

Development of the Heart

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The cardiovascular system is the first functional system of the embryo. The deployment starts in the third week. Not infrequently, there are congenital malformations of the heart or to the vessels close to the heart, so that knowledge of embryology is important in order to understand the pathogenesis. The following article explains how the heart is formed out of the trifoliate cotyledon.



The Previous Development in a Nutshell

The development of the heart begins on the basis of the **trifoliate cotyledon**. This consists of the upper **ectoderm**, the **mesoderm**, and the **lower-lying centrally endoderm**. One can imagine it like three layers of a disc, wherein the ectoderm is located in a fluid-filled bladder, the **amniotic cavity**. The endoderm, however, is attached to the **yolk sac**.

Within the mesoderm, a **notochord** is formed, which first develops a groove, then forms a tube. This is the **notochord**, the preliminary axis of the embryo. If you would from the yolk sac to the endoderm, you would see the center as notochord axial strips, laterally thereof the endoderm extends.

The part that is located cranial to the notochord is called a **precordial plate**. Little by little, the endoderm is pushed over the notochord and merged again so that they will be moved into the mesoderm, which is also located between the ectoderm and endoderm.

At the same time, on the "other side" - in the ectoderm, **neurulation** (= formation of a neural fold, which closes itself to the neural tube) takes place.

Following, the so-called **lateral and vertical folding** of the germinal layer occurs, which results in large cell rearrangements. One result of the lateral folding is the formation of an **intraembryonic body cavity**, the coelomic cavity. The parietal layer of the mesoderm and a subsequent layer of the ectoderm restrict it. The endoderm closes cranial and caudal to the **intestinal tube**, which is opened toward the yolk sac.

Phase 1: Cardiac Tube

The so-called cardiogenic zones, where the original cells of the heart facilities are located, are in front of the precordial plate. From **paired** and laterally applied heart tubes comes through the lateral folding an unpaired, **primitive heart tube**, which is now located at the bottom of the coelomic cavity.

The mesoderm surrounding the heart tube later becomes the myocardium.

Through looping and septation the heart, internal spaces develop hereinafter.

Phase 2: Heart Loop

The heart tube begins to **elongate** and **warp** in the fourth week of development so that a loop-like structure forms in the tube. There will be local, piecewise expansion of the lumen. From caudal to cranial spaces form like this:

- Sinus venosus
- Atrium primitivum
- Ventriculus primitivus
- Bulbus cordis
- Truncus arteriosus

The **caudal sections run ventrally** through the S-shaped cardiac loop, whereas the **cranial sections run dorsally**. The majority of the **left ventricle** is formed from the **ventriculus primitivus**, which additionally shifts slightly to the left during the forming of the loop.

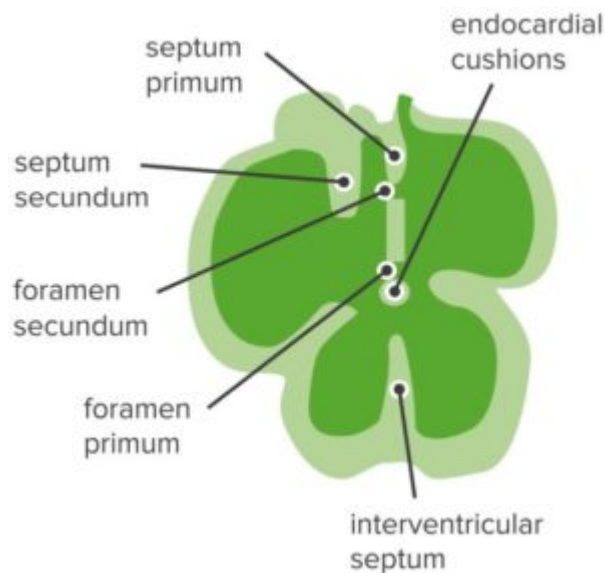
The proximal portion of the bulbus cordis forms the coarse walled portion of the **right ventricle**, while the so-called **conus cordis** is formed from the distal portions (additional stage).

The **truncus arteriosus** represents the precursor of the **ascending aorta**, as well as the **truncus pulmonalis**. Both structures, bulbus, and truncus are summarized as the **porta arteriosa** and are thus considered the (smooth-walled) outflow tract of the left and right ventricles.

The cardiac loop sections are already very similar to those in the final heart, but have not made a separation yet; therefore, the formation of the four cavities of the heart now occurs.

One Becomes Four: The Development of the Internal Cardiac Cavities

Between the primitive atrium and the primitive chamber, a narrow passage, which is called **atrioventricular canal**, is located. On the wall, two opposing thickenings occur - so-called **endocardial cushions**. They fuse together, which causes a breakdown in the right and left portions to occur.



"Terminology Heart" Image created by Lecturio

Within the **ventriculus primitivus**, a muscle bar, which later represents the **pars muscularis** of the **interventricular septum**, begins to move caudally to cranial. The two developing chambers are not yet completely closed. Initially, a foramen interventriculare remains cranially.

In the subsequent processes, the cone bead covers this opening. It denotes a membranous portion of the interventricular septum.

The outflow tract must be **divided into the chambers** as well. This is accomplished through the formation of the **aorticopulmonary septum**. The blood flow that is already flowing through the heart loops generates **helical pressure conditions** in the outflow tract. The septum aorticopulmonale is oriented according to this.

The **separation of the atria** begins with the formation of the **septum primum**, which initially grows from the ceiling of the atrium primitivum. On the other hand, another muscle bar pushes up from the endocardial cushion and fuses with it.

Again, another opening exists, the **foramen primum**. This will gradually close, while the septum primum tears above. This second, open space is called the **foramen secundum**.

Another **septum secundum** forms analogous to the septum primum, and, while it conceals the foramen secundum, it also has its own opening. This is the **foramen ovale**, which is covered by the adjacent septum primum; thus, two openings exist, each in two septa.

This **short circuit** between left and right atrium is prenatally necessary because the **pulmonary circulation is not yet functional**. The bloodstream can be maintained this way. After birth, when the high and low-pressure areas are forming, the septa are pressed against each other, so that the foramen normally **closes functionally**.

References

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