DIGESTIVE SYSTEM
The embryonic endoderm initially is widely connected with the yolk sac.

As a consequence of cephalocaudal and lateral folding, a portion of the endoderm-lined yolk sac cavity is incorporated into the embryo to form the primitive gut.
The gut system extends from the **buccopharyngeal membrane** to the **cloacal membrane**.

It consists of:

- **pharyngeal gut** (give rise to the pharynx and related glands)
- **foregut**
- **midgut**
- **hindgut**
The epithelium of the digestive system and the parenchyma of its derivatives originate in the endoderm.

The connective tissue, muscular and peritoneal components originate in the splanchnic mesoderm.
Developing gut and its derivatives are suspended from the dorsal to the ventral body wall by mesenteries. The mesenteries consist of two layers of peritoneum, provide pathways for blood and lymphatic vessels and nerves, enclose organs and connect it to the body wall.
The organs enclosed between peritoneal layers are called **intraperitoneal**, the organs that lie against the posterior body wall and are covered by peritoneum on their anterior wall only are called **retroperitoneal**.
Initially, *primitive gut* is in broad contact with the *mesenchyme* of the posterior abdominal wall.

By the fifth week, *connective tissue bridge becomes thinner*, and the caudal part of the *foregut, midgut* and a major part of the *hindgut* are suspended from *the posterior abdominal wall* by the *dorsal mesentery* (which extends from the lower end of the esophagus to the cloacal region of the hindgut).
The dorsal mesentery is finally divided into:

- **dorsal mesogastrium** (greater omentum) in the region of the stomach
- **dorsal mesoduodenum** in the region of duodenum
- **mesentery proper** in the region of the jejunal and ileal loops
- **dorsal mesocolon** – in the region of the colon
The **ventral mesentery** is formed only in the region of the terminal part of the esophagus, the stomach and the upper part of duodenum and is **derived** from the **septum transversum**.
The **ventral mesentery** is divided by growing **liver bud** into:

- **the lesser omentum** (the dorsal portion - extending from the lower portion of the esophagus, the stomach and the upper portion of the duodenum to the liver)
- **the falciform ligament** extending from the liver to the ventral body wall
The foregut gives rise to:

- the esophagus
- the trachea and lungs buds
- the stomach
- the duodenum  
  (proximal to the entrance to the bile duct)
- the liver
- the biliary apparatus
- the pancreas
The liver primordium appears in the middle of third week as an outgrowth of the endodermal epithelium at the distal end of the foregut.

The liver bud consists of rapidly proliferating cells that penetrate septum transversum.

While hepatic cells continue to penetrate the septum, the connection between the hepatic diverticulum and the duodenum narrows, forming the bile duct.
The outgrowth of the bile duct gives rise to the **gallbladder** and the **cystic duct**.

Hematopoietic cells, Kupffer cells and connective tissue cells are derived from mesoderm of the **septum transversum**.
The pancreas is formed by two buds originating from the endodermal lining of the duodenum:

- the **dorsal pancreatic bud** (in the dorsal mesentery)
- the **ventral pancreatic bud** growing close to the bile duct

The pancreatic buds fuse to form the definitive pancreas
The **midgut** forms the primary intestinal loop which gives rise to:

- the **duodenum** (distal to the entrance of the bile duct)
- the **jejenum**
- the **ileum**
- the **ascending colon**
- the **transverse colon**

(proximal two-thirds)
The apex of the primary intestinal loop remains temporarily in open connection with the yolk sac by through the vitelline duct (Meckel’s diverticulum).
During the **sixth** week, the intestinal loop **grows rapidly** and **protrudes** into the **umbilical cord** (physiological herniation)

During the **tenth** week it **returns** into the **abdominal cavity**.
ROTATION OF THE MIDGUT

The primary intestinal loop rotates around an axis formed by superior mesenteric artery.

When viewed from the front, this rotation is counterclockwise, and amounts approximately 270° when is complete.
Elongation of the small intestinal loop continues during rotation – the jejunum and ileum form a number of coiled loops.

The large intestine also elongates but not participate in the coiling phenomenon.

Rotation of the intestinal loop occurs during herniation (90) as well as during return of the intestinal loop into the abdominal cavity (180).
The **hindgut** gives rise to the:

- distal third of transverse colon
- descending colon
- sigmoid
- rectum
- upper part of the anal canal
The **hindgut enters the posterior region of the cloaca** (future anorectal canal) and the **allantois enters the anterior region of the cloaca** (future urogenital sinus).

**Breakdown of the cloacal membrane** covering this area provides **communication** to the **exterior** for the **anus** and **urogenital sinus**.
tooth development
enamel formation
RESPIRATORY SYSTEM
Trachea → Primary bronchi → Secondary bronchi → Tertiary bronchi → Bronchioles → Terminal bronchioles
The lung bud appears at 4th week after fertilisation and arise from an invagination of the median groove of the primitive pharynx (on the border of the pharynx and foregut).

Formation of the primordium is regulated by signals from the surrounding mesenchyme.
The epithelium of the larynx, trachea, bronchi, broncholi and alveoli originates in the endoderm.

The cartilaginous, muscular and connective tissue components of the lungs arise in the splanchnic mesoderm.
Initially, the lung bud is in open communication with the foregut.

Then **the diverticulum** expands caudally and **tracheoesophageal ridges** separate it from the **foregut**.
Subsequently, tracheoesophageal ridges fuse to form **tracheoesophageal septum** – and the foregut is divided into a **dorsal portion**: the esophagus and a **ventral portion**: the trachea and lung buds.

The respiratory primodium maintains its communication with the **pharynx** through the laryngeal orifice.
Larynx

The **internal lining** of the larynx originates from **endoderm**, whereas the **cartilages** and **muscles** originate from **mesenchyme** of the **fourth and sixth pharyngeal arches** – all laryngeal muscles are innervated by branches of the **vagus nerve**.
The derivatives of the fourth arch are innervated by the superior pharyngeal nerve.

The derivatives of the sixth pharyngeal arch are innervated by the recurrent laryngeal nerve.
Trachea, bronchi, lungs

At the beginning of the fifth week, the bronchial buds enlarge to form right and left main bronchi.

The right main bronchus forms three secondary bronchi, and the left, two.
With time, the lung primodia growth in caudal and lateral directions and expand into the body cavity.

At the beginning, the intraembryonic cavity is a common large space with the thoracic and the pelvic regions.

At the fourth week between upper (prospective thoracic cavity) and lower (prospective abdomen) portion of the intraembryonic cavity, septum transversum develops.
The septum transversum is **thick plate** of **mesodermal tissue** occupying the space between the **thoracic cavity** and the **stalk of the yolk sac**.

The septum transversum is the **primordium of the diaphragm**.
The septum transversum does not separate the thoracic and abdominal cavities completely but leaves large openings – the pericardioperitoneal canals.
The pericardioperitoneal canals – the spaces for the lungs growth – lie on each side of the foregut.

The pericardioperitoneal canals are narrow and are gradually filled by the expanding lung buds.
Ultimately the pleuroperitoneal folds separate the pericardioperitoneal canals from the peritoneal cavity and the pleuropericardial folds separate the pericardioperitoneal canals from the pericardial cavity – and as a consequence the primitive pleural cavities are formed.
The mesoderm, which covers the outside of the lung, develops into the visceral pleura.

The somatic mesoderm layer, covering the body wall from the inside develops into the parietal pleura.

The space between the parietal and visceral pleura becomes the pleural cavity.
During further development, secondary bronchi divides repeatedly in a dichotomous fashion, forming 10 tertiary (segmental) bronchi in the right lung and 8 in the left.

By the end of the sixth month, approximately 17 generations of subdivisions are formed. An additional 6 divisions form during postnatal life.
Pseudoglandular period
(5-16 weeks)
- branching has continued to form terminal bronchioles
- no respiratory bronchioles or alveoli are present
Canalicular period
(16-26 weeks)
- each terminal bronchiole divides into 2 or more respiratory bronchioles
- each respiratory bronchiole divides into 3-6 alveolar sacs
- vascular supply increases steadily
Terminal sac period
(26 weeks to birth)
- terminal sacs (primitive alveoli) form
- capilaries establish close contact
Alveolar period
(8 months to childhood)
- mature alveoli have well-developed epithelial-endothelial contacts
Fetal breathing movements begin before birth and cause aspiration of amniotic fluid. These movements are necessary for stimulating lung development and conditioning respiratory muscles.
When respiration begins at birth, most of amniotic fluid is **rapidly absorbed** by the blood and lymph capillaries.

Small amount of the lung fluid is **expelled via the trachea and bronchi** during delivery.
The **diaphragm develops** from four components:
- septum transversum (central tendon)
- pleuroperitoneal membranes
- dorsal mesentery of the esophagus
- muscular components of the body wall
A congenital diaphragmatic hernia is one of the more common malformations in the newborn (1/2000).

In case of cdh the peritoneal and pleural cavities are continuous with one another mostly along the posterior body wall.
The diaphragmatic hernias allows abdominal viscera (intestinal loops, stomach, spleen, liver) to enter the pleural cavity – push the heart, compress the lungs and cause large edefects of developing lungs (pulmonary hypoplasia and dysfunction).
Meckel’s diverticulum is commonly located in the:
A ileum
B ascending colon
C jejunum
D transverse colon
E duodenum
The primodium of which structure is located in the septum transversum?
A dorsal pancreas
B lung
C liver
D thymus
E heart
The yolk stalk is most closely associated with which artery?

A celiac
B umbilical
C superior mesenteric
D inferior mesenteric
E aorta