Core Surgical Sciences course for the Severn Deanery

Surgical Anatomy: Abdomen and pelvis – detailed learning objectives/stations

The session will be taught in small groups, with examination of prosections, and three rotating stations: anterior and posterior abdominal wall; abdominal cavity and viscera; pelvis and perineum.

Anterior and Posterior Abdominal Wall

1. Anterior abdominal wall and inguinal region

You should be able to describe:

- the boundaries of the abdominal cavity: the diaphragm superiorly; the pelvic diaphragm (pelvic floor) inferiorly; the anterior abdominal wall and the posterior abdominal wall; bony landmarks around the boundaries of the anterior abdominal wall
- the division of the anterior abdominal wall into 9 regions, in relation to anatomical landmarks (transpyloric plane joins the tips of the 9th costal cartilages bilaterally, level with L1 vertebra; intertubercular plane passes through iliac tubercles, level with L5 vertebra; midclavicular lines pass down through mid-inguinal point)
- the cutaneous innervation of the anterior abdominal wall
- the layers of the anterolateral abdominal wall (NB. No deep fascia over thorax or abdomen)
- the attachments of the inguinal ligament (the inferior free edge of the external oblique aponeurosis), from ASIS to the pubic tubercle
- Peritoneal folds on the anterior abdominal wall (median umbilical fold – over urachus; medial umbilical folds – over obliterated umbilical arteries; lateral umbilical folds – over inferior epigastric vessels)
- the inguinal canal, running from the the deep inguinal ring (opening in transversalis fascia just lateral to the inferior epigastric vessels) to the superficial inguinal ring (a deficiency in the external oblique muscle tendon, above and medial to the pubic tubercle), and the tendons/fascia which form its floor, roof, and walls; contents in male and female

2. Posterior abdominal wall

You should be able to identify and describe the bones and muscles contributing to the posterior abdominal wall: lumbar vertebrae, diaphragm, 12th rib, psoas major, iliacus, quadratus lumborum

You should be able to describe and identify the vessels and nerves of the posterior abdominal wall:

Abdominal aorta and its branches:

- coeliac axis
- renal arteries and SMA
- gonadal arteries
- IMA - arises 4cm above aortic bifurcation, behind horizontal (3rd) part of duodenum (L3)
- aorta bifurcates at L4
- common iliac arteries diverge to L5/S1 level and divide anterior to sacroiliac joint; Right common iliac is 5cm long; left is 4cm long
- Each common iliac gives small branches to peritoneum, psoas and uteter

- External iliac artery forms principal supply to lower limb
- Internal iliac artery supplies pelvic viscera, walls and gluteal region
- common iliac and gonadal arteries

IVC and its tributaries: common iliac, gonadal, renal and hepatic veins.

Branches of the lumbar plexus emerging around and through psoas: subcostal, ilioinguinal and iliohypogastric, genitofemoral, lateral femoral cutaneous, femoral, obturator nerves and the lumbosacral trunk.

You should be able to describe and identify the kidneys:

- Position and relations of the kidneys: extend from T12 to L3 with the hila at the level of L1; lie 3 finger breadths from the midline; right kidney slightly lower than the left
- The three 'capsules' of the kidney (fibrous capsule; perinephric fat; renal/extraperitoneal fascia)
- Posterior relations of each kidney (diaphragm, 12th rib, quadratus lumborum, psoas, transversus abdominis; subcostal, iliohypogastric, ilioinguinal nerves)
- Anterior relations of the right kidney (suprarenal gland, liver, 2nd part of duodenum, ascending colon) and left kidney (suprarenal gland, stomach, pancreas, spleen, descending colon)

You should be able to describe and identify the suprarenal glands:

- Right adrenal gland lies posterior to liver; left lies posterior to stomach and pancreas; both lie within the coverings of the perinephric fat and renal fascia
- Structure: outer cortex and inner medulla
- Right adrenal gland is pyramidal; left is crescent-shaped and larger)
- Supplied by inferior phrenic arteries, aorta and renal arteries;

You should be able to describe the external appearance and internal architecture of the kidneys:

- poles, hilum (order of structures entering/exiting)
- cortex; medullary pyramids; major and minor calyces; renal pelvis and hilum of the kidney
- lymph from the kidney drains to para-aortic nodes
- sympathetic innervation via renal plexus; afferents enter the spinal cord in the tenth, eleventh and twelth thoracic nerves

You should be able to discuss how and why an intravenous urogram (IVU) may be obtained, and the appearance of common problems on the IVU (eg: cystic or neoplastic disease may be seen, reduced renal blood flow, obstruction, bladder filling defects and emptying). There are three constrictions along the course of the ureter: pelvi-ureteric junction (PUJ), pelvic brim, vesico-ureteric junction (VUJ)

You should understand the anatomical basis of renal clinical problems, including:

- Developmental anomalies (polycystic kidneys, horseshoe kidney, duplication of the ureter, ectopic ureters, pelvic kidney)
- Urinary tract calculi – complications and treatment
- Referred pain from the kidney produces typical 'loin to groin' pain: visceral afferents in the least splanchnic nerve enter the spinal cord at T12, so pain is referred to T12 dermatome, corresponding to the flanks and pubic region.

You should be able to describe and identify the abdominal ureters:

- 25cm long; lined with uroepithelium/transitional epithelium
- Pelvis of ureter/renal pelvis variably embedded in kidneys – from intrarenal to extrarenal
- Abdominal ureter lies retroperitoneally (adherent to peritoneum), on the medial border of psoas major (anterior to the tips of transverse processes of lumbar vertebrae); crosses pelvic brim at bifurcation of common iliac artery
- Ureter crosses pelvic brim, over bifurcation of common iliac artery, turns forward and medially at level of ischial spine; lies close to seminal vesicle in the male; passes lateral to the cervix and under the uterine vessels in the female
- Blood supply to the ureter is derived from local arteries along its course (venous drainage via corresponding veins): aorta, renal artery, gonadal artery, internal iliac artery, inferior vesical artery
- Lymph drains to para-aortic nodes
- Nerve supply via autonomic plexuses

You should be able to describe the normal anatomy of the bladder, and mechanisms of continence and micturition:

- The empty bladder lies in the true pelvis, posterior to the pubic symphysis; expands out of the pelvis as it fills, to become intra-abdominal; ureteric peristalsis pumps urine into bladder; the network of detrusor fibres gives the bladder wall a trabeculated appearance – becomes more prominent in obstruction
- Supplied by superior and inferior vesical/vaginal artery
- Lymph drains to external and internal iliac nodes
- Parasympathetic motor innervation and sensation of distension
- Sympathetic efferents are vasomotor, motor to internal urethral sphincter and muscle of trigone
- Pain is carried by both parasympathetic and sympathetic afferents
- The external urethral sphincter (striated muscle, supplied by pudendal nerve) is also important in continence; midflow stop is achieved by contraction of external urethral sphincter with delayed reflex relaxation of detrusor muscle; external sphincter assisted by pelvic floor (levator ani muscle) in active continence

You should be able to discuss how and why urethral vs suprapubic catheterisation may be carried out.

You should understand the anatomical basis of common lower urinary tract pathologies, including:

- Urinary tract calculi - may lodge inside external urethral meatus
- Straddle injuries – urine collects in the superficial pouch
- Benign prostatic hyperplasia (BPH) - commonest urinary tract pathology in men
- Urinary tract infection (UTI) - commonest pathology in women
- Incontinence: stress incontinence; urge incontinence; overflow incontinence; incontinence after childbirth

Abdominal cavity and viscera

1. Peritoneum, peritoneal cavity and compartments

You should be able to describe the peritoneum:

- A thin serous membrane (similar to pleura and serous pericardium);
- Parietal and visceral layers; forms folds through which nerves and vessels reach the viscera
- Entire embryonic gut tube possesses a mesentery; some gut remains intraperitoneal and retains a mesentery, other parts become secondarily retroperitoneal
- Peritoneal fluid lubricates gut movement and expansion
- Visceral peritoneum innervated by autonomic afferents from viscera; parietal by somatic nerves

Describe the omenta, greater and lesser sacs:

- Lesser omentum - double fold of peritoneum joining the lesser curvature of the stomach to the visceral surface of the liver (part of the embryonic ventral mesogastrium)
- Lesser sac (omental bursa) - peritoneal pouch behind the lesser omentum and stomach; communicating with the greater sac (peritoneal cavity) at the epiploic foramen; formed by rotation of stomach during embryological development
- Dorsal mesentery of stomach forms greater omentum, gastrosplenic and splenorenal ligaments
- The greater omentum – a quadruple fold of peritoneum hanging down over the intestines, and attaching from the greater curvature of the stomach to the transverse colon; its two posterior layers adhere to the transverse mesocolon to form the posterior wall of lesser sac (surgically separable); contains fat and macrophages
- Splenic vessels and tail of pancreas in splenorenal lig
- Epiploic foramen (of Winslow) - vertical slit about 2.5cm long; anterior border formed by free edge of lesser omentum (containing portal vein posteriorly, bile duct and hep artery anteriorly, & autonomic nerves, lymphatics)

Describe the peritoneal compartments and pouches:

- Supracolic compartment above attachment of transverse mesocolon (over body of pancreas); infracolic below (NB. traction on root of mesentery stimulates pressure receptors and causes reflex drop in BP)
- Supracolic compartment divided into right and left subphrenic/diaphragmatic spaces by falciform ligament – extend up as far as sup layer of coronary ligament on right and anterior layer of left triangular ligament on the left
- Right subhepatic space (or hepatorenal pouch) between lower layer of coronary ligament and transverse mesocolon attachment (lowest part of cavity when supine – fluid accumulates here)
- Right paracolic gutter and right infracolic space lateral and medial to ascending colon, respectively
- Left paracolic gutter and left infracolic space lateral and medial to descending colon, respectively
- Left infracolic space cont with pelvic cavity
- Sigmoid mesocolon attaches down to S3 – then rectum

2. Digestive tract

You should be able to identify and describe the following parts of the digestive tract, within the abdominal cavity:

Oesophagus

- 25cm long
- Lies anterior to lower cervical vertebrae and prevertebral fascia, posterior to trachea in the neck; anterior to thoracic vertebrae, posterior to trachea, arch of the aorta, left bronchus, pericardium and left atrium in chest; passes through right crus of diaphragm; 1-2cm of abdominal oesophagus, with vagal trunks lying anterior and posterior; enters cardiac orifice of stomach
- Factors guarding against gastric reflux: contraction of right crus, angle of entry of oesophagus, longitudinal folds of oesophageal mucosa, high pressure zone in the last few cm, effect of increased intra-abdominal pressure on abdominal oesophagus
- Constrictions (may hold up endoscope) at cricopharyngeal sphincter; crossing of the left bronchus; at the diaphragm
- Outer longitudinal and inner circular muscle layers - upper third is striated muscle, becoming smooth muscle
- Lined with SSNKE, with mucous glands
- Innervation: autonomic afferents and efferents; parasympathetic efferents stimulate contraction
- Blood supply: upper third: inferior thyroid artery and vein; middle third: branches of thoracic aorta, drains to azygos vein; lower third: left gastric artery and vein (tributaries of the left gastric vein and azygos vein form portosystemic anastomosis)
- Lymph drainage: posterior mediastinal nodes

Stomach

- Relations: anteriorly: abdominal wall, left costal margin, left lobe of liver; posteriorly: lesser sac; superiorly: left dome of diaphragm
- Body, fundus, greater and lesser curvatures, pyloric antrum, pyloric canal, cardiac and pyloric sphincters
- Muscular wall: longitudinal, circular and oblique fibres
- Mucosa: thick and vascular, thrown into rugae; SSNKE replaced by simple columnar epithelium at cardia; forms gastric pits
- Intrinsic innervation from enteric nervous system; extrinsic innervation: parasympathetic from vagal trunks (large gastric branches run in lesser omentum near curvature); sympathetic from sympathetic trunks via coeliac plexus
- Blood supply coeliac axis (left gastric artery; right gastric artery from hepatic artery; right gastroepiploic artery from gastroduodenal branch of hepatic artery; left gastroepiploic and short gastric arteries from splenic artery); veins drain to portal system (portal vein; splenic and SM tributaries)
- Lymph drains from lesser curvature and upper body drains to right and left gastric nodes; lymph from greater curvature and lower body drains to pancreaticosplenic nodes (at splenic hilum) and gastroepiploic nodes; lower pylorus drains to hepatic nodes
- Prepyloric vein of Mayo (indicates position of pyloric sphincter) drains into right gastric vein

Duodenum

- 25cm long; First 2.5cm is intraperitoneal – between layers of omenta
- Gallbladder lies anterior to duodenal cap (no plicae circulares)
- 4 parts:
  - 1st part lies at L1, on transpyloric plane
  - 2nd part loops around head of pancreas; lies over hilum of right kidney, with coils of jejunum in front; receives hepatopancreatic ampulla of vater on major duodenal papilla about 10cm from pylorus (this also marks the division between foregut and midgut)
  - 3rd part crossed anteriorly by SM vessels (lies in both infracolic compartments)
  - 4th part breaks free from peritoneum at DJ flexure; fixed to psoas by fibrous tissue and by suspensory ligament ligament (of Treitz) to left crus
- Paraduodenal recess between 4th part and IMV (hernia may become incarcerated here)
- Secretin and parasympathetic fibres (from vagus) stimulate secretions and motility
- Blood supply from coeliac axis (superior pancreaticoduodenal artery) and SMA (inferior pancreaticoduodenal artery); first 2cm – usual site of ulceration – also receives blood from hepatic, gastroduodenal, and epiploic arteries; venous drainage to portal and SMV
- Lymph drains along arteries to coeliac and superior mesenteric nodes

Jejunum and ileum

- Both have plicae circulares and villous mucosa
- Jejunum (around 2m long) is thicker (wall feels 'double') and more vascular than ileum (around 3m long); jejunum has 'windows' in its arterial arcade; ileum has more layers of arcades and shorter straight arteries; jejunum lies in upper infracolic compartment (umbilical region); ileum lies in lower infracolic compartment and pelvic cavity (suprapubic region)
- Mucosa: columnar epithelium forms villi and intestinal glands (crypts of Lieberkuhn)
- In terminal ileum, lymphoid follicles congregate to form Peyer's patches; gut-associated lymphoid tissue (GALT) comprises Peyer's patches, peripheral lymphoid tissues and appendix
- Meckel's diverticulum: classically found in 2%, 2 feet from ileocaecal junction, and 2 inches long (but may be more proximal and length varies); may contain gastric, hepatic or pancreatic tissue; may ulcerate
- Jejunal and ileal branches of the SMA; vasa recta/straight arteries are end-arteries – occlusion may cause infarction
- Corresponding veins drain into portal system
- Lymph drains along the arteries to the superior mesenteric lymph nodes
- Autonomic nerves travel with blood vessels; parasympathetic stimulates contraction and secretion; sympathetic vasocontricts and inhibits peristalsis; sympathetic pain fibres enter spinal cord at T9 and 10 (referred umbilical pain)

Large intestine

- Large diameter compared with small bowel;
- Mucosa: no villi, only intestinal glands only – with many goblet cells; numerous lymphoid follicles in submucosa and mucosa; columnar epithelium changes to SSNKE in anal canal
- Taeniae (3 bands of longitudinal muscle) gather the bowel into sacculations, separated by narrower parts or haustra; taeniae coli converge on appendix; expand to coat the terminal sigmoid colon
- Ascending colon is retroperitoneal; transverse colon is intraperitoneal (the transverse mesocolon varies in length so that the transverse may even hang down to the pelvis); descending colon is retroperitoneal; the sigmoid colon is intraperitoneal (with its own sigmoid mesocolon)

- Splenic flexure attached to diaphragm by phrenicocolic ligament; risk of ischaemia in splenic flexure if arc of Riolan (inner arcade) not well developed; gut supplied by vagi to splenic flexure, then by pelvic splanchnic nerves; sympathetic supply to colon from T10-L2 - referred umbilical pain
- Appendices epiploicae (fatty tags on antimesenteric border; mucosa herniates into them in diverticulosis) common in descending and sigmoid colon
- Caceum usually intraperitoneal; appendix may lie in retrocaecal recess; The ileocaecal valve prevents reflux from the caecum to the ileum
- Vermiform appendix usually 6-9cm long; opens into posteromedial wall of caecum; the fold of peritoneum from terminal ileum to mesoappendix is termed the 'bloodless fold of Treves' – but may contain vessels; Anterior and posterior caecal arteries arise from ileocolic; mesenteric artery from posterior caecal - end-artery, may become thrombosed in appendicitis; position varies: may be retrocaecal, subcaecal, pelvic (hanging down over pelvic brim), anterior or posterior to the terminal ileum (preileal or postileal)
- Branches of the SMA and IMA anastomose to form a continuous arcade along the length of the bowel; SMA provides: ileocolic artery (supplies terminal ileum, caecum & appendix), right colic artery (to ascending colon) and middle colic artery (to proximal 2/3 of transverse colon); IMA provides: left colic artery (supplies distal 1/3 of transverse colon and descending colon), sigmoid artery (to sigmoid colon)
- Corresponding veins drain to the SMV and IMV, and then to the portal vein (portosystemic anastomoses may exist between the mesenteric veins and retroperitoneal systemic veins such as the renal, phrenic and lumbar veins)
- Lymphatics follow arteries – to superior or inferior mesenteric nodes; lymph from caecum and appendix drains to nodes along ileocolic artery

3. Abdominal organs

You should be able to identify and describe the following organs:

Liver

- Large, wedge-shaped organ occupying most of right hypochondrium & epigastrium; upper margin level with xiphisternal joint, lower margin a hand's breadth below; reaches to 5th intercostals space in midclavicular line on left; from ribs 7-11 on right in the midaxillary line
- Diaphragmatic & visceral surfaces separated by sharp inferior border
- Covered in visceral peritoneum apart from bare area; falciform ligament – to anterior abdominal wall; ligamentum teres (obliterated umbilical vein) and ligamentum venosum (obliterated ductus venosus)
- Portal vein, hepatic artery, bile duct from posterior to anterior at porta hepatis
- Bile canaliculi collect bile from hepatocytes…bile ductules in portal triad….intrahepatic ducts… right and left hepatic ducts….common hepatic duct, joined by cystic duct: bile duct
- Common hepatic artery may arise directly from aorta or from SMA; right hepatic may arise from SMA and left from left gastric; occlusion of hepatic arteries leads to infarction
- Right, left, quadrate and caudate lobes (physiologically – left and right lobes)
- 4 sectors, 8 segments by blood supply
- In liver transplant – liver plus IVC removed & replaced
- Portal vein divisions follow arteries; anastomoses with azygos vv in bare area; venous return mixes right to left; 3 hepatic veins drain to IVC
- 3-4 hepatic nodes at porta – drain to coeliac nodes
- Sympathetic innervation from coeliac ganglia; parasympathetic from anterior vagal trunk

Gallbladder

- Fibromuscular sac; stores & concentrates bile; 50ml capacity; bound to liver by connective tissue (may be embedded or hang free); fundus, body and neck; fundus contacts parietal peritoneum at tip of 9th costal cartilage
- Lined with columnar epithelium
- Cystic duct 2-3cm long, 2-3mm wide; spiral valve (of heister) in neck & cystic duct
- Cystic artery from right hepatic artery; multiple cystic veins drain to liver and ultimately into hepatic veins
- CCK from small intestine more imp than parasympathetic stimulation for emptying
- Afferents from T7-9 and some in phrenic – shoulder tip pain
- Bile duct 8cm long; may be embedded in pancreas below

Pancreas

- Structure and function:Head (lying in the curve of the duodenum), neck, body and tail (abutting the splenic hilum); retroperitoneal, behind lesser sac
- Uncinate process hooks behind SM vessels; transverse mesocolon attaches across head & body; splenic artery runs along upper border; tail runs in splenorenal ligament
- Main pancreatic duct (of Wirsung) begins in tail and runs the length of the gland; accessory (of Santorini) drains lower head and uncinate – 2 ducts communicate
- Composite exocrine and endocrine gland; acinar cells secrete trypsin, lipase, bicarbonate; islet cells secrete glucagon (alpha cells), insulin (beta cells) and somatostatin (gamma cells)
- Mainly supplied by splenic artery; head by superior and inferior pancreaticoduodenal arteries; corresponding veins drain to portal system
- Lymph drains to coeliac and SM nodes
- Secretin and CCK more important than parasympathetic stimulation for secretion
- Sympathetic vasoconstrictor & pain fibres

Spleen

- Intraperitoneal – peritoneal folds form gastrosplenic and lienorenal ligaments; anteriorly – the stomach and splenic flexure; posteriorly – the left kidney; laterally – the diaphragm (separating it from the 9^{th}, 10^{th} and 11^{th} ribs)
- Contains red and white pulp
- Extremely friable (it is the commonest abdominal organ to be injured by blunt trauma)
- Supplied by splenic artery and vein

Pelvis and perineum

1. Bones, ligaments and muscles of the pelvis

You should be able to:

Identify and describe the innominate bones (pubis, ilium and ischium) with particular reference to bony landmarks, and define the following:

- The pelvic inlet (pelvic brim), comprising: pubic crest, iliopectineal line, sacral promontory
- The false pelvis (part of the abdominal cavity) lying above the pelvic inlet, and the true pelvis below the inlet
- The pelvic outlet, comprising: coccyx, ischial tuberosities, ischiopubic rami, pubic symphysis (these are also the boundaries of the perineum)

Describe the functions of the bony pelvis: protection of pelvic viscera; supporting body weight; muscle attachment; in women, Supporting a gravid uterus and forming the birth canal

Identify and describe the actions and innervation of the muscles of the pelvic sidewall - obturator internus and piriformis

Identify and describe levator ani (forming the pelvic floor/diaphragm):

- Pubococcygeus (arising from posterior surface of pubis), including fibres which form slings around the prostate (levator prostatae) or vagina (pubovaginalis) and the rectum (puborectalis)
- Iliococcygeus (arising from the fascia over obturator internus)
- Supplied by S4 fibres from the sacral plexus
- Supports the pelvic viscera, and acts as a sphincter on the rectum and vagina - reflexively contracts to counter raised abdominal pressure, and relaxes to allow defaecation, micturition and parturition

NB. (Ischio) coccygeus is a functionally separate muscle from levator ani, and is represented merely by a few muscle fibres on the inner surface of the sacrospinous ligament

Describe and identify the layers of pelvic fascia:

- Parietal pelvic fascia - over obturator internus and piriformis
- Endopelvic fascia - between levator ani and peritoneum, condenses around neurovascular bundles to form ligaments, eg: sacrouterine and pubocervical ligaments, which provide additional support for pelvic viscera

2. Neurovascular supply to the pelvis

You should be able to:

Identify and describe the sacral and pelvic plexuses:

- The roots of the sacral plexus lie on the deep surface of piriformis; most of its branches pass out of the pelvis via the greater sciatic foramen. The pudendal nerve exits the greater sciatic foramen, wraps around the sacrospinous ligament, enters to the lesser sciatic foramen to lie in the pudendal (Alcock's) canal
- The inferior hypogastric (pelvic) plexuses lie within the endopelvic fascia, flanking (and supplying) the pelvic viscera; parasympathetic input derives from the pelvic splanchnic nerves (S2,3,4) and sympathetic from the superior hypogastric plexus and sympathetic chain

Describe the arterial supply to the pelvis: from the internal iliac, median sacral, ovarian and inferior mesenteric (provides superior rectal) arteries.

Identify the internal iliac artery and its main branches:

From the posterior division:

- Iliolumbar artery – supplies psoas, quadratus lumborum, vertebrae, ilium, iliacus
- Lateral sacral artery – supplies sacrum, sacral nerve roots, piriformis
- Superior gluteal artery – supplies gluteal muscles and skin of buttock

From the anterior division:

- Superior vesical artery (continues as obliterated umbilical artery)
- Obturator artery – supplies medial compartment of thigh
- Uterine artery – supplies uterus, oviduct, upper vagina, and vaginal artery in the female
- Middle rectal and inferior vesical arteries in the male
- Internal pudendal artery – supplies perineum
- Inferior gluteal artery – supplies gluteus maximus and obturator internus

Corresponding veins form plexuses around the viscera, and drain to the internal iliac vein.

3. Pelvic viscera

You should be able to

Identify and describe female organs:

Ovary:

- 3cm long (smaller post menopause)
- Lies vertically, in angle between internal and external iliac arteries (against parietal perironeum – supplied by obturator nerve; ovarian pain may be referred to medial thigh)
- Mesovarium attaches anterior border of ovary to broad ligament; ovarian ligament attaches to cornu of uterus; suspensory ligament of ovary contains ovarian artery and pampiniform plexus of veins (resolve into uterine veins)
- Lymph drains to para-aortic nodes
- Sympathetic vasoconstrictor and pain fibres
- Thin capsule (tunica albuginea); inner, vascular medulla; outer cortex containing follicles
- 1 million primordial follicles at birth; 40k by puberty, 400 ovulated

Oviducts:

- 10cm long, lies in free, upper edge of broad ligament
- Infundibulum, ampulla, isthmus, intramural (medial 1cm)
- Outer long, inner circular muscle wall; Lined with ciliated, columnar epithelium, highly folded
- Supplied by uterine and ovarian arteries; drained by corresponding veins
- Lymph drains to para-aortic and internal iliac nodes

Uterus:

- Flattened pear-shape; 10cm long; lies in free, upper edge of broad ligament
- Fundus, cornua (round ligament, oviduct and ovarian ligaments attach here), body, cervix; intestinal and vesical surfaces
- 3 layers of wall: endometrium (mucosa), myometrium (smooth muscle and connective tissue), perimetrium (visceral peritoneum - forms broad ligament laterally)
- Normally anteverted, anteflexed
- Uterine artery runs in base of broad ligament
- Lymph drains to internal and external iliac nodes, to para-aortic nodes (upper body) and superficial inguinal nodes (cornua – along round ligament)

The uterus and vagina are supported by levator ani, but also by endopelvic fascia (uterosacral and cardinal ligaments); both levator ani and the endopelvic fascia may be damaged in childbirth, leading to prolapse of the uterus

Vagina:

- 10cm long, fibromuscular (outer longitudinal, inner circular muscle) tube; lined with SSNKE; rugose mucosa
- Rectovaginal septum below rectouterine pouch
- Anterior, posterior and lateral fornices
- Urethra is embedded in anterior vaginal wall (intact vaginal support important in continence)
- Supplied by vaginal and uterine arteries; vaginal plexus of veins drains to internal iliac vein
- Lymph drains to external and internal iliac nodes (upper part) and to superficial inguinal nodes (lower part)
- Upper vagina supplied by autonomic nerves; sensation from lower vagina by pudendal and ilioinguinal nerves

Identify and describe internal male organs:

Testis, epididymis and scrotum

- Tough fibrous capsule: tunica albuginea
- Contains 200-300 lobules, which in turn contain the seminiferous tubules
- Seminiferous tubules drain into the rete testis… ~12 efferent ducts…head of the epididymis
- Epididymis (head, body and tail) lies on posterolateral surface of the testis (6m long - uncoiled)
- Coverings of testis: tunica vaginalis (remnant of the processus vaginalis, covering anterior, medial and lateral surfaces of each testis); then: internal spermatic fascia; cremasteric fascia & cremaster muscle; external spermatic fascia - same coverings as the cord; scrotum (subcutaneous tissue is continuous with Camper's fascia and contains Dartos muscle
- Testis supplies by testicular arteries; drain to pampiniform plexus which resolves into testicular veins (right drains into IVC, left into renal vein)
- Lymphatic drainage to para-aortic nodes (while scrotum drains to superficial inguinal nodes)
- T10 sympathetic fibres via renal and aortic plexus

Ductus deferens and the spermatic cord

- Fibromuscular tube, beginning at the tail of the epididymis, running superiorly in the spermatic cord, through the inguinal canal (deep inguinal ring lies just lateral to the inferior epigastric vessels; the superficial inguinal ring lies above and medial to the pubic tubercle), across the external iliac vessels and pelvic side wall (under to parietal peritoneum), turning medially near ischial spine towards the bladder, joining the duct of the seminal vesicle to form the ejaculatory duct - which opens into the prostatic urethra.
- Spermatic cord contains ductus deferens, testicular vessels, and sympathetic nerves; it is covered by layers of spermatic fascia, and accompanied by the ilioinguinal nerve

Prostate gland

- Fibromuscular and glandular; produces a third of seminal fluid
- True capsule (fibrous sheath) and false capsule (extraperitoneal fascia)
- Supplied by inferior vesical artery; venous drainage to prostatic plexus; lymph to internal iliac nodes
- Sympathetic innervation to smooth muscle

Seminal vesicles - coiled tubes (~5cm long uncoiled); produce ~60% of seminal fluid
Bulbourethral glands

Identify and describe the rectum (curved in humans):

- The rectum is a dilatable 'holding area' above levator ani – with the lowest part dilated as the rectal ampulla
- The rectum has three lateral flexures (middle flexure bulges to left); no mesentery, no sacculations, no appendices epiploicae; peritoneum covers front and sides of upper rectum
- Presacral (Waldeyer's) fascia between sacrum and rectum; rectovaginal (Denonvillier's) fascia
- Branches of superior rectal artery (continuation of IMA at pelvic brim) enter rectal wall, anastomose with branches of inferior rectal artery in anal canal; middle rectal vessels often small or absent
- Internal rectal venous plexus (in submucosa) and external plexus (external to muscle wall)
- Sympathetic innervation from hypogastric plexuses; parasympathetic from pelvic splanchnic nerves

Identify and describe the anal canal:

- 4cm long, from anorectal ring (level with coccyx) to the anus; mucosa, submucosa and muscle layer (all circular fibres – inner layer thickened as internal sphincter); 6 to 10 anal columns lie in upper anal canal, joined as anal valves inferiorly (pectinate line); columnar epithelium over anal columns, NKSSE below; KSSE at anus; submucosal fibroelastic tissue forms anal cushions
- Anal canal passes through funnel formed by levator ani and external anal sphincter; fibromuscular strands from sphincter pass to coccyx, forming anococcygeal ligament; sphincter attached to perineal body anteriorly
- Inferior rectal nerve (from pudendal) supplies anal canal below pectinate line and external sphincter
- Sympathetic nerves are motor to internal sphincter
- The anal canal is supplied by superior and inferior rectal arteries (drains to corresponding veins - portosystemic anastomosis)
- Lymph drains to internal iliac and inguinal nodes

4. Perineum and external genitalia

You should be able to:

Identify the boundaries of the perineum, its divisions and structures within them:

Urogenital triangle

- Bounded by symphysis pubis, pubic rami and a line between the ischial tuberosities
- Perineal membrane - free posterior edge anchored in the midline at the perineal body; pierced by urethra (and vagina); provides attachment for external genitalia, superficial and deep perineal muscles
- The penile root consists of the bulb (becomes the corpus spongiosum, containing the urethra) and paired crura (become corpora cavernosa); bulbourethral glands empty into the penile urethra
- The root of the clitoris includes a pair of bulbs and crura; the body has two corpora cavernosa (but no corpus spongiosum); the glans is partially covered by the prepuce
- The perineum is supplied by branches of the internal pudendal artery; corresponding veins drain into the internal pudendal vein
- Penile skin drains to superficial inguinal nodes; glans and corpora drain to deep inguinal nodes
- The perineum, penis and clitoris are supplied by branches of the pudendal nerve:
    - Erection (of penis or clitoris) is mediated by parasympathetic stimulation: smooth muscle in the corpora cavernosa relaxes, allowing increased arterial flow, which impedes venous return, so that the corpora cavernosa become turgid

- Emission is produced by sympathetic stimulation: Dartos muscle in the scrotum contracts, as does smooth muscle in vas deferens, prostate & seminal vesicle - to expel semen (spermatozoa & seminal plasma) into the urethra
- Ejaculation is produced by both sympathetic & somatic (pudendal nerve) stimulation: the smooth muscle of urethra & striated bulbospongiosus contracts to expel semen; the internal urethral sphincter at bladder neck contracts to prevent retrograde ejaculation, and the perineal muscles (supplied by pudendal nerve) around crura tighten to increase turgor as ejaculation approaches

NB. The superficial pouch is the area enclosed between the perineal membrane and the superficial fascia of the scrotum.

Anal triangle

- Bounded by coccyx, sacrotuberous ligament and line joining the ischial tuberosities
- Contains anal canal and external anal sphincter; ischianal fossae laterally and levator ani superiorly