EMBRYYOLOGY

B.SC. PART - II

PAPER - IV

FORMATION OF HEART

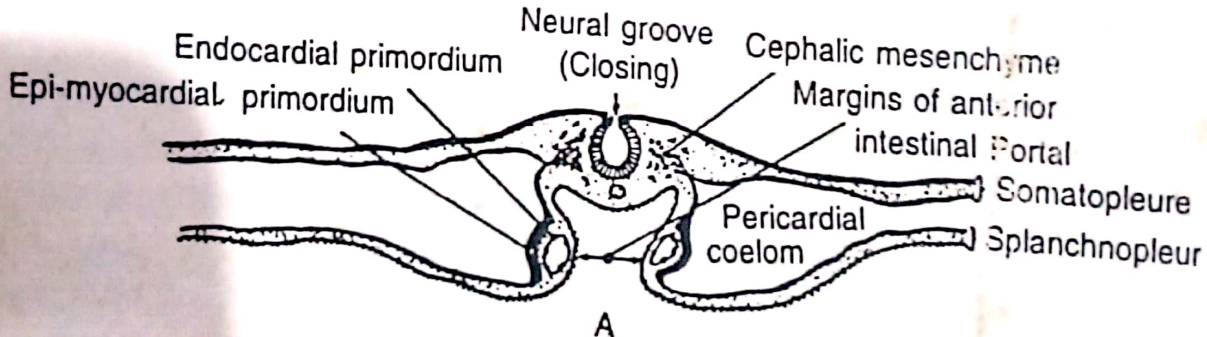
05

5.1. The vertebrate heart is essentially a modified blood vessel which is half artery and half vien. It has two kinds of chambers: thin-walled receiving chamber and thick-walled forwarding chamber. The two kinds of chambers are separated by the valves. The walls of the heart have three main histological elements comparable to a blood vessel, although the muscles of the heart are peculiar.

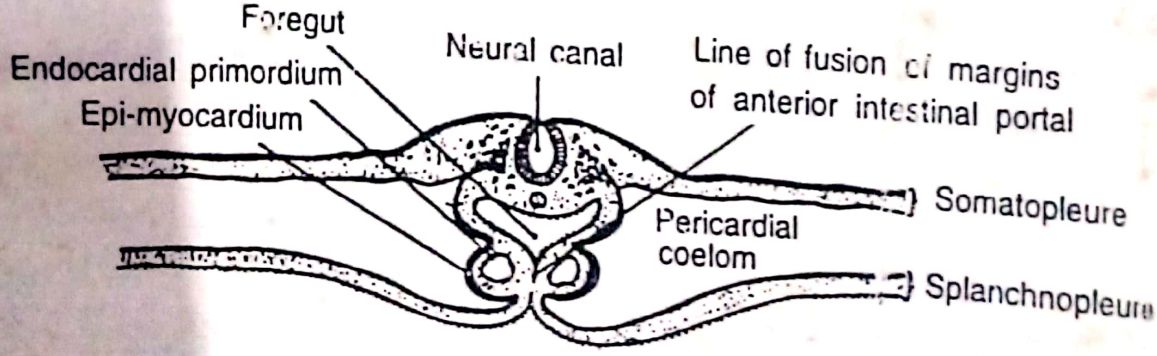
In the chick embryo, the first formation of heart can be seen as early as 25 hours of incubation. In the region of the pharynx, the ventral parts of the hypomere can be seen to be approaching one another. Between them and below the pharynx, mesenchymal cells are organized to form two thin-walled endothelial tubes. These two tubes fuse to form a single endocardial tube. This tube is surrounded by the thickened ventral mesentery. The wall of the original **endocardium** forms the lining of the adult heart. The surrounding part (formed by the mesentery) develops into (i) the **myocardium,** which is the muscular part of the heart; and into (ii) the visceral epithelium which is the covering layer. Later on, the heart acquires constrictions into chambers, differential thickening, and kinking of the chambers.

A detailed account of the formation of heart in chick is given below:

The first clear-cut indication of heart formation can be seen in the sections of the chick embryo of 25 hours of incubation. This can be seen as marked



A



B

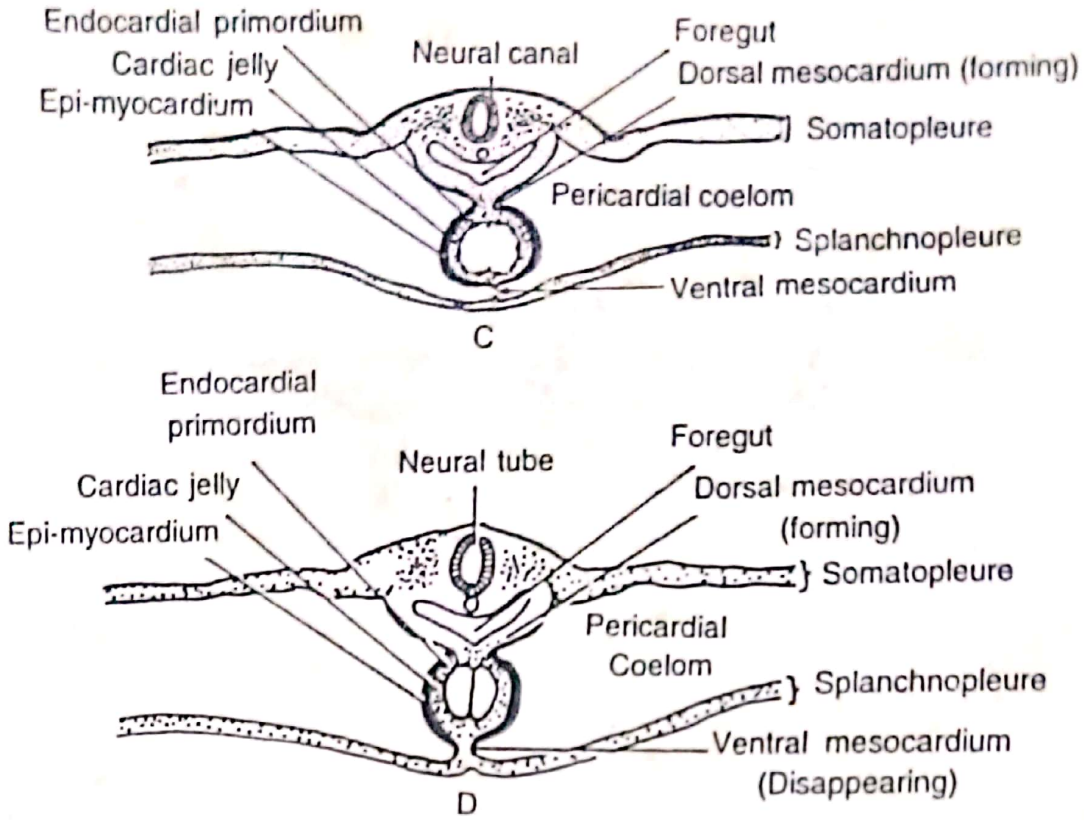


Fig. 5.1. Diagrams of transverse sections through the pericardial region of chick at various stages to show the formation of the heart. (A) at 26 hours; (B) at 27 hours; (C) at 28 hours; (D) at 29 hours.

regional thickening in the splanchnic mesoderm along the lateral margins of the instestinal portal, just posterior to the anterior intestinal portal. The regional thickenings, which are called the **primordia** of heart, are formed due to the rapid proliferation of cells in the splanchnic mesoderm. These proliferated cells become organized to form the **endocardial primordia.**

Along with the formation of endocardial primordia, the formation of **epi-myocardial primordia** also takes place. These two primordia are well-differentiated in the embryo of 26 hours of incubation. The endocardial primordia are a pair of tubular structures lying between endoderm and

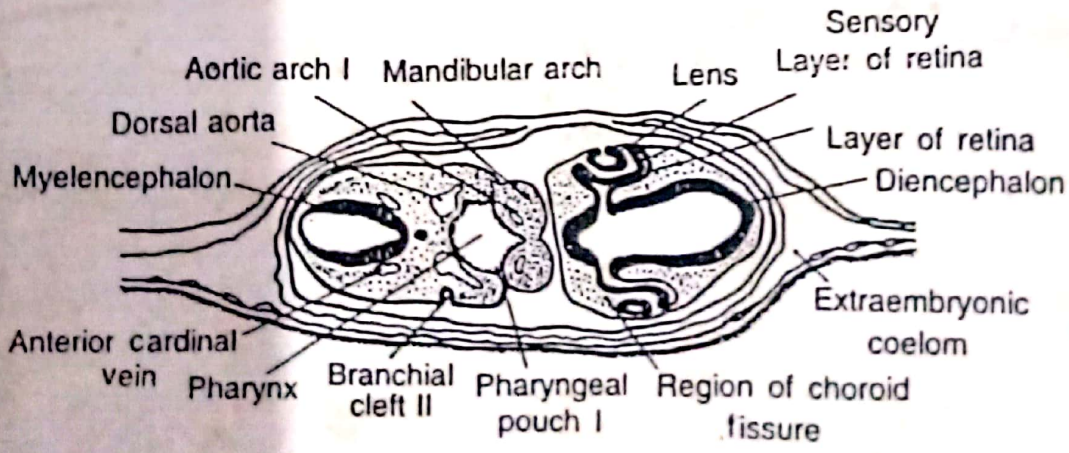


Fig. 5.2. Diagram of the outline of 55-hour chick embryo. Note the formation of retina and the lens.

mesoderm. These tubes are only a single cell in thickness. These tubes are ultimately going to give rise to the endothelial lining of the heart. The epi-myocardial primordia are destined to give rise to the external coat of the heart (epicardium) and to the heavy muscular layers of the heart (myocardium).

In 27 hours of incubation, the lateral margins of anterior intestinal portal begin to fuse. This process (i) lengthens the gut psoteriorly, (ii) causes the elongation of the pericardial region, (iii) brings the endocardial tubes of the left and right sides in the middle line below the newly-formed floor of the foregut.

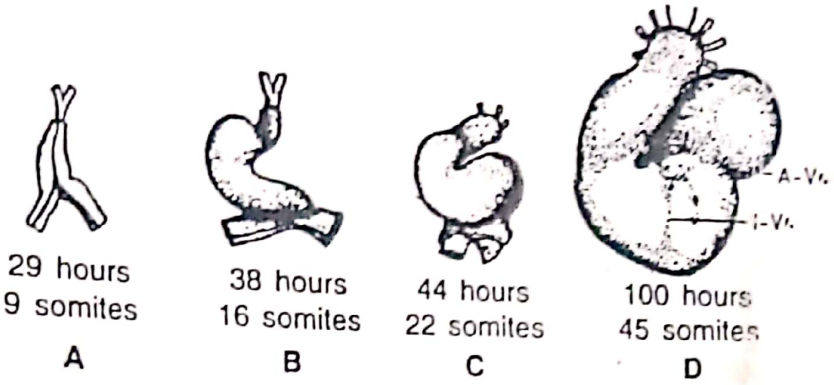


Fig. 5.3. Showing the ventral view of the heart at various stages of development

In 28 hours, the endocardial primordia are further approximated to each other, and in the next hour they fuse in their midregion to form a single tube. In the meantime, the epimyocardial areas of the mesoderm are also brought together, as first ventrally and then dorsally, to the endocardium. When this happens, the ventral splanchnic mesodermal layers are also approximated to give rise to ventral mesocardium. Likewise, the dorsal approximation of the mesodermal layers is called **dorsal mesocardium**. The ventral mesocardium disappears very soon, but the dorsal mesocardium, after being thinned out considerably, persists to which heart is supended in the pericardial region.

At 33 hours of incubation the midregion of the heart apppears enlarged and is displaced somewhat to the right side. Cardiac jelly is filled in the space betwen epi-myocardium and endocardium. This jelly provides a substratum for the movement of cells between these two primordial layers of the heart.

At 38 hours of incubation, the heart is bent to the right side so much as to extend beyond the lateral margin of the embryo. This bending process ruptures the dorsal mesocardium at the midregion. The breaking of the dorsal ventral mesocardia renders the heart free to undergo changes in form. After that the fundamental regions of the heart begin to take their shape. By 36 hours **the sinus venosus** begins to be represented by the paired primordia where **the common cardinals** meet the omphalomesenteric veins. The latter enter

the atrium. The persisting portion of the dorsal mesocardium holds the atrium close below the caudal part of the foregut. The ventricle part makes a U-shaped curve to the right. The discharging part of the ventricle is narrowed to the form truncus arteriosus. The part which is narrowed abrupty is called the **ventricular cone** or **conus.**

In this way one finds that the originai cephalo-caudal relations of the atrium and ventricle are reversed by the bending of the original tube into the U-shaped structure. The different regions of the heart become gradually constricted and clearly marked off. Truncus arteriosus can be seen to be closely applied to the ventral surface of the atrium during the fourth day of incubation. The atrium expands on either side of the truncus since the latter causes a depression in the atrium. The lateral expansion of the atrium is an indication of its division into left and right chambers. This is followed by the appearance of a longitudinal groove in the ventricle, which is an indication of the beginning of the separation of ventricle into left and right chambers.

Along with the formation of atrioventricular constriction, a groove is formed between the atrial region and the sinus venosus into which the great veins empty the blood. As the sinu-atrial groove deepens, the sinus is progressively delimited. By this time, the basic regional divisions of the heart are established in the order of the blood flow—**sinus venosus, atrium,** and **ventricle.**

The wall of the ventricle increases in thickness. On the internal face of the ventricle there develops a meshwork of interlacing muscular bands called the **trabeculae carnae.** From the apex of the ventricle grows a partition which moves towards the atrium. This septum is called the **interventricular septum.**

□□□