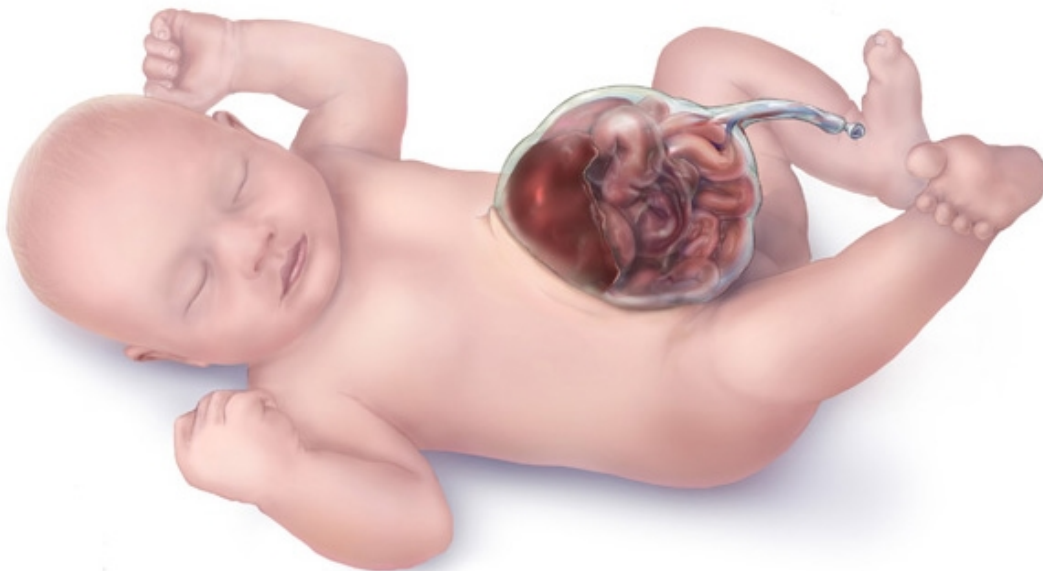


## Development of the Body Cavities

[See online here](#)

In the ranking of most popular study subjects among students, embryology is often near the bottom. In exams, the (admittedly) rare questions on the field can allow the student to shine by knowing only a limited number of facts, and, on a normal day in the clinic, symptoms and malformations stemming from this developmental period are hardly uncommon so it is indeed worthwhile looking into the details of this field, and not just for aspiring pediatricians. This article explains the most important facts about the development of the body cavities and the relevant symptoms.



## Human Body Cavities

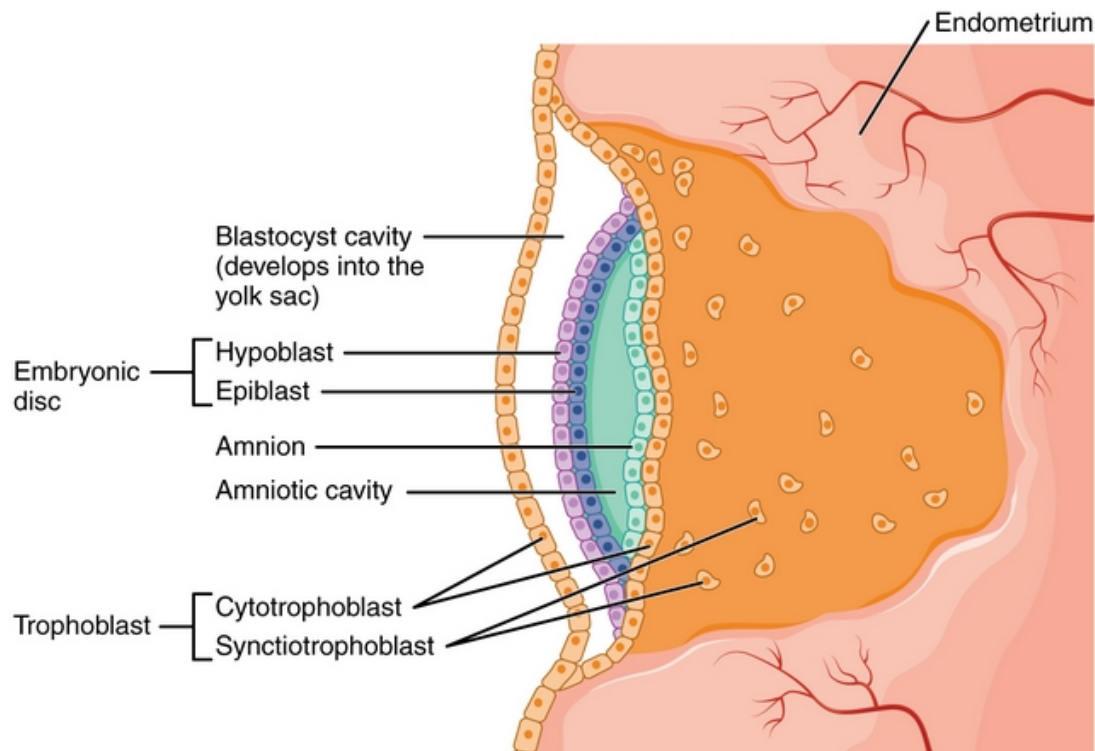
The two small spaces known as the pericardial and pleural cavities (**cavitas pericardialis and pleuralis**), which house the heart and lungs respectively, and the larger **peritoneal cavity** (cavitas peritonealis), in which the majority of the abdominal organs are located, are called the human body cavities. The body cavities are covered with a serous membrane (**tunica serosa**).



Picture: "Dorsal and Ventral Body Cavities" by philschatz. Licence: [CC BY 4.0](#)

The body cavities of a growing child develop in the **embryonic period**, during the fourth to eighth week of development (to remember this: early development 1st-3rd, embryonic period 4th-8th, and foetal period 9th-38th week of development).

Before the third week of pregnancy, the **trifoliate germinal disc** is present with the three blastodermic layers (ectoderm, mesoderm, endoderm: the variously differentiated precursor cells) as a **smooth embryonic disc**, and the extraembryonic cavities (**amniotic cavity** and **yolk sac**) are already developed.



Picture: "Development of the Embryonic Disc" by philschatz. Licence: [CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)

At the **end of the embryonic period**, the embryonic tissue is separated from the extraembryonic tissue. At this time, the end of the eighth week, the shape of the body is already recognizable and nearly all organs are in their proper place.

On incredibly rare occasions, the following facts are covered in the preliminary medical exam, and, for oral exams as well, you should only study these thoroughly if you have enough time or indications of the relevance hereof for the examiner. However, in order to understand the important symptoms resulting from these processes, everybody should have heard them at least once. They will be **relevant in clinical studies at the latest**.

## Development of the Trunk Wall

In the fourth week of development, two crucial developmental steps lead to the thoracic and abdominal wall - and thus the bodily form of the embryo - forming: the **lateral folding** (rolling) and the **craniocaudal folding** of the embryo. Both processes are caused by the significant growth of the **neural plate** and the formation of the **neural tube**.

One simple example helps visualize this: the C-shaped growth of the embryo results in a shape that resembles a mushroom. The edges of the mushroom's hood roll inward and grow medially, until the right and left sections merge into a sort of sphere.

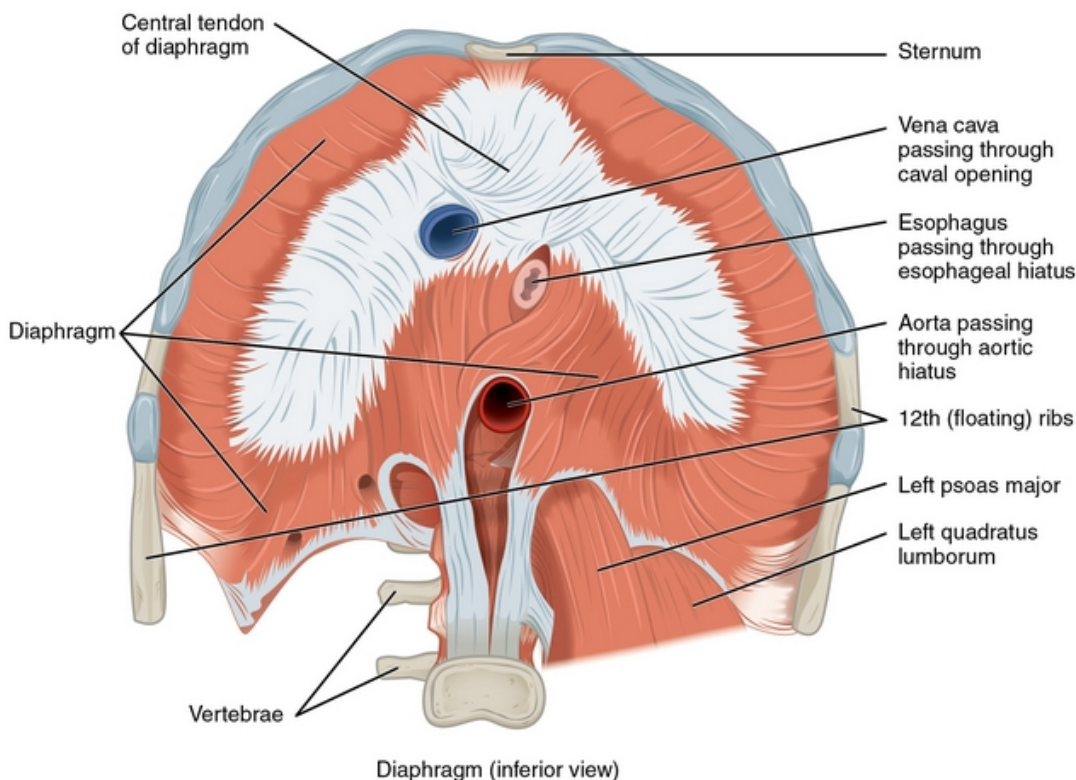
At the same time, the enclosures for the heart (**heart plate**) and the **septum transversum** (the eventual diaphragm) move into the sagittal plane, the middle of the embryo. The initially cohesive body cavity forms for the first time: the **intraembryonic**

**coelom** (Gr. *koilom* = hollow space). Through this coalescence, hollow spaces have formed in the intraembryonic mesoderm that will eventually form the body cavities.

Now a part of the intraembryonic, **lateral plate mesoderm cells** (do not get confused by the many word constructions: these are simply the rows of cells surrounding the mesoderm, sort of like the edge) is in contact with the ectoderm, and is now called the **somatopleura**. The cell layer bordering the enteroderm is called the **splanchnopleura**. The **septum transversum** (the eventual diaphragm) forms at the crossover point between the two.

## Separation of the Thoracic and Abdominal Cavities and Development of the Diaphragm

The **diaphragm** forms in the sixth to eighth week of development via the coalescence of the **septum transversum** and the **plicae pleuraperitoneales**.



Picture: "Muscles of the Diaphragm" by philschatz. Licence: [CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)

The **septum transversum** grows ventrally between the heart and the liver enclosure and into the body cavity, i.e. into the intraembryonic coelom. The pleuropericardial folds (**plicae pleuraperitoneales**) grow against it from the anterior, lateral trunk wall. Toward the end of the eighth week of development, these sections have coalesced to become the diaphragm, and the thorax and abdomen are spatially separated.

The muscles of the diaphragm first develop during the fourth month of pregnancy - precursor muscle cells from the anterior, lateral trunk wall inhabit them. The innervation of the diaphragm by the **n. phrenicus** is also easy to explain: during the embryonic period, the diaphragm moves in a caudal direction. During this **descent**, it simply takes the ventral branches of the cervical nerves CE - C5 with it.

**Note:** Memorise the innervation of the diaphragm. This is often covered in exams.

## Congenital Diaphragmatic Hernias



**Picture:** "Congenital right sided diaphragmatic hernia in a neonate - chest X-ray" by Kinderradiologie Olgahospital Klinikum Stuttgart. Licence: [CC BY-SA 4.0](https://creativecommons.org/licenses/by-sa/4.0/)

Congenital diaphragmatic hernias appear in one out of every 10,000 births on average. By definition, they result in displacement of abdominal organs (stomach, intestine) into the chest cavity via gaps in the diaphragm.

The most common congenital **hernia** is the **Bochdalek hernia** (95%). Its hernial orifice is almost always around the left **trigonum lumbocostale**. However, this weak point may also appear on the right, although it is effectively "sealed" by the liver on top of it.

The far less common **Morgagni hernia** (5%) appears in the right **trigonum sternocostale**.

Intestinal loops that have migrated into the thorax (referred to as an **enterothorax**) can lead to displacement and compression of the heart and lungs, depending on the size. Children afflicted exhibit respiratory failure, the chest cavity may be asymmetrically curved, and the stomach may be partially shrunken due to the missing "contents." Any peristaltic sounds may be auscultated via the thorax, and air-filled intestinal loops (white) may be visible above the diaphragm in X-ray images.

A diaphragmatic hernia may be visible during pregnancy via ultrasound - this is a **neonatological emergency**. Large hernias may result in insufficient space in the chest cavity, leading to underdevelopment (hypoplasia) of the lungs and its supplying vessels.

## Formation of the Pericardial and Pleural Cavity

The first, **primitive pericardial** cavity forms from fissures in the **mesenchyme** during the fifth week of development. At first, it is still connected to the **peritoneal cavity** via the **canales pericardioperitoneales**, as the diaphragm is not yet sealed.

At the same time, the respiratory buds grow in a dorsomedial direction from the root of the lung to the left and right into these two cavities, and their edges form the primitive pleural cavity. The **primitive pleural cavity** is lined by the aforementioned **splanchnopleura** (pleura parietalis), and the **somatopleura** (pleura visceralis) surrounds the developing lungs.

The two cavities are ultimately entirely separated by the protruding **plicae pleuropericardialis**, which ultimately coalesce into the **membrana pleuropericardialis**, which, in turn, merges with the root of the lung at the end of the embryonic period (eighth week).

## Formation of the Abdominal Cavity

The **abdominal cavity** also forms during the aforementioned changes in the embryo. Through the craniocaudal folding of the embryo, a small part of the adjacent **yolk sac** begins to obtain an intraembryonic position and is sealed into a type of tube: the development of the intestine has begun.

The developing intestine lying in the simple body cavity (**intraembryonic coelom**) is stretched out by the great growth in length, so that an **anterior and posterior intestinal portal** form, between which there still exists a connection to the yolk sac, located outside of them: the omphalomesenteric duct (**ductus omphaloentericus, ductus vitellinus**).

This plays a role in the physiological umbilical hernia and the formation of the umbilical cord. In addition, it may persist in adults, albeit rarely, as a so-called **Meckel's diverticulum** on the small intestine.

**Note:** The intestinal tube is formed by intraembryonic segments of the yolk sac.

The growing intestine is divided into a **foregut, midgut** and **hindgut**. The foregut will later form the stomatodaeum, i.e. the beginning of our gastrointestinal system, and is sealed by the **buccopharyngeal membrane**. On the anterior intestinal portal/the hindgut, the **cloacal membrane** forms the border with the amniotic cavity.

## Physiological umbilical hernia – a crucial step during development

The rapid growth of the midgut leads to a lack of space in the situs of the embryo. That is why a hernial sac with intestinal loops and vessels (the eventual **a. mesenterica superior**) moves into the **extraembryonic coelom** (also umbilical coelom) during the eighth to eleventh week of development. The segments of the intestine continue to grow within this, and eventually turn on the axis of the vessels (to be precise: once at 270 degrees counter-clockwise).

The individual intestinal segments are now located together in their proper position. Later in the development they are relocated back into the body cavity by the length growth of the embryo. If this step does not occur, the clinical symptoms of an **omphalocele** (see below) will arise.

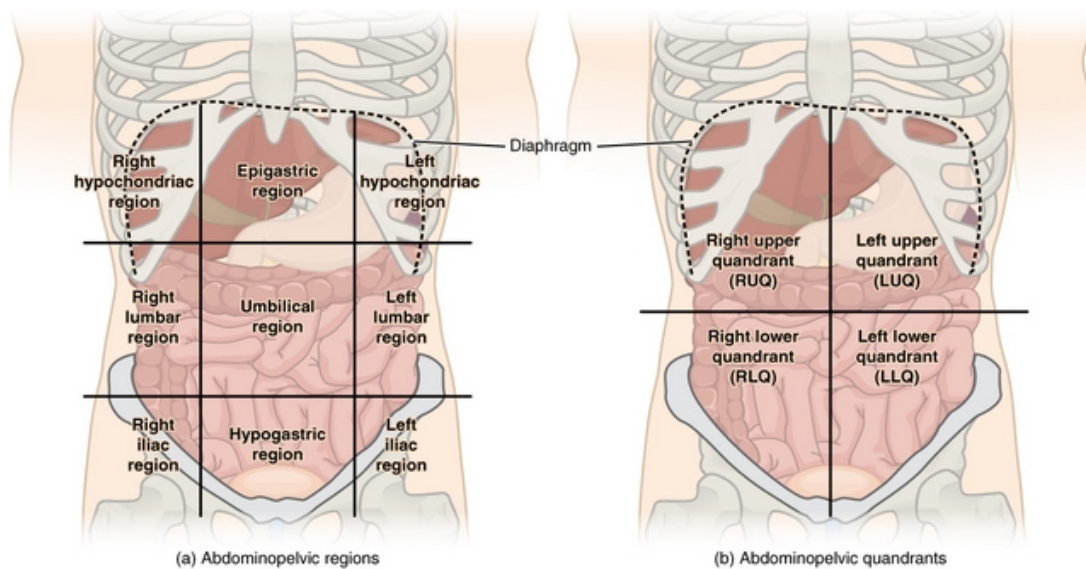
By this point, the aforementioned connection between the U-shaped midgut and yolk sac still exists: the **ductus omphaloentericus** (also ductus vitellinus or omphalomesenteric duct). This virtually “pulls” the intestinal loops out, and, upon further development, it becomes narrow and sealed. After the intestine has returned to the situs, this duct

becomes a structural part during the formation of the umbilical cord.

The omphalomesenteric duct can also be important for adults: a **Meckel's diverticulum** may remain in the event of poor regression. If the intestine is not completely withdrawn into the body during the physiological umbilical hernia, the result may be clinical symptoms of an **omphalocele**, and intestinal loops may be found outside the child's body during birth (see below).

## Development of the mesenteries and division of the peritoneal cavity

The intestine located within the body must also be fixed in the abdomen - the **mesenteries** fulfil this function. The midgut initially has two mesenteries on its upper segments (**mesenterium ventrale** and **dorsale**), which connect the intestinal tube with the anterior and posterior wall of the **peritoneal cavity**.



Picture: "Regions and Quadrants of the Peritoneal Cavity" by philschatz. Licence: [CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)

The upper segment of the peritoneal cavity is divided into a right and left section by these mesenteries during development. Namely, the caudal part of the **esophagus**, the stomach and the upper **duodenum** form from this upper part of the midgut.

The lower section of the intestine is merely held in place by a **mesenterium dorsale**; this results in a single cavity in the lower part of the peritoneal cavity, which the dorsally fastened intestinal tube reaches into.

## Malformations in the Development of the Body Cavities





Picture: "Omphalocele-Drawing" by Centers for Disease Control and Prevention. Licence: [CC BY-SA 3.0](https://creativecommons.org/licenses/by-sa/3.0/)

## The omphalocele

Should the intestinal loops fail to return to the developing body after the **physiological umbilical hernia**, a portion of the abdominal viscera may remain in a hernial sac in the umbilical cord. This is referred to as an **omphalocele**, or an **umbilical cord hernia**.

In most cases, these are parts of the small intestine and/or the liver. A persistent umbilical hernia can already be **diagnosed** during pregnancy **via sonography**. Due to the high risk of infection, affected children should be surgically treated immediately after birth.

In the event of an umbilical cord hernia, other malformations are present in 40% of cases, often right lateral **laparochisis** (abdominal wall defect). This means that abdominal organs are protruding from the right side of the body, are uncovered and usually infected, and a careful operation is imperative.

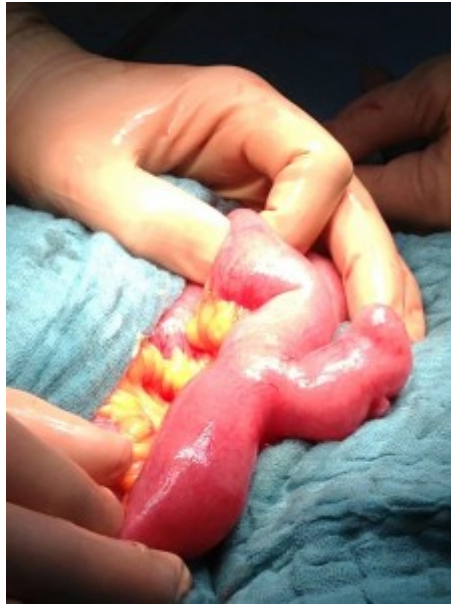


Picture: "Laparochisis Sagittal View" by X.Compagnion. Licence: [CC BY-SA 2.5](https://creativecommons.org/licenses/by-sa/2.5/)

With **gastroschisis**, the abdominal organs are protruding from the midline. The cause for this remains unclear. One possibility that has been discussed is that the hernial sac bursts during the physiological umbilical hernia, and the abdominal organs are subsequently left suspended in the amniotic fluid.

If a great amount of the intestine is outside the abdominal cavity, or if the child has a very small abdomen, it is **possible to first tend to the intestinal loops with a sterile plastic bag**. This is then placed over the child's stomach so that gravity slowly draws the intestinal loops back into the abdomen. The gap in the abdominal wall is then surgically sealed.

# Meckel's diverticulum



Picture: "Meckel-Divertikel" by Milliways. Licence: [CC BY-SA 3.0](https://creativecommons.org/licenses/by-sa/3.0/)

A protrusion of the small intestinal wall may remain on the individual as a remnant of the **omphalomesenteric duct**. This is the case for 1 or 2% of the population, more frequently men.

Due to the embryonically early formation of the omphalomesenteric duct, the **Meckel's diverticulum** (as its remnant) usually not only receives intestinal mucous – in over 50% of cases, gastral mucous cells, cells from the large intestine and cells from the pancreas are also possible.

Generally, a Meckel's diverticulum is located 50 to 75cm proximal to the junction of the ileum to the caecum. In most cases, such a diverticulum remains asymptomatic – in the event of inflammation, however, it may result in **gastrointestinal bleeding** and **peritonitis**, and the patients exhibit colicky pain and symptoms similar to [inflammation](#) of the appendix (**appendicitis**).

A Meckel's diverticulum is **removed surgically**. If there is any suspicion of appendicitis, and no intraoperative indication of an inflammation of the **appendix**, the surgeon must always inspect the **ileum** for a Meckel's diverticulum.

**Tip:** Due to the dearth of technical terminology, it is difficult for most students to study embryology. However, most terms are Greek or Latin in origin. Google the translation to better understand the terminology; this applies to many medical terms, but is especially helpful here.

You can learn more about embryology in the [Lecturio course on general and special embryology](#) from Dr. Steffen-Boris Wirth, M.D. or on the page [embryology.ch](#) of the Universities of Fribourg, Lausanne and Bern.

## Review Questions

The solutions can be found below the references.



### 1. What is an omphalocele?

- A. A persisting ductus omphaloentericus
- B. A hernial sac with abdominal viscera in the umbilical cord
- C. An eversion of the intestinal wall
- D. The connection between the pleural and pericardial cavities
- E. A defect of the abdominal wall in the newborn with emergent, bare intestinal loops

### 2. Which period during pregnancy is referred to as the embryonic period?

- A. 1st - 3rd week
- B. 3rd - 9th week
- C. 4th - 8th week
- D. 9th - 38th week
- E. 38th - 40th week

### 3. Where is a so-called Meckel's diverticulum most commonly found?

- A. The stomach
- B. The duodenum pars inferior
- C. The ileum
- D. The transverse colon
- E. The esophagus

## References

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**Correct answers:** 1B, 2C, 3C

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Notes