

Blue Boxes for Abdominopelvis Exam

Abdomen

- **Clinical Significance of Fascia and Fascial Spaces of Abdominal Wall (198)**
 - *Liposuction* is a surgical method for removing unwanted subcutaneous fat using a percutaneously placed suction tube and high vacuum pressure
 - Tubes are inserted subdermally through small skin incisions
 - When closing lower abdominal skin incisions, surgeons include the membranous layer of subcutaneous tissue when suturing bc of its strength
 - Between this layer and the deep fascia covering the rectus abdominis and external oblique muscles is a potential space where fluid may accumulate (eg urine from a ruptured urethra)
 - There are no barriers (other than gravity) to prevent fluid from spreading superiorly from this space
 - It cannot spread inferiorly into the thigh bc the membranous layer fuses with the deep fascia of the thigh (fascia lata) along a line approx 2.5 cm inferior and parallel to the inguinal ligament
 - The potential or fat-filled space between the endoabdominal fascia is of special importance in surgery
 - Provides a plane that can be opened, enabling the surgeon to approach structures on or in the interior aspect of the posterior abdominal wall, such as the kidneys or bodies of lumbar vertebrae, without entering the membranous peritoneal sac containing the abdominal viscera
 - Risk of contamination is minimized
 - Anterolateral part of this potential space between the transversalis fascia and the parietal peritoneum (the *space of Bogros*) is used for placing prostheses, for ex, when repairing inguinal hernias
- **Protuberance of the Abdomen (205)**
 - A prominent abdomen is normal in infants and young children bc
 - Their GI tracts contain considerable amounts of air
 - Their anterolateral abdominal cavities are enlarging
 - Their abdominal muscles are gaining strength
 - Infant's and young child's relatively large liver also accounts for some bulging
 - Abdominal muscles protect and support the viscera most effectively when they are well toned
 - The well-conditioned adult of normal weight has a flat or scaphoid (boat shaped, hollowed, concave) abdomen when in the supine position
 - 6 common causes of abdominal protrusion begin with F –
 - Food, fluid, fat, feces, flatus, fetus
 - Eversion of the umbilicus may be a sign of increased intra-abdominal pressure, usually resulting from *ascites* (abnormal accumulation of serous fluids in the peritoneal cavity) or a *large mass* (eg tumor, fetus, enlarged organ)
 - Excess fat accumulation owing to overnourishment most commonly involves the subcutaneous fatty layer
 - There may also be excessive depositions of extraperitoneal fat in some types of obesity
 - Tumors and organomegaly (organ enlargement such as splenomegaly) also produce abdominal enlargement
 - When the anterior abdominal muscles are underdeveloped or become atrophic, as a result of old age or insufficient exercise
 - They provide insufficient tonus to resist the increased weight of a protuberant abdomen on the anterior pelvis
 - Pelvis tilts anteriorly at the hip joints when standing (the pubis descends and the sacrum ascends) producing excessive *lordosis* of the lumbar region of the vertebral column
- **Abdominal Hernias (205)**
 - The anterolateral abdominal wall may be the site of *hernias*
 - Most occur in the inguinal, umbilical, and epigastric regions
 - *Umbilical hernias* – common in newborns bc the anterior abdominal wall is relatively weak in the umbilical ring, especially in low-birth-weight infants
 - Usually small and result from increased intra-abdominal pressure in the presence of weakness and incomplete closure of the anterior abdominal wall after ligation of the umbilical cord at birth
 - Herniation occurs through the umbilical ring
 - *Acquired umbilical hernias* occur most commonly in women and obese people

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- Extraperitoneal fat and/or peritoneum protrude into the hernial sac
- The lines along which the fibers of the abdominal aponeuroses interlace are also potential sites of herniation
 - Occasionally, gaps exist where these fiber exchanges occur – for ex in the midline or in the transition from aponeurosis to rectus sheath
 - Gaps may be congenital, the result of stresses of obesity and aging, of the consequence of surgical or traumatic wounds
- *Epigastric hernia* (hernia in the epigastric region through the linea alba) occurs in the midline between the xiphoid process and the umbilicus
- *Spigelian hernias* are those occurring along the semilunar lines
 - Tend to occur in people > 40 years old and are usually associated with obesity
 - The hernial sac, composed of peritoneum, is covered with only skin and fatty subcutaneous tissue
- **Palpation of the Anterolateral Abdominal Wall (206)**
 - Warm hands are especially important when palpating the abdominal wall bc cold hands make the anterolateral abdominal muscles tense, producing involuntary spasms of the muscles, known as *guarding*
 - Intense guarding, board-like reflexive muscular rigidity that cannot be willfully suppressed, occurs during palpation when an organ (such as the appendix) is inflamed and in itself constitutes a clinically significant sign of *acute abdomen*
 - The involuntary muscular spasms attempt to protect the viscera from pressure, which is painful when an abdominal infection is present
 - The common nerve supply of the skin and muscles of the wall explains why these spasms occur
 - Palpation of abdominal viscera is performed with the patient in the supine position with thighs and knees semiflexed to enable adequate relaxation of the anterolateral abdominal wall
 - Otherwise, the deep fascia of the thighs pulls on the membranous layer of the abdominal subcutaneous tissue, tensing the abdominal wall
 - Some people tend to place their hands behind their heads when lying supine, which also tightens the muscles and makes the exam difficult
 - Placing the upper limbs at the sides and putting a pillow under the person's knees tends to relax the anterolateral abdominal muscles
- **Superficial Abdominal Reflexes (206, 208)**
 - Physicians and surgeons examine the reflexes of the abdominal wall to determine if there is abdominal disease, such as appendicitis
 - The abdominal wall is the only protection most of the abdominal organs have
 - Consequently, it will react if an organ is diseased or injured
 - With the person supine and the muscles relaxed, the superficial abdominal reflex is elicited by quickly stroking horizontally, lateral to medial, toward the umbilicus
 - Usually, contraction of the abdominal muscles is felt
 - This reflex may not be observed in obese people
 - Similarly, any injury to the abdominal skin results in a rapid reflex contraction of the abdominal muscles
- **Injury to Nerves of the Anterolateral Abdominal Wall (208)**
 - The inferior thoracic spinal nerves (T7-T12) and the iliohypogastric and ilioinguinal nerves (L1) approach the abdominal musculature separately to provide the multi-segmental innervation of the abdominal muscles
 - Versus the limbs, in which multi-segmental peripheral nerves provide innervation
 - Thus they are distributed across the anterolateral abdominal wall, where they run obliquely but mostly horizontal courses and are susceptible to injury in surgical incisions or from trauma at any level of the abdominal wall
 - Injury to them during surgery or from an abdominal injury may result in weakening of the muscles
 - In the inguinal region, such a weakness may predispose an individual to development of an inguinal hernia
- **Abdominal Surgical Incisions (208-209)**
 - Surgeons use various incisions to gain access to the abdominal cavity
 - When possible, the incisions follow the cleavage lines (Langer lines) in the skin
 - The incision that allows adequate exposure and, secondarily, the best possible cosmetic effect, is chosen

- The location of the incision also depends on – the type of operation, the location of the organ(s) the surgeon wants to reach, bony or cartilaginous boundaries, avoidance of (especially motor) nerves, maintenance of blood supply, and minimizing injury to muscles and fascia of the wall while aiming for favorable healing
 - Thus before making an incision, the surgeon considers the direction of the muscle fibers and the location of aponeuroses and nerves
 - So, a variety of incisions are routinely used, each having specific advantages and limitations
- Instead of transecting muscles, causing irreversible necrosis (death) of muscle fibers, the surgeon splits them in the direction of (and between) their fibers
 - The rectus abdominis is an exception – it can be transected bc its muscle fibers run short distances between tendinous intersections and its segmental innervation enters at the lateral part of the rectus sheath
 - Therefore, nerves can be easily located and preserved
 - The surgeon chooses the part of the anterolateral abdominal wall that gives the freest access to the targeted organ with the least disturbance to the nerve supply to the muscles
 - Muscles and viscera are retracted toward, not away from, their neurovascular supply
 - Cutting a motor nerve paralyzes the muscles fibers supplied by it, thereby weakening the anterolateral abdominal wall
 - However, bc of overlapping areas of innervation between nerves, one or two small branches of nerves may usually be cut without a noticeable loss of motor supply to the muscle or loss of sensation to the skin
 - Little if any communication occurs between nerves from the lateral border of the rectus abdominis to the anterior midline
- *Oblique and transverse incisions* – used most commonly on one side of the midline and especially in the more peripheral abdomen where their direction is related to muscle fiber orientation, nearby hard tissue (costal margin or iliac or pubic crest), or minimizing potential nerve damage
 - **Gridiron (muscle-splitting) incisions** – often used for appendectomy
 - Oblique *McBurney incision* is made at the McBurney point, approx 2.5 cm superomedial to the ASIS on the spinoumbilical line
 - This incision is currently less popular than an almost transverse incision in the line of a skin crease
 - In either case, the external oblique aponeurosis is incised inferomedially in the direction of its fibers and retracted
 - The musculoaponeurotic fibers of the internal oblique and transverse abdominal are then split in the line of their fibers and retracted
 - The iliohypogastric nerve, running deep to the internal oblique, is identified and preserved
 - Carefully made, the entire exposure cuts no musculoaponeurotic fibers
 - Therefore, when the incision is closed, the muscle fibers move together and the abdominal wall is as strong after the operation as it was before
 - When kept relatively small and done carefully, the gridiron incision provides good access and avoids cutting, tearing, and stretching of nerves
 - **Suprapubic (Pfannenstiel) incisions** (“bikini” incisions) – made in the pubic hairline
 - These incisions – horizontal with a slight convexity – are used for most gynecological and obstetrical operations (eg for cesarean section and removal of a tubal pregnancy)
 - The linea alba and the anterior layers of the rectus sheath are transected and resected superiorly, and the rectus muscles are retracted laterally or divided through their tendinous parts allowing reattachment without muscle fiber injury
 - The iliohypogastric and ilioinguinal nerves are identified and preserved
 - **Transverse incisions** through the anterior layer of the rectus sheath and rectus abdominis provide good access and cause the least possible damage to the nerve supply of the rectus abdominis
 - This muscle may be divided transversely without serious damage bc a new transverse band forms that, when the muscle segments are rejoined, is similar to a tendinous intersection

- They are not made through the tendinous intersections bc cutaneous nerves and branches of the superior epigastric vessels pierce these fibrous regions of the muscle
 - They are most useful above the level of the umbilicus
 - They can be increased laterally as needed to increase exposure but are not good for exploratory procedures bc superior and inferior extension is difficult
 - **Subcostal incisions** provide access to the gallbladder and biliary ducts on the R side and the spleen on the L
 - Incision is made parallel but at least 2.5 cm inferior to the costal margins to avoid the 7th and 8th thoracic spinal nerves
 - **High-risk incisions** include pararectus and inguinal incisions
 - **Pararectus incisions** along the lateral border of the rectus sheath are undesirable bc they are likely to cut the nerve supply to the rectus abdominis
 - Blood supply from the inferior epigastric artery also may be compromised
 - **Inguinal incisions** for repairing hernias may injure the ilioinguinal nerve directly or it may be inadvertently included in the suture during closure of the incision
 - In such cases, people may feel pain in the L1 dermatome region, which includes the scrotum (or the labium majus)
 - **Incisional hernia** is a protrusion of omentum (a fold of peritoneum) or an organ through a surgical incision
 - Surgeons who make incisions based on a thorough knowledge of anterolateral abdominal wall anatomy will only occasionally have to deal with this problem
 - However, if the muscular and aponeurotic layer of the abdomen do not heal properly, an incisional hernia can result
 - Factors predisposing a patient to incisional hernia include advanced age or debility of the patient, obesity, and postoperative wound infection
 - **Minimally invasive (endoscopic) surgery**
 - Many abdominopelvic surgical procedures are now performed using an endoscope, in which tiny perforations of the abdominal wall allow the entry of remotely operated instruments, replacing the larger conventional incisions
 - Thus the potential for nerve injury, incisional hernia, or contamination through the open wound and the time required for healing are minimized
- **Reversal of Venous Flow and Collateral Pathways of Superficial Abdominal Veins (212)**
 - When flow in the SVC or IVC is obstructed, anastomoses between the tributaries of these systemic veins, such as the thoracoepigastric vein, may provide collateral pathways by which the obstruction may be bypassed
 - This allows blood to return to the heart
 - Small cutaneous (systemic) veins surrounding the umbilicus also anastomose with the paraumbilical vein (tributaries of the portal vein), which run with the obliterated umbilical vein (round ligament of the liver)
 - During either caval or portal obstruction, these anastomosing veins may also become distended, causing the *caput medusae* appearance (referring to the head of Medusa, who had writhing snakes for hair)
- **External Supravesicle Hernia (214)**
 - Leaves the peritoneal cavity through the supravesical fossa
 - Site of this hernia is medial to that of a direct inguinal hernia
 - The iliohypogastric nerve is in danger of injury during the repair of this rare type of hernia
- **Postnatal Patency of the Umbilical Vein (214)**
 - Before the birth of a fetus, the umbilical vein carries well-oxygenated, nutrient-rich blood from the placenta to the fetus
 - Although reference is often made to the “occluded” umbilical vein forming the round ligament of the liver, this vein is patent for some time after birth and is used for *umbilical vein catheterization*
 - For exchange transfusion during early infancy – for ex, in infants with erythroblastosis fetalis or hemolytic disease of the newborn
- **Maldescent of the testis (220)**
 - The testes are undescended in approx 3% of full-term and 30% of preterm infants
 - About 95% of maldescended testes occur unilaterally
 - If a testis has not descended or is not retractable (capable of being drawn down), the condition is *cryptorchidism*
 - The undescended testis usually lies somewhere along the normal path of its prenatal descend, commonly in the inguinal canal

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- The importance of cryptorchidism is greatly increased risk for developing malignancy in the undescended testis, particularly problematic bc it is not palpable and is not usually detected until cancer has progressed
- **Cancer of the Uterus and Labium Majus (220)**
 - Lymphogenous metastasis of cancer most commonly occurs along lymphatic pathways that parallel venous drainage of the organ that is the site of the primary tumor
 - This is also true of the uterus, the veins and lymph vessels of which mostly drain via deep routes
 - However, some lymphatic vessels follow the course of the round ligament through the inguinal canal
 - Thus, while occurring less often, metastatic uterine cancer cells (especially from tumors adjacent to the proximal attachment of the round ligament) can spread from the uterus to the labium majus (the developmental homologue of the scrotum and site of distal attachment of the round ligament)
 - From there it can spread to the superficial inguinal nodes, which receive lymph from the skin of the perineum (including the labia)
- **Inguinal Hernias (223-225)**
 - An inguinal hernia (rupture) is a protrusion of parietal peritoneum and viscera, such as the small intestine, through a normal or abnormal opening from the cavity in which they belong
 - Most hernias are reducible, meaning that they can be returned to their normal place in the peritoneal cavity by appropriate manipulation
 - Between 80 and 90% of abdominal hernias are in the inguinal region – the two main types are *direct* and *indirect inguinal hernias*
 - More than 2/3 are indirect hernias

Characteristic	Direct (Acquired)	Indirect (Congenital)
Predisposing factors	Weakness of anterior abdominal wall in the inguinal triangle (eg owing to distended superficial ring, narrow inguinal falx, or attenuation of aponeurosis in males >40 years old)	Patency of processus vaginalis (complete or at least superior part) in younger persons, mostly males
Frequency	Less common (1/3 to 1/4 of inguinal hernias)	More common (2/3 to 3/4 of inguinal hernias)
Exit from abdominal cavity	Peritoneum plus transversalis fascia (lies outside inner one or two fascial coverings of cord)	Peritoneum of persistent processus vaginalis plus all 3 fascial coverings of cord/round ligament
Course	Passes through or around the inguinal canal, usually traversing only medial 1/3 of canal, external and parallel to vestige of processus vaginalis	Traverses inguinal canal (entire canal if it is of sufficient size) within processus vaginalis
Exit from anterior abdominal wall	Via superficial ring, lateral to cord; rarely enters scrotum	Via superficial ring inside cord, commonly passing into scrotum/labium majus

- Normally, most of the processus vaginalis obliterates before birth, except for the distal part that forms the tunica vaginalis of the testis
 - The peritoneal part of the hernial sac of an indirect inguinal hernia is formed by the persisting processus vaginalis
 - If the entire stalk of the processus vaginalis persists, the hernia extends into the scrotum superior to the testis, forming a complete indirect inguinal hernia
- The superficial inguinal ring is palpable superolateral to the pubic tubercle by invaginating the skin of the upper scrotum with the index finger
 - The examiner's finger follows the spermatic cord superolaterally to the superficial inguinal ring
 - If the ring is dilated, it may admit the finger without causing pain
 - Should a hernia be present, a sudden impulse is felt against either the tip or pad of the examining finger when the patient is asked to cough
 - However, bc both inguinal hernia types exit the superficial ring, palpation of an impulse at this site does not discriminate type
- With the palmar surface of the finger against the anterior abdominal wall, the *deep inguinal ring* may be felt as a skin depression superior to the inguinal ligament, 2-4 cm superolateral to the pubic tubercle
 - Detection of an impulse at the superficial ring and a mass at the site of the deep ring suggests an *indirect hernia*

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- Palpation of a *direct inguinal hernia* is performed by placing the palmar surface of the index and/or middle finger over the inguinal triangle and asking the person to cough or bear down (strain)
 - If a hernia is present, a forceful impulse is felt against the pad of the finger
 - The finger can also be placed in the superficial inguinal ring
 - If a direct hernia is present, a sudden impulse is felt medial to the finger when the person coughs or bears down
- **Cremasteric Reflex (225)**
 - Contraction of the cremaster muscle is elicited by lightly stroking the skin on the medial aspect of the superior part of the thigh with an applicator stick or tongue depressor
 - The ilioinguinal nerve supplies this area of skin
 - The rapid elevation of the testis on the same side is the *cremasteric reflex*
 - This reflex is extremely active in children – consequently, hyperactive cremasteric reflexes may stimulate undescended testes
 - A hyperactive reflex can be abolished by having the child sit in a cross-legged, squatting position
 - If the testes are descended, they can then be palpated in the scrotum
- **Cysts and Hernias of the Canal of Nuck (225)**
 - Indirect inguinal hernias can occur in women, but they are approx 20 times more common in men
 - If the processus vaginalis persists in females it forms a small peritoneal pouch, known as the *canal of Nuck*, in the inguinal canal that may extend to the labium majus
 - In female infants, such remnants can enlarge and form cysts in the inguinal canal
 - The cysts may produce a bulge in the anterior part of the labium majus and have the potential to develop into an indirect inguinal hernia
- **Hydrocele (225-226)**
 - The presence of excess fluid in a *persistent processus vaginalis*
 - This congenital anomaly may be associated with an indirect inguinal hernia
 - The fluid accumulation results from secretion of an abnormal amount of serous fluid from the visceral layer of the tunica vaginalis
 - The size of the hydrocele depends on how much of the processus vaginalis persists
 - *Hydrocele of the testis* is confined to the scrotum and distends the tunica vaginalis
 - *Hydrocele of the cord* is confined to the spermatic cord and distends the persistent part of the stalk of the processus vaginalis
 - A congenital hydrocele of the cord and testis may communicate with the peritoneal cavity
 - *Detection of a hydrocele* requires transillumination, a procedure during which a bright light is applied to the side of the scrotal enlargement in a darkened room
 - The transmission of light as a red glow indicates excess serous fluid in the scrotum
 - Newborn male infants often have residual peritoneal fluid in their tunica vaginalis
 - However, this fluid is usually absorbed during the 1st year of life
 - Certain pathological conditions, such as injury and/or inflammation of the epididymis, may also produce a hydrocele in adults – a collection of serous fluid in the tunica vaginalis of the testis
- **Hematocele (226)**
 - *Hematocele of the testis* is a collection of blood in the tunical vaginalis that results, for ex, from rupture of branches of the testicular artery by trauma to the testis
 - Trauma may produce a scrotal and/or testicular hematoma (accumulation of blood, usually clotted, in any extravascular location)
 - Blood does not transilluminate; therefore, transillumination can differentiate a hematocele or hematoma from a hydrocele
 - A hematocele of the testis may be associated with a *scrotal hematocele*, resulting from effusion of blood into the scrotal tissues
- **Torsion of the Spermatic Cord (226)**
 - This twisting is a surgical emergency bc the testicle may die
 - The torsion obstructs the venous drainage, with resultant edema and hemorrhage, and subsequent arterial obstruction
 - If not untwisted promptly, necrosis of the entire testicle is likely
 - Torsion may occur at any age, but it is more common during adolescence

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- The twisting usually occurs just above the superior pole of the testis
- A high scrotal incision is made to approach the cord, and the testis and/or cord is rotated as necessary to reduce the torsion
 - To prevent recurrence or occurrence on the contralateral side, which is likely, both testes are surgically fixed to the scrotal septum
- **Anesthetizing the Scrotum (227)**
 - The anterior 1/3 of the scrotum is supplied by the L1 segment of the spinal cord through the ilioinguinal nerve
 - The posterior 2/3 of the scrotum are supplied mainly by the S3 spinal segment through the perineal and posterior femoral cutaneous nerves
 - Therefore, when a spinal anesthetic agent is administered, it must be injected more superiorly to anesthetize the anterior surface of the scrotum than is necessary to anesthetize the posterior surface
- **Spermatocele and Epididymal Cyst (228)**
 - *Spermatocele* is a retention cyst (collection of fluid) in the epididymis, usually near its head
 - Contain a milky fluid and are generally asymptomatic
 - An *epididymal cyst* is a collection of fluid anywhere in the epididymis
- **Vestigial Remnants of Embryonic Genital Ducts (228)**
 - When the tunica vaginalis is opened, rudimentary structures may be observed at the superior extremities of the testes and epididymis
 - These structures are small remnants of genital ducts in the embryo
 - They are rarely observed unless pathological changes occur
 - The *appendix of the testis* is a vesicular remnant of the cranial end of the paramesonephric duct, the embryonic genital duct that in the female forms half of the uterus
 - It is attached to the superior pole of the testis
 - The *appendices of the epididymis* are remnants of the cranial end of the mesonephric duct, the embryonic genital duct that in the male forms part of the ductus deferens, which are attached to the head of the epididymis
 - This part of the duct, together with the mesonephric tubules associated with it, normally forms the efferent ductules and epididymis
- **Variocele (228-229)**
 - The vine-like pampiniform plexus of veins may become dilated (varicose) and tortuous, producing a *varicocele*
 - Usually visible only when the man is standing or straining (the enlargement usually disappears when the person lies down, particularly if the scrotum is elevated while supine, allowing gravity to empty the veins)
 - Palpating a varicocele can be likened to feeling a bag of worms
 - May result from defective valves in the testicular vein, but kidney or renal vein problems can also result in distension of the pampiniform veins
 - Consequently, it is necessary to rule out kidney or other abdominal causes of varicocele
 - Occurs predominantly (99%) on the L side, probably bc the acute angle at which the R vein enters the IVC is more favorable to flow than the L renal vein, making it more susceptible to obstruction or reversal of flow
 - Patients with sudden onset of varicocele, a R-sided varicocele, or a varicocele that does not reduce in size in the supine position should be suspected of having a retroperitoneal neoplasm in the region of termination of the testicular vein
- **Cancer of the Testis and Scrotum (229)**
 - Lymphogenous metastasis is common to all testicular tumors, so a knowledge of lymphatic drainage is helpful in treatment
 - Bc the testes descend from the posterior abdominal wall to the scrotum during fetal development, their lymphatic drainage differs from that of the scrotum, which is an outpouching of anterolateral abdominal skin
 - Consequently –
 - *Cancer of the testis* – metastasizes initially to the retroperitoneal *lumbar lymph nodes*, which lie just inferior to the renal veins
 - Subsequent spread may be to mediastinal and supraclavicular nodes
 - *Cancer of the scrotum* – metastasizes to the *superficial inguinal lymph nodes*, which lie in the subcutaneous tissue inferior to the inguinal ligament and along the terminal part of the great saphenous vein
 - However, metastasis of testicular cancer may also occur by hematogenous spread to the lungs, liver, brain, and bone
- **Patency and blockage of the uterine tubes (232)**
 - It is theoretically possible for organisms to enter the female peritoneal cavity directly via the uterine tubes, but this *primary peritonitis* is rare

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- Bc of the effectiveness of the protective mechanisms of the female reproductive tract
 - Primary mechanism = *mucous plug* that effectively (but not literally) blocks the external opening of the uterus
- For fertilization to occur, the pathway from the peritoneal cavity to the vaginal orifice must be patent
 - Patency of the uterine tubes can be tested clinically by means of a technique in which air or radiopaque dye is injected into the uterine cavity
 - From which it normally flows through the uterine tubes and into the peritoneal cavity (*hysterosalpingography* in Pelvis section)
- **The Peritoneum and Surgical Procedures (232-233)**
 - Bc the peritoneum is well innervated, patients undergoing abdominal surgery experience more pain with large, invasive, open incisions of the peritoneum (*laparotomy*) than they do with small, laproscopic incisions or vaginal operations
 - The covering of the peritoneum (the *serosa*) makes watertight end-to-end anastomoses of intraperitoneal organs, such as the small intestine, relatively easy to achieve
 - It is more difficult to achieve watertight anastomoses of extraperitoneal structures that have an outer adventitial layer, such as the thoracic esophagus
 - Bc of the high incidence of complications such as peritonitis and adhesions after operations in which the peritoneal cavity is opened, efforts are made to remain outside the peritoneal cavity whenever possible
 - Eg translumbar or extraperitoneal anterior approach to the kidneys
 - When opening the peritoneal cavity is necessary, great effort is made to avoid contamination of the cavity
- **Peritonitis and Ascites (233)**
 - *Peritonitis* = infection and inflammation of the peritoneum
 - Occurs when bacterial contamination occurs during laparotomy or when the gut is traumatically penetrated or ruptured as the result of infection and inflammation (as in appendicitis)
 - Gas, fecal matter, and bacteria are allowed to enter the peritoneal cavity
 - Exudation of serum, fibrin, cells, and pus into the peritoneal cavity occurs, accompanied by pain in the overlying skin and an increase in the tone of the anterolateral abdominal muscles
 - Given the extent of the peritoneal surfaces and the rapid absorption of material, including bacterial toxins, from the peritoneal cavity, when a peritonitis becomes *generalized* (wide spread in the cavity), the condition is dangerous and perhaps lethal
 - In addition to the severe abdominal pain, tenderness, nausea and/or vomiting, fever, and constipation are present
 - *General peritonitis* occurs not only as a result of infection but also when an ulcer perforates the wall of the stomach or duodenum – spills acid content into the peritoneal cavity
 - *Ascites* = the clinical condition in which one has *ascitic fluid* (excess fluid) in the peritoneal cavity
 - May also occur as a result of
 - Mechanical injury (which may also produce internal bleeding) or other pathological conditions, such as portal hypertension (venous congestion)
 - Widespread metastasis of cancer cells to the abdominal viscera
 - Starvation (when plasma proteins fail to be produced, altering concentration gradients and producing a paradoxically protuberant abdomen)
 - → in all these cases, the peritoneal cavity may be distended with several liters of abnormal fluid, interfering with movements of the viscera
 - Rhythmic movements of the anterolateral abdominal wall normally accompany respirations
 - If the abdomen is drawn in as the chest expands (*paradoxical abdominothoracic rhythm*) and muscle rigidity is present, either peritonitis or pneumonitis (inflammation of the lungs) may be present
 - Bc the intense pain worsens with movement, people with peritonitis commonly lie with their knees flexed to relax their anterolateral abdominal muscles and breath shallowly (and hence more rapidly) reducing the intra-abdominal pressure and pain
- **Peritoneal Adhesions and Adhesiotomy (233)**
 - If the peritoneum is damaged, by a stab wound for ex, or infected, the peritoneal surfaces become inflamed, making them sticky with *fibrin*

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- As healing occurs, the fibrin may be replaced with fibrous tissue, forming abnormal attachments between the visceral peritoneum of a viscus and the parietal peritoneum of the adjacent abdominal wall
 - *Adhesions* (scar tissue) may also form after an abdominal operation (eg owing to a ruptured appendix) and limit the normal movements of the viscera
 - This tethering may cause chronic pain or emergency complications such as intestinal obstruction when the gut becomes twisted around an adhesion (*volvulus*)
 - *Adhesiotomy* = the surgical separation of adhesions
 - Adhesions are often found during dissection of cadavers (ex between spleen and diaphragm)
- **Abdominal Paracentesis (233)**
 - Treatment of generalized peritonitis includes removal of the ascitic fluid and, in the presence of infection, administration of large doses of antibiotics
 - Occasionally, more localized accumulations of fluid may have to be removed for analysis
 - Surgical puncture of the peritoneal cavity for the aspiration or drainage of fluid is called *paracentesis*
 - After injection of a local anesthetic agent, a needle or trocar and a cannula are inserted through the anterolateral abdominal wall into the peritoneal cavity through the linea alba, for ex
 - Needle is inserted superior to the empty urinary bladder and in a location that avoids the inferior epigastric artery
- **Intraperitoneal Injection and Peritoneal Dialysis (233-234)**
 - Peritoneum is a semipermeable membrane with an extensive surface area, much of which (the subdiaphragmatic portions in particular) overlies blood and lymphatic capillary beds
 - Therefore, fluid injected into the peritoneal cavity is absorbed rapidly
 - For this reason, certain anesthetic agents, such as solutions of barbiturate compounds, may be injected into the peritoneal cavity by *intraperitoneal (IP) injection*
 - In renal failure, waste products such as urea accumulate in the blood and tissues and ultimately reach fatal levels
 - *Peritoneal dialysis* may be performed in which soluble substances and excess water are removed from the system by transfer across the peritoneum
 - Performed using a dilute sterile solution that is introduced into the peritoneal cavity on one side and then drained from the other side
 - Diffusible solutes and water are transferred between the blood and the peritoneal cavity as a result of concentration gradients between the 2 fluid compartments
 - Peritoneal dialysis is usually employed only temporarily, however, bc changes in the mesothelial cells of the peritoneum and in the underlying connective tissue cause it to become progressively ineffective
 - For the long term it is preferable to use direct blood flow through a renal dialysis machine
- **Functions of the Greater Omentum (238)**
 - The greater omentum, large and fat laden, prevents the visceral peritoneum from adhering to the parietal peritoneum
 - Has considerable mobility and moves around the peritoneal cavity with peristaltic movements of the viscera
 - Often forms adhesions adjacent to an inflamed organ such as the appendix, sometimes walling it off and thereby protecting other viscera from it
 - Thus it is common when entering the abdominal cavity, in either dissection or surgery, to find the omentum markedly displaced from the “normal” position in which it is almost always depicted in anatomical illustrations
 - Also cushions the abdominal organs against injury and forms insulation against loss of body heat
- **Abscess Formation (238)**
 - Perforation of a duodenal ulcer, rupture of the gallbladder, or perforation of the appendix may lead to the formation of a *circumscribed collection of purulent exudates* in the subphrenic recess
 - The abscess may be walled inferiorly by adhesions
- **Spread of Pathological Fluids (238)**
 - Peritoneal recesses are of clinical importance in connection with the spread of pathological fluids such as pus, a product of inflammation
 - The recesses determine the extent and direction of the spread of fluids that may enter the peritoneal cavity when an organ is diseased or injured
- **Flow of Ascitic Fluid and Pus (238)**

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- Paracolic gutters are of considerable clinical importance bc they provide pathways for the flow of ascitic fluid and the spread of intraperitoneal infections
 - Purulent material (consisting of or containing pus) in the abdomen can be transported along the paracolic gutters into the pelvis, especially when the person is upright
 - Thus, to facilitate the flow of exudates into the pelvic cavity where absorption of toxins is slow, patients with peritonitis are often placed in the sitting position (at least a 45° angle)
 - Conversely, infections in the pelvis may extend superiorly to a subphrenic recess situated under the diaphragm, especially when the person is supine
 - Similarly, the paracolic gutters provide pathways for the spread of tumor cells that have sloughed from the ulcerated surface of a tumor and entered the peritoneal cavity
- **Fluid in the Omental Bursa (239)**
 - Perforation of the posterior wall of the stomach results in the passage of its fluid contents into the omental bursa
 - An inflamed or injured pancreas can also result in the passage of pancreatic fluid into the bursa, forming a *pancreatic pseudo-cyst*
- **Intestine in the Omental Bursa (239,241)**
 - Although uncommon, a loop of small intestine may pass through the omental foramen into the omental bursa and be strangulated by edges of the foramen
 - As none of the boundaries of the foramen can be incised bc each contains blood vessels, the swollen intestine must be decompressed using a needle
 - This way it can be returned to the greater peritoneal sac through the omental foramen
- **Severance of the Cystic Artery (241)**
 - Cystic artery must be ligated or clamped and then severed during *cholecystectomy*, removal of the gallbladder
 - Sometimes it is accidentally severed before it has been adequately ligated
 - Surgeon can control the hemorrhage by compressing the hepatic artery as it traverses the hepatoduodenal ligament
 - Index finger is placed in the omental foramen and the thumb on its anterior wall
 - Alternate compression and release of pressure on the hepatic artery allows the surgeon to identify the bleeding artery and clamp it
- **Esophageal Varices (247)**
 - Bc the submucosal veins of the inferior esophagus drain to both the portal and systemic venous systems, they constitute a portosystemic anastomosis
 - In *portal hypertension* (an abnormally increased blood pressure in the portal venous system), blood is unable to pass through the liver via the portal vein, causing a reversal of flow in the esophageal tributary
 - The large volume of blood causes the submucosal veins to enlarge markedly, forming *esophageal varices*
 - These distended collateral channels may rupture and cause severe hemorrhage that is life-threatening and difficult to control surgically
 - Commonly develop in alcoholics who have developed *cirrhosis* (fibrous scarring) of the liver
- **Pyrosis (248)**
 - Also known as heartburn
 - Most common type of esophageal discomfort or substernal pain
 - Burning sensation in the abdominal part of the esophagus is usually the result of regurgitation of small amounts of food or gastric fluid into the lower esophagus = *gastroesophageal reflux disorder (GERD)*
 - May also be associated with *hiatal (hiatus) hernia*
 - As indicated by its common name, heartburn, pyrosis is commonly perceived as a “chest” sensation
- **Displacement of the Stomach (250)**
 - Pancreatic pseudo-cysts and abscesses in the omental bursa may push the stomach anteriorly
 - This displacement is usually visible in lateral radiographs of the stomach and other diagnostic images, such as CT studies
 - Following *pancreatitis*, the posterior wall of the stomach may adhere to the part of the posterior wall of the omental bursa that covers the pancreas
 - This occurs bc of the close relationship of the stomach to the pancreas
- **Hiatal hernia (250,252)**

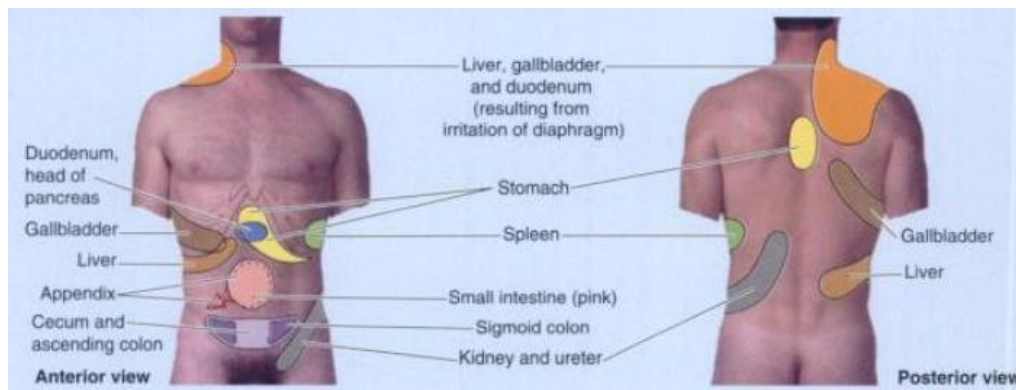
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- A protrusion of a part of the stomach into the mediastinum through the esophageal hiatus of the diaphragm
 - Occur most often in people after middle age, possibly bc of weakening of the muscular part of the diaphragm and widening of the esophageal hiatus
 - Often distressful and cause pain
 - Although clinically there are several types of hiatal hernias, there are 2 main types –
 - **Paraesophageal hiatal hernia** – less common
 - The cardia remains in its normal position
 - A pouch of the peritoneum, often containing part of the fundus, extends through the esophageal hiatus anterior to the esophagus
 - Usually no regurgitation of gastric contents occurs bc the cardinal orifice is in its normal position
 - **Sliding hiatal hernia**
 - Abdominal part of the esophagus, the cardia, and parts of the fundus of the stomach slide superiorly through the esophageal hiatus into the thorax
 - Especially when the person lies down or bends over
 - Some regurgitation of stomach contents into the esophagus is possible bc the clamping action of the R crus of the diaphragm on the inferior end of the esophagus is weak
- **Congenital Diaphragmatic Hernia (252)**
 - Part of the stomach and intestine herniated through a large posterolateral defect (foramen of Bochdalek) in the diaphragm
 - Found in approx 1/2200 newborn infants
 - Results from the complex development of the diaphragm
 - With abdominal viscera in the limited space of the prenatal pulmonary cavity, the lungs (especially the L lung) does not have room to develop
 - Bc of the consequent *pulmonary hypoplasia*, the mortality rate in these infants is high (approx 76%)
- **Pylorospasm (256)**
 - Spasmodic contraction of the pylorus sometimes occurs in infants, usually between 2 and 12 weeks of age
 - Characterized by failure of the smooth muscle fibers encircling the pyloric canal to relax normally
 - As a result, food does not pass easily from the stomach into the duodenum and the stomach becomes overly full, usually resulting in vomiting
- **Congenital Hypertrophic Pyloric Stenosis (256)**
 - A marked thickening of the smooth muscle in the pylorus that affects approx 1/150 male infants and 1/750 female infants
 - Normally, gastric peristalsis pushes chyme through the pyloric canal and orifice into the small intestine at irregular intervals
 - In these babies, however, the elongated overgrown pylorus is hard, and severe stenosis (narrowing) of the pyloric canal is present, resisting gastric emptying
 - Proximal part of the stomach becomes secondarily dilated bc of the pyloric obstruction
 - Cause is unknown, but genetic factors appear to be involved bc of this condition's high incidence in infants of monozygotic twins
- **Carcinoma of the Stomach (256)**
 - When the body or pyloric part of the stomach contains a malignant tumor, the mass may be palpable
 - Using *gastroscopy*, physicians can inspect the mucosa of the air-inflated stomach, enabling them to observe gastric lesions and take biopsies
 - The extensive lymphatic drainage of the stomach and the impossibility of removing all the lymph nodes create a surgical problem
 - The nodes along the splenic vessels can be excised by removing the spleen, gastrosplenic and splenorenal ligaments, and the body and tail of the pancreas
 - Involved nodes along the gastro-omental vessels can be removed by resecting the greater omentum
 - Removal of the aortic and celiac nodes and those around the head of the pancreas is difficult
- **Gastrectomy (256-257)**
 - *Total gastrectomy* – removal of the entire stomach – is uncommon
 - *Partial gastrectomy* – removal of part of the stomach – may be performed to remove a region of the stomach involved by a carcinoma, for ex

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- Bc the anastomoses of the arteries supplying the stomach provide good collateral circulation, one or more arteries may be ligated during this procedure without seriously affecting the blood supply to the part of the stomach remaining in place
 - When removing the pyloric antrum, for ex, the greater omentum is incised parallel and inferior to the right gastro-omental artery, requiring ligation of all the omental branches of this artery
 - The omentum does not degenerate, however, bc of anastomoses with other arteries, such as the omental banches of the L gastro-omental artery, which are still intact
- Partial gastrectomy to remove a carcinoma usually also requires removal of all involved regional lymph nodes
 - Bc cancer frequently occurs in the pyloric region, removal of the *pyloric lymph nodes* as well as the *R gastro-omental lymph nodes* also receiving lymph drainage from this region is specifically important
 - As stomach cancer becomes more advanced, the lymphogenous dissemination of malignant cells involves the *celiac lymph nodes*, to which all gastric nodes drain
- **Gastric Ulcers, *Helicobacter pylori*, and Vagotomy (257)**
 - An *ulcer* is an open sore
 - *Gastric ulcers* are open lesions of the mucosa of the stomach
 - *Peptic ulcers* describes lesions of the mucosa of the pyloric canal or, more often, the duodenum
 - Most ulcers (9 of 10) of the stomach and duodenum are associated with an infection of a specific bacterium, *H. pylori*
 - People experiencing severe chronic anxiety are most prone to the development of peptic ulcers
 - Often have gastric acid secretion rates that are as much as 15 times higher than normal between meals
 - It is thought that the high acid in the stomach and duodenum overwhelms the bicarbonate normally produced by the duodenum and reduces the effectiveness of the mucous lining, leaving it vulnerable to *H. pylori*
 - The bacteria erode that protective mucous lining of the stomach, inflaming the mucosa and making it vulnerable to the effects of gastric acid and digestive enzymes (pepsin) produced by the stomach
 - If the ulcer erodes into the gastric arteries, it can cause life-threatening bleeding
 - Most ulcers are eradicated, with low rates of recurrence, after antibiotic therapy combined with the use of antacids
 - Bc the secretion of acid by parietal cells of the stomach is largely controlled by the vagus nerves, *vagotomy* (surgical section of the vagus nerves) is performed in some people with chronic or recurring ulcers
 - May also be performed in conjunction with resection of the ulcerated area (*antrectomy*, or resection of the pyloric antrum) to reduce acid secretion
 - A *truncal vagotomy* (surgical section of the vagal trunks) is rarely performed bc the innervation fo other abdominal structures is also sacrificed
 - In *selective gastric vagotomy*, the stomach is denervated but the vagul branches to the pylorus, liver, and biliary ducts, intestines, and celiac plexus are preserved
 - A *selective proximal vagotomy* attempts to denervate even more specifically the area in which the parietal cells are located, hoping to affect the acid-producing cells while sparing other gastric function (motility) stimulated by the vagus nerve
 - A *posterior gastric ulcer* may erode through the stomach wall into the pancreas, resulting in referred pain to the back
 - In such cases, *erosion of the splenic artery* results in severe hemorrhage into the peritoneal cavity
 - Pain impulses from the stomach are carried by visceral afferent fibers that accompany sympathetic nerves
 - This fact is evident bc the pain of a recurrent peptic ulcer may persist after complete vagotomy, whereas patients who have has a bilateral sympathectomy may have a perforated peptic ulcer and experience no pain
- **Visceral Referred Pain (257-258)**
 - *Pain* is an unpleasant sensation associated with actual or potential tissue damage and mediated by specific nerve fibers to the brain, where its conscious appreciation may be modified
 - *Organic pain* arising from an organ such as the stomach varies from dull to severe
 - This pain is poorly localized
 - It radiates to the dermatome level, which receives visceral afferent fibers from the organ concerned

- *Visceral referred pain* from a gastric ulcer, for ex, is referred to the epigastric region bc the stomach is supplied by pain afferents that reach the T7 and T8 spinal accessory ganglia and spinal cord segments through the greater splanchnic nerve
 - The brain interprets the pain as though the irritation occurred in the skin of the epigastric region, which is also supplied by the same sensory ganglia and spinal cord segments
- Pain arising from the parietal peritoneum is of the somatic type and is usually severe
 - The site of its origin can be localized
 - The anatomical basis for this localization of pain is that the parietal peritoneum is supplied by somatic sensory fibers through thoracic nerves, whereas a viscus such as the appendix is supplied by visceral afferent fibers in the lesser splanchnic nerve
 - Inflamed parietal peritoneum is extremely sensitive to stretching
 - When digital pressure is applied to the anterolateral abdominal wall over the site of inflammation, the parietal peritoneum is stretched
 - When the fingers are suddenly removed, extreme localized pain is usually felt = *rebound tenderness*



- **Duodenal Ulcers (264)**
 - Also known as *peptic ulcers*
 - Inflammatory erosions of the duodenal mucosa
 - Most (65%) occur in the posterior wall of the superior part of the duodenum within 3 cm of the pylorus
 - Occasionally perforate the duodenal wall, permitting the contents to enter the peritoneal cavity and causing *peritonitis*
 - Bc the superior part of the duodenum closely relates to the liver, gallbladder, and pancreas, any of these structures may become adherent to the inflamed duodenum and also become ulcerated as the lesion continues to the tissue that surrounds it
 - Although bleeding from gastric or duodenal ulcers commonly occurs, *erosion of the gastroduodenal artery* (a posterior relation of the superior part of the duodenum) by a duodenal ulcer relates in severe hemorrhage in the peritoneal cavity and subsequent peritonitis
- **Developmental Changes in the Mesoduodenum (264)**
 - During the early fetal period, the entire duodenum has a mesentery
 - Most of it fuses with the posterior abdominal wall bc of pressure from the overlying transverse colon
 - Bc the attachment of the mesoduodenum to the wall is secondary (has occurred through formation of a *fusion fascia*), the duodenum and the closely associated pancreas can be separated (surgically mobilized) from the underlying retroperitoneal viscera during surgical operations involving the duodenum without endangering the blood supply to the kidney or the ureter
- **Paraduodenal Hernias (264)**
 - There are 2 or 3 inconstant folds and fossae (recesses) around the duodenojejunal junction
 - The *paraduodenal fold and fossa* are large and lie to the L of the ascending part of the duodenum
 - If a loop of intestine enters this fossa, it may strangulate
 - During repair of a *paraduodenal hernia*, care must be taken not to inure the branches of the inferior mesenteric artery and vein or the ascending branches of the left colic artery

- These are closely related to the paraduodenal fold and fossa
- **Brief Review of the Embryological Rotation of the Midgut (268)**
 - An understanding of the rotation of the midgut clarifies the adult arrangement of the intestines
 - The primordial gut comprises the foregut, midgut, and hindgut
 - Pain arising from the foregut derivatives – esophagus, stomach, pancreas, duodenum, liver, and biliary ducts – localizes in the epigastric region
 - Pain arising from the midgut derivatives – the small intestine distal to the bile duct, cecum, appendix, ascending colon, and most of the transverse colon – localizes in the periumbilical region
 - Pain arising from the hindgut derivatives – the distal part of the transverse colon, descending colon, sigmoid colon, and rectum – localizes in the hypogastric region
 - For 4 weeks, the rapidly growing midgut, supplied by the SMA, is physiologically herniated into the proximal part of the umbilical cord
 - It is attached to the yolk sac by the yolk stalk
 - As it returns to the abdominal cavity, the midgut rotates 270° around the axis of the SMA
 - As the relative size of the liver and kidney decreases, the midgut returns to the abdominal cavity as increased space becomes available
 - As the parts of the intestine reach their definitive positions, their mesenteric attachments undergo modification
 - Some mesenteries shorten and others disappear (eg most of the duodenal mesentery)
 - Malrotation of the midgut results in several congenital abnormalities such as volvulus (twisting) of the intestine
- **Navigating the Small Intestine (268)**
 - When portions of the small intestine have been delivered through a surgical wound, the proximal (orad) and distal (aborad) ends of a loop of bowel are not apparent
 - If you are trying to follow the intestine in a particular direction (eg attempting to follow the ileum to the ileocecal junction), it is important to know which end is which
 - Normal peristalsis may not be present to provide a clue
 - Place your hands on each side of the intestine and its mesentery, and then follow the mesentery with your fingers to its root (its attachment to the posterior abdominal wall, untwisting the loop of intestine as necessary)
 - Once the mesentery and intestine are straightened to match the direction of the root, the cranial end must be the orad end, and the caudal end the aborad end
- **Ischemia of the Intestine (268-270)**
 - Occlusion of the vasa recta by emboli results in *ischemia* of the part of the intestine concerned
 - If ischemia is severe, *necrosis* of the involved segment results and *ileus* (obstruction of the intestine) of the paralytic type occurs
 - Ileus is accompanied by a severe colicky pain, along with abdominal distention, vomiting, and often fever and dehydration
 - If the condition is diagnosed early (eg using a *superior mesenteric arteriogram*), the obstructed part of the vessel may be cleared surgically
- **Ileal Diverticulum (270-271)**
 - An *ileal diverticulum* (of Meckel) is a congenital anomaly that occurs in 1-2% of the population
 - A remnant of the proximal part of the embryonic yolk stalk, the diverticulum usually appears as a finger-like pouch
 - It is always at the site of attachment of the yolk stalk on the antimesenteric border (border opposite the mesenteric attachment) of the ileum
 - It is usually located 30-60cm from the ileocecal junction in infants and 50cm in adults
 - It may be free (74%) or attached to the umbilicus (26%)
 - Although the mucosa is mostly ileal in type, it may also include areas of acid-producing gastric tissue, pancreatic tissue, or jejuna or colonic mucosa
 - May become inflamed and produce pain mimicking that produced by appendicitis
 - If gastric tissue is included, a peptic ulcer may occur here
- **Position of the Appendix (275)**
 - A *retrocecal appendix* extends superiorly toward the R colic flexure and is usually free
 - Occasionally lies beneath the peritoneal covering of the cecum, where it is often fused to the cecum or the posterior abdominal wall

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- Appendix may project inferiorly toward or across the pelvic brim
- Anatomical position determines the symptoms and the site of muscular spasm and tenderness when the appendix is inflamed
- The base lies deep to a point that is 1/3 of the way along the oblique line joining the R ASIS to the umbilicus (the *McBurney point* on the *spinoumbilical line*)
- **Appendicitis (275)**
 - Acute inflammation of the appendix is a common cause of an *acute abdomen* = severe abdominal pain arising suddenly
 - Usually, digital pressure over the McBurney point registers maximum abdominal tenderness
 - In young people, it is usually caused by hyperplasia of lymphatic follicles in the appendix that occludes the lumen
 - In older people, the obstruction usually results from a *fecalith (coprolith)*, a concretion that forms around a center of fecal matter
 - When secretions from the appendix cannot escape, the appendix swells, stretching the visceral peritoneum
 - The pain usually commences as a vague pain in the periumbilical region bc afferent pain fibers enter the spinal cord at the T10 level
 - Later, severe pain in the RLQ results from irritation of the parietal peritoneum lining the posterior abdominal wall
 - Extending the thigh at the hip joint elicits pain
 - Acute infection of the appendix may result in *thrombosis* (clotting of blood) in the appendicular artery
 - Often results in ischemia, gangrene (death of tissue), and perforation of an acutely inflamed appendix
 - *Rupture of the appendix* results in infection of the peritoneum (*peritonitis*), increased abdominal pain, nausea and/or vomiting and *abdominal rigidity* (stiffness of the abdominal muscles)
 - Flexion of the R thigh ameliorates the pain bc it causes relaxation of the R psoas muscle, a flexor of the thigh
- **Appendectomy (275)**
 - Surgical removal of the appendix is usually performed through a transverse or gridiron (muscle-splitting) incision centered at the McBurney point in the RLQ
 - Traditionally, a gridiron incision is made perpendicular to the spinoumbilical line, but a transverse incision is also commonly used
 - The choice of incision site and type is at the surgeon's discretion
 - While typically the inflamed appendix is deep to the McBurney point, the site of maximal pain and tenderness indicates the actual location
 - Following incision of the skin and subcutaneous tissue, the external oblique aponeurosis is incised along the lines of its fibers
 - An opening is then made in the same way in the internal oblique and transverse abdominal muscles, thus avoiding their nerve supply
 - The iliohypogastric nerve is identified between the fleshy muscle layers and retracted
 - The transversalis fascia and peritoneum are incised, and the cecum is delivered into the surgical wound
 - The appendix arises from the convergence of the 3 teniae coli
 - If the appendix is not obvious, one of the teniae coli is traced to its base
 - The mesoappendix containing the appendicular vessels is firmly ligated and divided
 - The base of the appendix is tied, the appendix is excised, and its stump is usually cauterized and invaginated into the cecum
 - The incision is then closed in layers
 - Bc each muscle layer runs in a different direction, the incision is well protected when the retracted layers are returned to their normal position
 - In unusual cases of malrotation of the intestine, or failure of descent of the cecum, the appendix is not in the RLQ
 - When the cecum is high (*subhepatic cecum*), the appendix is in the R hypochondriac region and the pain localizes there, not in the RLQ
- **Laproscopy (275,277)**
 - When the diagnosis is unclear, examination of the abdominal contents with a *laproscope* passed through a small incision in the anterolateral abdominal wall is useful
 - Helps differentiate acute appendicitis from other causes of abdominal pain, including inflammatory pelvic disease
 - Laproscope has been used for many years by gynecologists in evaluating women with lower abdominal pain
 - In addition, laproscope is used for removal of gallbladder and appendix and for treating abdominal obstruction
- **Mobile Ascending Colon (277)**

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- When the inferior part of the ascending colon has a mesentery, the cecum and proximal part of the colon are abnormally mobile
 - This condition, present in approx 11% of people, may cause *volvulus of the colon*, an obstruction of intestine resulting from twisting
- *Cecopexy* may avoid volvulus and possible obstruction of the colon
 - In this anchoring procedure, a tenia coli of the cecum and proximal ascending colon is sutured to the abdominal wall
- **Colitis, Colectomy, Ileostomy, and Colostomy (279)**
 - Chronic inflammation of the colon (*ulcerative colitis*, *Chrohn disease*) is characterized by severe inflammation and ulceration of the colon and rectum
 - In some cases a *colectomy* is performed, during which the terminal ileum and colon, as well as the rectum and anal canal, are removed
 - And *ileostomy* is then constructed to establish an opening between the ileum and the skin of the anterolateral abdominal wall
 - Sometimes a *colostomy* is performed to create an artificial cutaneous opening into the colon
 - A *sigmoidostomy* establishes an artificial anus by creating a cutaneous opening into the sigmoid colon
- **Colonoscopy (279-280)**
 - The interior of the colon can be observed and photographed using an endoscope, usually a fiberoptic *colonoscope*
 - The endoscope is a flexible tube that inserts into the colon through the anus and rectum
 - Small instruments can be passed through the colonoscope and used to facilitate minor operative procedures, such as biopsies or removal of polyps
 - Most tumors of the large intestine occur in the rectum
 - Approx 12% of them appear near the rectosigmoid junction
 - The interior of the sigmoid colon is observed with a *sigmoidoscope (sigmoscope)*, a shorter endoscope, in a procedure called *sigmoidoscopy*
- **Diverticulosis (280-281)**
 - A disorder in which multiple false *diverticula* (external evaginations or out-pocketings of the mucosa of the colon) develop along the intestine
 - Primarily affects middle-aged and elderly people
 - Commonly (60%) found in the sigmoid colon
 - *Colonic diverticula* are not true diverticula bc they are formed from protrusions of mucous membrane only, evaginated through weak points (separations) developed between muscle fibers rather than involving the whole wall of the colon
 - Occur most commonly on the mesenteric side of the 2 nonmesenteric teniae coli, where nutrient arteries perforate the muscle coat to reach the submucosa
 - Subject to infection and rupture, leading to diverticulitis
 - They can distort and erode the nutrient arteries, leading to hemorrhage
 - Less likely to develop in individuals adhering to a diet high in fiber
- **Rupture of the Spleen (284)**
 - Although well protected by the 9th-12th ribs, the spleen is the most frequently injured organ in the abdomen
 - Severe blow on the L side may fracture one or more of these ribs, resulting in sharp bone fragments that can lacerate the spleen
 - In addition, blunt trauma to other regions of the abdomen that cause a sudden, marked increase in intra-abdominal pressure (eg by impalement on the steering wheel of a car or the handlebars of a motorcycle) can cause the thin capsule and overlying peritoneum of the spleen to burst
 - This disrupts its soft parenchyma or pulp (*ruptured spleen*)
 - If ruptured, there is profuse bleeding (*intraperitoneal hemorrhage*) and shock
- **Splenectomy and splenomegaly (285)**
 - Repair of a ruptured spleen is difficult
 - So, *splenectomy* (removal of the spleen) is often performed to prevent the person from bleeding to death
 - *Sub-total/partial splenectomy*, when possible, is followed by rapid regeneration
 - Even *total splenectomy* usually does not produce serious effects, especially in adults, bc most of its functions are assumed by other reticuloendothelial organs (eg the liver and bone marrow)
 - There is a grater susceptibility to certain bacterial infections

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- When the spleen is diseased, resulting from, for ex, granulocytic anemia (high leukocyte and WBC count), it may enlarge to 10 or more times its normal size and average a weight of 100-250g = *splenomegaly*
 - Spleen engorgement sometimes accompanies hypertension
 - The spleen is not usually palpable in the adult
 - Generally, if its lower edge can be detected when palpating below the L costal margin at the end of inspiration, it is enlarged about 3x its normal size
 - Also occurs in some forms of hemolytic or ganulocytic anemias, in which RBCs or WBCs, respectively, are destroyed at abnormally high rates
 - In such cases, a splenectomy may be life-saving
- **Accessory Spleen(s) (285-286)**
 - One or more small accessory spleens may form near the splenic hilum
 - They may be embedded partly or wholly in the tail of the pancreas –
 - Between the layers of the gastrosplenic ligament
 - In the infracolic compartment in the mesentery
 - In close proximity to the ovary or testis
 - In most affected individuals, only 1 accessory spleen is present
 - They are common (10%), usually small (approx 1cm in diameter, range from .2cm to 10cm), and often resemble a lymph node
 - Awareness of the possible presence of an accessory spleen is important bc if not removed during splenectomy, the symptoms that indicated removal of the spleen (eg *splenic anemia*) may persist
- **Splenic Needle Biopsy and Splenoportography (286)**
 - The relationship of the costodiaphragmatic recess of the pleural cavity to the spleen is clinically important
 - This potential space descends to the level of the 10th rib in the midaxillary line
 - Its existence must be kept in mind when doing a *splenic needle biopsy*, or when injecting radiopaque material into the spleen for visualization of the portal vein (*splenoportography*)
 - If care is not exercised, this material may enter the pleural cavity, causing *pleuritis*
- **Blockage of the Hepatopancreatic Ampulla and Pancreatitis (287)**
 - The main pancreatic duct joins the bile duct to form the hepatopancreatic ampulla and pierces the duodenal wall
 - So, a *gallstone* passing along the extrahepatic bile passages may lodge in the constricted distal end of the ampulla, where it opens at the summit of the major duodenal papilla
 - In this case, both the biliary and pancreatic duct systems are blocked, and neither bile nor pancreatic juice can enter the duodenum
 - However, bile may back up and enter the pancreatic duct, usually resulting in *pancreatitis*
 - A similar reflux of bile sometimes results from *spasms of the hepatopancreatic sphincter*
 - Normally, the sphincter of the pancreatic duct prevents reflux of bile into the pancreatic duct
 - If the hepatopancreatic ampulla is obstructed, the weak pancreatic duct sphincter may be unable to withstand the excessive pressure of the bile in the hepatopancreatic ampulla
 - If the accessory pancreatic duct connects with the main pancreatic duct and opens into the duodenum, it may compensate for an obstructed main pancreatic duct or spasm of the hepatopancreatic sphincter
- **Accessory Pancreatic Tissue (287)**
 - It is not unusual for accessory pancreatic tissue to develop in the stomach, duodenum, ileum or an ileal diverticulum
 - The stomach and duodenum are the most common sites
 - It may contain pancreatic islet cells that produce glucagon and insulin
- **Pancreatectomies (288)**
 - In the treatment of some people with chronic pancreatitis, most of the pancreas is removed = *pancreatectomy*
 - The anatomical relationships and the blood supply of the head of the pancreas, bile duct, and duodenum make it impossible to remove the entire head of the pancreas
 - Usually a rim of the pancreas is retained along the medial border of the duodenum to preserve the duodenal blood supply
- **Rupture of the Pancreas (288)**

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- The pancreas, as an exocrine organ, is not commonly a primary cause of clinical problems (except *diabetes*, an endocrine disorder of the islet cells) bc...
 - The pancreas is centrally located within the body and thus is well protected from all but the most severe penetrating trauma
 - The duodenum, into which its duct opens, is normally sterile
 - The pancreas, like the liver, has a considerable functional reserve
- So, most exocrine pancreatic problems are secondary to biliary problems
- Pancreatic injury can result, however, from sudden, severe, forceful compression of the abdomen, such as the force of impalement on a steering wheel in a car accident
 - Bc the pancreas lies transversely, the vertebral column acts as an anvil, and the traumatic force may rupture the friable pancreas
 - Rupture of the pancreas frequently tears its duct system, allowing pancreatic juice to enter the parenchyma of the gland and to invade adjacent tissues
 - Digestion of pancreatic and other tissues by pancreatic juice is quite painful
- **Pancreatic Cancer (288)**
 - Cancer involving the pancreatic head accounts for most cases of extrahepatic obstruction of the biliary ducts
 - Bc of the posterior relationships of the pancreas, cancer of the head often compresses and obstructs the bile duct and/or hepatopancreatic ampulla
 - This condition causes obstruction, resulting in the retention of bile pigments, enlargement of the gallbladder, and *jaundice* (obstructive jaundice)
 - Jaundice is the yellow staining of most body tissues, skin, mucous membranes, and conjunctiva by circulating bile pigments
 - Approximately 90% of people with pancreatic cancer have *ductular adenocarcinomas*
 - Severe pain in the back is frequently present
 - Cancer of the neck and body of the pancreas may cause portal or IVC obstruction bc the pancreas overlies these large veins
 - The pancreas's extensive drainage to relatively inaccessible lymph nodes and the fact that pancreatic cancer typically metastasizes to the liver early, via the portal vein, make surgical resection of the cancerous pancreas nearly futile
 - Median survival time, regardless of therapy, is 2-3 months after diagnosis
- **Subphrenic Abscesses (292)**
 - Peritonitis may result in the formation of localized abscesses in various parts of the peritoneal cavity
 - A common site for pus to collect is in a subphrenic recess or space
 - These *subphrenic abscesses* are more common on the R side bc of the frequency of ruptured appendices and perforated duodenal ulcers
 - Bc the R and L subphrenic recesses are continuous with the hepatorenal recess (the lowest [most gravity dependent] parts of the peritoneal cavity when supine), pus from a subphrenic abscess may drain into one of the hepatorenal recesses – especially when patients are bedridden
 - A subphrenic abscess is often drained by an incision inferior to, or through, the bed of the 12th rib
 - Obviates the formation of an opening in the pleura or peritoneum
 - An anterior subphrenic abscess is often drained through a subcostal incision located inferior and parallel to the R costal margin
- **Hepatic Lobectomy and Segmentectomy (293-294)**
 - When it was discovered that the R and L hepatic arteries and ducts, as well as branches of the R and L portal veins, do not communicate, it became possible to perform *hepatic lobectomies*
 - Removal of the R or L part of the liver can be done without excessive bleeding
 - Most injuries involve the R liver
 - More recently, especially since the advent of the cauterizing scalpel and laser surgery, it has become possible to perform *hepatic segmentectomies*
 - This procedure makes it possible to remove (resect) only those segments that have sustained a severe injury or are affected by a tumor
 - The intersegmental hepatic veins serve as guides to the planes between the hepatic divisions
 - They also provide a major source of bleeding with which the surgeon must contend

- The pattern of branching described here (p. 294-295) is the most common, but the segments vary considerably in size and shape as a result of individual variation in the branching of the hepatic and portal vessels
 - So, each hepatic resection is empirical, requiring ultrasonography, injection of dye, or balloon catheter occlusion to establish the patient's segmental pattern
- A larger injury that is likely to leave large areas of the liver devascularized may still require lobectomy
- **Rupture of the Liver (294)**
 - The liver is easily injured bc it is large, fixed in position, and friable (easily crumbled)
 - Often a fractured rib that perforates the diaphragm tears the liver
 - Bc of the liver's great vascularity and friability, liver lacerations often cause considerable hemorrhage and RUQ pain
 - In such cases, the surgeon must decide whether to remove foreign material and the contaminated or devitalized tissue by dissection or to perform a segmentectomy
- **Aberrant Hepatic Arteries (297)**
 - A more common variety of R or L hepatic artery that arises as a terminal branch of the hepatic artery proper may be replaced in part or entirely by an aberrant (accessory or replaced) artery arising from another source
 - The most common source of an *aberrant R hepatic artery* is the SMA
 - The most common source of an *aberrant L hepatic artery* is the L gastric artery
- **Variations in the Relationships of the Hepatic Arteries (297)**
 - In most people, the R hepatic artery crosses anterior to the portal vein
 - In some people, the artery crosses posterior to the portal vein
 - In most people, the R hepatic artery runs posterior to the common hepatic duct
 - But in some it crosses anterior to the duct, or the R hepatic artery arises from the IVC and does not cross the common hepatic duct at all
- **Unusual Formation of the Portal Vein (298)**
 - Usually, the portal vein forms posterior to the neck of the pancreas by the union of the superior mesenteric and splenic veins and ascends anterior to the IVC
 - In approx 1/3 of people, the IMV joins the confluence of the superior mesenteric and splenic veins = all 3 form the portal vein
 - In most people the IMV enters the splenic vein (60%) or the SMV (40%)
- **Hepatomegaly (298)**
 - The liver is a soft and highly vascular organ that receives a large amount of blood immediately before it enters the heart
 - The IVC and hepatic veins lack valves
 - Any rise in central venous pressure is directly transmitted to the liver, which enlarges as it becomes engorged with blood
 - Marked temporary engorgement stretches the fibrous capsule of the liver, producing pain around the lower ribs, particularly in the right hypochondrium
 - This engorgement, particularly in conjunction with increased or sustained diaphragmatic activity, has been proposed as an underlying cause of "runner's stitch," perhaps explaining why it is a R-sided phenomenon
 - In addition to diseases that produce hepatic engorgement such as congestive heart failure, bacterial and viral diseases such as hepatitis can cause liver enlargement
 - When the liver is massively enlarged, its inferior edge may be readily palpable below the R costal margin and may even reach the pelvic brim in the RLQ
 - Tumors also enlarge the liver
 - The liver is a common site of *metastatic carcinoma* (secondary cancers spreading from organs drained by the portal system of veins)
 - Cancer cells may also pass to the liver from the thorax, especially from the R breast, bc of the communications between thoracic lymph nodes and the lymphatic vessels draining the bare area of the liver
 - Metastatic tumors form hard, rounded nodules within the hepatic parenchyma
 - Bc of the great functional reserve of the liver, signs of liver failure may be absent in a liver loaded with metastatic tumors
- **Cirrhosis of the Liver (298)**
 - The liver is the primary site for detoxification of substances absorbed by the digestive system
 - So it is vulnerable to cellular damage and consequent scarring, accompanied by regenerative nodules

- There is progressive destruction of hepatocytes (parenchymal liver cells) in *hepatic cirrhosis* and replacement of them by fat and fibrous tissue
- Although many industrial solvents, such as carbon tetrachloride, produce cirrhosis, the condition develops most frequently in people suffering from chronic alcoholism
 - *Alcohol cirrhosis*, the most common of many causes of *portal hypertension*, is characterized by enlargement of the liver resulting from fatty changes and fibrosis
- The liver has great functional reserve, and so the metabolic evidence of liver failure is late to appear
 - Fibrous tissue surrounds the intrahepatic blood vessels and biliary ducts, making the liver firm, and impeding the circulation of blood through it = *portal hypertension*
- The treatment of advanced cirrhosis may include the surgical creation of a *portosystemic* or *portocaval shunt*, anastomosing the portal and systemic venous systems
- **Liver Biopsy (300)**
 - Used to obtain hepatic tissue for diagnostic purposes
 - Bc the liver is located in the R hypochondriac region where it receives protection from the overlying thoracic cage, the needle is commonly directed through the 10th intercostal space in the midaxillary line
 - Before the physician takes the biopsy, the person is asked to hold his/her breath in full expiration to reduce the costodiaphragmatic recess and to lessen the possibility of damaging the lung and contaminating the pleural cavity
- **Infundibulum of the Gallbladder (303)**
 - In diseased states of the gallbladder, a dilation or pouch appears at the junction of the neck of the gallbladder and the cystic duct = *infundibulum of the gallbladder* (Hartmann pouch)
 - When this pouch is large, the cystic duct arises from its upper L aspect, not from what appears to be the apex of the gallbladder
 - Gallstones commonly collect in the infundibulum
 - If a peptic duodenal ulcer ruptures, a false passage may form between the infundibulum and the superior part of the duodenum, allowing gallstones to enter the duodenum
- **Mobile Gallbladder (303)**
 - The gallbladder has a short mesentery in approx 4% of people
 - Such gallbladders are subject to vascular torsion and infarction (sudden insufficiency of arterial or venous blood supply)
- **Variations in the Cystic and Hepatic Ducts (303-304)**
 - Occasionally, the cystic duct runs alongside the common hepatic duct and adheres closely to it
 - The cystic duct may be short or even absent
 - In some people, there is low union of the cystic and common hepatic ducts
 - As a result, the bile duct is short and lies posterior to the superior part of the duodenum, or even inferior to it
 - When there is low union, the 2 ducts may be joined by fibrous tissue, making clamping the cystic duct difficult without injuring the common hepatic duct
 - Occasionally, there is high union of the cystic and common hepatic ducts near the porta hepatis
 - In other cases, the cystic duct spirals anteriorly over the common hepatic duct before joining it on the L side
 - Understanding the variations in arteries and bile duct formation is important for surgeons when they ligate the cystic duct during *cholectomy*, the surgical removal of the gallbladder
- **Accessory Hepatic Ducts (304)**
 - Common and are in positions of danger during cholecystectomy
 - An accessory duct is a normal segmental duct that joins the biliary system outside the liver instead of within it
 - Bc it drains a normal segment of the liver, it leaks bile if inadvertently cut during surgery
 - Of 95 gallbladders and biliary ducts studied, 7 had accessory ducts, 4 joined the common hepatic duct near the cystic ducts, 2 joined the cystic duct, and 1 was an anastomosing duct connecting the cystic duct with the common hepatic duct
- **Gallstones (304)**
 - Concretion in the gallbladder, cystic duct, or bile duct composed chiefly of cholesterol crystals
 - Much more common in females, and incidence increases with age
 - In approx 50% of people, gallstones are “silent” (asymptomatic)
 - Over a 20 year period, 2/3 of asymptomatic people with gallstones remain symptom free
 - The longer stones remain quiescent, the less likely symptoms are to develop

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- For gallstones to cause clinical symptoms, they must obtain a size sufficient to produce mechanical injury to the gallbladder or obstruction of the biliary duct
- Common sites for gallstones –
 - The distal end of the hepatopancreatic ampulla is the narrowest part of the biliary passages
 - The infundibulum of the gallbladder
 - May also lodge in the hepatic and cystic ducts
 - A stone lodged in the cystic duct causes *biliary colic* (intense, spasmodic pain)
 - When the gallbladder relaxes, the stone may pass into the gallbladder
 - If the stone blocks the cystic duct, *cholecystitis* (inflammation of the gallbladder) occurs bc of bile accumulation, causing enlargement of the gallbladder
- Pain develops in the
 - Epigastric region and later shifts to the R hypochondriac region at the junction of the 9th costal cartilage and the lateral border of the rectus sheath, indicated by the linea semilunaris
 - May also cause pain in the posterior thoracic wall or R shoulder owing to irritation of the diaphragm
- If bile cannot leave the gallbladder, it enters the blood and causes *jaundice*
- Ultrasound and CT scans are common non-invasive techniques for locating stones
- **Gallstones in the Duodenum (305)**
 - Normal anatomy may be distorted by disease processes
 - A gallbladder that is dilated and inflamed owing to an impacted gallstone in its duct may develop adhesions with adjacent viscera
 - Continued inflammation may break down (ulcerate) the tissue boundaries between the gallbladder and a part of the alimentary tract adherent to it, resulting in *cholecystenteric fistula*
 - Bc of their proximity to the gallbladder, the superior part of the duodenum and the transverse colon are most likely to develop a fistula of this type
 - The fistula would enable a large gallstone, incapable of passing through the cystic duct, to enter the alimentary tract
 - A large gallstone entering the small intestine in this way may become trapped at the ileocecal valve, producing a bowel obstruction (*gallstone ileus*)
 - Also permits gas from the alimentary tract to enter the gallbladder, providing a diagnostic and radiographic sign
- **Cholecystectomy (305)**
 - People with severe *biliary colic* usually have their gallbladders removed
 - *Laparoscopic cholecystectomy* often replaces the open surgical method
 - The cystic artery most commonly arises from the R hepatic artery in the *cystohepatic triangle*
 - In current clinical use, the cystohepatic triangle is defined inferiorly by the cystic duct, medially by common hepatic duct, and superiorly by the inferior surface of the liver
 - Careful dissection of the cystohepatic triangle early during cholecystectomy safeguards these important structures should there be anatomical variations
 - Errors during gallbladder surgery commonly result from failure to appreciate the common variations in the anatomy of the biliary system, especially its blood supply
 - Before dividing any structure and removing the gallbladder, surgeons identify all 3 biliary ducts, as well as the cystic and hepatic arteries
 - It is usually the R hepatic artery that is in danger during surgery and must be located before ligating the cystic artery
 - Bile duct injury is a serious complication of cholecystectomy, which is estimate to occur in 1 per 600 cases, and the risk appears to be modestly higher for laparoscopic cholecystectomy
- **Portosystemic Shunts (307)**
 - A common method for reducing portal hypertension is to divert blood from the portal venous system to the systemic venous system by creating a communication between the portal vein and the IVC
 - This *portacaval anastomosis* or *portosystemic shunt* may be done where these vessels lie close to each other posterior to the liver

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- Another way of reducing portal pressure is to join the splenic vein to the L renal vein, after splenectomy = *splenorenal anastomosis* or *shunt*
- **Portal Hypertension (307-308)**
 - When scarring and fibrous from cirrhosis obstruct the portal vein in the liver, pressure rises in the portal vein and its tributaries, producing *portal hypertension*
 - The large volume of blood flowing from the portal system to the systemic system at the sites of portal-systemic anastomoses produces *varicose veins*, especially in the lower esophagus
 - The veins may become so dilated that their walls rupture, resulting in hemorrhage
 - Bleeding from esophageal varices (abnormally dilated veins) at the distal end of the esophagus is often severe and may be fatal
 - In severe cases of portal obstruction, the veins of the anterior abdominal wall (normally caval tributaries) that anastomose with the paraumbilical veins (normally portal tributaries) may become varicose and look somewhat like small snakes radiating under the skin around the umbilicus
 - Called *caput medusae* bc of its resemblance to the serpents on the head of Medusa
- **Perinephric Abscess (308)**
 - The attachments of the renal fascia determine the path of extension of a *perinephric abscess*
 - For ex, fascia at the renal hilum attaches to the renal vessels and ureter, usually preventing the spread of pus to the contralateral side
 - However, pus from an abscess (or blood from an injured kidney) may force its way into the pelvis between the loosely attached anterior and posterior layers of the pelvic fascia
- **Nephroptosis (308,311)**
 - Bc the layers of renal fascia do not fuse firmly inferiorly to offer resistance, abnormally mobile kidneys may descend more than the normal 3cm when the body is erect
 - When kidneys descend, the suprarenal glands remain in place bc they lie in a separate fascial compartment and are firmly attached to the diaphragm
 - *Nephroptosis* (dropped kidney) is distinguished from an *ectopic kidney* (congenital misplaced kidney) by a ureter of normal length that has loose coiling or kinks bc the distance to the bladder has been reduced
 - The kinks do not seem to be of significance
 - Symptoms of intermittent pain in the renal region, relieved by lying down, appear to result from traction of the renal vessels
 - The lack of inferior support for the kidneys in the lumbar region is one of the reasons transplanted kidneys are placed in the iliac fossa of the greater pelvis
 - Other reasons for this placement are the availability of major blood vessels and convenient access to the nearby bladder
- **Renal Transplantation (311-312)**
 - Now an established operation for the treatment of selected cases of chronic renal failure
 - The kidney can be removed from the donor without damaging the suprarenal gland bc of the weak septum of renal fascia that separates the kidney from this gland
 - The site for transplanting a kidney is in the iliac fossa of the greater pelvis
 - This site supports the transplanted kidney, so that traction is not placed on the surgically anastomosed vessels
 - The renal artery and vein are joined to the external iliac artery and vein, respectively, and the ureter is sutured into the urinary bladder
- **Renal Cysts (312)**
 - Cysts in the kidney, multiple or solitary, are common findings during ultrasound examinations and dissection of cadavers
 - Adult *polycystic disease of the kidneys* is an important cause of renal failure
 - It is inherited as an autosomal dominant trait
 - The kidney are markedly enlarged and distorted by cysts as large as 5cm
- **Pain in the Pararenal Region (312)**
 - The close relationship of the kidneys to the psoas major muscle explains why extension of the hip joints may increase pain resulting from inflammation in the pararenal arteries
 - Bc these muscles flex the thighs at the hip joints

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- **Accessory renal vessels (314)**
 - During their “ascent” to their final site, the embryonic kidneys receive their blood supply and venous drainage from successively more superior vessels
 - Usually the inferior vessels degenerate as superior ones take over the blood supply and venous drainage
 - Failure of these vessels to degenerate results in *accessory renal arteries and veins*
 - Known as “polar arteries and veins” when they enter/exit the poles of the kidneys
 - Variation in the number and position of these vessels occur in approx 25% of people
- **Congenital Anomalies of the Kidneys and Ureters (314-315)**
 - *Bifid renal pelvis and ureter* are fairly common
 - These anomalies result from division of the *metanephric diverticulum* (ureteric bud), the primordium of the renal pelvis and ureter
 - The extent of ureteral duplication depends on the completeness of embryonic division of the metanephric diverticulum
 - May be unilateral or bilateral
 - But, separate openings into the bladder are uncommon
 - Incomplete division of the metanephric diverticulum results in a bifid ureter
 - Complete division results in a *supernumerary kidney*
 - An uncommon anomaly is a *retrocaval ureter*, which leaves the kidney and passes posterior to the IVC
 - The embryonic kidney are close together in the pelvis
 - In approx 1/600 fetuses, the inferior poles (rarely the superior poles) of the kidneys fuse to form a *horseshoe kidney*
 - This U-shaped kidney usually lies at the level of L3-L5 vertebrae bc the root of the *inferior mesenteric artery* prevented normal descent of the abnormal kidney
 - Horseshoe kidney usually produces no symptoms
 - Associated abnormalities of the kidney and renal pelvis may be present, obstructing the ureter
 - Sometimes the embryonic kidney on one or both sides fails to ascend to the abdomen and lies anterior to the sacrum
 - Although uncommon, awareness of the possibility of an *ectopic pelvic kidney* should prevent it from being mistaken for a pelvic tumor and removed
 - A pelvic kidney in a woman can also be injured by or cause obstruction during childbirth
 - Pelvic kidneys usually receive their blood supply from the common iliac arteries
- **Renal and Ureteric Calculi (319)**
 - *Calculi* are composed of salts or inorganic or organic acids or of other materials
 - They may form and become located in the calices of the kidneys, ureters, or urinary bladder
 - A *renal calculus* (kidney stone) may pass from the kidney into the renal pelvis and then into the ureter
 - If the stone is sharp, or it is larger than the normal lumen of the ureter (approx 3mm) causing excessive distension of this muscular tube, the *ureteric calculus* will cause severe intermittent pain (*ureteric colic*) as it is gradually forced down the ureter by waves of contraction
 - The calculus may cause complete or intermittent obstruction of urinary flow
 - Depending on the level of obstruction, which changes, the pain may be referred to the lumbar or inguinal regions, or the external genitalia and/or testis
 - The pain is referred to the cutaneous areas innervated by spinal cord segments and sensory ganglia, which also receive visceral afferents from the ureter, mainly T11-L2
 - The pain passes inferoanteriorly “from the loin to the groin” as the stone progresses through the ureter
 - The loin is the lumbar region, and the groin is the inguinal region
 - The pain may extend into the proximal anterior aspect of the thigh by projection through the genitofemoral nerve (L1, L2), the scrotum in males and the labia majora in females
 - The extreme pain may be accompanied by marked alimentary upset (nausea, vomiting, cramping, and diarrhea) and a generalized sympathetic response that may to various degrees mask the more specific symptoms
 - Ureteric calculi can be observed and removed with a *nephroscope*, an instrument that is inserted through a small incision
 - Another technique, *lithotripsy*, focuses a shockwave through the body that breaks the stone into small fragments that pass with the urine
- **Hiccups (328)**

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- Involuntary, spasmodic contractions of the diaphragm, causing sudden inhalations that are rapidly interrupted by spasmodic closure of the glottis (aperture of the larynx) which checks the inflow of air and produces a characteristic sound
- Result from irritation of afferent or efferent nerve endings or of medullary centers in the brainstem that control the muscles of respiration, particularly the diaphragm
- Have many causes, such as indigestion, diaphragm irritation, alcoholism, cerebral lesions, and thoracic and abdominal lesions, all which disturb the phrenic nerves
- **Section of a Phrenic Nerve (330)**
 - In the neck, results in complete paralysis and eventual atrophy of the muscular part of the corresponding half of the diaphragm, except in people who have an accessory phrenic nerve
 - Paralysis can be recognized radiographically by its permanent elevation and paradoxical movement
 - Instead of descending on inspiration, it is forced superiorly by the increased intra-abdominal pressure secondary to descent of the opposite unparalyzed hemidiaphragm
- **Referred Pain from the Diaphragm (330)**
 - Radiates to 2 different areas bc of the difference in the sensory nerve supply of the diaphragm
 - Pain resulting from irritation of the diaphragmatic pleura or the diaphragmatic peritoneum is referred to the shoulder region, the area of skin supplied by the C3-C5 segments of the spinal cord
 - These segments also contribute anterior rami to the phrenic nerves
 - Irritation of peripheral regions of the diaphragm, innervated by the inferior intercostal nerves, is more localized, being referred to the skin over the costal margins of the anterolateral abdominal wall
- **Rupture of the Diaphragm and Herniation of Viscera (330)**
 - Can result from a sudden large increase in either intrathoracic or intra-abdominal pressure
 - Common cause is severe trauma to the thorax or abdomen during a car accident
 - Most diaphragmatic ruptures are on the L side (95%) bc the R side of the diaphragm receives reinforcement from its close association with the liver
 - A non-muscular area of variable size called the *lumbosacral triangle* usually occurs between the costal and lumbar parts of the diaphragm
 - This part of the diaphragm is normally formed only by fusion of the superior and inferior fascias of the diaphragm
 - When a *traumatic diaphragmatic hernia* occurs, the stomach, small intestine and mesentery, transverse colon, and spleen may herniate through this area into the thorax
 - *Hiatal hernia*, a protrusion of part of the stomach into the thorax through the esophageal hiatus, is discussed above
 - The structures that pass through the esophageal hiatus (vagal trunks, L inferior phrenic vessels, esophageal branches of the L gastric vessels) may be injured during surgical procedures on the esophageal hiatus (eg repair of a hiatus hernia)
- **Congenital Diaphragmatic Hernia (330)**
 - *Posterolateral defect of the diaphragm* is the only relatively common congenital anomaly of the diaphragm
 - Herniation almost always occurs on the L owing to the presence of the liver on the R
 - Occurs in approx 1/2200 newborn infants and is associated with *congenital diaphragmatic hernia* (prenatal herniation of abdominal contents into the thoracic cavity)
 - Life-threatening breathing difficulties may be associated with this anomaly bc of the compromised space available for the development and inflation of lungs
- **Psoas Abscess (333)**
 - Although the prevalence of *tuberculosis* (TB) has been greatly reduced, there is currently a resurgence of TB, especially in Africa and Asia
 - Sometimes this reaches pandemic proportions, owing to AIDS and drug resistance
 - TB of the vertebral column is quite common
 - An infection may spread through the blood to the vertebrae (*hematogenous spread*), particularly during childhood
 - An abscess resulting from TB in the lumbar region tends to spread from the vertebrae into the psoas sheath, where it produces *psoas abscess*
 - As a consequence, the psoas fascia thickens to form a strong stocking-like tube
 - Pus from the abscess passes inferiorly along the psoas muscle within its fascial tube over the pelvic brim and deep to the inguinal ligament

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- Usually surfaces in the superior part of the thigh
- Pus can also reach the psoas sheath by passing from the posterior mediastinum when the thoracic vertebrae are diseased
- The inferior part of the *iliac fossa* is often tense and raises a fold that passes to the internal aspect of the iliac crest
 - The superior part of this fascia is loose and may form a pocket – the *iliacosubfascial fossa* – posterior to the above-mentioned fold
 - Part of the large intestine, such as the cecum and/or appendix on the R side and the sigmoid colon on the L side, may become trapped in this fossa, causing considerable pain
- **Posterior Abdominal Pain (335)**
 - The iliopsoas has extensive and clinically important relations to the kidneys, ureters, cecum, appendix, sigmoid colon, pancreas, lumbar lymph nodes, and nerves of the posterior abdominal wall
 - When any of these structures is diseased, movement of the iliopsoas usually causes pain
 - When intra-abdominal inflammation is suspected, the *iliopsoas test* is performed
 - The person is asked to lie on the unaffected side and to extend the thigh on the affected side against the resistance of the examiner's hand
 - The elicitation of pain with this maneuver is a *positive psoas sign*
 - An acutely inflamed appendix, for ex, will produce a positive R psoas sign
 - Bc the psoas lies along the vertebral column and the iliacus crosses the sacroiliac joint, disease of the intervertebral and sacroiliac joints may cause *spasm of the iliopsoas*, a protective reflex
 - *Adenocarcinoma of the pancreas* in advanced stages invades the muscles and nerves of the posterior abdominal wall
 - Produces excruciating pain bc of the close relationship of the pancreas to the posterior abdominal wall
- **Partial Lumbar Sympathectomy (337)**
 - May be included in the treatment of some patients with arterial disease in the lower limbs
 - Consists of the surgical removal of 2 or more lumbar sympathetic ganglia by division of their rami communicantes
 - Surgical access to the sympathetic trunks is commonly through a lateral extraperitoneal approach bc the sympathetic trunks lie retroperitoneally in the extraperitoneal fatty tissue
 - Surgeon splits the muscles of the anterior abdominal wall and moves the peritoneum medially and anteriorly to expose the medial edge of the psoas major, along which the sympathetic trunk lies
 - The L trunk is often overlapped slightly by the aorta
 - The R trunk is covered by the IVC
 - The intimate relationships of the sympathetic trunks to the aorta and IVC also makes these large vessels vulnerable to injury during lumbar sympathectomy
 - So the surgeon carefully retracts them to expose the sympathetic trunks that usually lie in the groove between the psoas major laterally and the lumbar vertebral bodies medially
 - These trunks are often obscured by fat and lymphatic tissue
 - Knowing that identification of the sympathetic trunks is not easy, great care is taken not to remove inadvertently part of the genitofemoral nerve, lumbar lymphatics, or ureter
- **Pulsations of the Aorta and Abdominal Aortic Aneurysm (338)**
 - Bc the aorta lies posterior to the pancreas and stomach, a tumor of these organs may transmit pulsations of the aorta that could be mistaken for an *abdominal aortic aneurysm* (a localized enlargement of the aorta)
 - Deep palpation of the midabdomen can detect an aneurysm, which usually results from a congenital or acquired weakness of the arterial wall
 - Pulsations of a large aneurysm can be detected to the L of the midline
 - The pulsatile mass can be moved easily from side to side
 - Medical imaging can confirm the diagnosis in doubtful cases
 - *Acute rupture of an abdominal aortic aneurysm* is associated with severe pain in the abdomen or back
 - If unrecognized, such an aneurysm has a mortality rate of nearly 90% bc of heavy blood loss
 - Surgeons can repair an aneurysm by opening it, inserting prosthetic graft (such as one made of Dacron), and sewing the wall of the aneurysmal aorta over the graft to protect it

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- Many vascular problems formerly treated with open repair, including aneurysm repair, are not being treated by means of endovascular catheterization procedures
- When the anterior abdominal wall is relaxed, particularly in children and thin adults, the inferior part of the abdominal aorta may be compressed against the body of the L4 vertebra by firm pressure on the anterior abdominal wall, over the umbilicus
 - This pressure may be applied to control bleeding in the pelvis or lower limbs
- **Collateral Routes for Abdominopelvic Venous Blood (341)**
 - 3 collateral routes, formed by valveless veins of the trunk, are available for venous blood to return to the heart when the IVC is obstructed or ligated
 - 2 of these routes (one involving the superior and inferior epigastric veins, and the other involving the thoracoepigastric vein) were mentioned in the anterior abdominal wall section
 - The 3rd route involves the *epidural venous plexus* inside the vertebral column, which communicates with the *lumbar veins* of the inferior caval system, and the tributaries of the *azygos system of veins*, which is part of the superior caval system
 - The inferior part of the IVC has a complicated developmental history bc it forms from parts of 3 sets of embryonic veins
 - Therefore, IVC anomalies are relatively common and most of the, such as *persisting left IVC*, occur inferior to the renal veins
 - These anomalies result from the persistence of embryonic veins on the L side, which normally disappear
 - If a left IVC is present, it may cross to the R side at the level of the kidneys

Pelvis and Perineum

- **Variations in the Male and Female Pelves (362)**
 - Although anatomical differences between male and female pelves are usually clear cut, the pelvis of any person may have some features of the opposite sex
 - See p. 362 Figure B3.1
 - The *android* and *anthropoid* types are most common in males
 - The *gynecoid* and *android* types are most common in white females
 - The *gynecoid* and *anthropoid* types are most common in black females
 - The *platypelloid* type is uncommon in both sexes
 - The *gynecoid pelvis* is the normal female type
 - Its pelvic inlet typically has a rounded oval shape and a wide transverse diameter
 - An *android* (masculine or funnel-shaped) *pelvis* in a woman may present hazards to successful vaginal delivery of a fetus
 - In forensic medicine (the application of medical and anatomical knowledge for the purposes of law), identification of human skeletal remains usually involves the diagnosis of sex
 - A prime focus of attention is the pelvic girdle bc sexual differences usually are clearly visible
 - Even fragments of the pelvic girdle are useful in determining sex
- **Pelvic Diameters (Conjugates) (362-363)**
 - The size of the lesser pelvis is particularly important in obstetrics bc it is the bony canal through which the fetus passes during a vaginal birth
 - To determine the capacity of the female pelvis for childbearing, the diameters of the lesser pelvis are noted radiographically or manually during a pelvic exam
 - The minimum AP diameter of the lesser pelvis, the *true* (obstetrical) *conjugate* from the midline of the sacral promontory to the posterosuperior margin (closest point) of the pubic symphysis, is the narrowest fixed distance through which the baby's head must pass in a vaginal delivery
 - This distance, however, cannot be measured directly during a pelvic exam bc of the presence of the bladder
 - So, the *diagonal conjugate* is measured by palpating the sacral promontory with the tip of the middle finger, using the other hand to mark the level of the inferior margin of the pubic symphysis on the examining hand

- After the examining hand is withdrawn, the distance between the tip of the index finger (1.5cm shorter than the middle finger) and the marked level of the pubic symphysis is measured to estimate the true conjugate, which should be 11.0cm or greater
- In all pelvic girdles, the ischial spines extend toward each other, and the *interspinous distance* between them is normally the narrowest part of the *pelvic canal* (the passageway through the pelvic inlet, lesser pelvis, and pelvic outlet, through which a baby's head must pass at birth)
 - This is not a fixed distance
 - During a pelvic exam, if the ischial tuberosities are far enough apart to permit 3 fingers to enter the vagina side by side, the subpubic angle is considered sufficiently wide to permit passage of an average fetal head at full term
- **Pelvic Fractures (363-364)**
 - AP compression of the pelvis occurs during crush accidents (eg when a heavy object falls on the pelvis)
 - This type of trauma commonly produces fractures of the pelvic rami
 - When the pelvis is compressed laterally, the acetabula and ilia are squeezed toward each other and may be broken
 - Fractures of the bony pelvic ring are almost always multiple fractures or a fracture combined with a joint dislocation
 - To illustrate this, try breaking a pretzel ring at just one point
 - Some pelvic fractures result from tearing away of bone by the strong ligaments associated with the sacroiliac joints
 - Pelvic fractures can result from direct trauma to the pelvic bones, such as occurs during a car accident
 - Or they can be caused by forces transmitted to these bones from the lower limbs during falls on the feet
 - Weak areas of the pelvis, where fractures often occur, are the pubic rami, the acetabula (or the area immediately surrounding them), the region of the sacroiliac joints, and the alae of the ilium
 - Pelvic fractures may cause injury to pelvic soft tissues, blood vessels, nerves, and organs
 - Fractures in the pubo-obturator area are relatively common and are often complicated bc of their relationship to the urinary bladder and urethra, which may be ruptured or torn
 - Falls onto the feet or buttocks from a high ladder may drive the head of the femur through the acetabulum into the pelvic cavity, injuring pelvic viscera, nerves, and vessels
 - In people <17 years old, the acetabulum may fracture through the triradiate cartilage into its 3 developmental parts or the bony acetabular margins may be torn away
- **Spondylolysis and Spondylolisthesis (366-367)**
 - **Spondylolysis** is a defect allowing part of a *vertebral arch* (the posterior projection from the vertebral body that surrounds the spinal canal and bears the articular, transverse, and spinal processes) to be separated from its body
 - Spondylolysis of vertebra L5 results in the separation of the vertebral body from the part of its vertebral arch bearing the inferior articular processes
 - The inferior articular processes of L5 normally interlock with the articular processes of the sacrum
 - When the defect is bilateral, the body of L5 may slide anteriorly on the sacrum so that it overlaps the sacral promontory = **spondylolisthesis**
 - The intrusion of the L5 body into the pelvic inlet reduces the AP diameter of the pelvic inlet, which may interfere with parturition
 - It may also compress spinal nerves, causing low back or lower limb pain
 - Obstetricians test for spondylolisthesis by running their fingers along the lumbar spinous processes
 - An abnormally prominent L5 process indicates that the anterior part of L5 and the vertebral column superior to it may have moved anteriorly relative to the sacrum and the vertebral arch of L5
 - Medical imaging, such as sagittal MRI, are taken to confirm the diagnosis and to measure the AP diameter of the pelvic inlet.
- **Relaxation of Pelvic Ligaments and Increased Joint Mobility during Pregnancy (367-368)**
 - The larger cavity of the interpubic disc of females increases in size during pregnancy
 - This change in size increases the circumference of the lesser pelvis and contributes to increased flexibility of the pubic symphysis
 - Increased levels of sex hormones and the presence of the hormone *relaxin* cause the pelvic ligaments to relax during the latter half of pregnancy, allowing increased movement at the pelvic joints

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- Relaxation of sacroiliac joints and the pubic symphysis permits as much as a 10-15% increase in diameters (mostly transverse, including the interspinous distance), facilitating passage of the fetus through the pelvic canal
- The coccyx is also allowed to move posteriorly
- The one diameter that remains unaffected is the true (conjugate) diameter between the sacral promontory and the posterosuperior aspect of the pubic symphysis
- Relaxation of sacroiliac ligaments causes the interlocking mechanism of the sacroiliac joint to become less effective
 - This permits greater rotation of the pelvis, contributing to the lordotic (“swayback”) posture often assumed during pregnancy with the change in the center of gravity
- Relaxation of ligaments is not limited to the pelvis, and the possibility of joint dislocation increases during late pregnancy
- **Injury to the Pelvic Floor (373)**
 - During childbirth, the pelvic floor supports the fetal head while the cervix of the uterus is dilating to permit delivery of the fetus
 - The perineum, levator ani, and pelvic fascia may be injured during childbirth
 - The pubococcygeus, the main and most medial part of the levator ani, is torn most often
 - This part of the muscle is important bc it encircles and supports the urethra, vagina, and anal canal
 - Weakening of the levator ani and pelvic fascia, resulting from stretching or tearing during childbirth, may alter the position of the neck of the bladder and the urethra
 - These changes may cause *urinary stress incontinence*, characterized by dribbling of urine when intra-abdominal pressure is raised during coughing and lifting, for ex
- **Prenatal “Relaxation” Training for Participatory Childbirth (373,375)**
 - Parents wishing to participate actively in the birth of their baby may take prenatal training (eg Lamaze classes)
 - Among other things, this attempts to train women to learn how to relax voluntarily the muscles of the pelvic floor while simultaneously increasing intra-abdominal pressure through contraction of the diaphragm and anterolateral abdominal wall muscles
 - The aim of this method is to facilitate passage of the fetus through the birth canal
 - Actively pushing (“bearing down”) to aid the uterine contractions that expel the baby without providing resistance (and perhaps minimizing obstetrical tearing) caused by contraction of the pelvic muscles
 - Except when defecating or urinating, the natural reflex is to contract pelvic musculature in response to increased intra-abdominal pressure
- **Injury to the Pelvic Nerves (382)**
 - During childbirth, the fetal head may compress the nerves of the mother’s sacral plexus, producing pain in the lower limbs
 - The *obturator nerve* is vulnerable to injury during surgery (eg during removal of cancerous lymph nodes from the lateral pelvic wall)
 - Injury to this nerve may cause painful spasms of the adductor muscles of the thigh and sensory deficits in the medial thigh region
- **Iatrogenic Injury of the Ureters during Ligation of Uterine Artery (387)**
 - The fact that the ureter passes immediately inferior to the uterine artery near the lateral part of the fornix of the vagina is clinically important
 - The ureter is in danger of being inadvertently clamped (crushed), ligated, or transected during a *hysterectomy* (excision of the uterus) when the uterine artery is ligated and severed to remove the uterus
 - The point at which the uterine artery and ureter cross lies approx 2cm superior to the ischial spine
- **Ligation of the Internal Iliac Artery and Collateral Circulation in the Pelvis (388)**
 - Occasionally the internal iliac artery is ligated to control pelvic hemorrhage
 - Bc of the numerous anastomoses between the artery’s branches and adjacent arteries, ligation does not stop the blood flow but it does reduce blood pressure, allowing *hemostasis* (arrest of bleeding) to occur
 - Examples of collateral pathways to the internal iliac artery include the following pairs of anastomosing arteries:
 - Lumbar and iliolumbar
 - Median sacral and lateral sacral
 - Superior rectal and middle rectal
 - Inferior gluteal and deep artery of the thigh

- Blood flow in the artery is maintained, although it may be reversed in the anastomotic branch
 - The collateral pathways may maintain the blood supply to the pelvic viscera, gluteal region, and genital organs
- **Iatrogenic Injury of the Ureters during Ligation of Ovarian Artery (389)**
 - The ureters are vulnerable to injury when the ovarian vessels are ligated during an *ovariectomy* (excision of the ovary)
 - Bc these structures are close to each other as they cross the pelvic brim
- **Iatrogenic Compromise of the Ureteric Blood Supply (394)**
 - The ureters may be injured during abdominal, retroperitoneal, pelvic, or gynecological operations as a result of inadvertently interrupting their blood supply
 - Identification of the ureters during their full course through the pelvis is an important preventive measure
 - The longitudinal anastomoses between arterial branches to the ureter are usually adequate to maintain the blood supply along the length of the ureters, but occasionally they are not
 - Traction on the ureter during surgery may lead to delayed rupture of the ureter
 - The denuded ureteral segment becomes gangrenous and leaks or ruptures 7-10 days after surgery
 - When traction is necessary, it should be applied with great care
 - It is useful to realize that, although the blood supply to the abdominal segment of the pelvic ureter approaches from a medial direction, that of the pelvic segment approaches from a lateral direction
 - The ureters should be retracted accordingly
- **Ureteric Calculi (394)**
 - The ureters are expansile muscular tubes that dilate if obstructed
 - Acute obstruction usually results from a **ureteric calculus**
 - The symptoms and severity depend on the location, type, and size of the calculus and on whether it is smooth or spiky
 - Although passage of small calculi usually causes little or no pain, larger ones produce severe pain
 - The pain caused by a calculus is a *colicky pain* (resembling colonic pain), which results from hyperperistalsis in the ureter superior to the level of the obstruction
 - May cause complete or intermittent obstruction of urinary flow
 - May occur anywhere along the ureter, but it occurs most often at the 3 sites where the ureters are normally relatively constricted:
 - 1 - At the junction of the ureters and renal pelves
 - 2 – Where they cross the external iliac artery and pelvic brim
 - 3 – During their passage through the wall of the urinary bladder
 - The presence of calculi can be confirmed by abdominal radiographs or an intravenous urogram
 - May be removed by open surgery, endoscopy (*endourology*), or lithotripsy
 - *Lithotripsy* uses shock waves to break up a stone into small fragments that can be passed in the urine
- **Cystocele – Hernia of the Bladder (400)**
 - Loss of bladder support in females by damage to the perineal muscles or their associated fascia can result in herniation of the bladder into the vaginal wall
 - A cystocele may also result from prolapsed of pelvic viscera secondary to injury to the pelvic floor during childbirth
- **Suprapubic Cystotomy (400)**
 - The superior surface of an empty bladder lies at the level of the superior margin of the pubic symphysis
 - But, as the bladder fills it extends superiorly above the symphysis into the loose areolar tissue between the parietal peritoneum and anterior abdominal wall
 - The bladder then lies adjacent to this wall without the intervention of peritoneum
 - Consequently, the distended bladder may be punctured (*suprapubic cystotomy*) or approached surgically superior to the pubic symphysis for the introduction of in-dwelling catheters or instruments without traversing the peritoneum and entering the peritoneal cavity
 - Urinary calculi, foreign bodies, and small tumors may also be removed from the bladder through a suprapubic extraperitoneal incision
- **Rupture of the Bladder (400)**

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- Bc of the superior position of the distended bladder, it may be ruptured by injuries to the inferior part of the anterior abdominal wall or by fractures of the pelvis
 - The rupture may result in the escape of urine extraperitoneally or intraperitoneally
 - Rupture of the superior part of the bladder frequently tears the peritoneum, resulting in extravasation (passage) of urine into the peritoneal cavity
 - Posterior rupture of the bladder usually results in passage of urine extraperitoneally into the perineum
- **Cystoscopy (401)**
 - The interior of the bladder and its 3 orifices can be examined with a *cytoscope*
 - During *transurethral resection of a tumor*, the instrument is passed into the bladder through the urethra
 - Using a high-frequency electrical current, the tumor is removed in small fragments that are washed from the bladder with water
- **Clinically Significant Differences between Male and Female Urethrae (405)**
 - The female urethra is distensible bc it contains considerable elastic tissue, as well as smooth tissue
 - It can be easily dilated without injury
 - Consequently, the passage of catheters or cystoscopes is easier in females
 - Infections of the urethra, and especially the bladder, are more common in women bc the female urethra is short, more distensible, and is open to the exterior through the vestibule of the vagina
- **Male Sterilization (405-406)**
 - The common method of male sterilization is a **deferentectomy**, popularly called a **vasectomy**
 - During this procedure, part of the ductus deferens is ligated and/or excised through an incision in the superior part of the scrotum
 - Hence, the subsequent ejaculated fluid from the seminal glands, prostate, and bulbourethral glands contains no sperm
 - The unexpelled sperm degenerate in the epididymis and the proximal part of the ductus deferens
 - *Reversal of a deferentectomy* is successful in favorable cases (patients <30 years old and <7 years postoperation) in most instances
 - The ends of the sectioned ductus deferentes are reattached under an operating microscope
- **Abscesses in the Seminal Glands (406)**
 - Localized collections pus (abscesses) in the seminal glands may rupture, allowing pus to enter the peritoneal cavity
 - Seminal glands can be palpated during a rectal exam, especially if enlarged or full
 - They are palpated most easily when the bladder is moderately full
 - They can also be massaged to release their secretions for microscopic examination to detect *gonococci*, for ex (the organisms that cause gonorrhoea)
- **Hypertrophy of the Prostate (409)**
 - The prostate is of considerable medical interest bc enlargement or **benign hypertrophy of the prostate (BHP)**, is common after middle age, affecting virtually every male who lives long enough
 - An enlarged prostate projects into the urinary bladder and impedes urination by distorting the prostatic urethra
 - The middle lobe usually enlarges the most and obstructs the internal urethral orifice
 - The more the person strains, the more the valve-like prostatic mass occludes the urethra
 - BHP is a common cause of urethral obstruction, leading to *nocturia* (need to void during the night), *dysuria* (difficulty and/or pain during urination), and *urgency* (sudden desire to void)
 - BPH also increases the risk of bladder infections (*cystitis*) as well as kidney damage
 - The prostate is examined for enlargement and tumors (focal masses or asymmetry) by *digital rectal examination*
 - The palpability of the prostate depends on the fullness of the bladder
 - A full bladder offers resistance, holding the gland in place and making it more readily palpable
 - The malignant prostate feels hard and often irregular
 - In advanced stages, can
 - In advanced stages, cancer cells metastasize both
 - Via lymphatic routes – initially to the internal iliac and sacral lymph nodes and later to distant nodes
 - Via venous routes – by way of the internal vertebral venous plexus, to the vertebrae and brain
 - Bc of the close relationship of the prostate to the prostatic urethra, obstructions may be relieved endoscopically

- The instrument is inserted transurethraly through the external urethral orifice and spongy urethra into the prostatic urethra
 - All or part of the prostate, or just the hypertrophied part, is removed = *transurethral resection of the prostate (TURP)*
 - In more serious cases, the entire prostate is removed along with the seminal glands, ejaculatory ducts, and the terminal parts of the deferent ducts = *radical prostatectomy*
- TURP and improved open operative techniques attempt to preserve the nerves and blood vessels associated with the capsule of the prostate that pass to and from the penis
 - Increases the possibility for patients to retain sexual function after surgery as well as restoring normal urinary control
- **Distension of the Vagina (412)**
 - The vagina can be markedly distended, particularly in the region of the posterior part of the fornix
 - For ex, distension of this part allows palpation of the sacral promontory during a pelvic exam and accommodates the erect penis during intercourse
 - The vagina is especially distended by the fetus during parturition, particularly in an AP direction when the fetus's shoulders are delivered
 - Lateral distention is limited by the ischial spines, which project posteromedially, and the sacrospinous ligaments extending from these spines to the lateral margins of the sacrum and coccyx
 - The birth canal is thus deep anteroposteriorly and narrow transversely at this point, causing the fetus's shoulders to rotate into the AP plane
- **Digital Examination through the Vagina (413)**
 - Bc of its relatively thin, distensible walls and central location within the pelvis, the cervix, ischial spines, and sacral promontory can be palpated with the digits in the vagina and/or rectum = *manual pelvic exam*
 - Pulsations of the uterine arteries may also be felt through the lateral parts of the fornix, as may irregularities of the ovaries, such as cysts
- **Vaginal Fistulae (413)**
 - Bc of the close relationship of the vagina to adjacent pelvic organs, obstetrical trauma during long and difficult labor may result in weaknesses, necrosis, or tears in the vaginal wall and sometimes beyond
 - These may form or subsequently develop into open communications (*fistulas*) between the vaginal lumen and that of the adjacent bladder, urethra, rectum, or perineum
 - Urine enters the vagina from both *vesicovaginal* and *urethrovaginal fistulas*, but the flow is continuous from the former and occurs only during micturition from the latter
 - Fecal matter may be discharged from the vagina when there is a *retrovaginal fistula*
- **Culdoscopy and Culdocentesis (413)**
 - An endoscopic instrument (**culdoscope**) can be inserted through the posterior part of the vaginal fornix to examine the ovaries or uterine tubes (ex for the presence of a tubal pregnancy)
 - Bc it involves less disruption of tissue, *culdoscopy* has been largely replaced by *laparoscopy*
 - Provides greater flexibility for operative procedures and better visualization of pelvic organs
 - There is also less risk of bacterial contamination of the peritoneal cavity
 - A pelvic abscess in the rectouterine pouch can be drained through an incision made in the posterior part of the vaginal fornix = **culdocentesis**
 - Similarly, fluid in the peritoneal cavity (eg blood) can be aspirated by this technique
- **Cervical Cancer, Cervical Examination, and Pap Smear (418)**
 - Until 1940, cervical cancer was the leading cause of death in North American women
 - The decline in the incidence and number of women dying from cervical cancer is related to the accessibility of the cervix to direct visualization and to cell and tissue study by means of Pap (Papanicolaou) smears
 - These procedures allow for the detection of premalignant cervical conditions
 - The vagina can be distended with a *vaginal speculum* to enable inspection of the cervix
 - To prepare a Pap smear –
 - A spatula is placed on the external os of the uterus
 - The spatula is rotated to scrape cellular material from the mucosa of the vaginal cervix

- Followed by insertion of a cytobrush into the cervical canal that is rotated to gather cellular material from the supravaginal cervical mucosa
- The cellular material is then placed on glass slides for microscopic examination

- **Examination of the Uterus (418)**

- The size and disposition of the uterus may be examined by *bimanual palpation*
 - 2 fingers of the R hand are passed superiorly in the vagina, while the other hand is pressed inferoposteriorly on the pubic region of the anterior abdominal wall
- The size and other characteristics of the uterus can be determined in this way (eg whether the uterus is in its normal anteverted position)
 - When softening of the uterine isthmus occurs (*Hegar sign*), the cervix feels as though it were separated from the body
 - Softening of the isthmus is an early sign of pregnancy
- The uterus can be further stabilized through rectovaginal examination, which is used if examination via the vagina alone does not yield clear findings

- **Disposition of the Uterus and Uterine Prolapse (419)**

- When intra-abdominal pressure is increased, the normally anteverted and anteflexed uterus is pressed against the bladder
 - However, the uterus may assume other dispositions, including –

- Excessive anteflexion



- Anteflexion with retroversion



- Retroflexion with retroversion



- Instead of pressing the uterus against the bladder, increased intra-abdominal pressure tends to push the retroverted uterus, a solid mass positioned upright over the vagina (a flexible, hollow tube), into or even through the vagina
 - A retroverted uterus will not necessarily prolapsed but it is more likely to do so
 - Pregnancies involving a retroverted uterus are considered to be higher risk pregnancies
 - This situation is exacerbated in the presence of a disrupted perineal body or with atrophic (“relaxed”) pelvic floor ligaments and muscles

- **Hysterectomy (421)**

- Owing to the frequency of uterine and cervical cancer, **hysterectomy**, excision of the uterus, is a relatively common procedure
 - The uterus may be surgically approached and removed through the anterior abdominal wall or through the vagina

- **Anesthesia for Childbirth (422-424)**

- Several options are available to women to reduce the pain and discomfort experienced during childbirth
 - *General anesthesia* has advantages for emergency procedures and for women who choose it over regional anesthesia
 - Renders the mother unconscious; she is unaware of the labor and delivery
 - Clinicians monitor and regulate maternal respiration and both maternal and fetal cardiac function
 - Childbirth occurs passively under the control of maternal hormones with the assistance of an obstetrician
 - The mother is spared pain and discomfort but is unaware of the earliest moments of her baby’s life
 - *Regional anesthesia* includes a spinal, pudendal nerve, or caudal epidural block
 - It is for women who wish to participate actively (eg using the Lamaze method) and be conscious of their uterine contractions to “bear down,” or push, to assist the contractions and expel the fetus, yet do not wish to experience all the pain of labor

- A **spinal block**, in which the anesthetic agent is introduced with a needle into the spinal subarachnoid space at the L3-L4 vertebral level, produces complete anesthesia inferior to approx the waist level
 - The perineum, pelvic floor, and birth canal are anesthetized, and motor and sensory functions of the entire lower limbs, as well as sensation of uterine contractions, are temporarily eliminated
 - The mother is conscious, but she must depend on electronic monitoring of uterine contractions
 - If labor is extended or the level of anesthesia is inadequate, it may be difficult or impossible to re-administer the anesthesia
 - Bc the anesthetic agent is heavier than CSF, it remains in the inferior spinal subarachnoid space while the patient is inclined
 - The anesthetic agent circulates into the cerebral subarachnoid space in the cranial cavity when the patient lies flat following the delivery
 - A severe headache is a common sequel to spinal anesthesia
- A **pudendal nerve block** is a peripheral nerve block that provides local anesthesia over the S2-S4 dermatomes (the majority of the perineum) and the inferior quarter of the vagina
 - It does not block pain from the superior birth canal (uterine cervix and superior vagina), so the mother is able to feel uterine contractions
 - It can be readministered, but to do so may be disruptive and involve the use of a sharp instrument in close proximity to the infant's head
 - Anatomical basis of the administration is in the "Administration of Pudendal and Ilioinguinal Nerve Blocks" blue box
- The **caudal epidural block** is a popular choice for participatory childbirth
 - It must be administered in advance of the actual delivery, which is not possible with a precipitous birth
 - The anesthetic agent is administered using an in-dwelling catheter in the *sacral canal*, enabling administration of more anesthetic agent for a deeper more prolonged anesthesia, if necessary
 - Within the sacral canal, the anesthesia bathes the S2-S4 spinal nerve roots, including the pain fibers from the uterine cervix and superior vagina, and afferent fibers from the pudendal nerve
 - Thus, the entire birth canal, pelvic floor, and majority of the peritoneum are anesthetized, but the lower limbs are not usually affected
 - The pain fibers from the uterine body (superior to the pelvic pain line) ascend to the inferior thoracic-superior lumbar levels
 - These and the fibers superior to them are not affected by anesthetic, so the mother is aware of her uterine contractions
 - With epidural anesthesia, no "spinal headache" occurs bc the vertebral epidural space is not continuous with the cranial epidural space
- **Infections of the Female Genital Tract (426)**
 - Bc the female genital tract communicates with the peritoneal cavity through the abdominal ostia of the uterine tubes, infections of the vagina, uterus, and tubes may result in *peritonitis*
 - Conversely, inflammation of the tube (*salpingitis*) may result from infections that spread from the peritoneal cavity
 - A major cause of infertility in women is blockage of the uterine tubes, often the result of salpingitis
- **Patency of the Uterine Tubes (426)**
 - **Hysterosalpingography**
 - Patency of the uterine tubes may be determined by a radiographic procedure involving injection of a water-soluble radiopaque material into the uterus and tubes
 - **Endoscopy**
 - Patency of the uterine tubes can also be determined by *hysteroscopy*, examination of the interior of the tubes using an endoscopic instrument (*hysteroscope*), which is introduced through the vagina and uterus
- **Ligation of the Uterine Tubes (426)**
 - Surgical method of birth control
 - Oocytes discharged from the ovaries that enter the tubes of these patients degenerate and are soon absorbed
 - Most surgical sterilizations are done by either abdominal tubal ligation or laproscopic tubal ligation
 - *Abdominal tubal ligation* – usually performed through a short suprapubic incision made at the pubic hairline

- *Laparoscopic tubal ligation* – done with a laproscope, which is similar to a small telescope with a powerful light
 - It is inserted through a small incision, usually near the umbilicus
- **Ectopic Tubal Pregnancy (426-427)**
 - In some women, collections of pus may develop in the uterine tube (*pyosalpinx*) and the tube may be partly occluded by adhesions
 - In these cases, the blastocyst may not be able to pass along the tube to the uterus, although the sperm have obviously done so
 - The blastocyst may implant in the mucosa of the uterine tube, producing an **ectopic tubal pregnancy**
 - Although implantation may occur in any part of the tube, the common site is the ampulla
 - Tubal pregnancy is the most common type of ectopic gestation
 - It occurs in approx 1/250 pregnancies in North America
 - If not diagnosed early, ectopic tubal pregnancies may result in rupture of the uterine tube and severe hemorrhage into the abdominopelvic cavity during the first 8 weeks of gestation
 - Tubal rupture and the associated hemorrhage constitute a threat to the mother's life and result in death of the embryo
 - On the R side, the appendix often lies close to the ovary and uterine tube
 - This close relationship explains why a ruptured tubal pregnancy and the resulting peritonitis may be misdiagnosed as acute appendicitis
 - In both cases, the parietal peritoneum is inflamed in the same general area, and the pain is referred to the RLQ of the abdomen
- **Laparoscopic Examination of the Pelvic Viscera (428)**
 - Visual examination of the pelvic viscera is especially useful in diagnosing many conditions affecting the pelvic viscera, such as *ovarian cysts* and tumors, *endometriosis* (the presence of functioning endometrial tissue outside the uterus), and *ectopic pregnancies*
 - **Laparoscopy** involves inserting a laproscope into the peritoneal cavity through a small (approx 2cm) incision below the umbilicus
 - Insufflation of inert gas creates a pneumoperitoneum to provide space to visualize, and the pelvis is elevated so that gravity will pull the intestines into the abdomen
 - The uterus can be externally manipulated to facilitate visualization, or additional openings (ports) can be made to introduce other instruments for manipulation or to enable therapeutic procedures (eg ligation of the tubes)
- **Rectal Examination (433)**
 - Many structures related to the anteroinferior part of the rectum may be palpated through its walls (eg the prostate and seminal glands in males and the cervix in females)
 - In both sexes, the pelvic surfaces of the sacrum and coccyx can be palpated
 - Other things that can be palpated –
 - The ischial spines and tuberosities
 - Enlarged internal iliac lymph nodes
 - Pathological thickening of the ureters
 - Swellings of the ischioanal fossa (eg ischioanal abscesses and abnormal contents in the rectovesical pouch in the male or the rectouterine pouch in the female)
 - Tenderness of an inflamed appendix may also be detected rectally if it descends into the lesser pelvis (pararectal fossa)
 - The internal aspect of the rectum can be examine with a *protoscope*, and biopsies of lesions may be taken through this instrument
 - During insertion of a *sigmoidoscope*, the curvatures of the rectum and its acute flexion at the rectosigmoid junction have to be kept in mind so that the patient does not undergo unnecessary discomfort
 - The operator must also know that the *transverse rectal folds*, which provide useful landmarks for the procedure, may temporarily impede passage of these instruments
- **Resection of the Rectum (433)**

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- When resecting the rectum in males (eg during cancer treatment), the plane of the rectovesical septum (a fascial septum extending superiorly from the perineal body) is located so that the prostate and urethra can be separated from the rectum
 - In this way, these organs are not damaged during the surgery
- **Disruption of the Perineal Body (435)**
 - The perineal body is an especially important structure in women bc it is the final support of the pelvic viscera
 - It links muscles that extend across the pelvic outlet, like crossing beams supporting the overlying pelvic diaphragm
 - Stretching or tearing the attachments of perineal muscles from the perineal body can occur during childbirth, removing support from the pelvic floor
 - As a result *prolapse of the pelvic viscera*, including prolapse of the bladder (through the urethra) and prolapse of the uterus and/or vagina (through the vaginal orifice) may occur
 - The perineal body can also be disrupted by trauma, inflammatory disease, and infection, which can result in formation of a *fistula* (abnormal canal) connected to the vestibule
 - Attenuation of the perineal body, associated with diastasis (separation) of the puborectalis and pubococcygeus parts of the levator ani, may also result in the formation of a *cystocele*, *rectocele*, and/or *enterocele*
 - These are herniations of the part of the bladder, rectum, or rectovaginal pouch, respectively, into the vaginal wall
- **Episiotomy (436)**
 - A surgical incision of the perineum and inferoposterior vaginal wall
 - Often made to enlarge the vaginal orifice during vaginal surgery and labor
 - It was long held that episiotomy decreases the prevalence of excessive perineal body attenuation and decreases trauma to the pelvic diaphragm, preventing jagged tears of the perineal muscles
 - They are still performed in >50% of vaginal deliveries in the US
 - It is generally agreed that episiotomy is indicated when descent of the fetus is arrested or protracted, when instrumentation is necessary (eg use of obstetrical forceps), or to expedite delivery when there are signs of fetal distress
 - However, routine prophylactic episiotomy is widely debated
 - The perineal body is the major structure incised during a **median episiotomy**
 - The rationale of the median incision is that the scar produced as the wound heals will not be greatly different from the fibrous tissue surrounding it
 - Also, bc the incision extends only partially into this fibrous tissue, some physicians believe that the incision is more likely to be self-limiting, resisting further tearing
 - However, when further tearing does occur, it is directed toward the anus, and sphincter damage or anovaginal fistulae are potential consequences
 - Recent studies indicate medial episiotomies are associated with an increased incidence of severe lacerations, associated in turn with an increased incidence of long-term incontinence and pelvic prolapse
 - **Mediolateral episiotomies** are also performed
 - These do not appear to increase the incidence of severe laceration and are less likely to be associated with damage to the anal sphincters and canal
 - *Note:* The clinical use of the term *mediolateral* is technically inappropriate here
 - It actually refers to an incision that is initially a medial incision that then turns laterally as it proceeds posteriorly, circumventing the perineal body and directing further tearing away from the anus
- **Rupture of the Urethra in Males and Extravasation of Urine (441-442)**
 - *Fracture of the pelvic girdle*, especially those resulting from separation of the pubic symphysis and puboprostatic ligaments, often cause a *rupture of the intermediate part of the urethra*
 - Rupture of this part of the urethra results in the extravasation of urine and blood into the **deep perineal pouch**
 - The fluid may pass superiorly through the urogenital hiatus and distribute extraperitoneally around the prostate and bladder
 - The common site of *rupture of the spongy urethra* and *extravasation of urine* is in the bulb of the penis
 - This injury usually results from a forceful blow to the perineum (*straddle injury*), such as falling on a metal beam or, less commonly, from the incorrect passage (*false passage*) of a transurethral catheter or device that fails to negotiate the angle of the urethra in the bulb of the penis

- Rupture of the corpus spongiosum and spongy urethra results in urine passing from it (extravasating) into the **superficial perineal space**
 - The attachments of the perineal fascia determine the direction of flow of the extravasated urine
 - Urine may pass into the loose connective tissue in the scrotum, around the penis, and superiorly, deep to the membranous layer of subcutaneous connective tissue of the inferior anterior abdominal wall
 - The urine cannot pass far into the thighs bc the membranous layer of superficial perineal fascia blends with the fascia lata, enveloping the thigh muscles, just distal the inguinal ligament
 - In addition, urine cannot pass posteriorly into the anal triangle bc the superficial and deep layers of perineal fascia are continuous with each other around the superficial perineal muscles and with the posterior edge of the perineal membrane between them
 - Rupture of a blood vessel into the superficial perineal pouch resulting from trauma would result in a similar containment of blood in the superficial perineal pouch
- **Starvation and Rectal Prolapse (445)**
 - The fat bodies of the ischioanal fossae, along with the buccal fat pads, are among the last reserves of fatty tissue to disappear with starvation
 - In the absence of the support provided by the ischioanal fat, rectal prolapse is relatively common
- **The Pectinate Line – A Clinically Important Landmark (449)**
 - Also called the **dentate** or **mucocutaneous line** by some clinicians
 - It is a particularly important landmark bc it is visible and approximates the level of important anatomical changes related to the transition from visceral to parietal
 - This transition affects such things as the types of tumors that occur, and the direction in which they metastasize
- **Anal Fissures and Perianal Abscesses (449-450)**
 - The ischioanal fossae are occasionally the sites of infection, which may result in the formation of **ischioanal abscesses**
 - These collections of pus are quite painful
 - Infections may reach the ischioanal fossae in several ways –
 - After *cryptitis* (inflammation of the anal sinuses)
 - Extension from a **pelvirectal abscess**
 - After a tear in the anal mucous membrane
 - From a penetrating wound in the anal region
 - Diagnostic signs of an ischioanal abscess are fullness and tenderness between the anus and the ischial tuberosity
 - A perianal abscess may rupture spontaneously, opening into the anal canal, rectum, or perianal skin
 - Bc the ischioanal fossae communicate posteriorly through the **deep postnatal space**, an abscess in one fossa may spread to the other one and form a semicircular “horseshoe-shaped” abscess around the posterior aspect of the anal canal
 - In chronically constipated persons, the anal valves and mucosa may be torn by hard feces
 - An **anal fissure** (slit-like lesion) is usually located in the posterior midline, inferior to the anal valves
 - It is painful bc this region is supplied by sensory fibers of the inferior rectal nerves
 - **Perianal abscesses** may follow infection of anal fissures, and the infection may spread to the ischioanal fossae and form ischioanal abscesses or spread into the pelvis and form **pelvirectal abscesses**
 - An **anal fistula** may result from the spread of an anal infection and cryptitis
 - One end of this abnormal canal (fistula) opens into the anal canal and the other end opens into an abscess in the ischioanal fossa or into the perianal skin
- **Hemorrhoids (450-451)**
 - **Internal hemorrhoids** (piles) are prolapses of rectal mucosa (more specifically, of the so-called rectal cushions) containing the normally dilated veins of the **internal rectal venous plexus**
 - They are thought to result from a breakdown of the muscularis mucosae, a smooth muscle layer deep to the mucosa
 - They occur quite predictably in the L lateral, R anterolateral, and R posterolateral positions (positions of the anal cushions)
 - Those that prolapse through the anal canal are often compressed by the contracted sphincters, impeding blood flow
 - As a result, they tend to strangulate and ulcerate

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- Bc of the presence of abundant arteriovenous anastomoses, bleeding from internal hemorrhoids is characteristically bright red
- Although all forms (including normal anal cushions misinterpreted as abnormalities) were once treated aggressively, current practice is to treat only prolapsed, ulcerated internal hemorrhoids
- **External hemorrhoids** are thromboses (blood clots) in the veins of the **external rectal venous plexus** and are covered by skin
 - Predisposing factors for hemorrhoids include pregnancy, chronic constipation, and prolonged toilet sitting and straining, and any disorder that impedes venous return, including increased intra-abdominal pressure
 - The anastomoses between the superior, middle, and inferior rectal veins form clinically important communications between the portal and venous systems
 - The superior rectal vein drains into the IMV, whereas the middle and inferior rectal veins drain through the systemic system into the IVC
 - An abnormal increase in pressure in the valveless portal system or veins of the trunk may cause enlargement of the superior rectal veins
 - Results in an increase in blood flow or stasis in the **internal rectal venous plexus**
 - In the **portal hypertension** that occurs in relation to hepatic cirrhosis, the portocaval anastomosis between the superior and the middle and inferior rectal veins, along with the portocaval anastomoses elsewhere, may become varicose
 - Those in the esophagus are especially prone to rupture
 - It is important to note that the veins of the rectal plexuses *normally* appear varicose (dilated and tortuous), even in newborns
 - Internal hemorrhoids occur most commonly in the *absence* of portal hypertension
- Regarding pain from and the treatment of hemorrhoids, it is important to note –
 - The anal canal superior to the pectinate line is visceral
 - Thus it is innervated by visceral afferent pain fibers, so that an incision or needle insertion in this region is painless
 - Internal hemorrhoids are not painful and can be treated without anesthesia
 - However, inferior to the pectinate line, the anal canal is somatic, supplied by the inferior anal (rectal) nerves containing somatic sensory fibers
 - Therefore, it is sensitive to painful stimuli (eg to the prick of a hypodermic needle)
 - External hemorrhoids can be painful but often resolve in a few days
- **Anorectal Incontinence (451)**
 - Stretching of the pudendal nerve(s) during a traumatic childbirth can result in *pudendal nerve damage* and anorectal incontinence
- **Urethral Catheterization (452-453)**
 - Reasons to do a urethral catheterization
 - Done to remove urine from a person who is unable to micturate
 - Also performed to irrigate the bladder and to obtain an uncontaminated sample of urine
 - When inserting catheters and *urethral sounds* (slightly conical instruments for exploring and dilating a constricted urethra) the curves of the male urethra must be considered
 - Just distal to the perineal membrane, the spongy urethra is well covered inferiorly and posteriorly by erectile tissue of the bulb of the penis
 - However, a short segment of the intermediate part of the urethra is unprotected
 - Bc the urethral wall is thin and bc of the angle that must be negotiated to enter the intermediate part of the spongy urethra, it is vulnerable to rupture during the insertion of urethral catheters and sounds
 - The intermediate part, the least distensible part, runs inferoanteriorly as it passes through the external urethral sphincter
 - Proximally, the prostatic part takes a slight curve that is concave anteriorly as it traverses the prostate
 - *Urethral stricture* may result from external trauma of the penis or infection of the urethra
 - Urethral sounds are used to dilate the constricted urethra in such cases
 - The spongy urethra will expand enough to permit passage of an instrument approx 8mm in diameter

- The external urethral orifice is the narrowest and least distensible part of the urethra
 - Hence, an instrument that passes through this opening normally passes through all other parts of the urethra
- **Distension of the Scrotum (453)**
 - The scrotum is easily distended
 - In people with large indirect inguinal hernias, for ex, the intestine may enter the scrotum, making it as large as a soccer ball
 - Similarly, inflammation of the testis (*orchitis*), associated with mumps, bleeding in the subcutaneous tissue, or chronic lymphatic obstruction (as occurs in the parasitic disease *elephantiasis*), may produce an enlarged scrotum
- **Palpation of the Testes (453)**
 - The soft, pliable skin of the scrotum makes it easy to palpate the testes and the structures related to them (eg the epididymis and the ductus deferens)
 - The left testis commonly lies at a more inferior level than does the right one
- **Hypospadias (458)**
 - A common congenital anomaly of the penis, occurring in 1/300 newborns
 - Types –
 - In the simplest and most common form, **glanular hypospadias**, the external urethral orifice is on the ventral aspect of the glans
 - In other infants, the defect is in the body of the penis = **penile hypospadias**
 - May also be in the perineum = **penoscrotal** or **scrotal hypospadias**
 - Hence the external urethral orifice is on the urethral surface of the penis – in penile and scrotal
 - Embryological basis –
 - Basis of glanular and penile hypospadias is failure of the *urogenital folds* to fuse on the ventral surface of the developing penis and form the spongy urethra
 - Basis of scrotal hypospadias is failure of the *labioscrotal folds* to fuse and form the scrotum
 - The cause of hypospadias is not clearly understood, but it appears to have a multifactorial origin (ie, genetic and environmental factors are involved)
 - Close relatives of patients with hypospadias are more likely than the general population to have the anomaly
 - It is generally believed that hypospadias is associated with an inadequate production of androgens by the fetal testes
 - Differences in the timing and degree of hormonal insufficiency probably account for the different types
 - The less common but more severe forms, in which the external urethra orifice is located on the penile body or in the perineum, may interfere with normal urination in the usual male in the standing position
- **Female Circumcision (464)**
 - Although illegal and now being actively discouraged in most countries, female circumcision is widely practiced in some cultures
 - The operation performed during childhood removes the prepuce of the clitoris and commonly also removes part or all of the clitoris and the labia minora
 - This disfiguring procedure is thought to inhibit sexual arousal and gratification
- **Vulvar Trauma (464)**
 - The highly vascular bulbs of the vestibule are susceptible to disruption of vessels as the result of trauma (eg athletic injuries such as jumping hurdles, sexual assault, and obstetrical injury)
 - These injuries often result in vulvar hematomas in the labia majora, for ex
- **Infection of the Greater Vestibular Glands (464)**
 - These glands are usually not palpable, but are so when infected
 - Occlusion of the vestibular gland duct can predispose the individual to infection of the gland
 - The greater vestibular gland is the site or origin of most vulvar adenocarcinomas
 - **Bartholinitis**, inflammation of the greater vestibular glands, may result from a number of pathogenic organisms
 - Infected glands may enlarge to a diameter of 4-5cm and impinge on the wall of the rectum
 - Occlusion of the gland duct without infection can result in the accumulation of mucin = **Bartholin cyst**
- **Administration of Pudendal and Ilioinguinal Nerve Blocks (465-466)**
 - To relieve perineal pain during childbirth, **pudendal nerve block anesthesia** may be performed by injecting a local anesthetic agent into the tissues surrounding the pudendal nerve

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- The injection is made where the nerve crosses the lateral aspect of the sacrospinous ligament, near its attachment to the ischial spine
 - The needle may be passed through the overlying skin or, more commonly, through the vagina parallel to the palpating finger
- Bc the fetus's head is usually stationed within the lesser pelvis at this stage, it is important that the physician's finger is always positioned between the needle tip and the baby's head during the procedure
- To abolish sensation from the anterior part of the perineum, an **ilioinguinal nerve block** is performed
- When patients continue to complain of pain sensation after proper administration of a pudendal or pudendal and ilioinguinal nerve blocks, it is usually the result of overlapping innervation by the perineal branch at the posterior cutaneous nerve of the thigh
- → read about other types of childbirth anesthesia in the "Anesthesia for Childbirth" blue box (above)
- **Kegel Exercises for Increased Development of Female Perineal Muscles (467)**
 - In females, the superficial transverse perineal muscle, bulbospongiosus, and external anal sphincter, through their common attachment to the perineal body, form crossing beams over the pelvic outlet to support the perineal body, as in males
 - In the absence of the functional demands related to urination, penile erection, and ejaculation in males, the muscles are commonly relatively undeveloped in women
 - However, when developed, they contribute to the support of the pelvic viscera, and help prevent urinary stress incontinence and postpartum prolapse of pelvic viscera
 - Therefore, many gynecologists as well as prepartum classes for participatory childbirth recommend that women practice **Kegel exercises** using the perineal muscles, such as successive interruption of the urine flow during urination
 - Prepartum childbirth classes emphasize that in learning to voluntarily contract and relax the perineal muscles, women become prepared to resist the tendency to contract the musculature during uterine contractions
 - This allows a less obstructed passage for the fetus and decreases the likelihood of tearing the perineal muscles
 - **Vaginismus (467)**
 - The initial distension of the bulbospongiosus and transverse perineal muscles are thought to trigger the involuntary spasms of the perivaginal and levator ani muscles of **vaginismus**, an emotional (psychosomatic) gynecological disorder
 - It is encountered clinically when pelvic exam is attempted
 - In mild forms, it causes *dyspareunia* (painful intercourse)
 - In severe forms, it prevents vaginal entry and is reportedly a cause of unconsummated marriages