obturator canal is the space in the obturator foramen that is not covered with obturator membrane. It transmits the obturator nerve and vessels, and it is on the anterior, not lateral, side of the pelvis. Finally, the pectineal line is the ridge on the pubis that creates the anterior border of the pelvic inlet and is an important landmark of the inguinal region.

3. The correct answer is: **D** It is tensed during defecation.

The pelvic floor is not tensed during defecation--it is relaxed so that feces can be released from the rectum. When rectal stretch receptors are stimulated, afferent impulses are sent to the spinal cord (which mediates local reflexes) and to the brain (which alerts the body of the urge to defecate). The pelvic splanchnic nerves mediate local parasympathetic reflexes that cause the rectal musculature to contract and the internal sphincter to relax. These reflexes are promoting the expulsion of feces. However, the external sphincter and levator ani muscles can be voluntarily contracted--they receive somatic innervation from the pudendal and levator ani nerves. This contraction allows feces to be retained until a suitable time. So, tensing the pelvis floor does not expel feces--it retains feces.

The area between the pelvic floor and the pelvic brim is the true pelvic cavity. This is the area that contains the pelvic viscera. Pelvic diaphragm is another name for the pelvic floor, and it is mostly made by levator ani, a funnel-shaped muscle. The pelvic floor also projects into the anal triangle, a space bounded by the posterior margin of the perineal membrane and the two sacrotuberous ligaments.

4.

The correct answer is: **E** puborectalis
Puborectalis is the part of levator ani that is closest to the vagina and urethra. This muscle may be injured during a difficult childbirth. By doing Kegel exercises, where women contract and relax the pelvic floor, these injured muscles may be strengthened and urinary continence may be improved. Besides levator ani, coccygeus is the second muscle that makes the pelvic floor. However, it extends between the ischial spine and the side of the coccyx/lower sacrum, so it is not next to the vagina and urethra and is not important for maintaining urinary continence. Ischiocavernosus compresses the corpus cavernosum. It is closely applied to the crus penis/clitoris in the perineum. Obturator internus and piriformis laterally rotate and abduct the thigh. Although these muscles originate in the pelvis, they are functionally more important to the lower limb.

5. The correct answer is: **pelvic splanchnic nerves**

Pelvic splanchnic nerves carry parasympathetic fibers from the lateral horn of the spinal cord at the S2, 3, and 4 levels. They can be seen coming off of the ventral primary rami of S2, 3, and 4 and going to the inferior hypogastric plexus. These nerves provide parasympathetic innervation to the pelvic viscera and the GI tract distal to the left colic flexure. (Remember, the vagus gives parasympathetic innervation to the rest of the gut.) Sacral splanchnic nerves come off the sacral sympathetic chain ganglia, carrying sympathetic fibers that will go to the inferior hypogastric plexus. To remember the difference between the pelvic and sacral splanchnics, just remember that the sacral splanchnics are named after a spinal cord segment, just like the thoracic, lumbar, and cervical splanchnics that you know and love. These all carry sympathetic fibers. Pelvic splanchnics are not named after a spinal cord segment and they're different--they carry parasympathetic fibers.

The grey rami communicantes are structures that postganglionic sympathetic neurons travel on to get out of the sympathetic trunk and rejoin a spinal nerve. There are gray rami in the pelvis. The white rami communicantes are structures that preganglionic sympathetic fibers use to get out of a spinal nerve to enter the sympathetic trunk. White rami
are seen between the T1 to L2 levels, but not in the pelvis. Finally, the hypogastric nerves carry postganglionic sympathetic nerves from the superior hypogastric plexus to the inferior hypogastric plexus.

6. The correct answer is: **D** Under; cervix

Remember—the ureter passes under the uterine artery, in the inferior portion of the mesometrium, near the cervix! This is a very important relationship—see Netter Plate 370 for a picture.

7. The correct answer is: **C** Levator ani

Urinary stress incontinence happens when the bladder can’t handle increased compression during exercise, coughing, or sneezing. This form of incontinence is the result of relaxation of the pelvic muscles and displacement of the urethrovessiculal junction. Remember—levator ani is the major pelvic muscle which elevates the pelvic floor. So, if this muscle became injured during a vaginal birth, a woman might experience urinary incontinence.

The bulbospongiosus muscle is found in the perineum; it compresses the vestibular bulb and constricts the vaginal orifice. Coccygeus is a smaller muscle found posterior to levator ani. It also elevates the pelvic floor, but it is not as important as levator ani. So, injury to coccygeus alone would not cause incontinence. Obturator internis is a muscle which leaves the pelvis through the lesser sciatic foramen and inserts on the greater trochanter of the femur; it laterally rotates and abducts the thigh. Finally, piriformis is a muscle that leaves the pelvis through the greater sciatic foramen and inserts on the greater trochanter; it also allows for lateral rotation and abduction of the thigh.

8. The correct answer is: **D** Sacral splanchnics
The sacral splanchnic nerves do not come out of the sacral nerve roots--instead, these nerves come from the sacral sympathetic ganglia. So, anesthesia bathing the sacral nerve roots would not affect the sacral splanchnic nerves, which are coming from the sympathetic trunk. The sacral splanchnic nerves contribute to the inferior hypogastric plexus and provide sympathetic innervation to the vascular smooth muscle of the pelvic viscera.

The pelvic splanchnic nerves are comprised of fibers from S2, 3, and 4, and pudendal nerve is made of the ventral primary rami of S2-4. These nerves would be numbed if the sacral nerve roots were anesthetized. Finally, the S2 dorsal root and S2 ventral primary ramus would also be anesthetized by the caudal epidural block.

9. The correct answer is: **B** Levator ani

Urinary stress incontinence happens when the bladder can't handle increased compression during exercise, coughing, or sneezing. This form of incontinence is the result of relaxation of the pelvic muscles and displacement of the urethrovesical junction. Remember--levator ani is the major pelvic muscle which elevates the pelvic floor. So, if this muscle became injured during a vaginal birth, a woman might experience urinary incontinence.

Coccygeus is a smaller muscle found posterior to levator ani. It also elevates the pelvic floor, but it is not as important as levator ani. So, injury to coccygeus alone would not cause incontinence. Obturator internis is a muscle which leaves the pelvis through the lesser sciatic foramen and inserts on the greater trochanter of the femur; it laterally rotates and abducts the thigh. Piriformis is a muscle that leaves the pelvis through the greater sciatic foramen and inserts on the greater trochanter; it also allows for lateral rotation and abduction of the thigh. The transverse perineal muscle is a muscle of the perineum--it fixes and stabilizes the perineal body/central tendinous point.
10. The correct answer is: **D** Sacral plexus

The sacral plexus includes contributions from L4 through part of S4. It supplies motor innervation to muscles of the pelvic diaphragm, muscles of the urogenital diaphragm, and muscles of the posterior hip, posterior thigh, leg and foot. It supplies sensory innervation to the skin of the perineum, posterior thigh, leg and foot. So, this patient's pain and weakness in the thigh, as well as his inability to empty his rectum, point to damage in the sacral plexus.

The inferior hypogastric plexus lies between the pelvic viscera and the pelvic wall-- it supplies sympathetic innervation to the vascular smooth muscle of the pelvic vessels and parasympathetic innervation to the pelvic viscera (from the pelvic splanchnic nerves). The inferior mesenteric plexus supplies sympathetic innervation to the smooth muscle of the vessels supplying the descending colon, sigmoid colon and rectum. The lumbar plexus innervates the muscles of the lower abdominal wall, the cremaster muscle, psoas major and minor, quadratus lumborum, and iliacus. Finally, the superior hypogastric plexus is the continuation of the intermesenteric plexus--it supplies the vascular smooth muscle of the pelvic viscera and transmits pain sensation from the pelvic viscera.

11. The correct answer is: **C** Levator ani

The levator ani is the muscle immediately lateral to the ampulla of the rectum, so this is where the cancer would have spread. This muscle is important for elevating the pelvic floor. The obturator internus and piriformis muscles are lateral and posterior to the rectum--they would not be affected by the cancer. The sphincter urethrae encircles and compresses the urethra. Bulbospongiosus is a muscle in the perineum which compresses the bulb of the penis and the spongy urethra in men and compresses the vestibular bulb and constricts the vaginal orifice in women.
12. The correct answer is: A Umbilical

The umbilical artery supplies the superior part of the bladder by giving off the superior vesical arteries. In males, this artery supplies the ductus deferens via the artery of the ductus deferens. Distal to those branches, the umbilical artery is not patent, and it becomes the medial umbilical ligament. The middle rectal artery supplies blood to the middle of the rectum, while the obturator artery supplies blood to the medial thigh and hip. The inferior gluteal artery supplies blood to gluteus maximus, and the uterine artery supplies blood to the uterus.

13. The correct answer is: B preganglionic parasympathetics--inferior hypogastric

Although all the other splanchnic nerves carry sympathetic fibers, the pelvic splanchnic nerves transmit preganglionic parasympathetic fibers from S2, 3, and 4. These fibers are carried to the inferior hypogastric plexus. The parasympathetic fibers from the inferior hypogastric plexus supply the smooth muscle of the pelvic viscera, while the sympathetic fibers from the inferior hypogastric plexus supply vascular smooth muscle of vessels supplying the pelvic viscera. The superior hypogastric plexus is a continuation of the intermesenteric plexus--it contributes sympathetic fibers to the inferior hypogastric plexus through hypogastric nerves.

14. The correct answer is: C Obturator internus

The fascia of obturator internus has two specializations. First, there is a strong band on the medial edge of obturator internus that stretches between the spine of the ischium and the superior pubic ramus. This is the arcus tendineus levator ani, which gives origin to the levator ani muscles. The other specialization is the obturator membrane, which nearly covers the entire obturator foramen, only leaving space for the
obturator nerves and vessels to exit. Coccygeus is a muscle that elevates the pelvic diaphragm--it is found posterior to levator ani. Obturator externus is not found in the pelvis--it takes origin from the external surface of the obturator membrane and inserts on the femur. It is an important muscle for laterally rotating the thigh. The piriformis muscle takes origin from the anterior surfaces of S2 to S4, both between and lateral to the sacral foramina. It exits the pelvis via the greater sciatic foramen, inserting on the greater trochanter of the femur in order to rotate the thigh laterally.

15. The correct answer is: Pelvic splanchnic nerves

Pelvic splanchnic nerves come from the anterior branches of S2 through S4. These are parasympathetic nerves, which send parasympathetic neurons to the hypogastric plexus, and therefore the pelvic viscera and distal colon. Hypogastric nerves are from the superior hypogastric plexus. These nerves transmit sympathetic neurons to the hypogastric plexus, and therefore the pelvic viscera. The pudendal nerve is a branch of the sacral plexus. It provides motor innervation to the muscles of the perineum, and it is the primary sensory innervation to the genitalia. Sacral splanchnic nerves are from the second and/or third ganglia of the sacral sympathetic trunk. These provide a secondary way for sympathetic neurons to reach the hypogastric plexus, and therefore the pelvic viscera.