Development of the digestive system

Development of esophagus

The esophagus is formed approximately in the **4th week** caudally from the primitive pharynx. It is separated from the basics of the respiratory system by a tracheoesophageal septum. At first the esophagus is short, but with the descent of the heart and lungs it lengthens rapidly. In the seventh week, it will grow to its final relative length. The epithelium and glands of the esophagus originate from the entoderm of the foregut, in the upper two thirds the esophageal muscle is transversely striated, originates from the mesenchyme of caudal pharyngeal arches and is innervated by the vagus nerve, the lower third is formed by smooth muscle from the adjacent splanchnic mesenchyme.

Development of stomach

- At week 4, spindle-shaped enlargement of the front intestine of the embryo,
- the shape and placement change due to the different growth rate of individual walls and the change of the position of organs in the vicinity,
- the stomach rotates 90 ° around its longitudinal axis (originally the left side ventrally, originally the right dorsally),
  - therefore, the vagus nerve also moves forward from the originally left side and backwards from the right side,
- originally the posterior wall grows faster than the anterior wall, therefore a major and minor curvature is formed,
- the cranial and caudal part also shifts from its central axis,
  - the caudal part (pylorus) moves to the right and up,
  - the cranial part (cardia) moves left and down,
- the axis of the stomach now points from top to bottom and to the right.

Congenital malformations of the stomach

- Pyloric stenosis - hypertrophy of the gastric muscle in the pyloric area,
  - one of the most common defects, probably occurs already in the fetal period,
  - restriction of digestion, severe vomiting.

Development of intestine

Front intestine

- From the oropharyngeal membrane below the outlet of the liver and pancreas,
- epithelium and glands - endoderm of the yolk sac,
- muscles - ectomesenchym of pharyngeal arches, splanchnic (lateral) mesoderm,
- sublingual and submandibular salivary gland, esophagus, stomach, part of duodenum, liver, gallbladder, pancreas.

Middle intestine

- reaches the Cannon-Boehm point (in the area of flexura lienalis = flexura coli sinistra),
- part of the duodenum, jejunum, ileum, caecum, ascending and most of the transverse colon.

Hind intestine

- Terminated by a cloacal membrane (linea dentata canalis analis),
- descending colon, rectum.

Another structures

Structures attaching the primitive intestine

- Ventral mesogastrium (disappears for middle and hindgut)

-> omentum minus a ligamentum falciforme hepatis - boundaries of the bursa omentalis.

- Dorsal mesogastrium (complete, allow rotation of organs in the peritoneal cavity) -> omentum majus, mesenterium, mesoappendix, mesocolon transversum, mesocolon sigmoideum, Treitz retropancreatic membrane.

Three body cavities

The coelom cavity is gradually divided into:

- pericardial cavity (pericardial),
- pleural cavity,
- peritoneal cavity.

Development of duodenum

The duodenum arises from the terminal part of the front intestine and part of the middle intestine - the border is below the opening of the ductus choledochus. Due to the rotation of the stomach, the duodenum takes the shape of the letter C and turns to the right. Like the pancreas, it finds itself in the retroperitoneum (except for the pars superior duodenum).

During the 2nd month, the lumen of the duodenum is temporarily closed due to the proliferation of enterocytes, but after several apoptosis it opens again.

The anterior bowel supplies the truncus coeliacus, the middle intestine and the superior mesenteric artery → duodenum therefore has a double supply.

Development of liver and gallbladder

The liver is established in the 3rd week of embryonic development as a deflection of the entodermal lining of the caudal part of the foregut growing into the septum transversum. Growing epithelial cells come into contact with the vv. vitellinae and vv. umbilicales, which form the basis of hepatic sinusoids. Hematopoietic and Kupffer cells, along with liver stromal cells, arise from the mesoderm of the septum transversum. The epithelial lining of the bile ducts is of entodermal origin, the remaining parts of their walls are again from the mesoderm septum transversum.

Dividing the liver puff

Shortly after formation, the liver puff begins to divide into the cranial pars hepatica and the caudal pars cystica.

Pars hepatica

Pars hepatica is the upper, larger part of the liver bud. It grows into the mesenchyme of the septum transversum, the caudal part of which forms the ventral mesogastrium and divides it into the ventral ligament falciforme hepatis and the dorsal omentum minus. The mesodermal cover of the septum transversum forms a visceral peritoneum on the liver, except for a small cranial area fused to the part of the septum transversum forming the center of the diaphragm tendineum, the so-called area nuda hepatis. By week 10, the liver is growing rapidly, which is greatly contributed by hematopoietic function of the liver. Liver growth is one of the causes of pushing the intestinal loop into the umbilical coelom and creating physiological umbilical hernia from the 6th to the 10th week of development.

Pars cystica

Pars cystica is the lower, smaller part of the liver bud growing into the lower edge of the ventral mesogastrium. It gives rise to extrahepatic bile ducts (ductus hepaticus, ductus cysticus + gallbladder, ductus choledochus). The mesodermal cover of the septum transversely around the ductus choledochus forms the hepatoduodenal ligament. The extrahepatic bile ducts are first formed as a solid epithelial column, which is later luminized by the mechanism of vacuolation and cell degeneration. The ductus choledochus is first deposited ventrally from the front intestine, but due to the rotation of the duodenum, it later reaches behind it.

Liver function during embryonic development

1. Hematopoiesis - From the 6th week of development, bone marrow is gradually replaced, at birth only small islands of hematopoietic tissue.
2. Bile production - From the 12th week of development, at a time when extrahepatic bile ducts are already formed.

Development of mesogastrium

- The stomach is connected to the body walls by the ventral and dorsal mesogastrium → thanks to the rotation of the stomach, these hinges also rotate,
  - the dorsal mesogastrium is originally located in the middle line of the body; it is pulled to the left → behind the stomach the bursa omentalis (cavum peritonei minus) is formed,
  - the ventral mesogastrium is pulled to the right → in the 5th week the base of the spleen from the mesoderm is formed here, which proliferates between the leaves of the dorsal mesogastrium,
- as the stomach rotates, the posterior mesogastrium lengthens and the portion between the spleen and the posterior midline is finally applied to the posterior body wall; there is a connection with the parietal

peritoneum,
    - the posterior leaf of the mesogastria and peritoneum parietale disappear at the point of contact,
    - the spleen remains in the peritoneal cavity.
        - spleen ligaments:
            - *ligamentum lienorenale* - connects the spleen to the posterior wall of the body in the area of the left kidney,
            - *ligamentum gastrolienale* - connects the spleen to the stomach,
- by attaching the posterior mesogastrium to the posterior wall of the body, the final position of the pancreas is given → it is placed retroperitoneally, the cauda pancreatis extends into the dorsal mesogastrium,
    - the pancreas is covered by the peritoneum only on its anterior side and becomes a secondary retroperitoneal organ,
- the posterior mesogastrium (stored caudally after rotation) gives rise to a sac-shaped duplication of its bilayer - omentum majus,
    - intervenes in front of the colon transversum and the loops of the small intestine,
        - later the inner layers of the duplicate merge → a simple double leaf emerges, receding from the curvator major,
            - the posterior surface of this double leaf is placed on the hinge of the colon transversum and merges with it and the visceral peritoneum → the gastrocolicum ligament is formed,
- the ventral mesogastrium is a derivative of the mesoderm septum transversum.
    - The septum transversum thins with the growth of the liver - it forms the peritoneum of the liver, the ligamentum falciforme hepatis and the omentum minus.
        - The margin of the falciform ligament contains the umbilical vein, obliterates after birth to form ligaments. teres hepatis
    - The hepatoduodenal ligament (free margin of the omentum minus) contains the portal triad - the choledochus duct, the portal vein and the hepatica propria artery
        - It also contains the ventral border of the foramen epiploicum (foramen Winslowi), which connects the bursa omentalis with the rest of the peritoneal cavity.

References

- SADLER, Thomas W. *Langmanova lékařská embryologie : Překlad 10. vydání.* 1. vydání. Praha : Grada Publishing, a. s, 2011. 432 s. ISBN 978-80-247-2640-3.
- MOORE, Keith L a T.V.N PERSAUD. *Zrození člověka : Embryologie s klinickým zaměřením.* 1. vydání. 2000. 564 s. ISBN 80-85866-94-3.