Digestive system
(Systema digestorium/alimentarium)

Lecture #1
Internal organs are grouped into

1. **System**
   - Have the same functions and development
     - *Digestive system*
     - *Respiratory system*

2. **Apparatus**
   - Have the same development but different functions
     - *Urogenital apparatus*
Internal organs:

- Parenchymal organs
- Hollow (tubular) organs
Parenchymal organs

- Parenchyma – specialized tissue that carries out the specific functions of the organ
- Parenchymal organs have stromal **capsule**, that gives off **trabecules** into the parenchyma
- **Stroma** contains lymphatic and blood vessels, nerves
Layers of the wall:
1) *Tunica mucosa*
2) *Tunica submucosa*
3) *Tunica musculosa* (longitudinal and circular)
4) *Tunica serosa/adventitia*
Alimentary system

- is a complex of organs with the function of mechanical and chemical treatment of food, absorption of the treated nutrients, and excretion of undigested remnants.
Overview of Digestive Anatomy

**SALIVARY GLANDS**
Secretion of lubricating fluid containing enzymes that break down carbohydrates

**PHARYNX**
Pharyngeal muscles propel materials into the esophagus

**ESOPHAGUS**
Transport of materials to the stomach

**STOMACH**
Chemical breakdown of materials via acid and enzymes; mechanical processing through muscular contractions

**LIVER**
Secretion of bile (important for lipid digestion), storage of nutrients, many other vital functions

**GALLBLADDER**
Storage and concentration of bile

**LARGE INTESTINE**
Dehydration and compaction of undigestible materials in preparation for elimination

**SMALL INTESTINE**
Enzymatic digestion and absorption of water, organic substrates, vitamins, and ions
Fig. 4.22 Four-quadrant topographical pattern.

Fig. 4.23 Nine-region organizational pattern.
Development of digestive system
Gastrulation – formation of germ layers (4th week)

- Ectoderm
- Mesoderm
- Endoderm
Intraembryonic mesoderm plates:
- *Paraxial (dorsal) mesoderm* – axial skeleton (somites)
- *Intermediate mesoderm* – urogenital apparatus
- *Lateral mesoderm (somatic and splanchnic)* – appendicular skeleton and internal organs
Lateral mesoderm forms two plates: somatic and splanchnic.

EEM, extraembryonic mesoderm; YS, Yolk sac; NP, neural plate.
With lateral folding, mesoderm is recruited to gut wall

- Lateral folding of the embryo completes the gut tube
- Mesodermal layer of the gut tube is called splanchnic (visceral) mesoderm - derived from lateral plate mesoderm
- Somatic mesoderm lines body cavity
Tubular organ layers development

- Mucosa
  - Epithelial lining and glands
  - Lamina propria
  - Muscularis mucosae

- Submucosa

- Muscularis externa

- Adventitia/Serosa

- Derived from endoderm

- Derived from visceral mesoderm
Intraembryonic body cavity (coelom) ➔ Peritoneal cavity

Primitive gut tube ➔ Tubular organs (gut)

Dorsal mesentery ➔ Mesentery
**Stomodeum** – cranial entrance of the gut tube

**Omphalomesenteric duct** = **vitelline duct** (joins yolk sac and midgut lumen)

**Proctodeum** – caudal exit of the gut tube

**Foregut**
From foregut develop:
- Esophagus
- Stomach
- Duodenum (proximal part)
- Liver, pancreas, gall bladder
- Respiratory tube

Blood supply – *truncus coeliacus*
Sympathetic innervation – *n. splanchnicus major*
Parasympathetic innervation – *n. vagus*
1. The stomach form fusiform dilatation of the foregut, suspended from body wall by a dorsal and ventral gastric mesentery.
2. The dorsal portion grows more rapidly – formation of the greater curvature.
3. The primitive stomach rotates 90 degrees clockwise around longitudinal axis.
5. Dorsal gastric mesentery – greater omentum.
Liver bud arise from foregut endoderm towards septum transversum (developing diaphragm) in response to signals from nearby mesoderm
Development of the liver

Endoderm → Liver parenchyma
Mesoderm → Capsule, stroma
Primitive ventral mesentery → Falciform ligament
Primitive dorsal mesentery → Lesser omentum
- **Ventral pancreatic bud** – outgrowth of liver bud
- **Dorsal pancreatic bud** – outgrowth of duodenal bud into the stomach mesentery. Dorsal pancreatic bud – accessory pancreatic duct.
- The rotation of the duodenum to the right carries the ventral pancreatic bud dorsally, where it fuses with the dorsal pancreatic bud.
Retroperitoneal position of the pancreas and duodenum
From midgut develop:
- Duodenum distal to the opening of the bile duct
- The rest of intestine (ileum, jejunum)
- Cecum and appendix
- Ascending and proximal 2/3 of transverse colon

Blood supply – *a. mesenterica superior*
Sympathetic innervation – *n. splanchnicus minor*
Parasympathetic innervation – *n. vagus*
Development of the midgut and colon

- Vitelline duct
- Omphalomesenteric duct = vitelline duct (joins yolk sac and midgut lumen) – axis for rotation
Development of the midgut and colon

Herniation and rotation:

- Growth of the GI tract exceeds volume of abdominal cavity so the tube herniates through umbilicus

- While herniated, gut undergoes a primary rotation (fig B) of 90° “counterclockwise” (when looking at the embryo); this corresponds with the rotation of the stomach, and positions the appendix on the left. The primary rotation also brings the left vagus n. to the FRONT (hence the change in its name to ANTERIOR vagus n.

- With the growth of the embryo, the abdominal cavity expands thus drawing the gut tube back within the abdominal cavity and causing an additional, secondary rotation (fig C) of 180° CCW (positioning the appendix on the RIGHT)

- Once in the abdominal cavity, the colon continues to grow in length, pushing the appendix to its final position in the lower right quadrant.

- Note the attachment of the vitelline duct to the gut at the region of the ileum. The duct normally regresses during development, but not always....
Meckel’s diverticulum
- remnant of the omphalomesenteric duct (the vitelline duct)
Premature birth – disorders of the digestive system

Intestinal malrotation

Variety of appendix position
Cecum and appendix
From hindgut develop:
- The rest 1/3 of transverse colon
- Descending and sigmoid colon, rectum

Blood supply – *a. mesenterica inferior*
Sympathetic innervation – *nn. splanchnici lumbales et pelvini*
Parasympathetic innervation – *nn. splanchnici pelvini*
Caudal end of the hindgut – proctodeum (9th week)
Cloacal membrane is not ruptured
Atresia of rectum
Superior to that line the intestine derives from the embryonic hindgut and the epithelium derives from endoderm.
- a. et v. mesenterica inferior

Inferior to that line the epithelium derives from ectoderm.
- a. et v. iliaca interna
**Pectinate line** - anatomical border between rectum and anal canal

**Anal pecten** – 1) place between pectinate and anocutaneous lines; 2) level of internal (involuntary) muscular anal sphincter.

**Anocutaneous line (“white line”)** – 1) lower border of internal anal sphincter; 2) mucous layer changes to skin.
Development of GI and blood supply

Fig. 4.96 Divisions of the gastrointestinal tract into foregut, midgut, and hindgut, summarizing the primary arterial supply to each segment.
Foregut derivatives include which of the following?

1) The esophagus
2) The stomach
3) The proximal duodenum
4) The ileum
5) The liver
6) The descending colon

1, 2, 3, 5
Midgut derivatives include which of the following?

1) The stomach
2) The distal duodenum
3) The ileum
4) The jejunum
5) The appendix
6) The descending colon

2, 3, 4, 5
Which of the following cells are endodermal derivatives?

1) Pancreatic acinar cells
2) Alpha and beta cells in the islets of Langerhans
3) Liver parenchymal cells
4) Cells lining the lumen of the gallbladder
5) Cells lining the lumen of intestine
6) Muscular layer of intestinal wall
7) Peritoneum
8) Connective tissue and blood vessels of the organs

1, 2, 3, 4, 5
Situs viscerum inversus partialis/totalis

Normal position

Inverse position
Development of peritoneum and its derivatives

*Peritoneum* – serose membrane lining organs and walls of the abdominal cavity
- is derived from *intraembryonic mesoderm*
Peritoneal cavity

Layers of peritoneum:
- **Parietal peritoneum** (covers abdominal walls)
- **Visceral peritoneum** (forms serous covering of the internal organs)
  - Layers continue one to another without any gap
Lateral mesoderm forms two plates: somatic and splanchnic mesoderm.

EEM, extraembryonic mesoderm; YS, Yolk sac; NP, neural plate.
Intraembryonic body cavity (coelom) → Peritoneal cavity
Somatic mesoderm → Parietal peritoneum
Splanchnic mesoderm → Visceral peritoneum
Peritoneal cavity

- **Female** – it communicates with external environment through fallopian tubes-uterine-vagina
- **Male** – it is closed serous sac
Abdominal cavity vs Peritoneal cavity
Abdominal cavity

- Space in the trunk below diaphragm

**Walls:**
- **Superior** – diaphragm
- **Anterior and lateral** – broad muscles of abdomen
- **Posterior** – the lumbar segment of the spine and muscles (m. psoas major, m. quadratus lumborum)
- **Inferior** – iliac bones and pelvic diaphragm
Position of the organs

**Intraperitoneal**
- totally covered by peritoneum
- Hepar
- Stomach (++)
- Spleen
- Jejunum (+)
- Ileum (+)
- Caecum
- Appendix vermiformis (+)
- Sigmoid colon (+)
- Superior part of rectum (+)
- Uterine (+)

+ - presence of mesenterium
Position of the organs

**Mesoperitoneal**

- 3 sides are covered (the 4\textsuperscript{th} side is covered by adventitia)
  - Ascending and descending colon
  - Middle part of the rectum
  - Full gallbladder and urinary bladder
Position of the organs

- **Extraperitoneal / retroperitoneal**
  - not covered (or only 1 side)
  - Duodenum
  - Pancreas
  - Kidney
  - Ureter
  - Empty gallbladder and urinary bladder
Blood behind peritoneum
Kidney access surgery
Derivatives of the peritoneum

- Ligaments
- Mesentery (mesenterium and mesolon)
- Omentum (majus and minus)
Derivatives of the peritoneum

Ligaments = 2 layers of peritoneum

- Lig. falciforme
- Lig. coronarium
- Lig. hepatogastrica
- Lig. hepatoduodenale
- Lig. hepatorenale
- etc.
Derivatives of the peritoneum

Mesentery =

= 2 layers of peritoneum + vessels and nerves

- Structures that suspend visceral organs from the body wall
- Carry arteries, veins, lymphatic vessels and nerves
Mesenteries are established as the visceral organs grow into the intraembryonic coelom and carry their mesothelial covering and vessels with them.
Derivatives of the peritoneum mesenteries

- The mesenterium (small intestine)
- The mesoappendix
- The transverse mesocolon
- The sigmoid mesocolon

Meso + Greek name of the organ
Derivatives of the peritoneum

Omentum = 2 layers of peritoneum + fatty tissue
Omentum minus

- Lig. hepatogastricum
- Lig. hepatoduodenale

Contain:
- Ductus hepaticus communis
- A. hepatica
- V. porta

Omentum minus - *ventral mesentery* of the stomach
Omentum majus
(4 layers of peritoneum)

Anterior lamina
(2 layers of peritoneum)

+ Posterior lamina
(2 layers of peritoneum)

Omentum majus - dorsal mesentery of the stomach
Omentum majus

- Lig. gastrophrenicum
- Lig. gastrosplenicum
- Lig. splenophrenicum
- Lig. gastrocolicum
Bursa omentalis
Omental foramen (Winslow`s foramen)

- Connects busra omentalis with the whole peritoneal cavity

- Walls:
  - Superior – lobus caudatus hepatis
  - Anterior – lig. hepatoduodenum
  - Inferior – duodenum
  - Posterior – parietal peritoneum
Fig. 4.54 Transverse section illustrating the continuity between the greater and lesser sacs through the epiploic foramen.
Fibrin
Adhesions
Sinuses
(infracolic spaces, right and left)
Paracolic gutter, right and left
Recesses of peritoneal cavity

- Right subphrenic recess
- Left subphrenic recess
- Left subhepatic recess
- Right subhepatic recess
- Hepatorenal recess
Recesses of peritoneal cavity
(near duodenum)

- Recessus duodenalis superior et inferior
- Recessus paraduodenalis
- Recessus supraduodenalis
Recesses of peritoneal cavity
(near caecum)

1 - Recessus ileocaecalis superior
2 - Recessus ileocaecalis inferior
3 - Recessus retrocaecalis
Recesses of peritoneal cavity
(near sigmoid colon)
Internal surface, the lower part of the anterior abdominal wall

1 – plica umbilicalis mediana (obliterated urachus)
2 – plica umbilicalis medialis
3 – plica umbilicalis lateralis
4 – fossa supravesicalis
5 – fossa inguinalis medialis
6 – fossa inguinalis lateralis
Peritoneum in pelvic cavity

Excavatio rectovesicalis

Excavatio rectouterina (Douglas pouch)

Excavatio vesicouterina
Peritoneal fluid

- serose fluid, 75ml

Functions:
- moistens the peritoneum
- decreases friction between organs

Excavatio hepatorenalis

Excavatio rectovesicalis

Pelvic cavity
Ascite (abdominal dropsy)

- Accumulation of fluid in peritoneal cavity (liver cirrhosis, hepatic cancer or heart insufficiency)

Charaf-ed-Din. Surgical puncture of the abdominal cavity of the aspiration of peritoneal fluid with a canula on a patient suffering from dropsy, 1466
THANK YOU FOR YOUR ATTENTION!