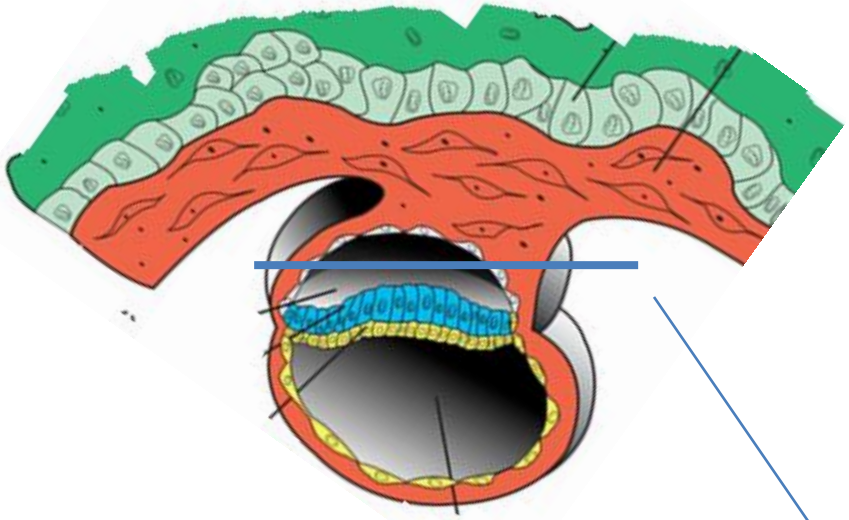
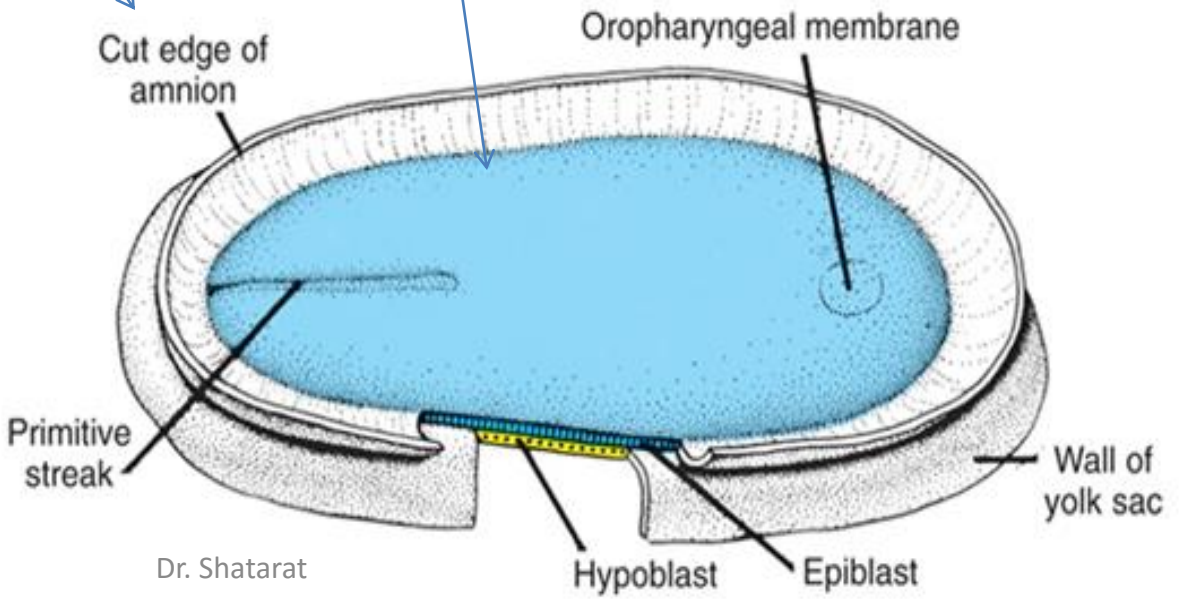
When you see this diagram, remember that you are looking at the embryo **from above, through the amniotic cavity, where the epiblast appears as an oval disc**





DEVELOPMENT OF CARDIOVASCULAR SYSTEM

Dr. Shatarat

Why the embryo needs the vascular system?

because the embryo is no longer able to satisfy its nutritional requirements by diffusion alone.

When it appears?

The vascular system appears in the **middle of the third week**, *As the first major system to function in the embryo*

Where it appears?

CARDIAC PROGENITOR CELLS LIE *IN THE EPIBLAST*

with later contributions from neural crest mesenchyme

The Cardiac progenitor cells migrate from the Epiblast

Through

Primitive streak

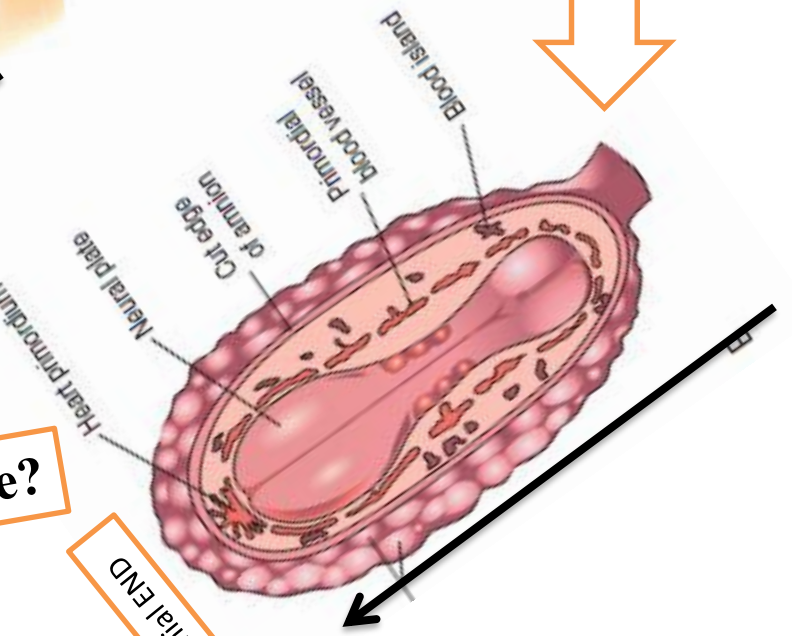
In a

Cranial direction on each side of the notochordal process and around the prechordal plate

Buccopharyngeal membrane

Caudal END

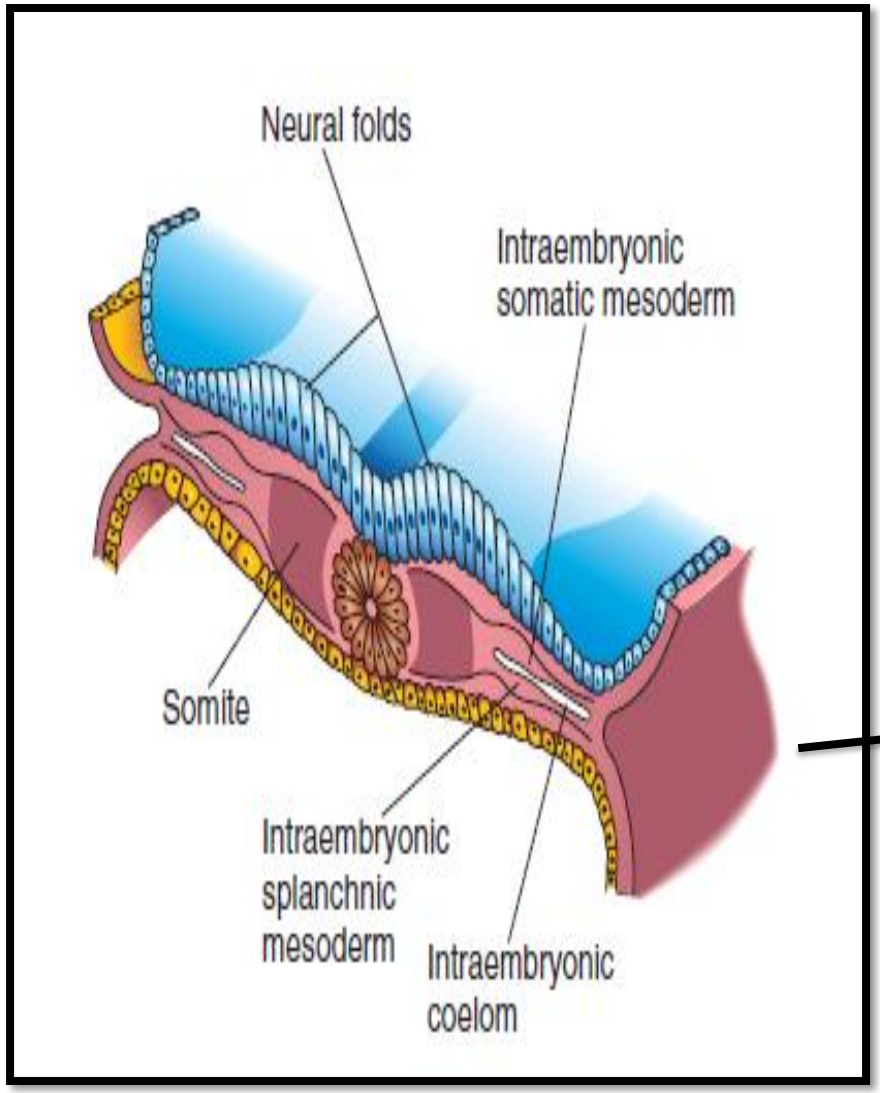
Cranial END

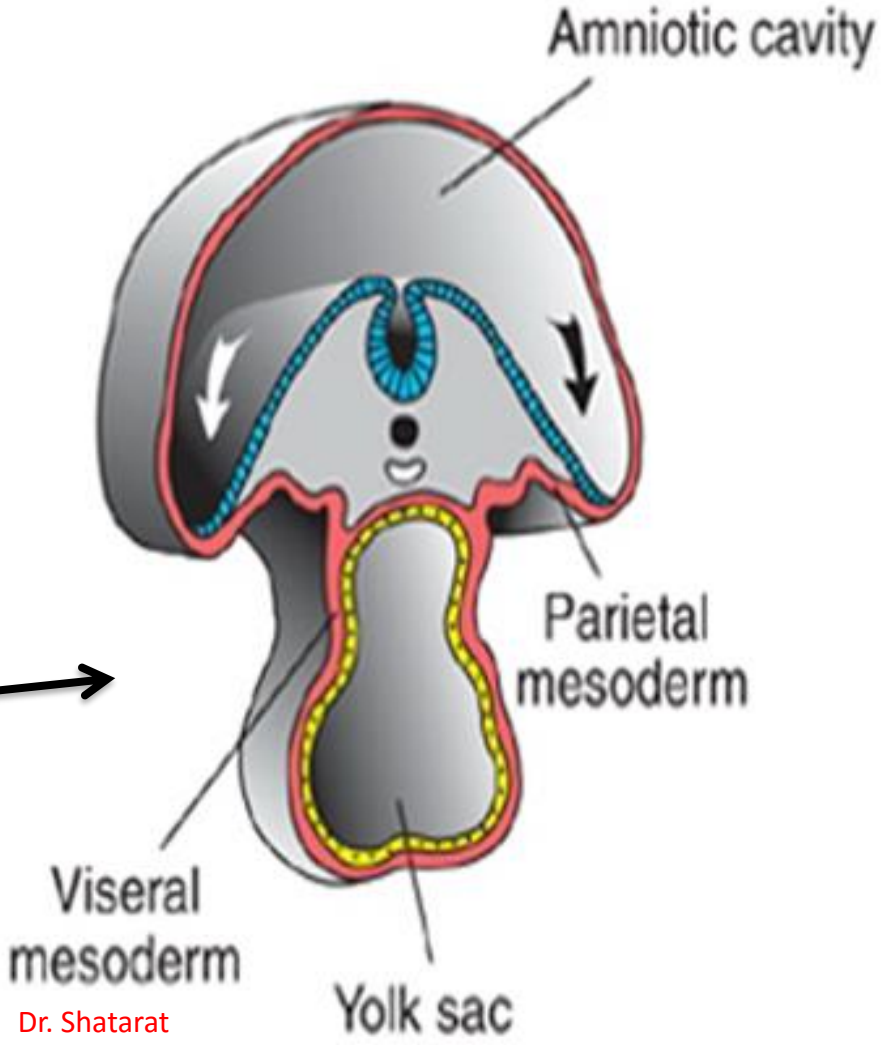


Cranial END

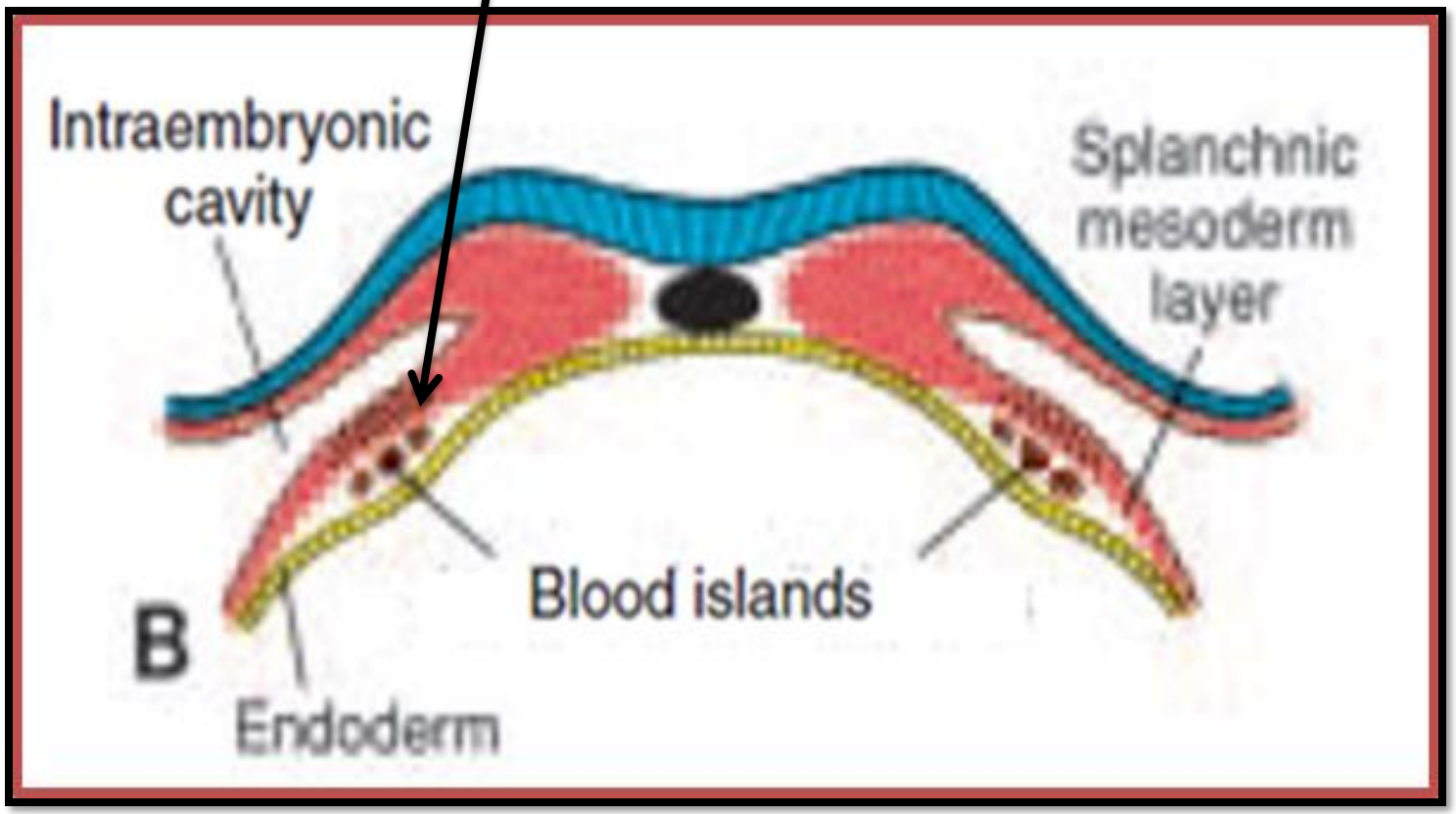
Where do the Cardiac progenitor cells migrate?

into the **splanchnic layer** of the lateral plate mesoderm





into the **splanchnic layer** of the lateral plate mesoderm



The cells from both sides meet cranially to form the

Primary Heart Field (PHF)

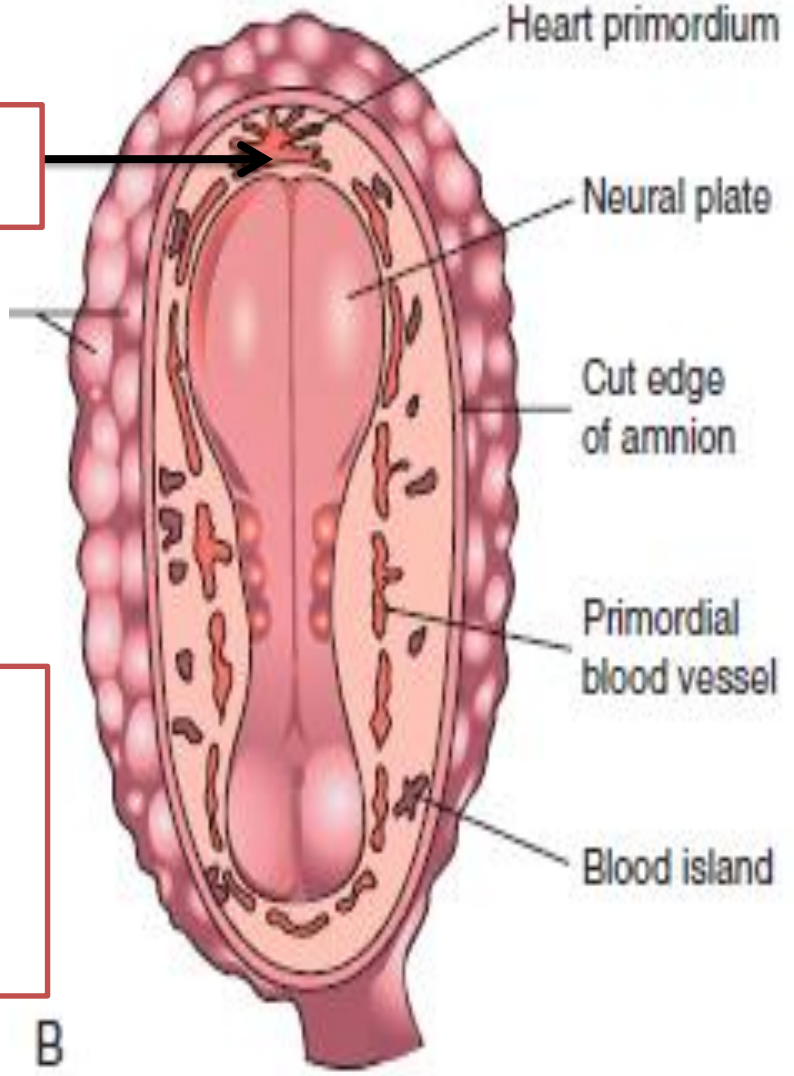
These cells will form :

- The atria
- Left ventricle
- Part of right ventricle

- The remainder of the right ventricle
- outflow tract (conus cordis and truncus arteriosus)

Are derived from the

Secondary Heart Field (SHF)



Formation Of the Heart Tube

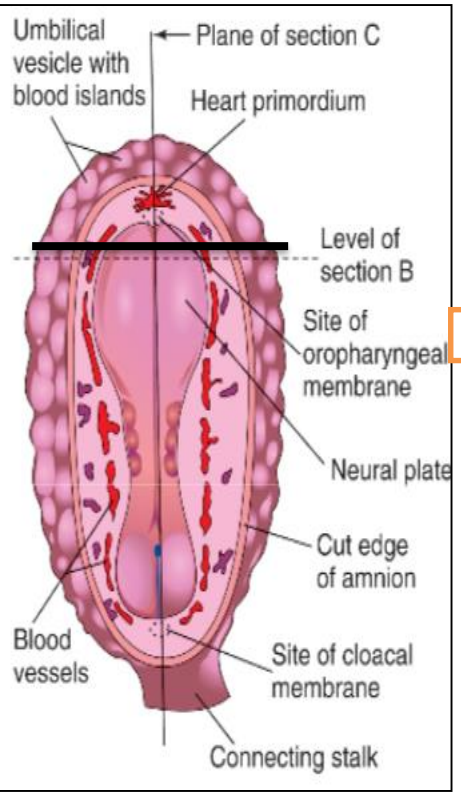
ONE-SOMITE AND TWO-SOMITE STAGES

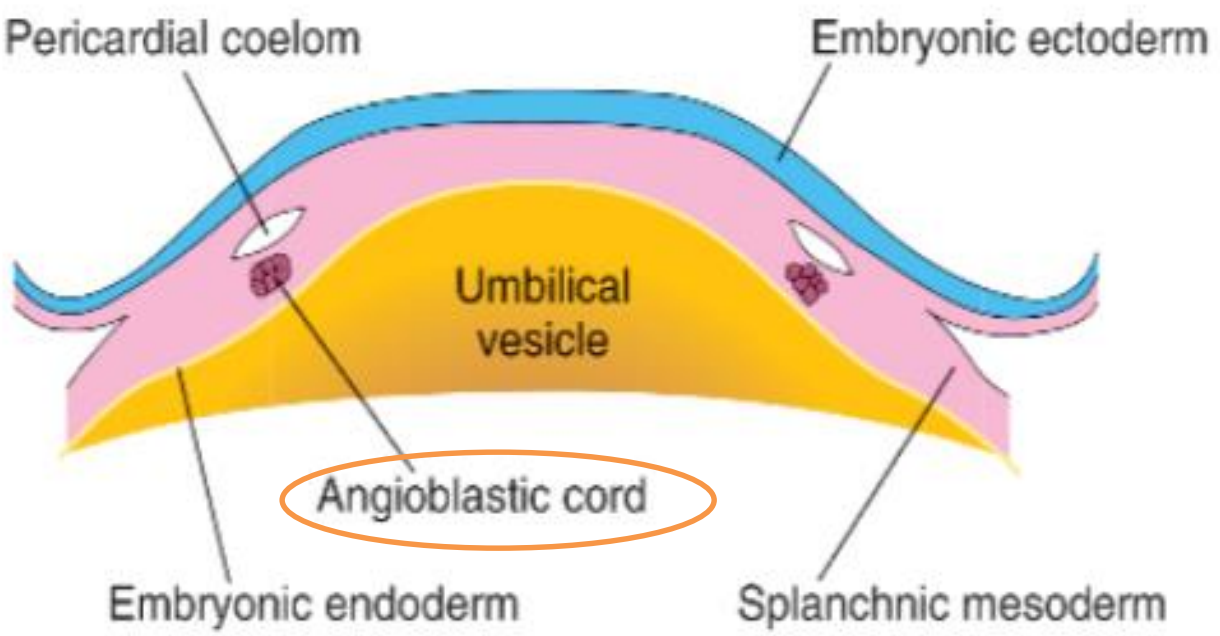
Dr. Shatarat

Paired endothelial strands

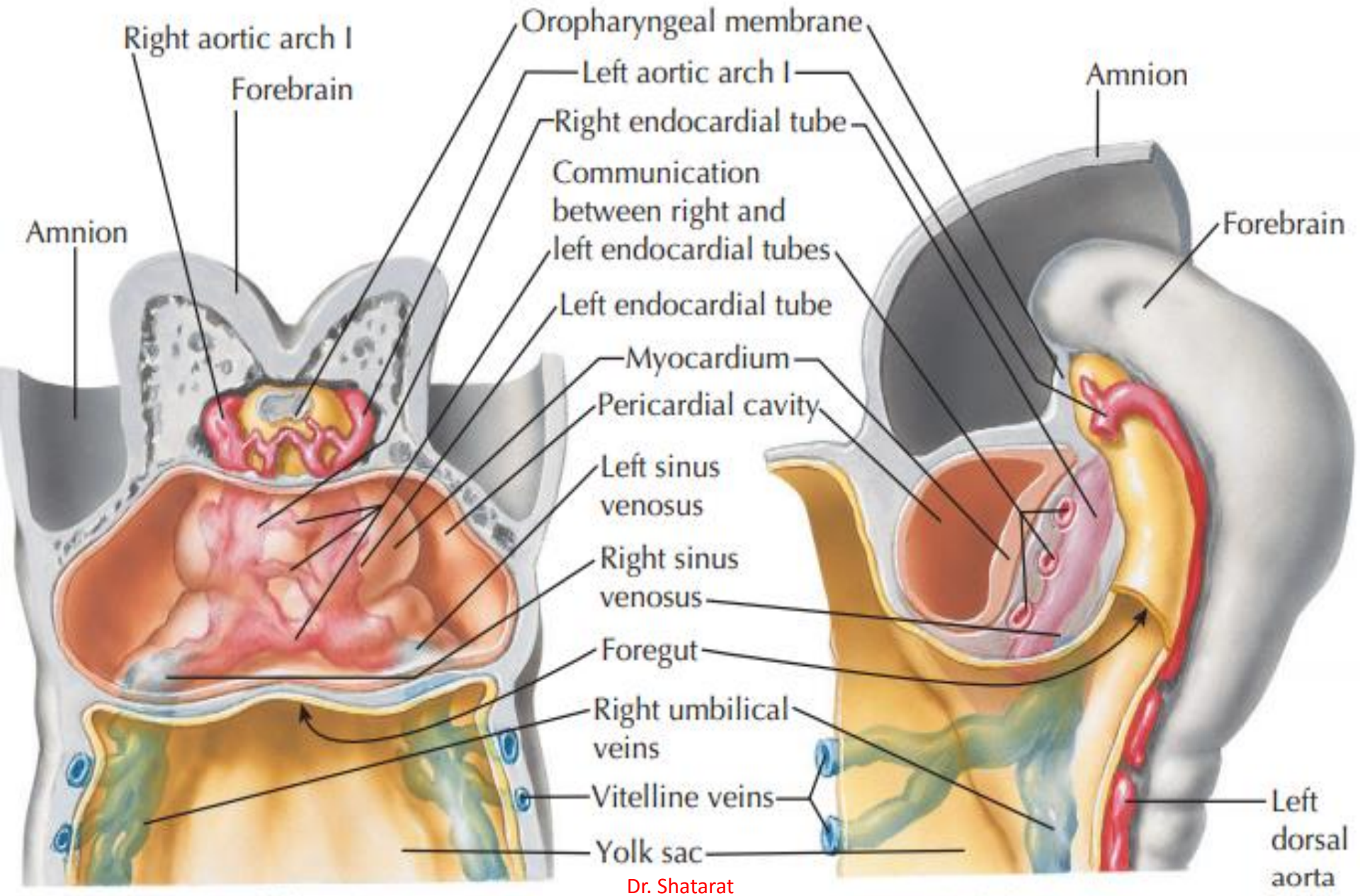
ANGIOBLASTIC CORDS

appear in the cardiogenic mesoderm during the third week of development





Four-somite stage (2.0 mm) at approximately 22 days



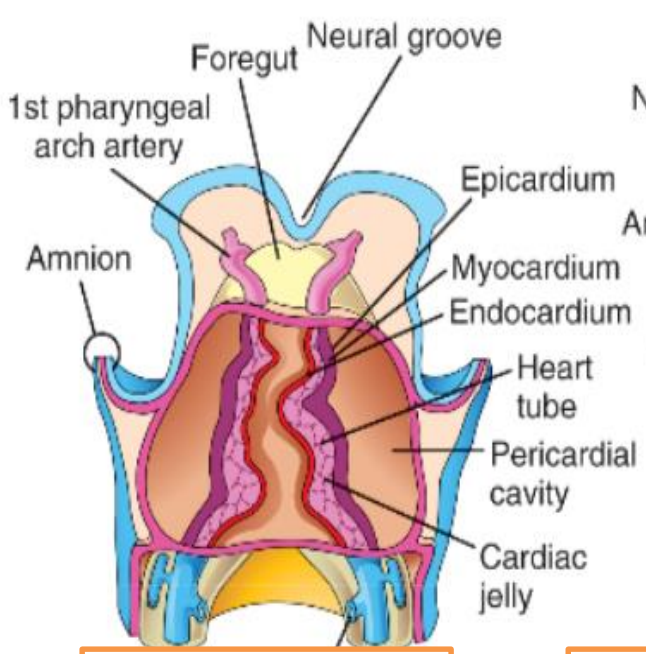
Dr. Shatarat

Ventral dissection **Sagittal dissection**

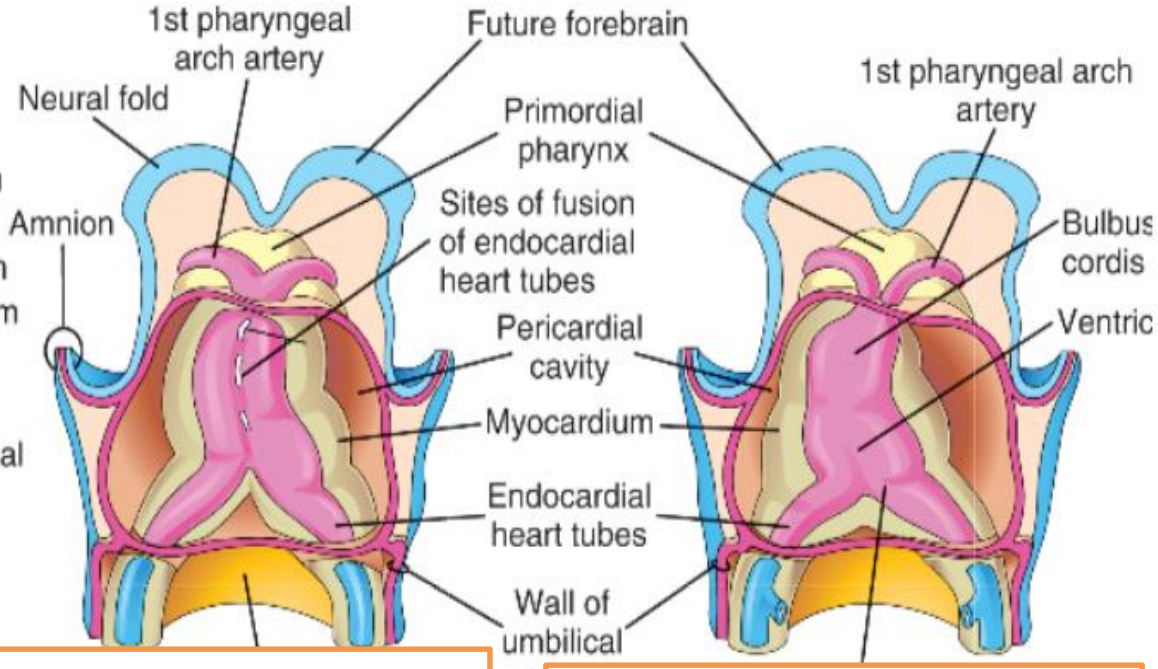
These cords canalize to form two **heart tubes** that soon fuse as embryo

folds laterally

to form a single **heart tube** late in the third week

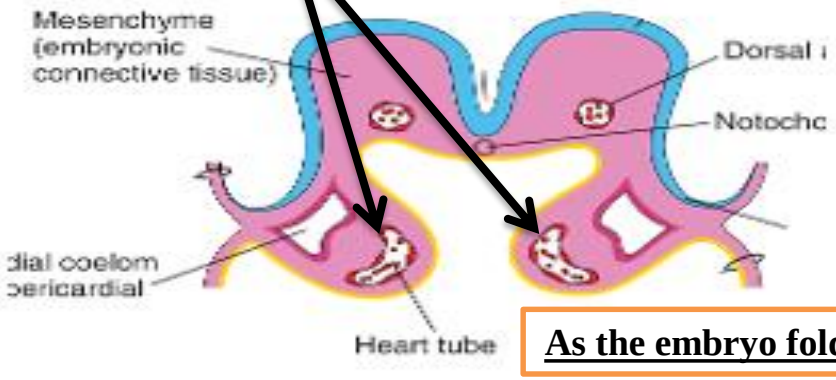


Two hearts tubs

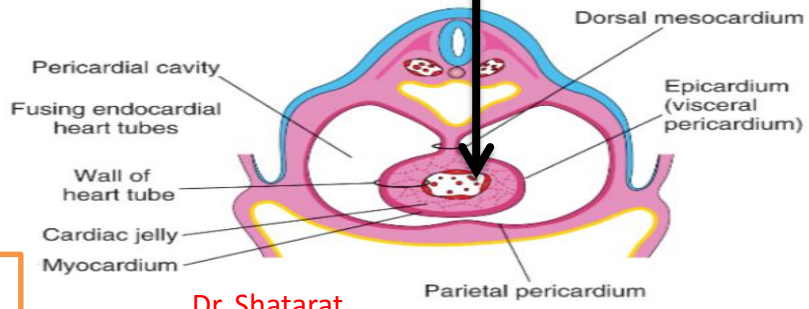


The two tubs are Fused

Single heart tube is formed

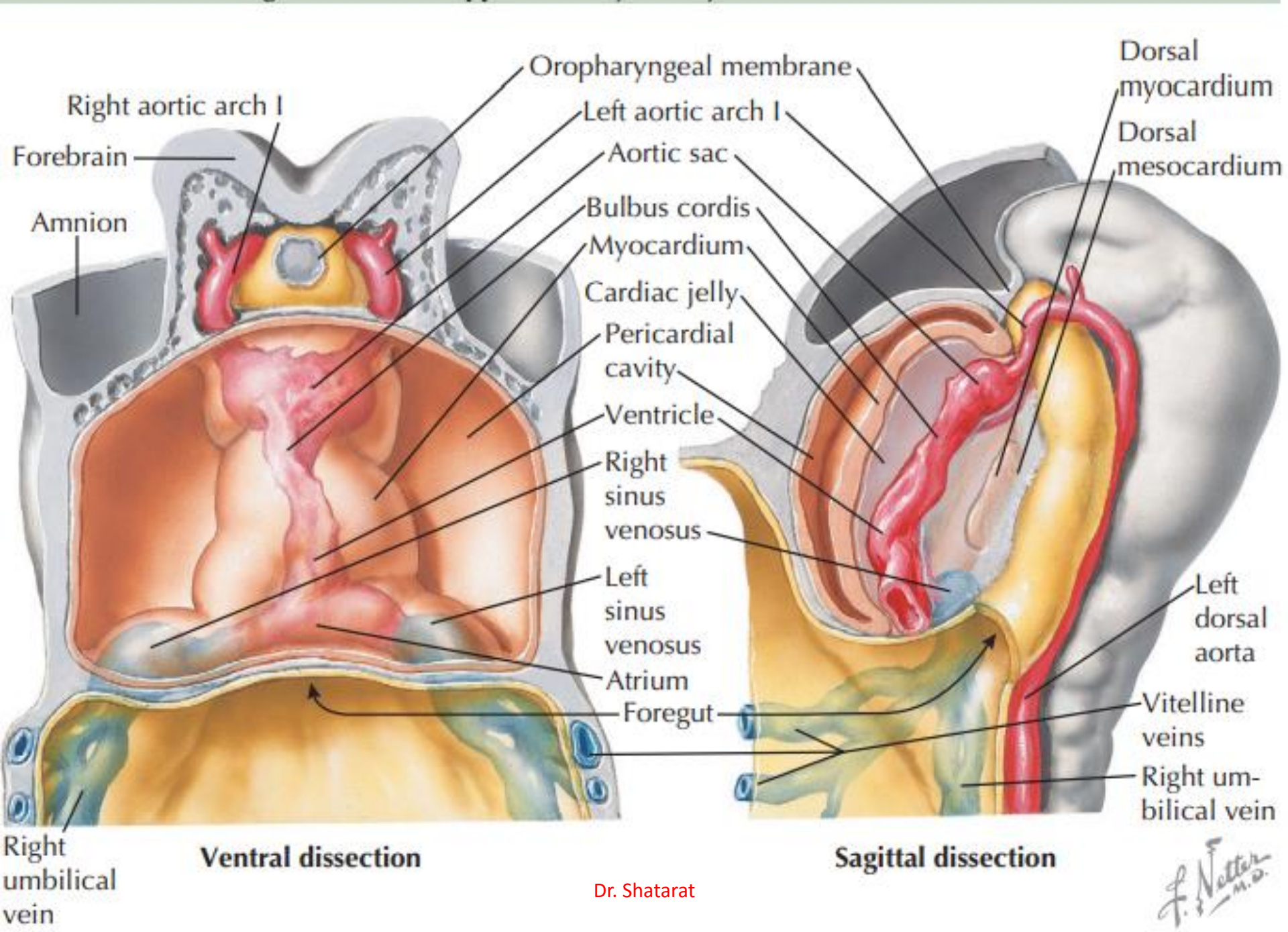


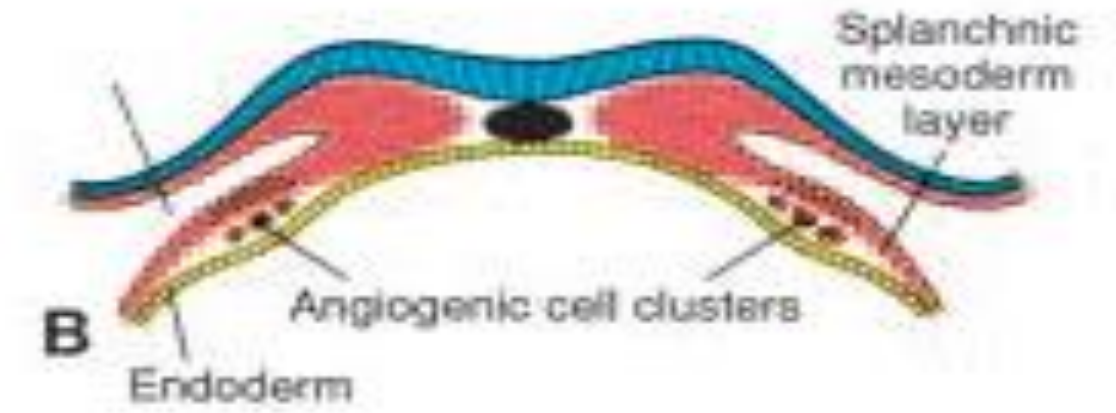
As the embryo folds laterally



Dr. Shatarat

Seven-somite stage (2.2 mm) at approximately 23 days





note

In addition to the cardiogenic region, other blood islands appear bilaterally, parallel and close to the midline of the embryonic shield. These islands form a pair of longitudinal vessels, the **dorsal aortae.**

Formation of the cardiac loop

What we have by now

The heart is essentially

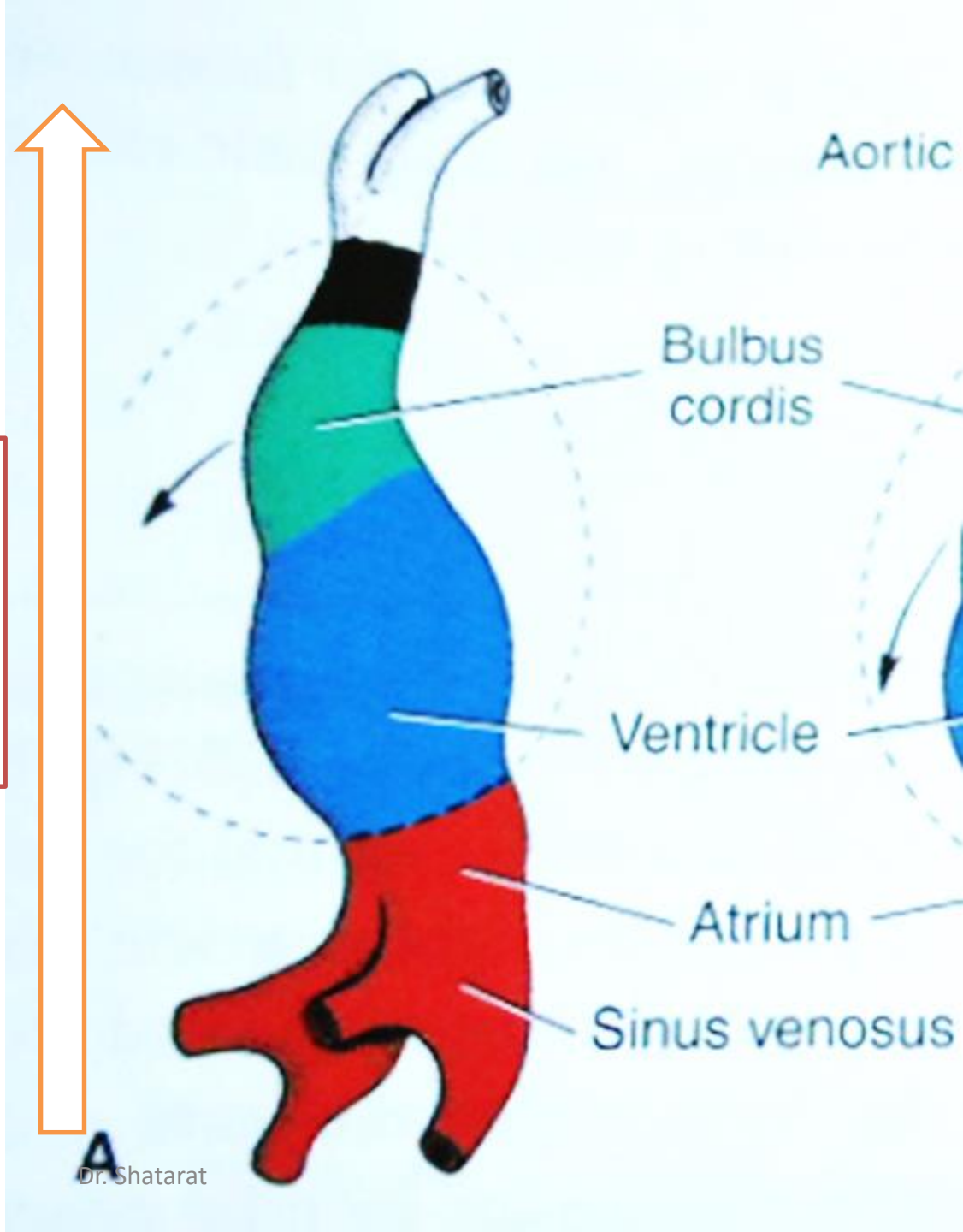
- a straight tube with **a caudal venosus end and cranial arterial end**
- *It lies within the pericardial cavity*
- *is attached posteriorly only by the dorsal mesocardium*

The embryo now
is about 2.2 mm long
is approximately 23 days old
begins to beat

About 3 days have elapsed between the appearance of intraembryonic vasculogenesis and the formation of the **endocardial tube**

Differential growth defines five segments of the heart tube: (from caudal to cephalic or according to direction of blood flow)

1- Sinus venosus
2- Primitive atrium.
3- primitive ventricle.
4- Bulbus cordis (conus).
5- truncus arteriosus.



The arterial end of the heart is fixed by the pharyngeal arches

Remember that at this stage of development

The venous end of the heart is fixed by the septum transversum

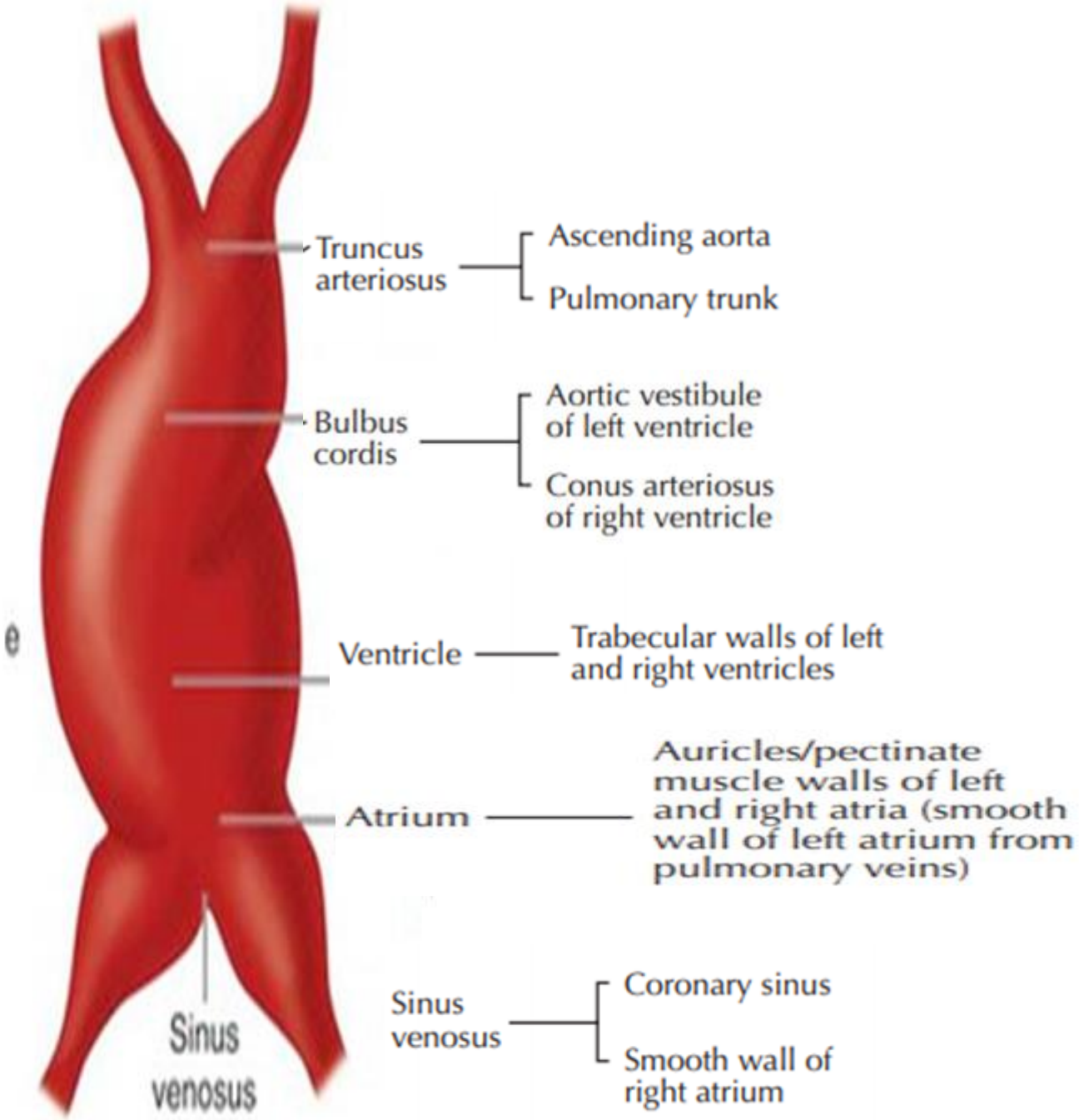

Truncus arteriosus
Ascending aorta
Pulmonary trunk
Bulbus cordis
Aortic vestibule of left ventricle
Conus arteriosus of right ventricle
Ventricle
Trabecular walls of left and right ventricles
Atrium
Auricles/pectinate muscle walls of left and right atria (smooth wall of left atrium from pulmonary veins)
Sinus venosus
Coronary sinus
Smooth wall of right atrium
Sinus venosus

Table III-2-1. Adult Structures Derived From the Dilatations of the Primitive Heart

Embryonic Dilatation	Adult Structure
Truncus arteriosus (neural crest)	Aorta; Pulmonary trunk; Semilunar values
Bulbus cordis	Smooth part of right ventricle **(conus arteriosus)** Smooth part of left ventricle **(aortic vestibule)**
Primitive ventricle	Trabeculated part of right ventricle Trabeculated part of left ventricle
Primitive atrium*	Trabeculated part of right atrium (pectinate muscles) Trabeculated part of left atrium (pectinate muscles)
Sinus venosus (the only dilation that does not become subdivided by a septum)	Right—Smooth part of right atrium **(sinus venarum)** Left—Coronary sinus and oblique vein of left atrium

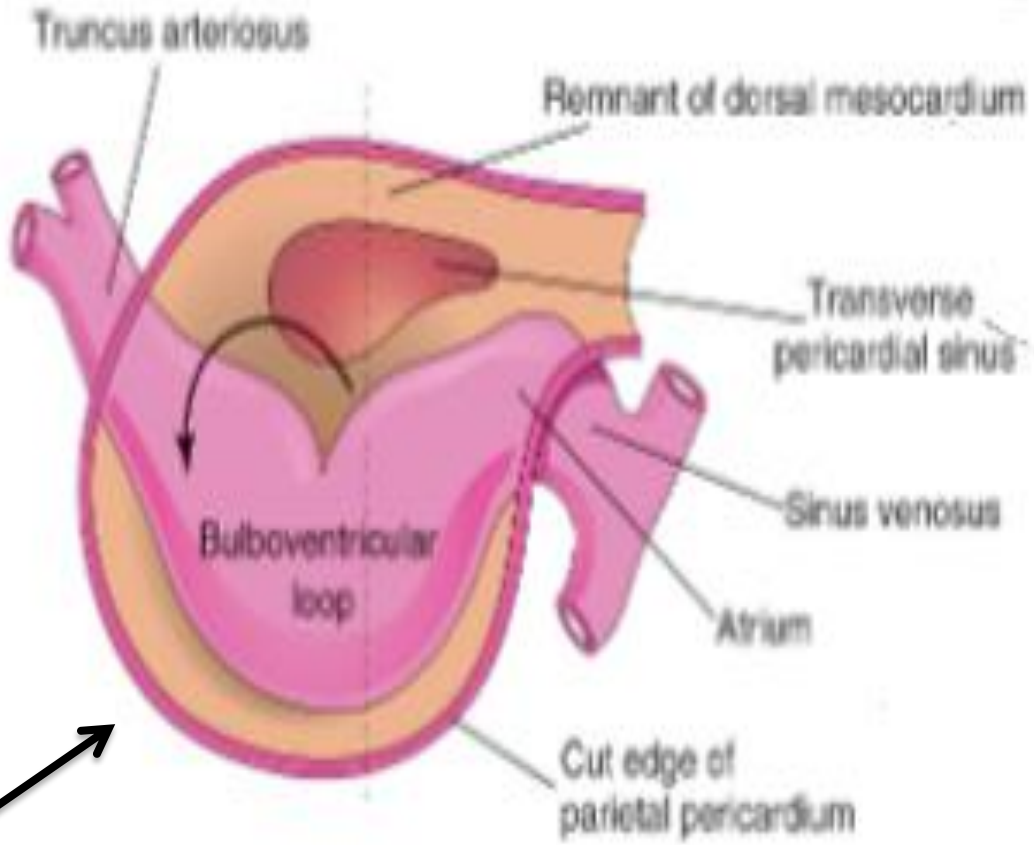
*The **smooth-walled part** of the **left atrium** is formed by incorporation of parts of the **pulmonary veins** into its wall. The **smooth-walled part** of the **right atrium** is formed by the incorporation of the **right sinus venosus**.

The part of the tube lying within the pericardial cavity is made up of bulbus cordis and ventricle

Because the **bulbus cordis** and **ventricle** grow **faster** than the other regions

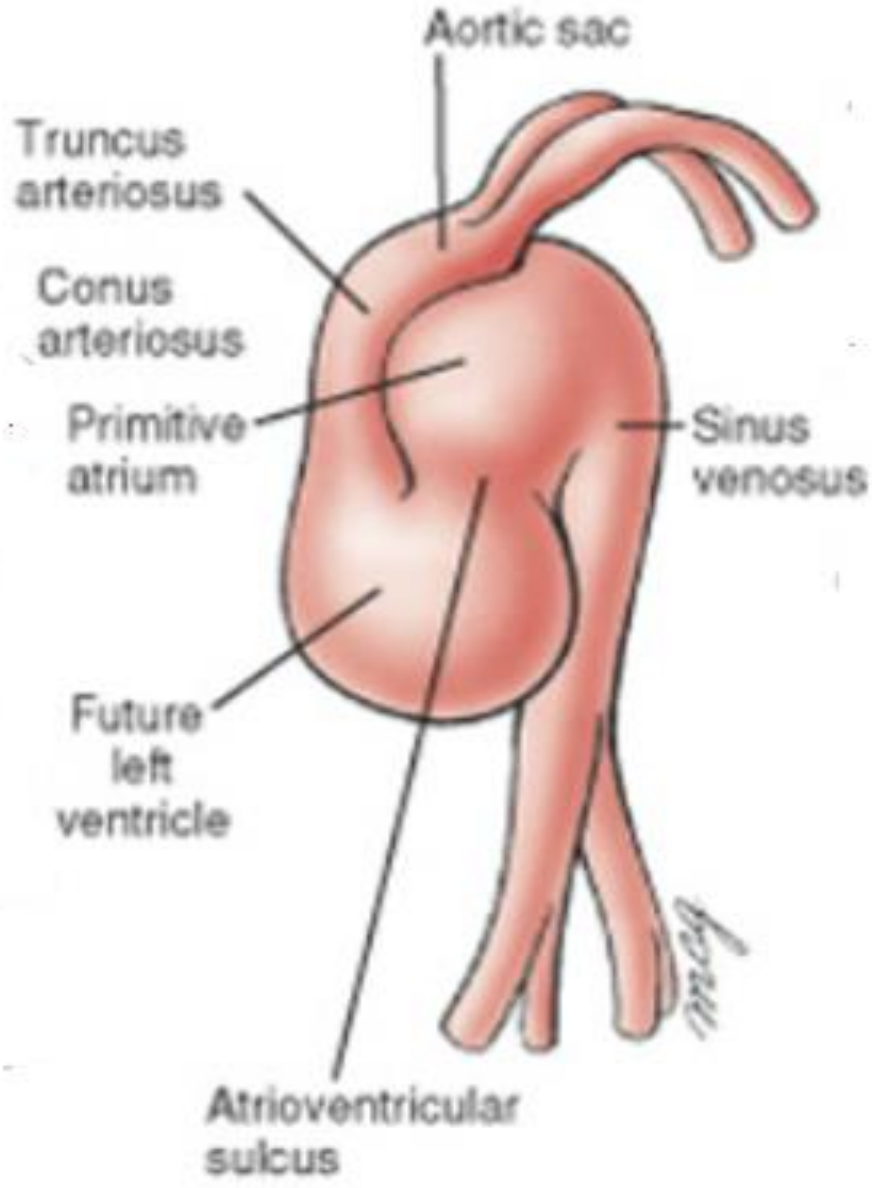
the heart bends on itself (usually bends to the right, thus the proximal bulbus cordis (RV) lying anterior and to the right of the primitive ventricle) forming

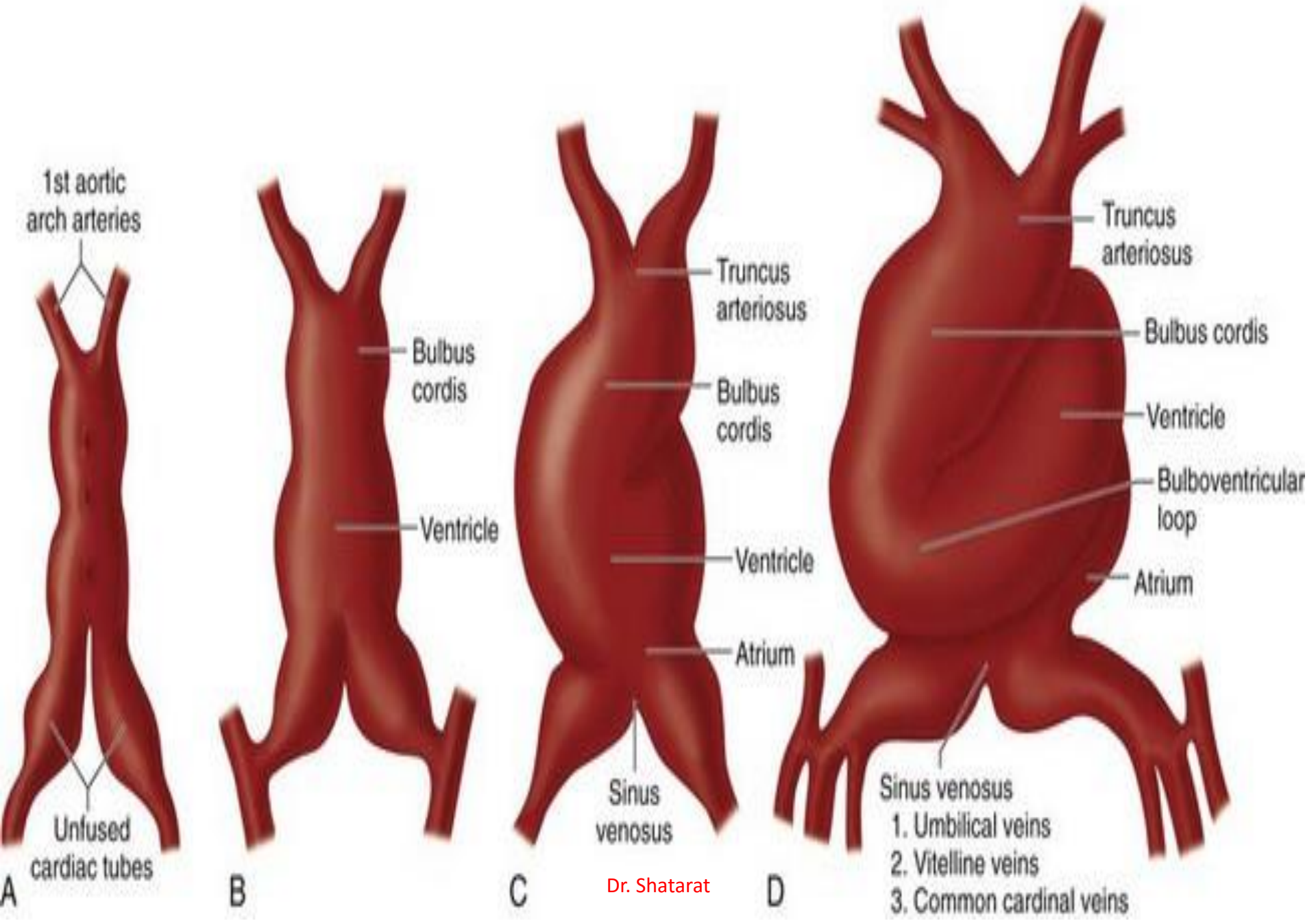
a U-shaped **bulboventricular loop**



As the atrium and sinus venosus are freed from **the septum transverum** they come to lie behind and above the ventricle and the heart tube is now

S-shaped

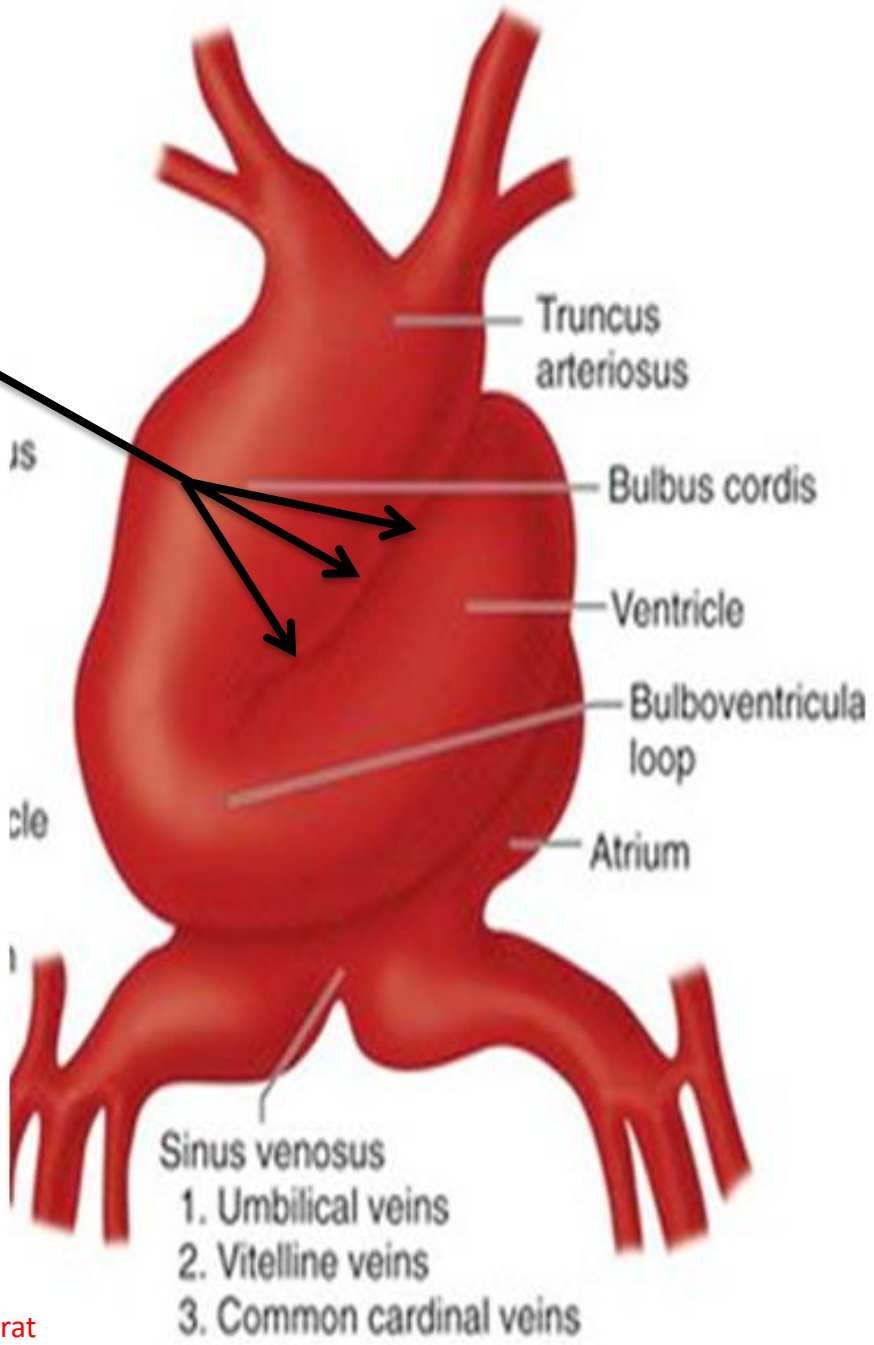



1st aortic arch arteries
Unfused cardiac tubes
A
Bulbus cordis
Ventricle
B
Truncus arteriosus
Bulbus cordis
Ventricle
Atrium
Sinus venosus
C
Truncus arteriosus
Bulbus cordis
Ventricle
Bulboventricular loop
Atrium
Sinus venosus
1. Umbilical veins
2. Vitelline veins
3. Common cardinal veins
D

At this stage

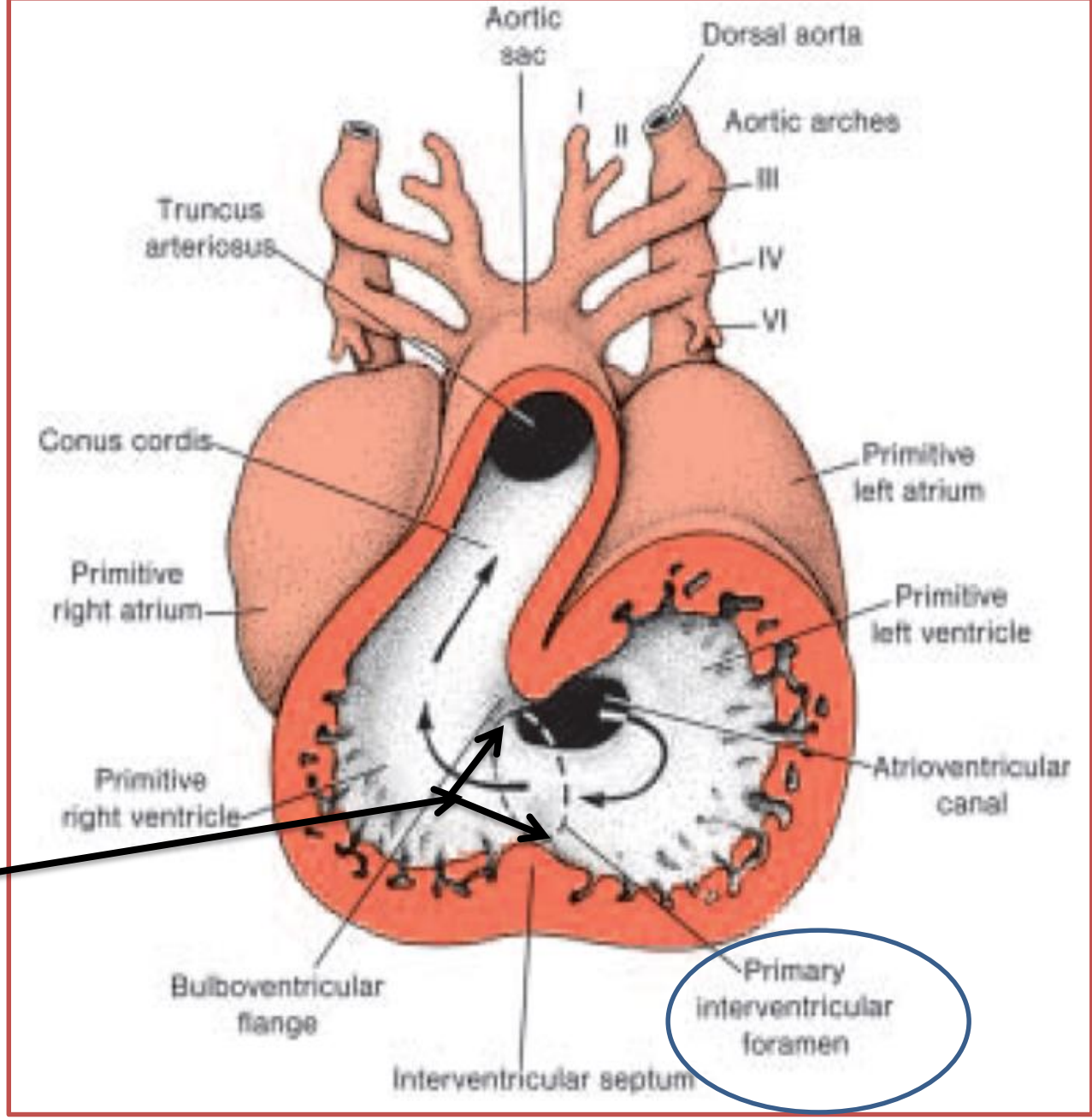
The embryo is now about 3.2 mm long and approximately 25 days old, and it possesses 20 somites

- At this stage the bulbus cordis and ventricle are separated by a deep bulbo-ventricular sulcus.

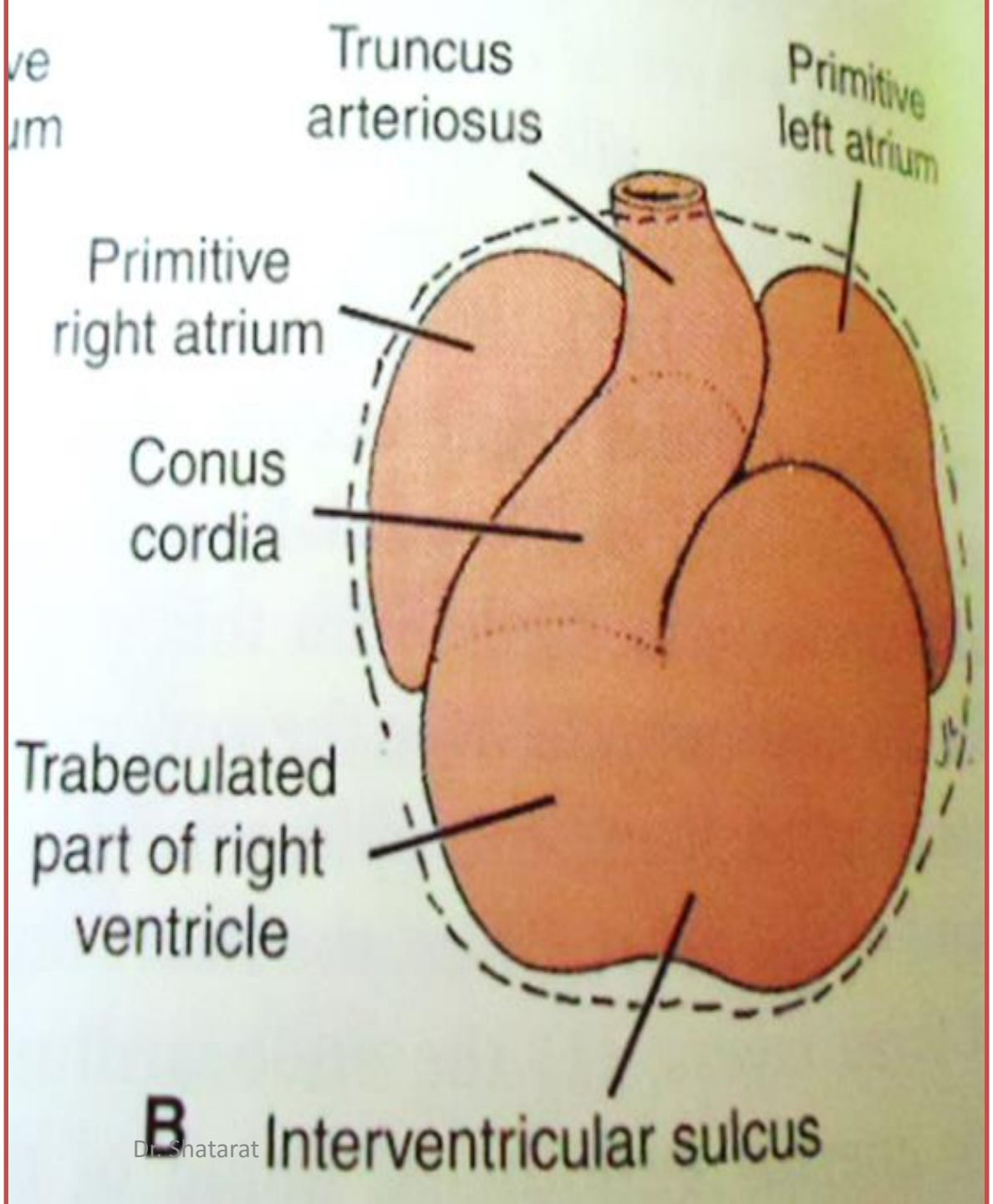


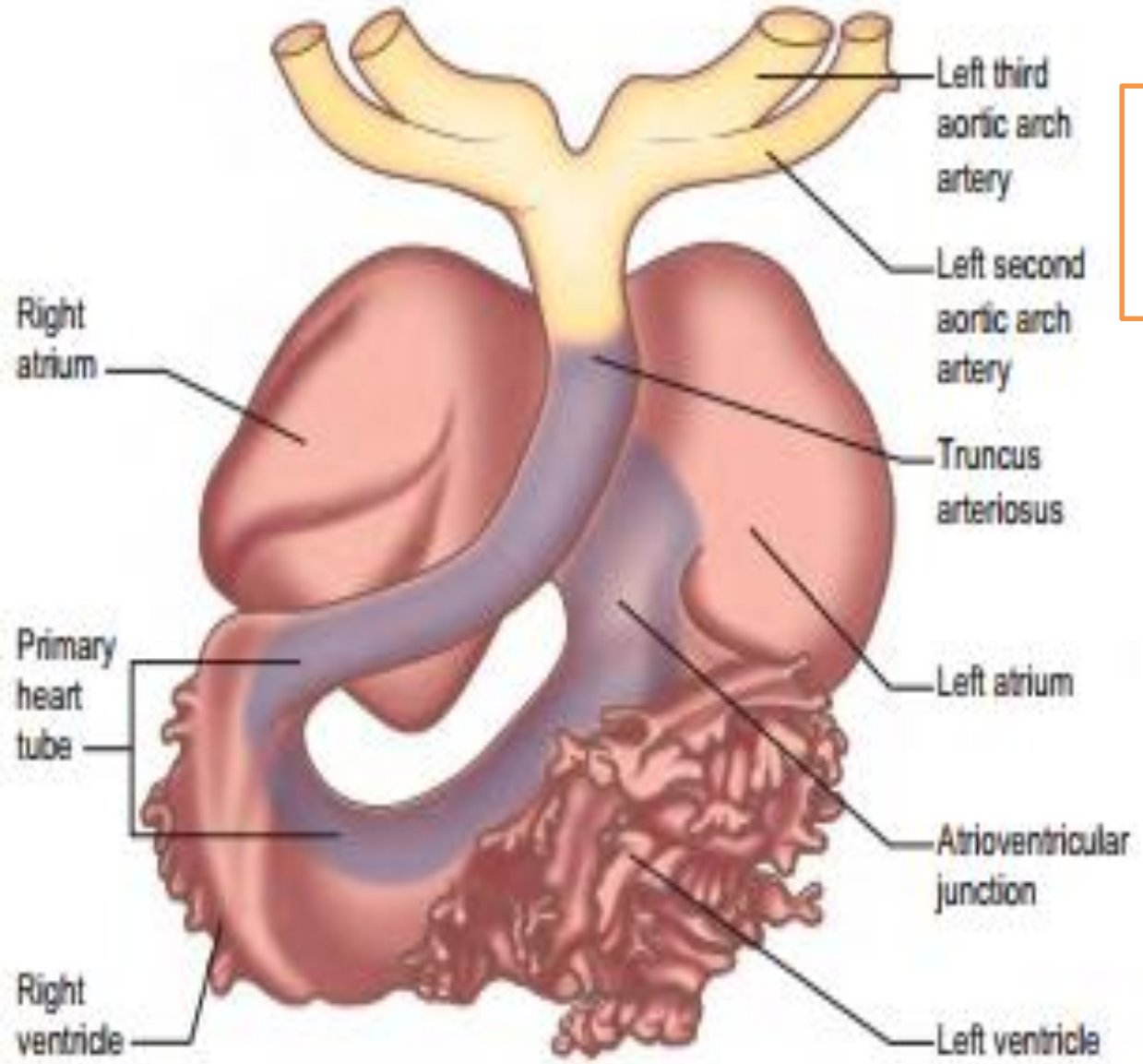
- This sulcus gradually becomes shallower so that the bulbus cordis and the ventricle come to form **one chamber** which communicates with the truncus arteriosus.

The **primary interventricular foramen**



- The atrial chamber expands so that parts of it come to project forwards on either side of the truncus

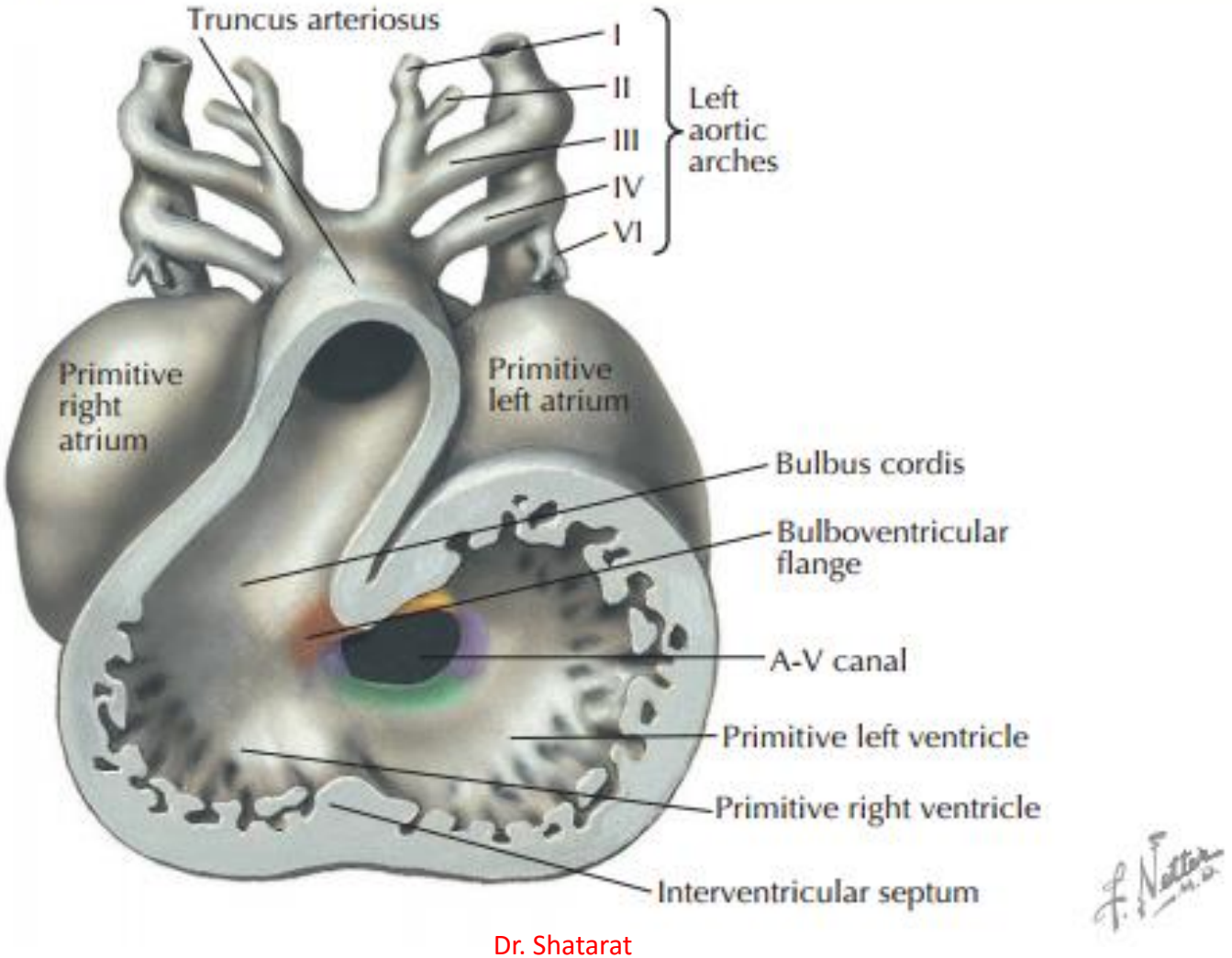




The atrial chamber expands so that parts of it come to project forwards on either side of the truncus

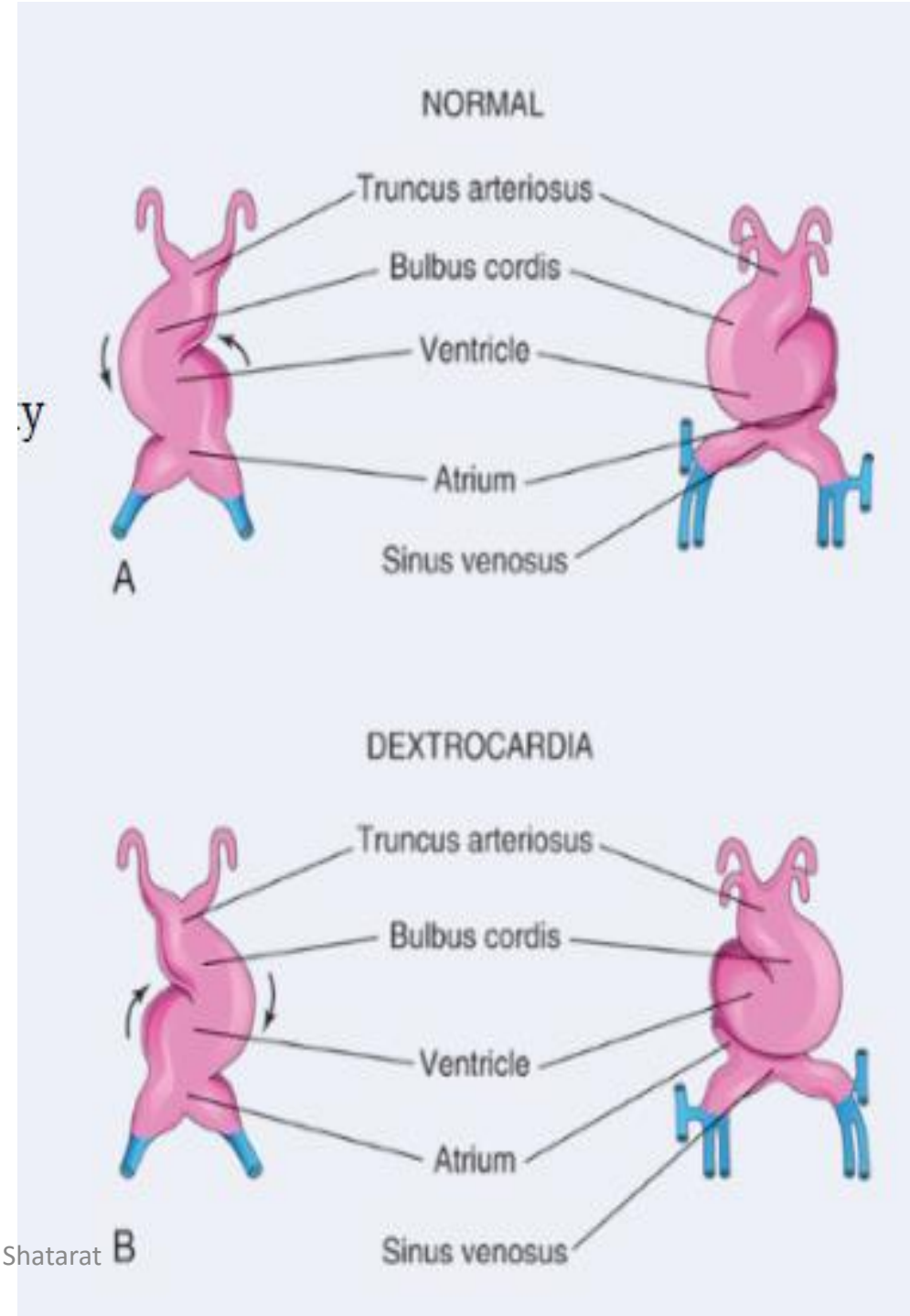
As a result of these changes the exterior of the heart assumes its definitive shape

4 to 5 mm (approximately 27 days)

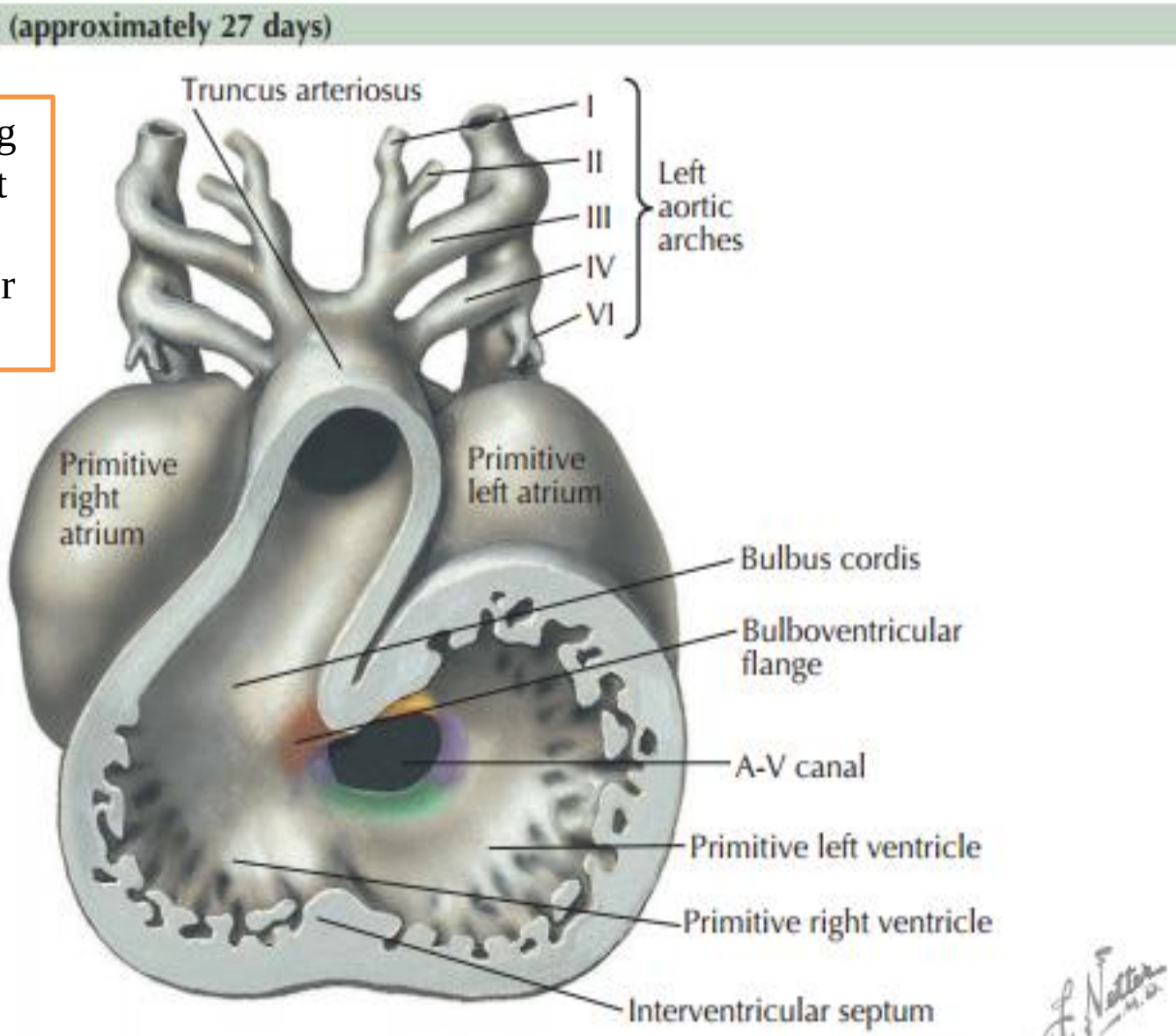


Abnormalities of Cardiac Looping

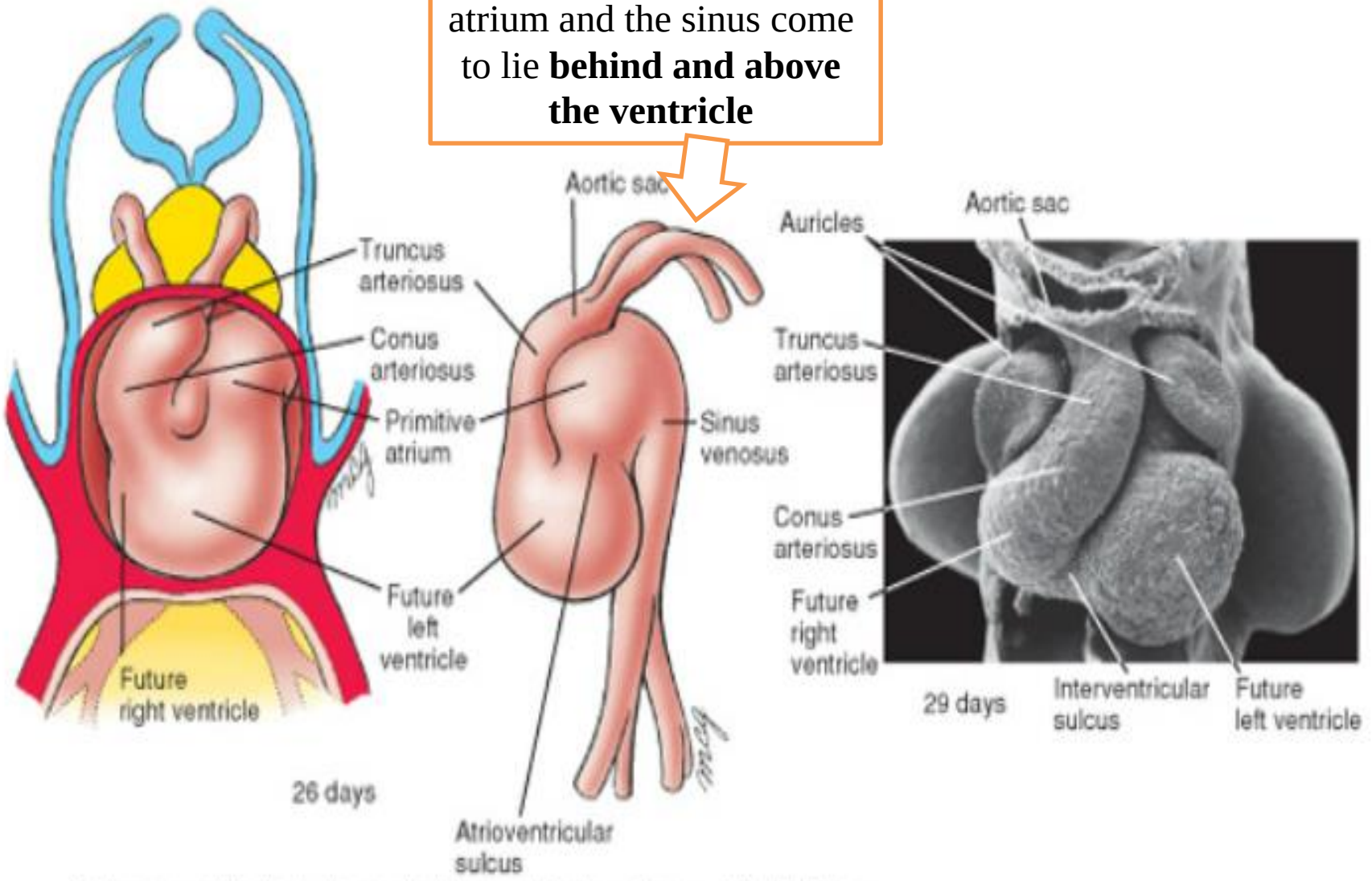
Dextrocardia, in which the heart lies on the right side of the thorax instead of the left,
is caused because the heart loops to the left instead of the right.
Dextrocardia may coincide with situs inversus, a complete reversal of asymmetry in all organs. Situs inversus, which occurs in 1/7000 individuals, usually is associated with normal physiology, although there is a slight risk of heart defects. In other cases sidedness is random, such that some organs are reversed and others are not



At the end of the looping and rotation of the heart tube the arterial and venous ends come closer together



It should be noted that the atrium and the sinus come to lie **behind and above the ventricle**



From the venous end

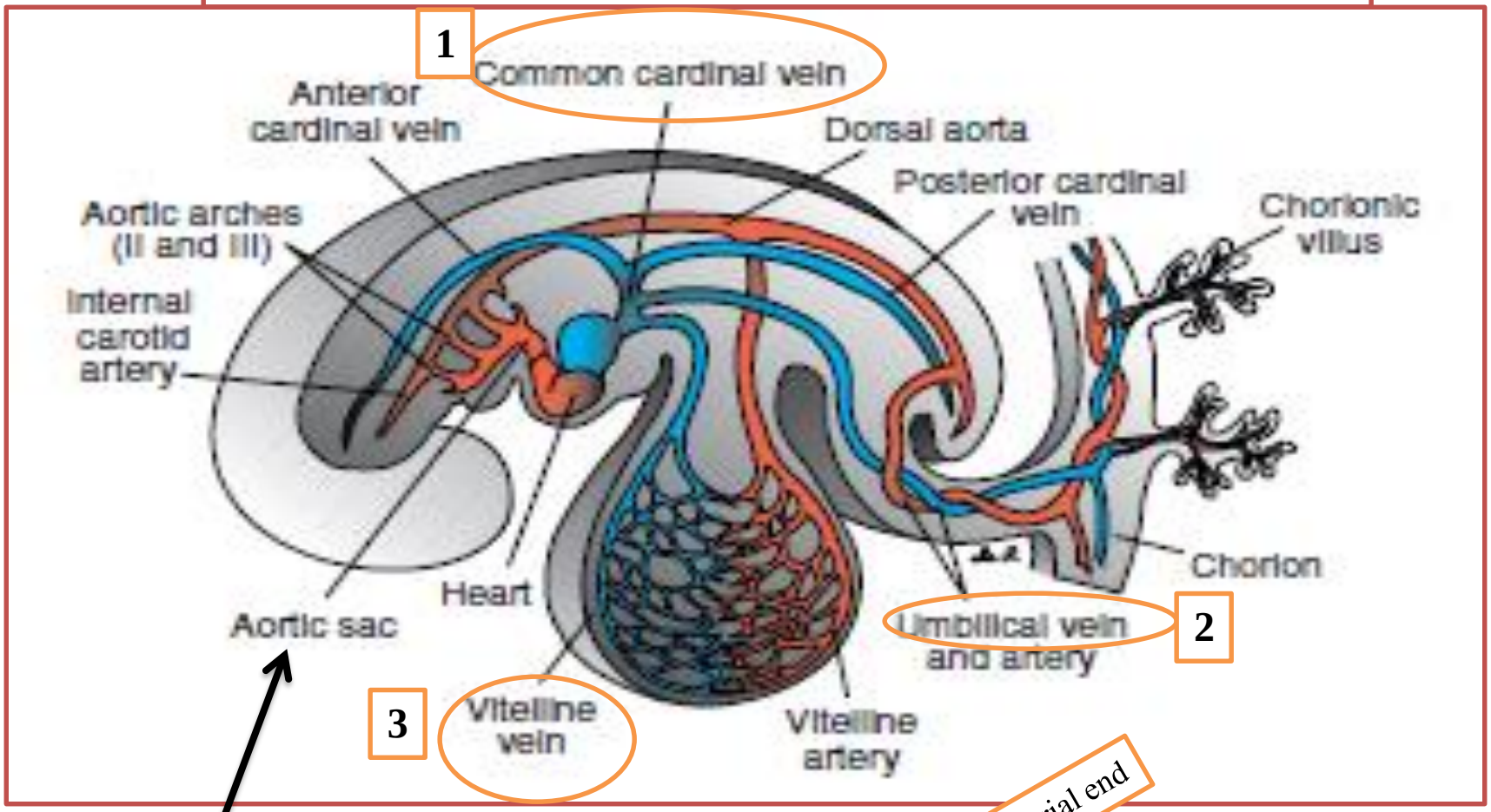
The sinus venosus represent the venous end of the heart

It receives 3 veins:

1- Common cardinal vein → body wall

2- Umbilical vein → from placenta

3- Vitelline vein → from yolk sac



The tubular truncus arteriosus (TA) is continuous cranially with the aortic sac

From the arterial end

Dr. Shatarat

Circulation through Primordial Heart

Blood enters the sinus venosus
From: 1-The common cardinal veins
2-The umbilical veins
3-The vitelline veins

Blood enters
The Primordial Atrium

Atrioventricular (AV) Canal

The Primordial Ventricle.

The Bulbus Cordis

Truncus Arteriosus
into the aortic sac, from which it is distributed to the pharyngeal arch arteries the dorsa aortae for distribution to the
embryo
umbilical vesicle
placenta