Alimentary System – Overview and Development

**Cavity of the Mouth**
- Cavity of the mouth develops from the oral pit, which is lined with the ectoderm; the pit becomes deeper gradually and reaches the cephalic end of the foregut; germ layers, the ectoderm and entoderm fuse here. Oral pit is bounded above by the frontal eminence, which forms due to the growth of the brain; on the sides and below, the visceral arches bound oral pit.
- Mucous membrane of the vestibule of the mouth forms a series of folds: frenula of lips, buccal bands and transverse folds on the hard palate. Hard palate in newborn in the first months of lie is flattened.

**Tongue**
- Before the development of the vestibule, cavity of the mouth is occupied by the tongue, which in the newborn and infants is broad and very flat. The tongue is laid down as several lingual swellings, which are buds lying on the floor of the primary cavity of the mouth; one unpaired swelling, and 2 lateral swellings. Swellings are situated in front of the foramen caecum at the tongue give rise to the body of the tongue.
- All of these lingual germs fuse quickly and leave a mark at the junction of the root with the body of the tongue in the form of the sulcus terminalis in front of and along which are the vallate papillae.
- The epithelial layer of the tongue forms papillae among which the vallate papillae and folia linguæ appear first and the fungiform and the filiform papillae later.
- Muscles of the tongue develop from the myotomes of the occipital region, which grow into the root of the tongue.

**Teeth**
- Laid down in second month of the intrauterine life; enamel is derived from the ectolast while the dentine, cement and pulp form from the mesoblast.
- (1st) Dental lamina is the first to appear grows into the underlying mesenchyme which gives rise to the gingival swellings. Bulges then form onto dental lamina due to the growth of the epithelium and the enamel organs of the teeth form in this manner.
- Mesenchyme penetrates them on the 10th week from which the dental papillae are derived. Mesenchyme surround enamel organ thickens to form the dental sac which fuses with the dental papila.
- (2nd) Tooth germs – they separate from the dental lamina into which the mesenchyme grows and which loses connection with the epithelium of the cavity of the mouth.
- (3rd) In fourth month of embryonic development, dentine, enamel and pulp of the tooth form.
- Crown forms before the infant is born.
- Encountered order of eruption of deciduous teeth:
  - Medial incisors - between 6th and 8th month
  - Lateral incisors - from 7th to 9th month
  - First molars - between the 12th and 15th month
  - Canine teeth - from 15th and 20th month
  - Second molars - from age of 20-30 months
Cricopharyngeus
- Lowest fibers of inferior constrictor muscle
- Pharyngeal raphe
- Pharyngeal plexus
- Sphincter at lower end of pharynx

Longitudinal Elevators
Stylopharyngeus
- Styloid process of temporal bone
- Posterior border of thyroid cartilage
- Glossopharyngeal nerve
- Elevates larynx during swallowing

Salpingopharyngeus
- Auditory tube
- Blends with palatopharyngeus
- Pharyngeal plexus
- Elevates pharynx

Palatopharyngeus
- Palatine aponeurosis
- Posterior border of thyroid cartilage
- Pharyngeal plexus
- Elevates wall of pharynx, pulls palatopharyngeal arch medially

Arterial Supply
- Tonsillar artery - branch of facial artery
- Ascending and descending palatine artery
- Lingual artery
- Ascending pharyngeal artery

Venous Drainage
- Pharyngeal venous plexus
- Pterygoid venous plexus
- Internal jugular vein
- Facial vein

Lymphatic Drainage
- Retropharyngeal nodes
- Paratracheal nodes
- Infrahyoid lymph nodes
- These drain into the deep cervical nodes

Innervation
- Nasal pharynx – maxillary nerve
- Oral pharynx – glossopharyngeal nerve
- Laryngeal pharynx – internal laryngeal branch of the vagus nerve
Submucosa
➢ Collagen and elastin fibers
➢ Proper oesophageal glands

Muscularis
➢ Superior third is skeletal muscle
➢ Middle third is skeletal/smooth muscle
➢ Inferior third is smooth muscle (inner circular layer and outer longitudinal layer)

Tunica Adventitia contains connective tissue with blood vessels and nerves.

Blood Supply - Arteries
➢ Cervical Part- supplied by inferior thyroid artery which is a branch of subclavian artery
➢ Thoracic part - oesophageal branch of thoracic aorta.
➢ Abdominal part- left gastric artery and left phrenic artery

Venous Drainage
➢ Cervical part - inferior thyroid vein, which is a part of the brachiocephalic vein.
➢ Thoracic part - hemizygous and azygous vein
➢ Abdominal part - left gastric vein which goes to portal vein

Innervation
➢ Parasympathetic - Vagus nerve
➢ Sympathetic - Thoracic sympathetic trunk

Lymphatic Drainage
➢ Paratracheal lymph nodes
➢ Inferior deep cervical lymph nodes
➢ Posterior paratracheal lymph nodes
➢ Left gastric lymph nodes drain to celiac lymph nodes
➢ All these drain into thoracic duct which is the largest lymph vessel
Descending Colon
- Measures up to 22.5cm
- Mesoperitoneal
- Lies on the posterior abdominal wall on the extreme left at the lateral wall
- Continues from the left colic flexure, inferiorly, to the left iliac crest
- Passes anteriorly to the lateral border of the kidney and quadratus lumborum muscle
- Laterally, between the colon and abdominal wall is the left paracolic gutter which drains fluid that leaks from the colon
- Turns medially to become the sigmoid colon

Pelvic (Sigmoid) Colon
- Intraperitoneal
- Links the descending colon and rectum
- Extends from iliac crest to S3
- Forms 2 loops: proximal – lies on the iliacus muscle with the convexity direction downwards, distal – lies on psoas major muscle and its convexity is directed upwards.
- Part of the pelvic colon is below the arcuate line in the true pelvis and is continuous with the rectum.
- Sigmoid colon has a mesentery called sigmoid mesocolon.
- The root of the mesentery crosses the floor of the iliac fossa along a line descending obliquely from left to right.
- Root of pelvic mesocolon runs across iliacus and psoas muscle and left colon non iliac vessels and left ureter, which, run along arcuate line.
- After bending over the arcuate line the roof of the mesentery passes across the region of the left sacro-iliac joint to the anterior surface of the upper sacral vertebrae.
- At the level of S3 the pelvic mesocolon terminates at the origin of mesorectum.

Arterial Supply
- Sigmoid artery divides into the ascending and descending branches – Descending and Sigmoid Colon
- Left colic artery - Descending colon
- Branches of the left colic and sigmoid arteries (branches of the IMA) anastomose to form a part of the marginal artery
- Vasa recta arises from this artery

Venous Drainage
- Inferior mesenteric vein (drains into the splenic vein which drains into the portal vein)

Lymphatic Drainage
- Ileocolic, right colic, left colic, middle colic, internal iliac - SM lymph nodes

Innervation
- Inferior and Superior mesenteric plexus
- Sympathetic – Sympathetic trunk: Coelic, superior mesenteric, inferior mesenteric ganglion
- Parasympathetic – intestinal branches (Vagus nerve)
- Pelvic nerves – descending and sigmoid colon, rectum
Rectum

- 14-18cm
- Situated in the pelvis
- Anterior to the sacrum and coccyx
- **Continuation of the sigmoid colon from S3 to the anus**
- Terminal part of the large intestine and the digestive tract in general
- In males, it is posterior to the fundus of the urinary bladder separated by rectovesical pouch
- In females, it is posterior to the uterus and vagina - separated by vesicouterine pouch
- It has two parts; pelvic and perineal.
- Pelvic part – above the floor of the pelvis, in the cavity of the true pelvis and is subdivided into a narrower supra-ampullar part and a wide ampulla of the rectum.
- Supra - ampulla part is intraperitoneal
- Ampulla part is expanded and is retroperitoneal
- **The second part is under the pelvic diaphragm in the perineal region and is known as the anal canal.**
- It has 2 flexures - sacral and anorectal flexure
- Anteriorly are the superior, intermediate and inferior flexures.
- Anal canal extends from the superior part of the pelvic diaphragm from the anorectal junction to the anus (3-4 cm) and is extraperitoneal
- Longitudinal ridges called anal columns, which are joined by anal valves inferiorly, characterize mucous membrane. Superior to the valves are recesses called anal sinuses of rectal venous plexus.
- Anal canal has two sphincters - internal anal sphincter (involuntary, smooth) and external anal sphincter (voluntary, striated).

**Histology**

**Mucosa**
- Simple columnar epithelium w/ goblet cells (rectum) and stratified squamous (anal canal)
- Contains crypts with rectal glands but no villi

**Submucosa**
- Contains sinuses of the rectal venous plexus
- Solitary lymphatic nodules are embedded in submucous coat

**Muscularis**
- Inner circular layer - forms internal sphincter in anal canal
- Outer longitudinal layer – **fibres of the rectococcygeal muscle stretching from the anterior sacrococcygeal ligament** are interlaced posteriorly into the longitudinal muscle layer of the lower portion of the ampulla.
- Myenteric plexus

**Serosa**
Bile Duct

- Hepatocytes secrete bile into the bile canaliculi, which drains into the interlobular biliary ducts, which drains into the large collecting bile ducts which merges to form the right and left hepatic ducts which merge to form the common hepatic duct which is joined on the right side by the cystic duct to form the common bile duct.

- Cystic duct transports bile to the gallbladder for temporary storage

- The common bile duct descends posterior to superior part of the duodenum and joins the major pancreatic duct to form the hepatopancreatic ampulla which opens into the major duodenal papilla on the descending part of duodenum

Histology

- Simple columnar epithelium
- Lamina propria and submucosa have mucous glands
- Thin muscularis (becomes thicker to form the sphincter at the duodenal papilla)
- Serosa

Arterial Supply

- Common hepatic artery

Innervation

- Hepatic plexus
- Sympathetic trunk – vagus nerve and phrenic nerve
Narrow part of the sac closest to the opening is the **vestibule of the omental bursa**, which is bounded by the caudate lobe of the liver superiorly and by the head of the pancreas inferiorly.
Meatus’s

- Sphenoid recess - receives opening of the sphenoidal sinus
- Superior nasal meatus - into which ethmoidal sinuses open
- Middle nasal meatus - leads to ethmoidal infundibulum which communicates with frontal sinus by frontonasal duct. Frontonasal sinus opens into semilunar hiatus
- Inferior nasal meatus - into which nasolacrimal duct opens
- Common nasal meatus - into which the other meatuses and recesses open

Histology
Mucosa, submucosa, cartilage/muscle layer/adventitia

- Respiratory epithelium - ciliated pseudostratified columnar epithelium with ciliated columnar epithelium, goblet cells, brush cells, small granules (endocrine cells) and basal cells. LP - glands and venous plexus
- Olfactory epithelium - pseudostratified columnar epithelium with olfactory neurons, supporting cells, basal cells and olfactory glands in the lamina propria

Arterial Supply

- Anterior and posterior ethmoidal artery (branch of ophthalmic artery) - lateral and medial walls and septum
- Sphenopalatine artery (branch of maxillary artery) - “”
- Greater palatine artery (branch of maxillary artery) - runs through incisive canal - septum
- Septal branch of superior labial artery (branch of facial artery) - septum
- External nose receives anterior ethmoidal, sphenopalatine artery, nasal branches of infraorbital artery and lateral nasal branches of the face

Venous Drainage

- Submucosal venous plexus beneath the mucosa drains into the sphenopalatine, facial and ophthalmic vein
- Venous blood from the external nose drains mostly into the facial vein via angular and lateral nasal veins

Innervation

- Ophthalmic nerve
- Maxillary nerve
- Olfactory nerves
- Sympathetic - carotid plexus
- Parasympathetic - pterygoid palatine ganglion branches
Inlet of the Larynx
- Inlet looks backward and upward into the laryngeal part of the pharynx.
- Opening is wider in front than behind
- Inlet is bounded in front by the posterior surface of epiglottis, behind the apices of the arytenoid cartilages and laterally by the aryepiglottic folds.
- A piriform fossa is situated on both sides between the aryepiglottic folds and the inner surface of thyroid cartilage.

Cavity of the Larynx
- Shaped like an hourglass
- Extends from the inlet to the lower border of the cricoid cartilage, where it is continuous with the border of the cricoid cartilage, where it is continuous with the cavity of the trachea, it has 3 regions:
  - Vestibule of the larynx – situated between the inlet and vestibular folds
  - Middle region – between vestibular folds above and vocal folds below
  - Lower region – between vocal folds above and lower border of cricoid cartilage below
- Sinus of the larynx – a depression extending under the base of the vestibular ligament is formed on the mucous membrane, on the lateral side of the larynx between the vocal and vestibular folds.
- Saccule of the larynx – diverticulum of mucous membrane that ascends from the sinus. The mucous secretion lubricates the vocal cords.

Laryngeal folds
- Vestibular fold is a fixed fold on each side of the larynx. It is formed by mucous membrane covering vestibular ligament and is vascular and pink in colour.
- Vocal folds mobile fold on each side of the larynx and is concerned with voice production.
- The vocal fold moves with respiration
- The gap between the vocal folds is called the rima glottis.
- The glottis is bounded in front by the vocal folds and behind by the medial surface of the arytenoid cartilages.
- The glottis is the narrowest part of the larynx and measures about 2.5cm from front to the back in the male adult and less in female.
- Rima glottis has 2 parts 1) the intermembranous part between the free borders of the vocal folds, 2) intercartilaginous part (respiratory part), the wider segment of rima glottides extending into the space between the arytenoid cartilages.
- Infraglottic cavity – part of the larynx below the vocal folds, it widens conically downwards to be continuous with the cavity of the trachea

Joints
Cricoid cartilage and Thyroid cartilage are joined together by:
- The paired cricothyroid joint, which is formed by the articular facet of the inferior horn of the thyroid cartilage.
- The cricothyroid ligament closes the space between the lower border of the thyroid cartilage and the upper border of the arch of the cricoid cartilage. Anteriorly on the midline it is thickened by elastic fibers. To the back of this ligament is the elastic membrane of the larynx. Its lower part is called the cricovocal membrane, which is attached to the cricoid
Urinary System – Overview and Development

➢ Mesoblast takes part in the formation of the organs of the urogenital system; it gives rise to the kidneys and reproductive glands
➢ Ectoblast lining the cloaca and the entoblast of the dorsal part of hindgut take part in the formation of the efferent urinary and genital ducts and reproductive organs

Kidneys
➢ Kidneys go through 3 development stages: pronephros, mesonephros and metanephros
➢ Pronephros – laid down in the middle of the 3rd week, mesonephros – in the middle of the 4th week. Both these stages are superseded in the intra-uterine period.
➢ Lobate structure (14 lobes on average) is seen distinctly of newborn but disappears by age of 2-4.
➢ Kidney of newborn measures 3.5 in length, 1.7 in breadth, 1.6cm in thickness and weighs 11-12g.
➢ Upper end of the kidney is at the level of the lower border of the body of T11 at the age of 3-5 months of life and reaches the level of the adult by 2 years
➢ Position of the hilum of the kidney is on the level of L2 in newborn and at L1 in adult

Ureter
➢ Pelvis of ureter is wider than in adult and ureters are more tortuous
➢ Urinary bladder develops from a mesodermal germ which comes from union of the ventral part of the cloaca with the allantois

Urinary Bladder
➢ Bladder of newborn is spindle-shaped, by age of 5 is a plum, by 10 is egg-shaped, by 15-17 is the adult shape. Internal urethral orifice in the newborn is often at level of the upper border of the symphysis
**Histology**
Capsule of urethra is composed of elastic fibres

**Mucous**
- Transitional epithelium in prostatic part of urethra
- Stratified columnar epithelium in membranous part
- Single layer columnar epithelium at the beginning of spongy part and with stratified columnar epithelium in the distal portion
- In the spongy part, the mucous membrane is fused with the erectile tissue to which its smooth muscular fibres belong

**Muscularis**
- Only prostatic and membranous part

**Arterial Supply**
- Internal and external pudendal arteries

**Venous Drainage**
- Inferior vesical vein
- Middle rectal vein
- Internal pudendal vein

**Lymphatic Drainage**
- Internal iliac
- Deep inguinal

**Innervation**
- Hypogastic and lumbosacral plexuses
Testis

- Testis is a paired gland situated in the lower part of the scrotum
- They are ellipsoid in shape
- Measures 4.5 length, 3cm in width, 2cm in thickness
- They produce spermatozoa and hormones such as testosterone
- Develop in the abdominal cavity but descend down
- Suspended in the scrotum by the spermatic cord, by its posterior border. The posterior border bears the epididymis.
- Left testicle is suspended more inferiorly

Surfaces
- Medial
- Lateral

Borders
- Front/ anterior
- Posterior

Margins
- Anterior
- Posterior

Structure
- Upper and lower extremity
- Made up of parenchyma enclosed in a dense connective tissue tunica albuginea; the septa of the testis stretch from it into the parenchyma and divide the gland into the lobes of the testis. These septa run to posterior border of the testis and fuse in the upper part to form the mediastinum testis.
- Mediastinum is a wedge-like thickening of the tunica albuginea and has a spongy structure.
- From this, fibrous septa penetrate the testes and break it up into 100-250 testicular lobules.
- Each lobule contains connective tissue with Leydig cells and 3-4 convoluted seminiferous tubules, which measure 70-100cm in length.
- The convoluted tubules contain germ-forming cell from which spermatozoa develop. At the apex of the lobe ¾ convoluted tubules unite to form the straight seminiferous tubules. On entering the mediastinum testis, the straight tubules anastomose to form a network called the rete testis.
- Up to 18 efferent ductules arise from the rete in the mediastinum, which pierce the tunica albuginea and enter the head of the epididymis.
- The testis with the epididymis is invested in the tunica vaginalis testis, which forms a closed serous cavity around them.
- Visceral layer is fused with tunica albuginea for its entire length, except for an area on the posterior border which it leaves uncovered before passing over to the epididymis; nerves and vessels enter the testis through this area and parietal layer.
Spermatic Cord

- Paired round band measuring 18-20 cm
- Begins from deep inguinal ring to the posterosuperior periphery of the testis.
-Suspends the testis and raises it to the inguinal canal by the cremaster muscle.
-Passes through the inguinal canal
-Exits at the superficial inguinal ring
-Ends in the scrotum at the posterior border of the testis

Constituents
- Ductus deferens
- Testicular artery
- Venous pampiniform plexus
- Lymph vessels of the testis
- Nerves, arteries and veins of vas deferens

Fascia
- The components of the spermatic cord are enclosed into the common coats of the spermatic cord and testis.
- Inner layer corresponds to the transversalis fascia of the abdomen, is called the internal spermatic fascia.
- Cremaster muscle raises the testis lies on the common coat. Its bundles are bound by the CT fibres forming the cremaster fascia.
- The fascia together with the muscle and the adjoining tissue is enclosed in the external spermatic fascia which is a continuation of the intercrural fibres of the aponeurosis of the external oblique muscle of the abdomen.
Bulbourethral glands

- Two bulbo-urethral glands are pea-shaped yellowish-brown bodies situated behind the membranous part of the urethra at the blind end of the bulb of the penis. The bundles of the deep transverse perinei muscle embrace them.
- The separate lobules of the gland are joined by dense CT.
- The ducts of each lobule fuse to form the common duct of the bulbo-urethral gland which is surrounded by the fibres of the sphincter urethrae muscle.
- The duct of the gland measures up to 6cm in length.
- It passes anteriorly and slightly downwards, pierces the bulb of the penis and opens into the cavity of the urethra.

**Histology**
- Simple cuboidal/columnar - secrete mucus

**Arterial Supply**
- Arteries of the bulb of penis which arises from internal pudendal artery

**Innervation**
- Hypogastric plexus
Ovaries

➢ The ovary is a **paired organ**, the **female gonad**, in which **ova** are formed and mature.
➢ They are **almond shaped**
➢ They are situated on the **lateral wall of the true pelvis**, to the **side of the fundus** of the uterus where it’s attached by the **mesentery to the posterior layer** of the **broad ligament of the uterus below the uterine tube**.
➢ Ovary is bluish-white in colour, its surface is slightly uneven and it has a flattened oval shape.

**Relations**

➢ Ovary lies on lateral wall of true pelvis and is encased superiorly, laterally and partly medially by the lateral portion of uterine tube.
➢ Tubal end of ovary comes in contact with **parietal peritoneum** and is lodged in the ovarian fossa which is bordered:
  ➢ **Superiorly** - external iliac vessels
  ➢ **Posteriorly** - internal iliac vessels and the ureter
  ➢ **Anteriorly** - lateral umbilical ligament
  ➢ **Inferiorly** - obturator and uterine arteries
➢ Tubal end of ovary faces the ovarian fimbria of the uterine tube and is held by the **infundibulopelvic ligament**, which stretches to **fascia psoatica** and the **psoas major muscle**. This ligament contains vessels and nerves of the ovary.
➢ **Ligament of the ovary** stretches in the broad ligament of the uterus from the **uterine end of the ovary to the border of the uterus** on which it terminates below the uterine tube.

**Surfaces**

➢ Medial – directed at the abdominal cavity & the true pelvis
➢ Lateral – directed at true pelvis

**Borders**

➢ Straight mesovarian border
➢ Convex free border

**Ends**

➢ Tubal end facing the **fimbriae of the tube**
➢ Uterine end, which is sharper and **faces the uterus**

**Size**

➢ 2.5 - 5.0cm in length
➢ 1.5 - 3.0cm in breadth
➢ 0.5 - 1.5cm in thickness

The **mesovarian border of the ovary** is attached to the **posterior layer** of the **broad ligament of the uterus** by a **peritoneal duplicature** called the **mesovarium** transmitting vessels and nerves from the **broad ligament** into the **hilum of the ovary**, which is a **narrow groove** to which the **mesovarium** is **attached**. Free border of the ovary is convex and suspended freely into the cavity of the pelvis.
**Arterial Supply**
- External and internal pudendal arteries (branch of internal iliac artery)

**Venous Drainage**
- Labial veins, internal pudendal veins

**Lymphatic Drainage**
- Superficial and deep inguinal lymph nodes
- Internal iliac lymph nodes

**Innervation**
- Uterovaginal plexus
- Pudendal branches - anterior and posterior labial branches, dorsal clitoral nerve (sensory)