Functional anatomy of the digestive system

KNMU, Department of human anatomy, Associate professor, PhD, Lupyr Marina
Theme: The functional anatomy of the digestive system.

Plan

1. The processes of digestion.
2. The basic functions of the compartments of the digestive system.
3. The review of a structure of the digestive system
   - the oral region
   - the pharynx
   - the esophagus
   - the stomach
   - the small intestine
   - the large intestine
   - the liver
   - the pancreas
   - peritoneum
The Digestive System (systema digestorium) is a complex of organs whose function consists in mechanical and chemical treatment of the food, absorption of the treated nutrients and excretion of undigested remnants of the food.

The processes of digestion consist of:
1. ingestion, or eating;
2. peristalsis, or involuntary sequential muscular contractions that move ingested nutrients along the digestive tract;
3. digestion, or the conversion of large nutrient particles into small molecules;
4. absorption, or the passage of usable nutrient molecules from the small intestine into the blood stream and lymphatic system.
5. defecation, or the elimination from the body of undigested and unabsorbed material as a solid waste.
The digestive system has following functions:

- **In the mouth** the gustatory sense, the temperature and the consistence of the food are determined. The teeth chew food and saliva from the salivary glands is added to the food to facilitate the formation of the manageable bolus.

- In the saliva there is the proteino-mucous substance (mucin) and protein (lisocim). Mucin washes the food and breaks up the storch a little. And lisocim renders some hormfull substances. Usually food is in the cavity of the mouth during 15-16 sec. Deglutition or swallowing is voluntarily initiated in the oral cavity. This process pushes the bolus into the pharynx. The pharynx conducts food through the esophagus to the stomach.

- **The stomach** stores food during few hours, here the food undergoes the first stages of digestion during which the hard components are converted to a semiliquid or pasty mixture. The food mixed with the gastric juice, containing hydrochloric acid, the digestive enzyme – pepsin, the gastric mucous and the hormon – gastrin probably.

- Then the food passes to the **small intestine**, where the main digestion and absorption take place. In the cavity of the small intestine there are the intestine juice, the bile, and the pancreatic juice. The medium is alkaline.

- **Large intestine** carries undigested substances, absorbs additional water, some medicines and glucose from it, and evacuates the fecal materials. The vermiform appendix has important immunological functions in infants and children, which vary with age.
The liver performs numerous functions. First of them is:

1. The bile secretion. Bile is an important agent in digestion, especially of fats. Liver bile passes via the hepatic ducts into the first part of the small intestine (duodenum), when fat-containing chyme enters the duodenum from the stomach.

2. The protective role by detoxifying substances which are formed as the products of digestion, drugs and alcohol.

3. The storehouse for various substances such as glycogen, lipids, vitamins and iron.

4. Metabolizing the products of digestion – principally degradation products of proteins and carbohydrates.

5. The synthesis of plasma proteins, fibrinogen and prothrombin.

6. The metabolism of carbohydrates and the regulation of blood glucose.

7. The metabolism of fats and the regulation of blood lipids.

8. The haemopoietic function – especially during fetal life.
These digestive system consists of the mouth, or oral cavity, pharynx, or throat, esophagus, stomach, small intestine and large intestine, which finishes with anus. From mouth to anus this canal is about 9 meters long. The associated structures of the digestive system include the teeth, the lips and the cheeks, the tongue, the salivary glands, the pancreas, the liver, with the gall bladder and the bile duct.
• **The pancreas** is both exocrine and endocrine gland. As gland which takes part in the digestion. It produces pancreatic juice.

• The endocrine production is the secretion of the hormone insulin and the hormone glucagon for the carbohydrate metabolism.
The review of a structure of the digestive system.
The oral region includes: the oral cavity
• the palate
• the gingivae (gums)
• the teeth
• the tongue
• the salivary glands.
• **THE ORAL CAVITY (cavum oris)**
• The oral cavity (mouth) consists of two parts:
  • The vestibule
  • The mouth proper
• The vestibule bounded by: externally – lips and cheeks, Internally – teeth and gums.
The mouth proper (cavum oris proprium).

It is bounded:

Superiorly – by the palate;

Inferiorly – by the diaphragm of the oris.

Laterally and anteriorly – by the teeth and gingivae.

Posteriorly – it communicates with the oropharinx.
2. THE TEETH.

Teeth are vital anatomical formation situated in the dental alveoli of the jaws. They are grouped according to their structural characteristics, location and function. Teeth are divided into incisors (dentes incisivi), canines (dentes canini), premolars (dentes premolares), and molars (dentes molares). Incisors are used mainly for seizing and biting food; canines are used for tearing; molars and premolars are for grinding food.

Twenty deciduous teeth — (primary or “milk” teeth) began to develop in the jaws before birth. The first tooth usually erupts (or “cutting teeth”) at 6 to 8 months after birth and the last by 20 to 24 months of age. Compared to permanent teeth, milk teeth have wider and shorter roots. The half of each jaw has 2 milk incisors, 1 canine and 2 molars (common number 20 teeth). These The half of each jaw has 2 incisors, 1 canine, 2 premolars and 3 molars (common number 32).
Parts and Types of Teeth.

- A crown.
- A neck.
- A root.
Зубы

Deciduous (primary) Usual age of eruption

Permanent (colored blue) Usual age of eruption

Upper central incisor (7th year)
Upper canine (cuspid) (11th-12th year)
Upper lateral incisor (8th year)
Upper 1st premolar (9th year)
Upper 2nd premolar (10th year)
Upper 1st molar (6th year)
Upper 2nd molar (12th-13th year)

Upper 2nd molar (20-24)
Upper 1st molar (16-21 months)
Upper central incisor (8-10 months)

Upper lateral incisor (8-10)
Upper canine (cuspid) (16-20)
Lower canine (cuspid) (15-21)
Lower lateral incisor (15-21)
Lower central incisor (6-9 months)
Lower 1st molar (15-21 months)
Lower 2nd molar (20-24 months)

3rd molars (17th-25th year)

Lower 2nd molar (12th-13th year)
Lower 1st molar (5th year)
Lower 2nd premolar (10th year)
Lower 1st premolar (9th year)
Lower canine (cuspid) (11th-12th year)
Lower lateral incisor (8th year)
Lower central incisor (7th year)
2. THE NECK.
The neck is the part of the tooth between the crown and the root.

3. THE ROOT.
The root is fixed in the alveolus (tooth socket) by a fibrous periodontal ligaments. The number of roots varies – the incisors and canines have a single root each, the maxillary molars have three roots; the mandibular molars two.
THE TONGUE (latin – lingua, greek - glossa).

- The tongue is situated partly in the mouth and partly in the oropharynx. It consists of three parts:
  - a tip,
  - a body,
  - a root.
- The mucous membrane on the oral back part of the tongue is rough, owing to the presence of numerous papillae. They are:
- The filiform papillae – numerous, rough, and threadlike. They are arranged in rows parallel to the sulcus terminalis and contain afferent nerve endings that are sensitive to touch, temperature, pain.
- The fungiform papillae – small and mushroom-shaped. They usually appear as pink or red spots. Contain taste receptors located in the taste buds – sweet, solt.
- The vallate (curcumvallate) papillae – are the largest papillae (1 to 2 mm in diameter). They lie just anterior to the sulcus terminalis and appear similar to short, flat-topped cylinders sunken into the mucosa. A deep, circular trench (trough), the walls of which are studded with taste buds, surrounds the vallate papillae. Contain taste receptors of the bitter taste.
- The foliate papillae – are small lateral folds of the lingual mucosa: they are poorly developed in humans. Contain taste receptors located in the taste buds – sour taste.
- The conic papillae (conicae).
- The lentiforme papillae.
MUSCLES OF THE TONGUE

The tongue is divided into halves by a median fibrous lingual septum that lies deep to the median groove. In each half of the tongue, there are four extrinsic and four intrinsic muscles.

EXTRINSIC MUSCLES, OR SKELETAL MUSCLES OF THE TONGUE

The group contents of four muscles:
- The Genioglossus Muscle,
- The Hyoglossus Muscle,
- The Styloglossus Muscle,
- The Palatoglossus Muscle.

INTRINSIC, OR OWN MUSCLES

- The superior longitudinal m.
- The inferior longitudinal m.
- The transverse m.
- The vertical m.

They originate outside the tongue and attaches to it. These muscles mainly move the tongue, but they can alter its shape as well.
5. THE PALATE.

The palate consists of two regions:
- the anterior two-thirds or bony part – the hard palate;
- the mobile posterior one-third or fibromuscular part – the soft palate.

Within the structure of the soft palate there are several paired striated muscles:
- The tensor veli palatini muscle.
- The levator veli palatine muscle.
- The uvulaeae muscle.
- The palatoglossus muscle.
- The palatopharyngeus muscle.
• **The parotid gland (glandula parotidea)**
  
  The excretory duct of the parotid gland (*parotid*, or Stensen’s *duct*) comes out for beneath its anterior edge, passes to the front 1-2 cm below the zygomatic arch, along the outer surface of the masseter muscle. It rounds the anterior edge of this muscle, perforates the buccinators muscle and opens into the vestibule of mouth at the level of the second upper molar.

• **The submandibular gland (glandula submandibularis).**
  
  The *submandibular* (Wharton’s) duct opens on the sublingual papilla, next to the lingual frenulum.

• **The sublingual gland (glandula sublingualis)**
  
  The *major sublingual duct* (main excretory duct) opens on the sublingual papilla.
THE PHARYNX

• The pharynx is an unpaired organ, which situated in the region of the head and neck. It is part of both the digestive and the respiratory system. It is shaped like an infundibular tube, which is fixed on the base of the skull. Its located at the level of C4 vertebra.

• The pharynx is divided into the nasopharynx, the oropharynx, laryngopharynx.

• The wall of the pharynx consists of the mucosa, submucosa, the musculare and adventitia.
THE OESOPHAGUS

- The oesophagus (esophagus) is a hollow tubular organ connecting the pharynx and the stomach, which serves to conduct food masses. The esophagus begins at the level of C5-C7 vertebrae and enters the stomach at the level of T9-T12 vertebrae. It has the cervical, the thoracic and the abdominal part. The wall of the oesophagus is made up of four layers: the mucosa, submucosa, muscular layer and adventitia.
THE STOMACH

The stomach has an **anterior wall**, which face forward and upward, and a **posterior wall**, which faces backward and downward. It also has cardiac orifice, cardiac part, from left side – fundus, which on the bottom, body. The narrowing right part of the stomach, the pyloric part (pylorus), it subdivided into two parts. It has a wide part – the pyloric cavity, and a narrow part – the pyloric canal.
Stomach in Situ

- Round ligament (ligamentum teres of liver)
- (obliterated umbilical vein)
- Fallopio ligament
- Left lobe of liver
- Abdominal esophagus
- Diaphragm
- Fundus of stomach
- Cardiac notch (incisura)
- Hepatogastric ligament (part of lesser omentum)
- Right lobe of liver
- Gallbladder
- Right kidney (retroperitoneal)
- Epiploic (omentum) foramen (of Winslow)
- Hepatoduodenal ligament (part of lesser omentum)
- Left colic (splenic) flexure
- Greater omentum
- Greater curvature
- Lesser curvature
- Jejunum
- Jejunum
- Pylorus
- Duodenum
- Right colic (hepatic) flexure
Stomach

Variations in Position and Contour

Hypertonic stomach  Orthotonic stomach  Hypotonic stomach  Atonic stomach

Variations of stomach in relation to body habitus
THE SMALL INTESTINE

The small intestine (intestinum tenue) is a part of the alimentary tract located between the stomach and the large intestine. Together with the large intestine it forms the longest part of the digestive system. The small intestine is divided into the duodenum, jejunum and ileum.

THE DUODENUM

The duodenum is the beginning part of the small intestine. It is situated on the posterior wall of the abdominal cavity. The duodenum is a continuation of the pylorus. It has the shape of a horseshoe, which rounds the head of the pancreas. The duodenum consists of the superior, descending, horizontal and ascending part.
Duodenum in Situ

- Portal vein
- Proper hepatic artery
- Common bile duct
- Suprarenal gland
- Liver (cut)
- Right free margin of lesser omentum (hepatoduodenal)
- Pylorus
- Superior (1st) part of duodenum
- Right colic (hepatic) flexure
- Transverse mesocolon and its cut edges
- Descending (2nd) part of duodenum
- Ascending colon
- Head of
- Superior mesenteric vessels
- Psoas major muscle
- Horizontal (3rd) part of duodenum
- Root of mesentery (cut edges)
- Descending colon
- Inferior mesenteric artery
- Ascending (4th) part of duodenum
- Abdominal aorta
- Inferior vena cava
- Kidney
- Duodenojejunal flexure and jejunum (cut)
- Inferior duodenal fold and fossa
- Left colic (splenic) flexure
- Transverse colon (cut)
Mucosa and Musculature of Jejunum

- Loop from superior mesenteric artery (intestinal branches)
- Mesentery
- Straight arteries (arteriae rectae)
- Serosa (visceral peritoneum)
- Longitudinal muscle layer
- Circular muscle layer
- Submucosa
- Mucosa
- Solitary lymph follicle (nodule)
- Circular folds (of Kerckring)

Barium radiograph of jejunum
Mucosa and Musculature of Ileum

- Straight arteries (arteriae rectae)
- Mesentery
- Arterial arcades from superior mesenteric artery branches
- Serosa (visceral peritoneum)
- Longitudinal muscle layer
- Circular muscle layer
- Submucosa
- Mucosa
- Circular folds
- Solitary lymph follicles (nodules)
- Aggregate lymph follicles (Peyer’s patches)

Barium radiograph of ileum
THE LARGE INTESTINE

The large intestine (intestinum crassum) continues from the small intestine. It is divided into the 6 parts: caecum with the vermiform processus, ascending, transverse, descending, sigmoid colon and rectum.
Ileocecal Region
Labial Form of Ileocecal Sphincter

- Free tenia (tenia libera)
- Labial form of ileocecal sphincter (as seen commonly post mortem and occasionally in vivo)
- Terminal part of ileum
- Opening of vermiform appendix
- Frenulum
- Vermiform appendix
- Free tenia (tenia libera)
Mucosa and Musculature of Large Intestine

- Transverse colon
- Transverse mesocolon
- Semilunar folds
- Left colic (splenic) flexure
- Omental tenia
- Haustra
- Peritoneum (cut away)
- Omental tenia (exposed by hook)
- Free tenia (tenia libera)
- Ascending colon
- Cecum
- Ileocecal opening
- Ileum
- Vermiform appendix
- Sigmoid mesocolon
- Sigmoid colon
- Rectosigmoid junction (teniae spread out and unite to form longitudinal muscle layer)
- Rectum
- Levator ani muscle
- External anal sphincter muscle
- Greater omentum (cut away)
- Epiploic appendices
- Haustra
- Peritoneum (cut away)
- Omental tenia (exposed by hook)
- Free tenia (tenia libera)
THE LIVER

The liver (hepar) the largest gland of the body. The liver has visceral and diaphragmatic surfaces. The diaphragmatic surface faces upward and to the front. The visceral surface is flat and is directed downwards and to the back. On the visceral surface of the right liver lobe, there are two small areas called the **quadrate and caudate lobe**.
THE GALLBLADDER
The gallbladder (vesica fellea) is a pear-shaped organ, in which bile is accumulated and concentrated. It has a fundus, a body and a neck.
Variations in Form of Liver

- Very small left lobe, deep costal impressions
- Complete atrophy of left lobe (left portal vein compression)
- Transverse, "saddlelike" liver, relatively large left lobe
- "Tonguelike" process of right lobe
- Very deep renal impression and "corset constriction"
- Diaphragmatic grooves
The Pancreas
It has head, body and tail. It exocrine part secrete pancreatic juice, it endocrine part secrete insulin, glucagon).
**The Peritonium**

Like any serous sacs it consists of two layers, parietal (*peritoneum parietale*) which lines the abdominal wall and visceral (*peritoneum viscerale*)

The cavity of the peritoneum is divided into three regions or storeys:

- Upper storey, bounded superiorly by the diaphragm and inferiorly by the root of the mesocolon transversum.
- Middle storey extends downwards from the root of the mesocolon transversum to the entrance of the true pelvis.
- Lower storey begins at the line of the entrance into the true pelvis and corresponds to the cavity of the pelvis which is the lowest part of the abdominal cavity.

The liver with the gall bladder, the stomach, spleen, pancreas and the upper part of the duodenum are located in this storey.

The loops of the jejunum and the ilium (in the middle), the part of the duodenum (posteriorly) and the large intestine except the rectum (on the sides) are located in this storey.

The rectum and urinary bladder located in third story in male. In female—urinary bladder, uterus and rectum.
Greater Omentum and Abdominal Viscera

- Falciform ligament
- Left lobe of liver
- Right lobe of liver
- Stomach
- Gallbladder
- Greater omentum overlying transverse colon and small intestine (jejunum and ileum)