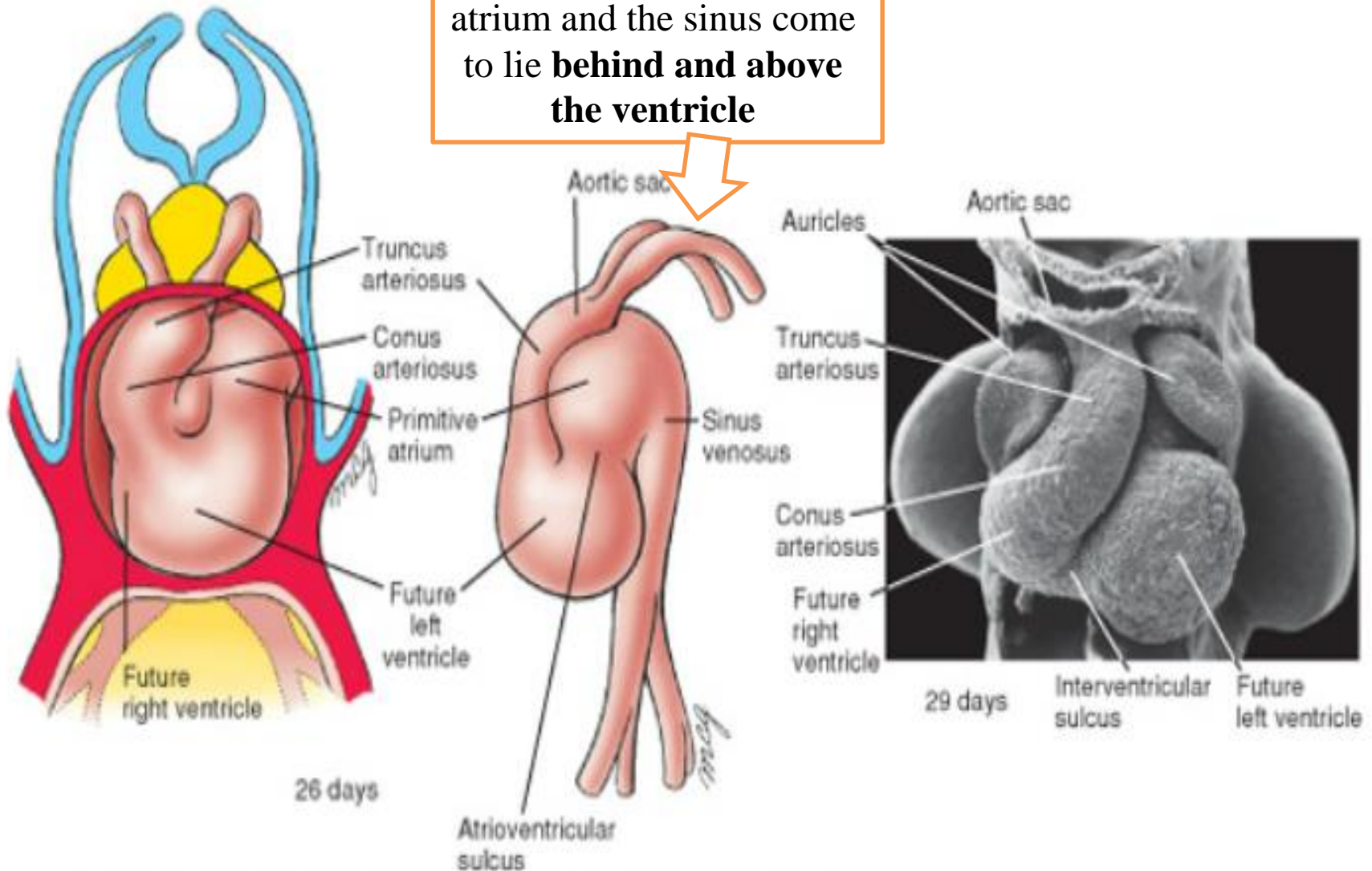


It should be noted that the atrium and the sinus come to lie **behind and above the ventricle**

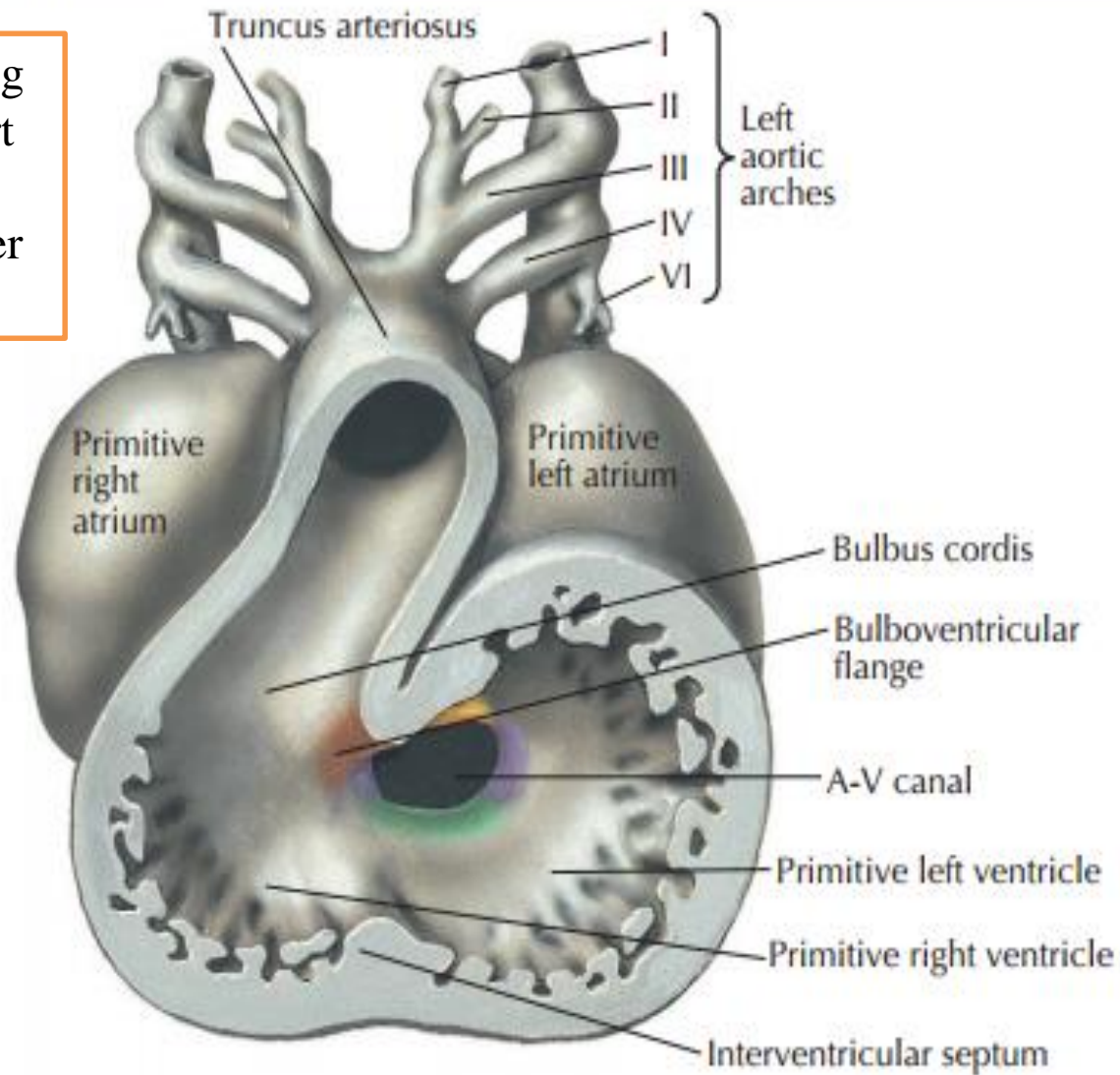


Schoenwolf et al: Larsen's Human Embryology, 4th Edition.

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4 to 5 mm (approximately 27 days)

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



The **stage** is now set for the **septation of the heart**

lasts about 10 days

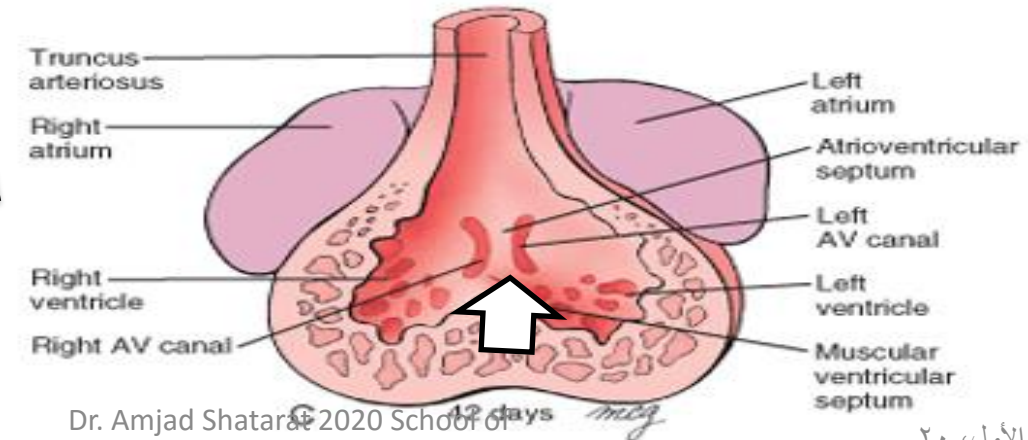
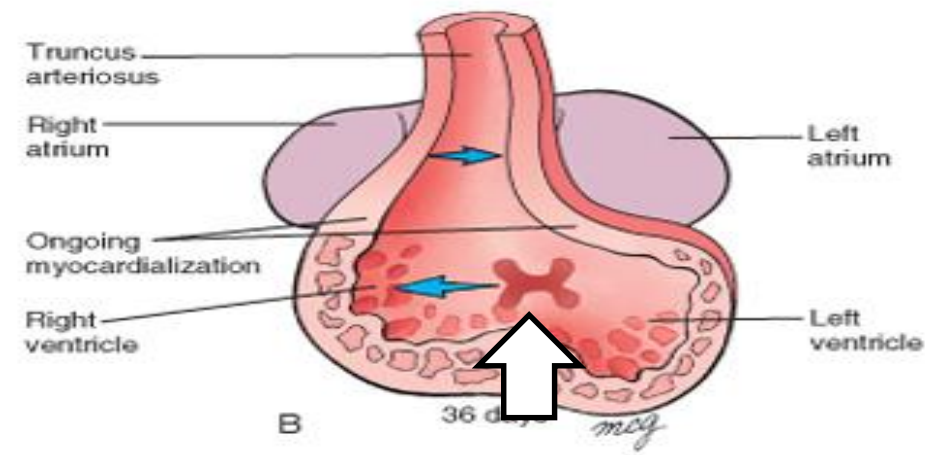
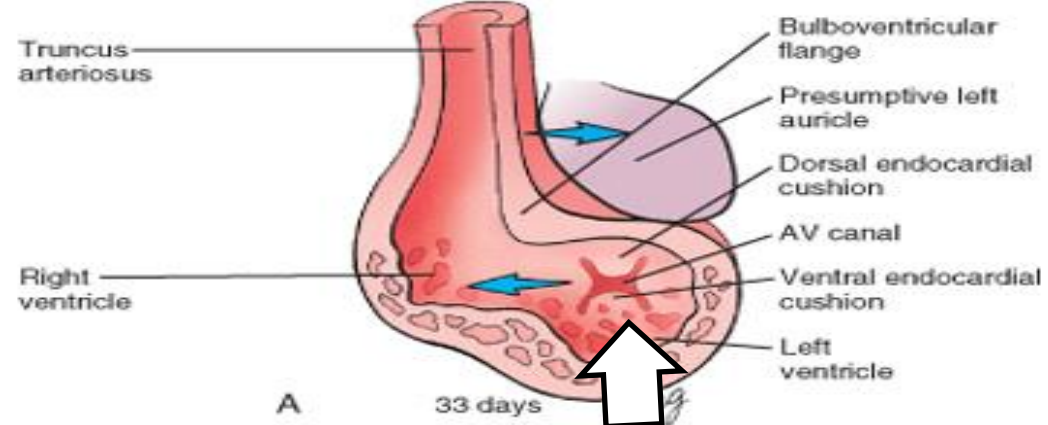
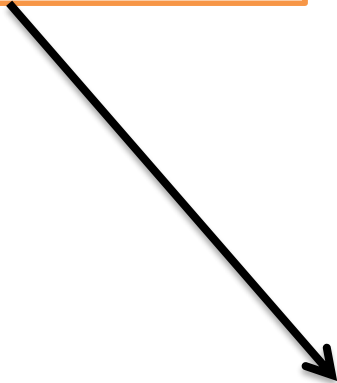
No major changes occur in the external appearance of the heart

The formation of the various cardiac septa
occurs more or less **simultaneously**

Would you please appreciate
The position of the AV canal



*As the heart tube develops,
it eventually pulls the AV
canals and cushion from the
left to the medially as seen
in the illustration below.*



Fate of atrio-ventricular (A-V) canal

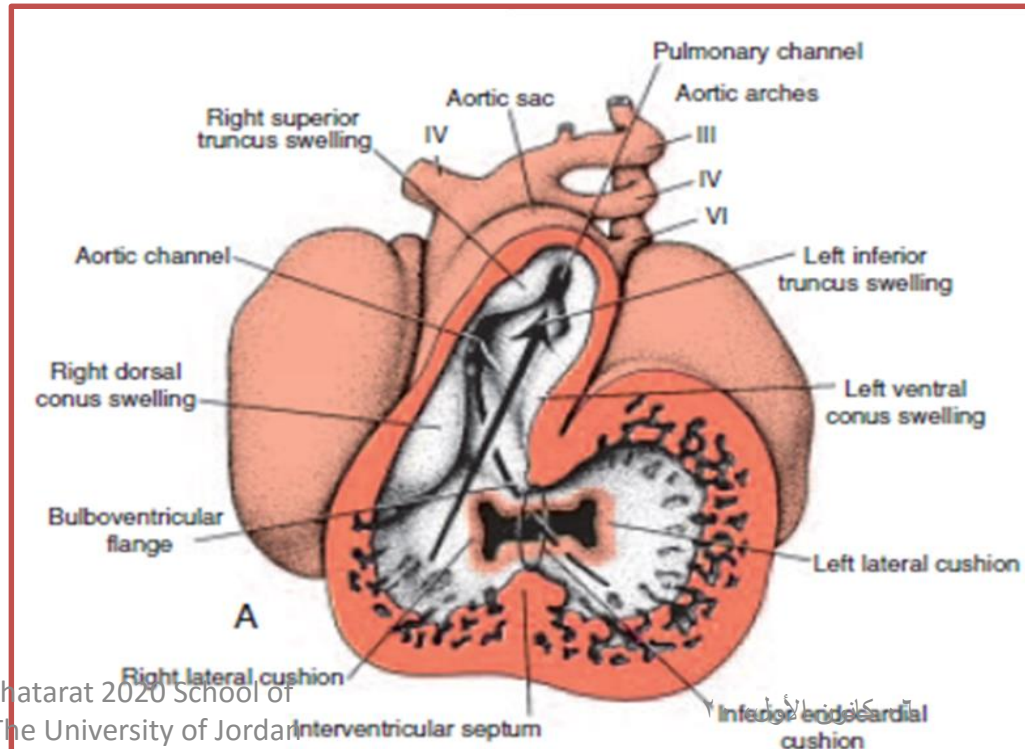
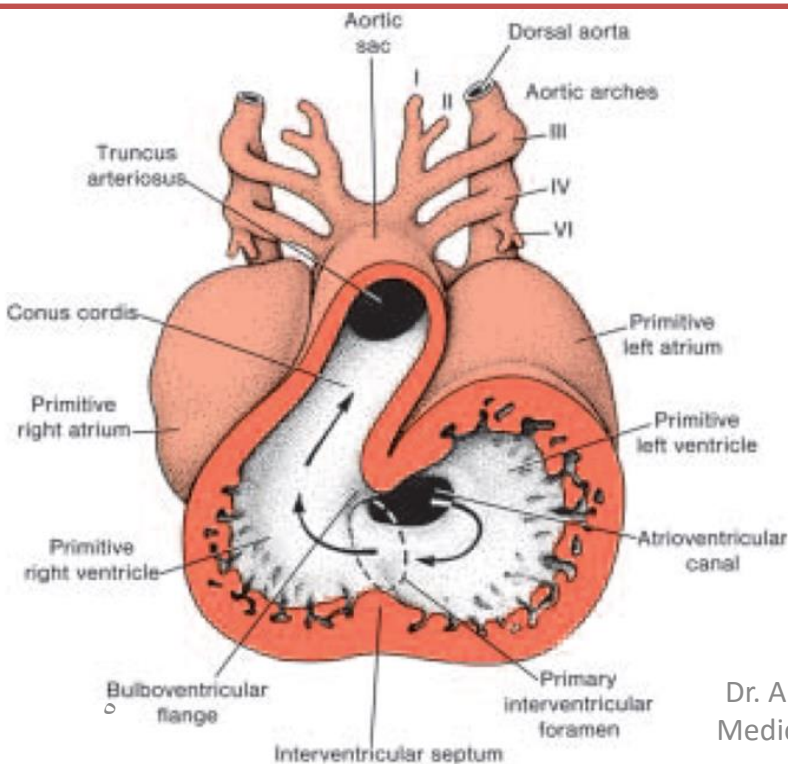
1- First it has a round opening then it becomes transverse.

2- Two thickenings (the atrio-ventricular or endocardial cushions) appear on its dorsal and ventral walls.

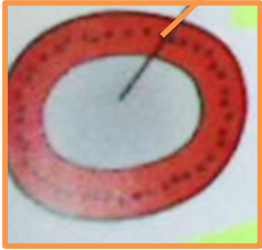
3- They grow towards each other and fuse forming

THE SEPTUM INTERMEDIUM

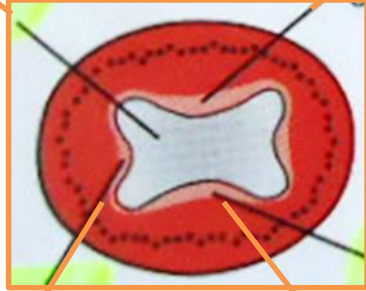
Thus dividing the canal into right and left halves



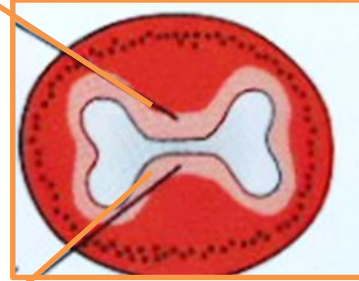
Common atrioventricular canal



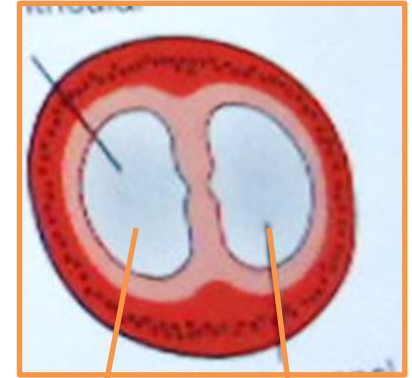
Superior endocardial cushion



Lateral cushion



Inferior endocardial cushion



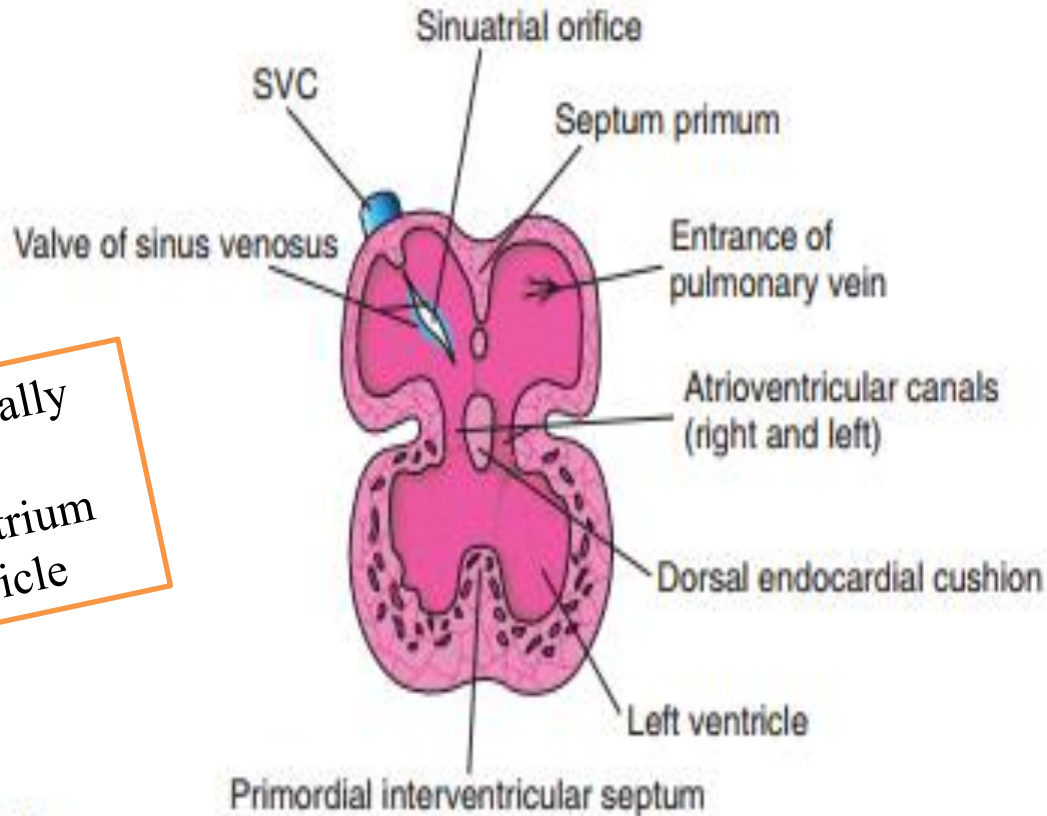
Right and left atrioventricular canals

Round atrio-ventricular canal

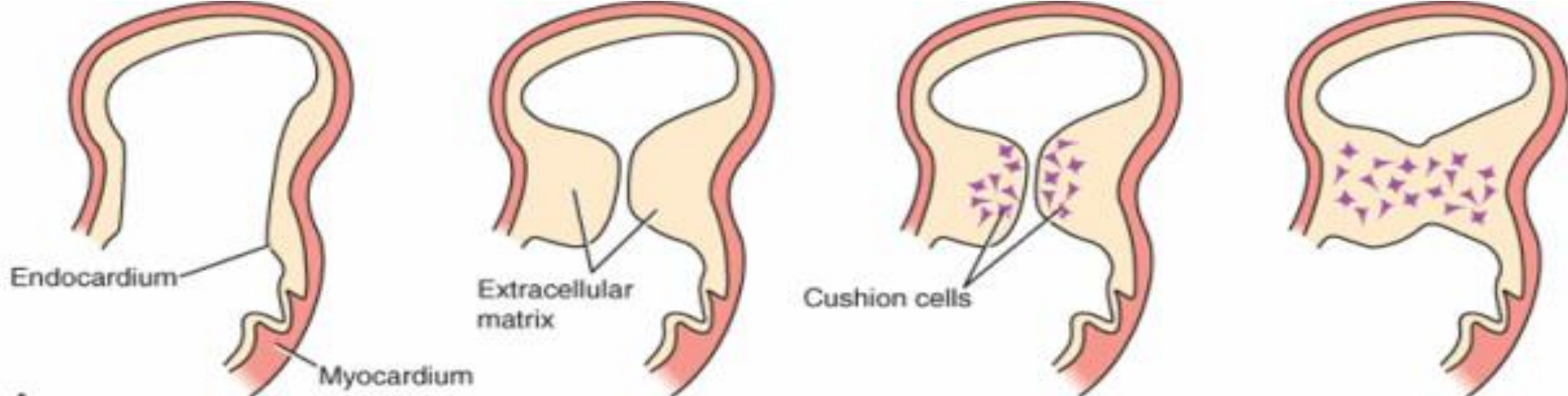
Canal becomes transverse

Dorsal and ventral endocardial cushions

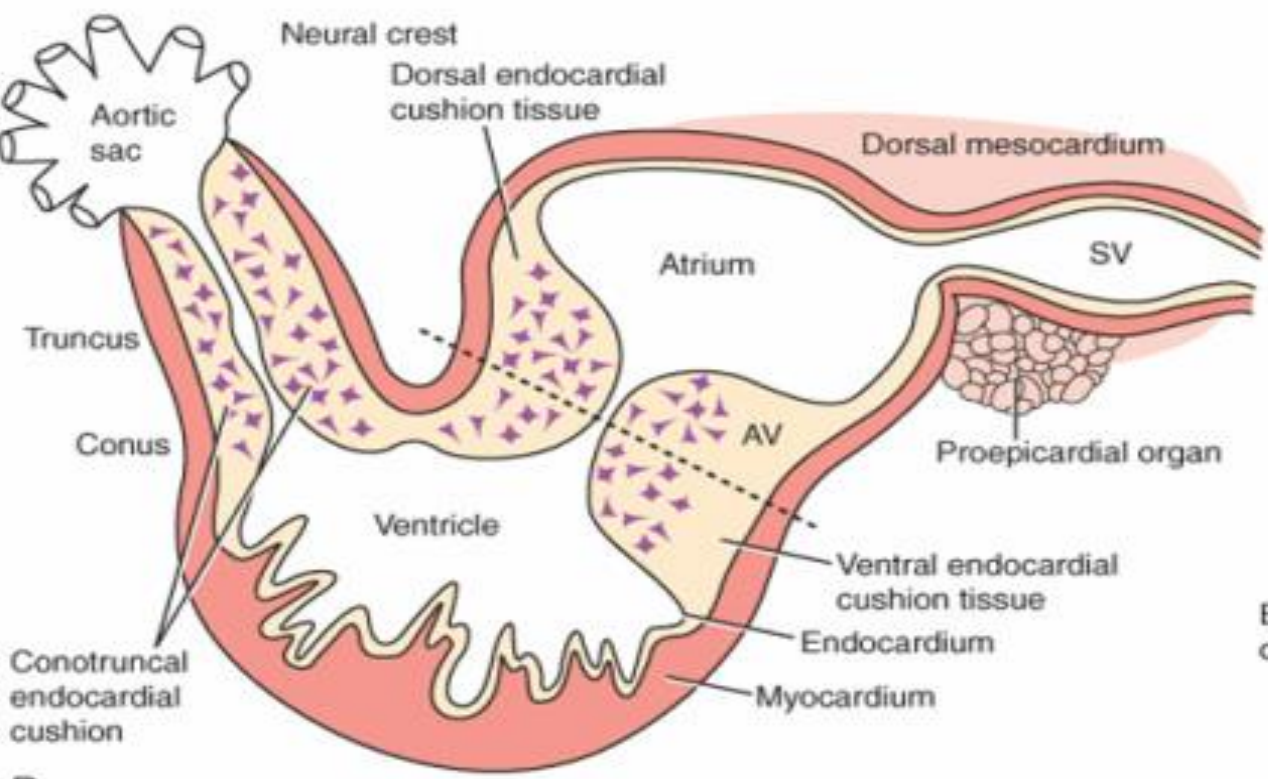
Now we have Right and left atrioventricular canals



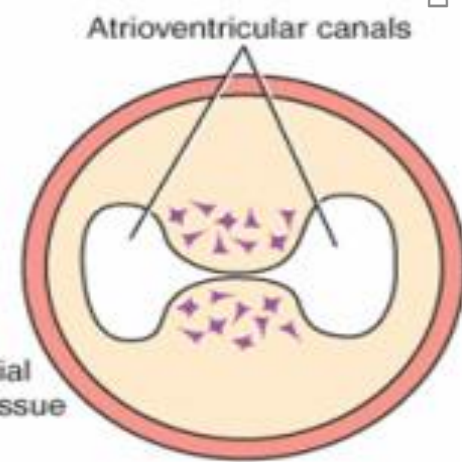
These canals partially separate the primordial atrium from the ventricle



A



B

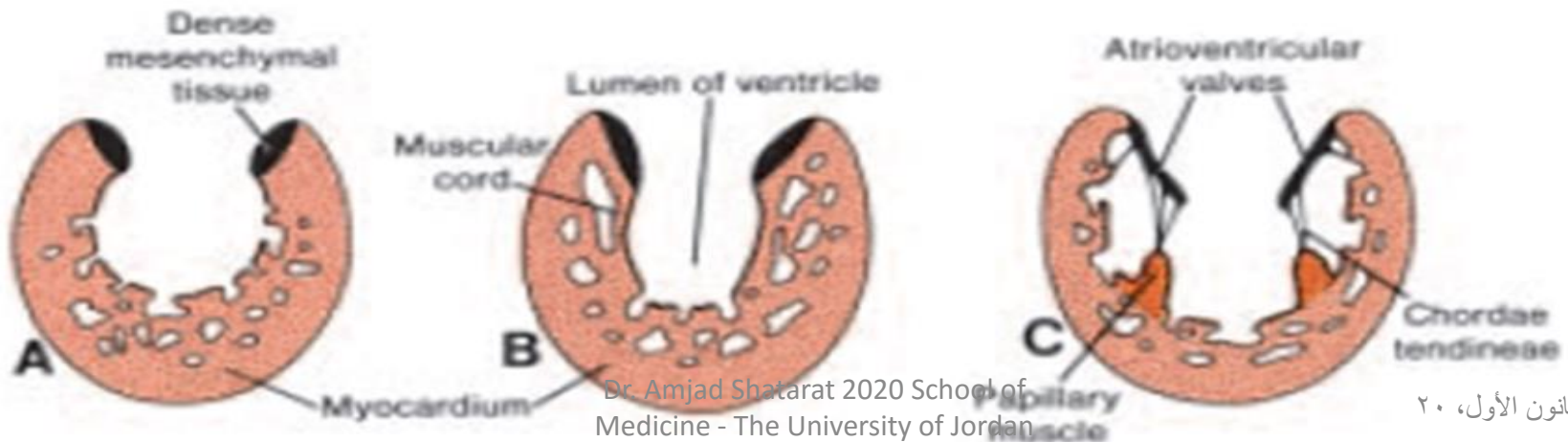


C

SEPTUM FORMATION IN THE ATRIOVENTRICULAR CANAL

- each atrioventricular orifice is surrounded by local proliferations of mesenchymal tissue derived from the endocardial cushions.
- when the blood stream hollows the surface of these proliferations, the mesenchymal tissue becomes fibrous and forms *the valves* which remain attached to the ventricular wall by muscular cords which will degenerate and being replaced by dense connective tissue → **chordae tendineae**.

Note: Recent evidence shows that neural crest cells contribute to formation of semilunar cusps



It should be noted that the *endocardial cushions developing in the atrioventricular region or conotruncal region are derived from*

neural crest cells migrating from the cranial neural folds to the outflow tract region.

Formation of the interatrial septum

Atrial septation

THE SEPTUM PRIMUM

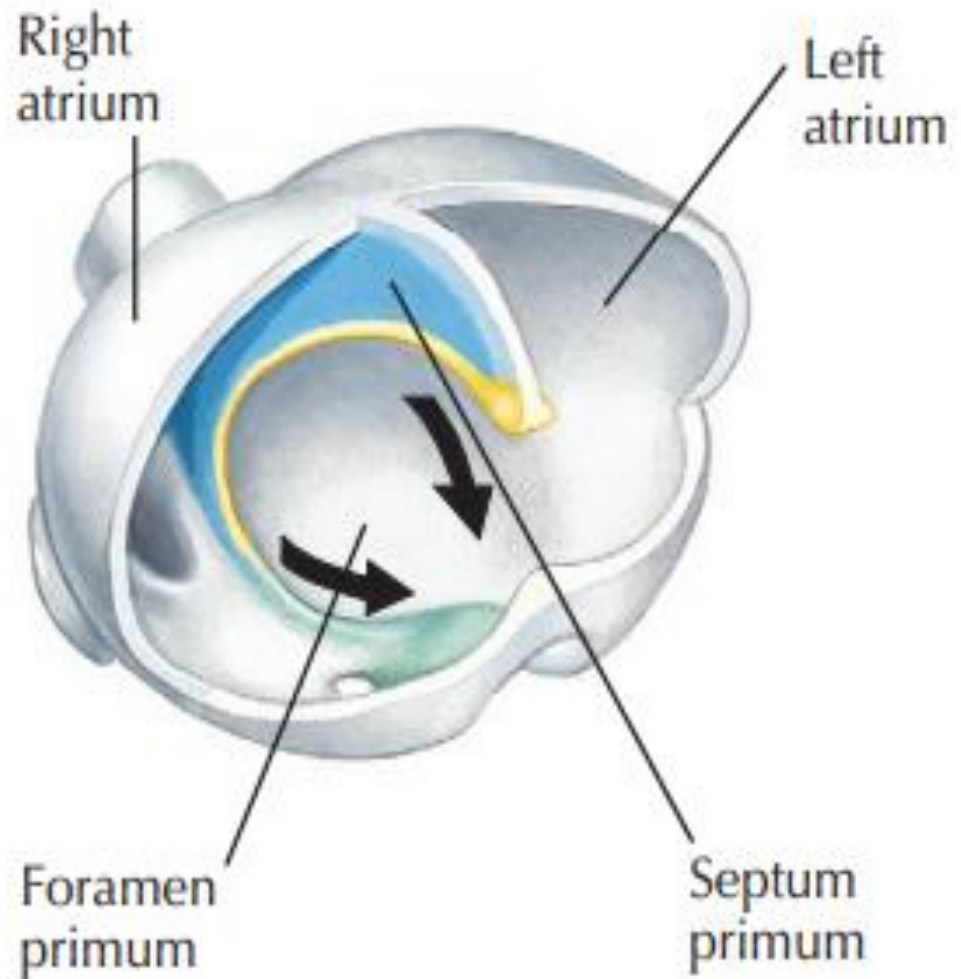
which is sickle-shaped or (crescent-shaped) septum appears and extends from the roof down to and fusing with the endocardial cushions (**septum intermedium**)

As this curtain-like septum (the septum primum) develops, **a large opening** forms between its free edge and the endocardial cushions



This opening is called

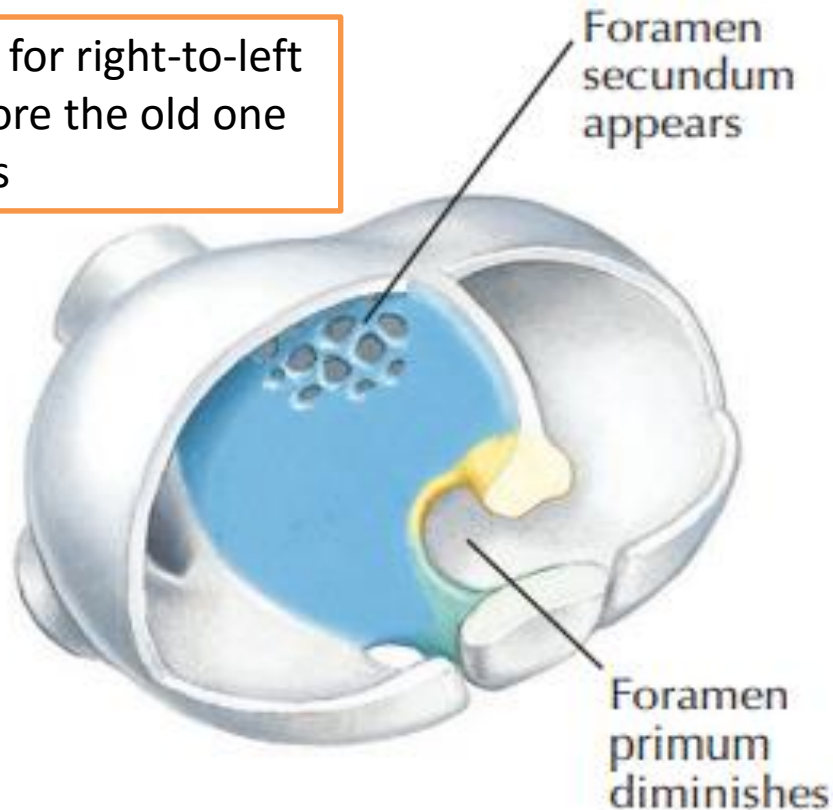
The foramen primum



- The foramen allows **shunting of oxygenated blood from the right to the left atrium.**
- The foramen becomes progressively **smaller and disappears as the septum primum fuses with the endocardial cushions**

Before the foramen primum disappears, the **upper part** the septum primum breaks down (perforations, produced by **apoptosis (programmed cell death)**), to form the foramen secundum (**ostium secundum**).

Thus, a new channel for right-to-left shunting opens before the old one closes

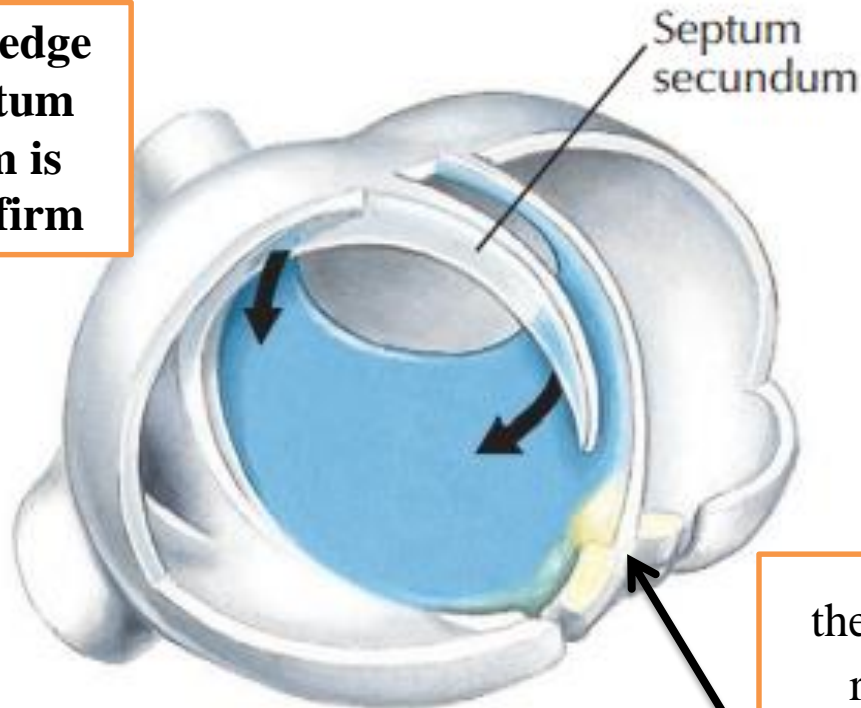


The foramen primum

Disappears as the septum primum fuses with the endocardial cushions (septum intermedium)

Septum secundum, grows from the ventrocranial wall of the atrium, immediately to the right of the septum primum

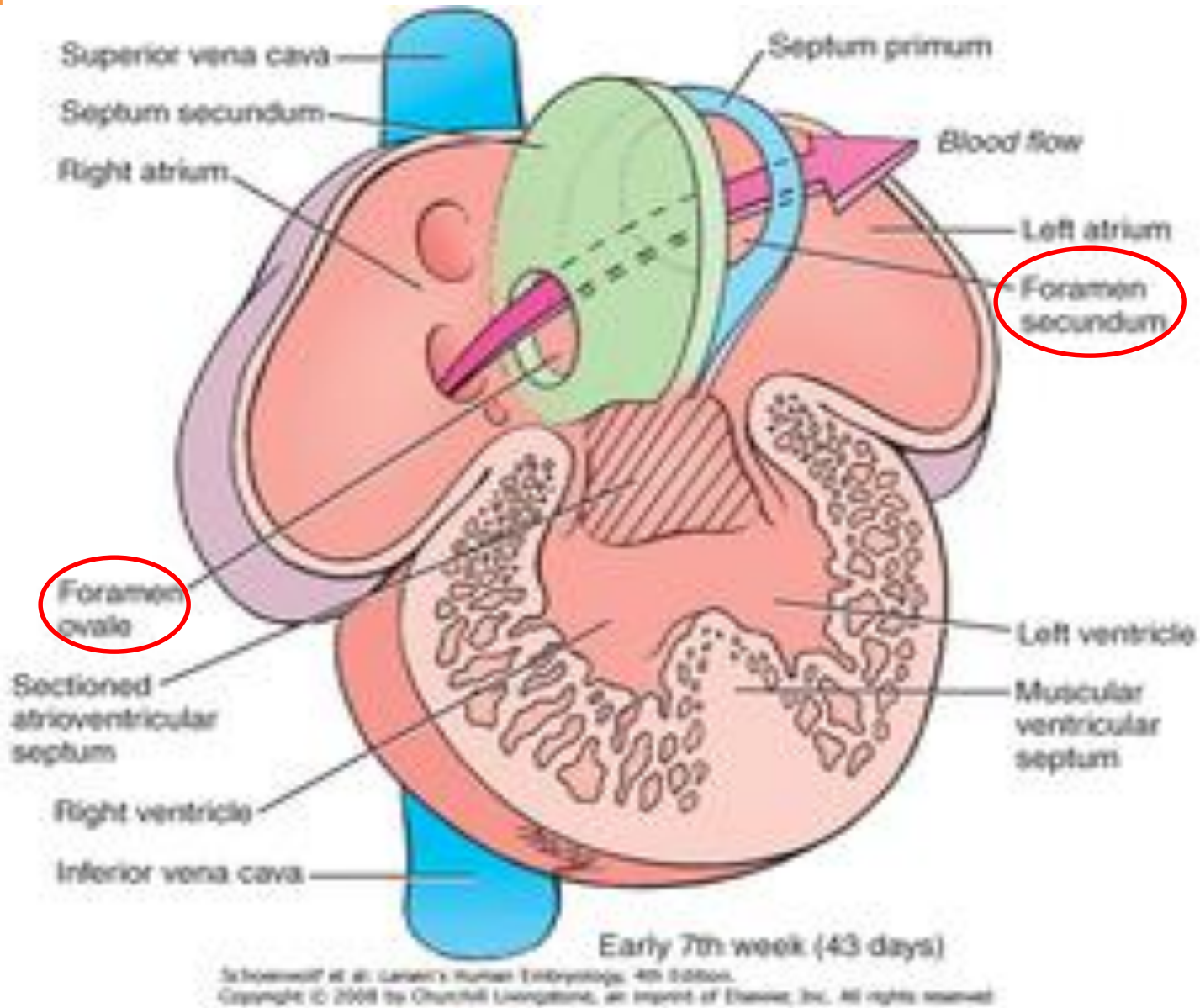
The lower edge of the septum secundum is thick and firm



the septum secundum **does not** reach the endocardinal cushions (septum intermedium)

it gradually overlaps the **foramen secundum** in the septum primum

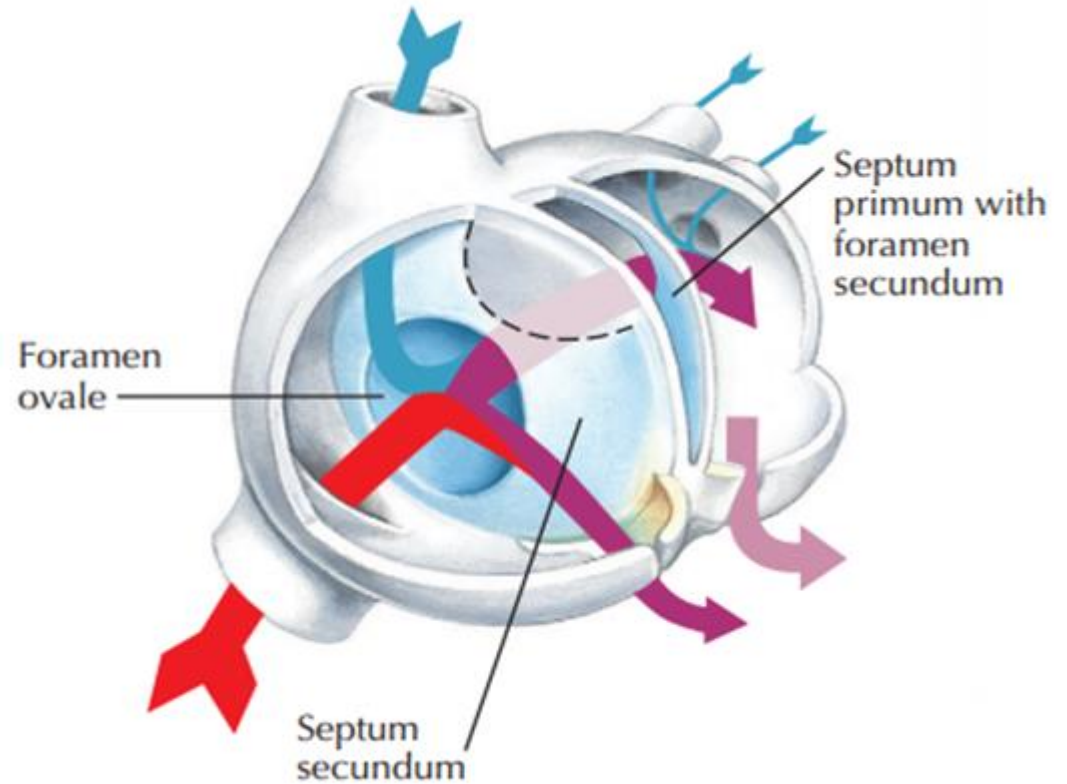
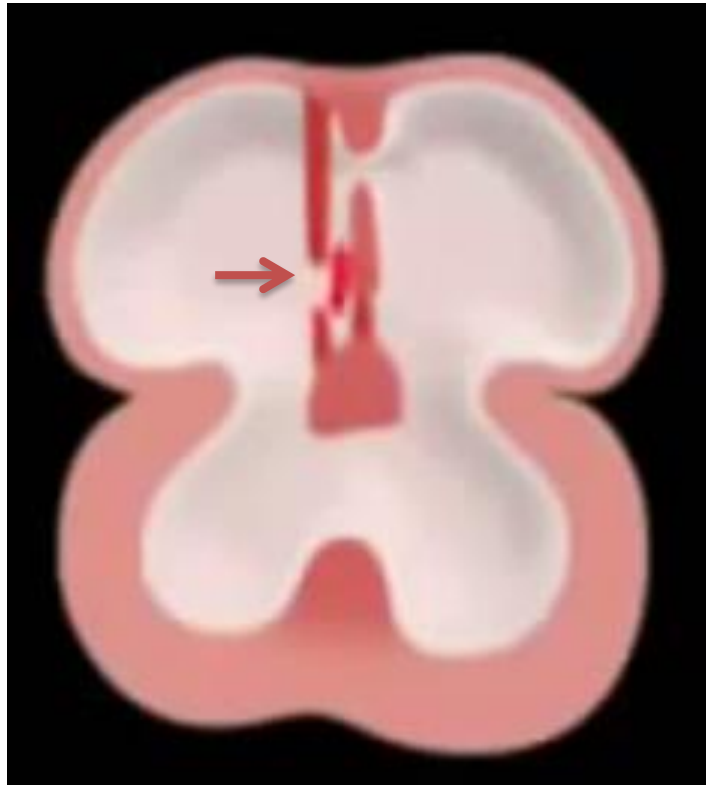
Therefore, throughout the rest of fetal development, blood that shunts from the right atrium to the left atrium passes through two openings: the foramen ovale near the floor of the right atrium, and the foramen secundum near the roof of the left atrium



The opening between
septum secundum and the septum primum
Is called

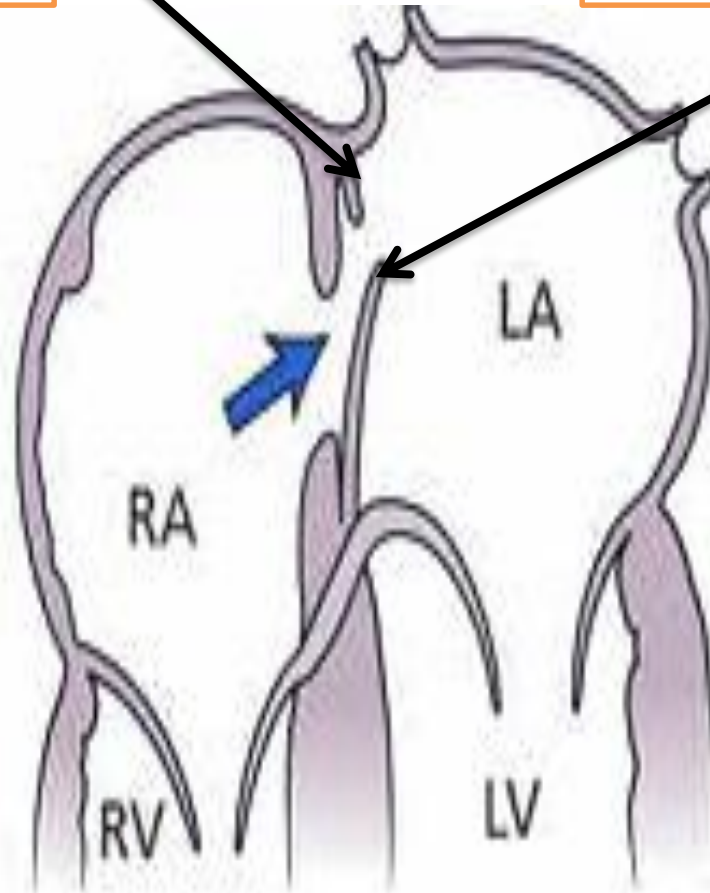
(foramen ovale)

which persist throughout fetal life

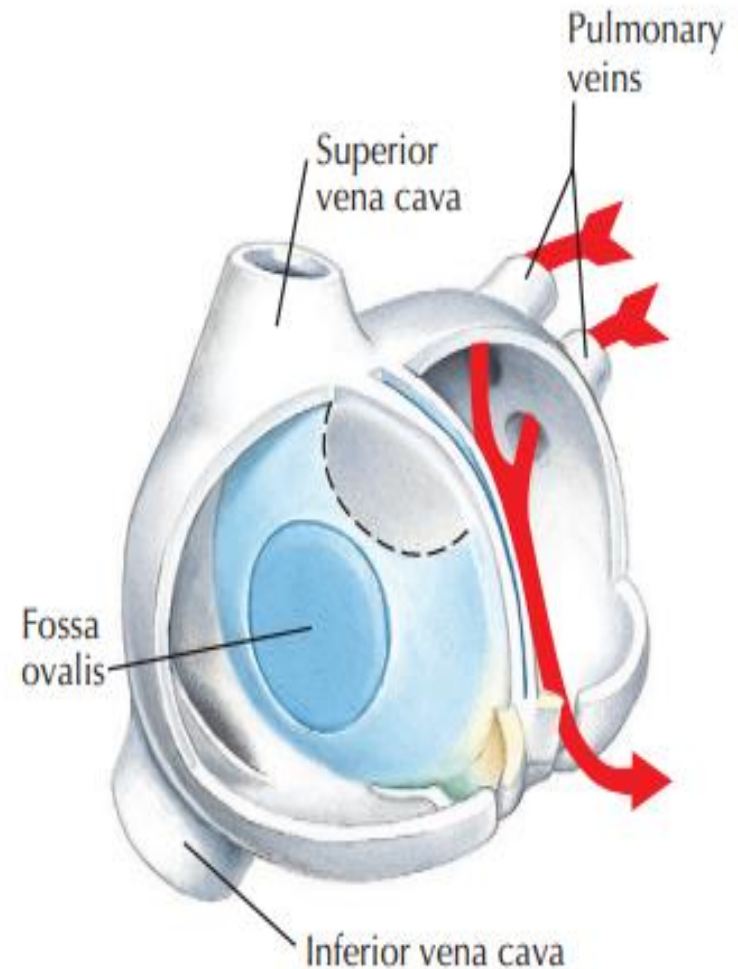


The cranial part of the septum primum gradually disappears

The remaining part of the septum primum, attached to the endocardial cushions, forms the **valve of the oval foramen**



- The lower edge of the septum secundum is thick and firm. In contrast, the edge of the septum primum that forms the lower boundary of the foramen secundum is thin and mobile like a flap.
- When blood tends to flow from the right to the left atrium, this thin flap moves away and there is no obstruction to blood flow.
- however, when there is a tendency for blood to flow from left to right this flap comes into apposition with the septum secundum and closes the opening.

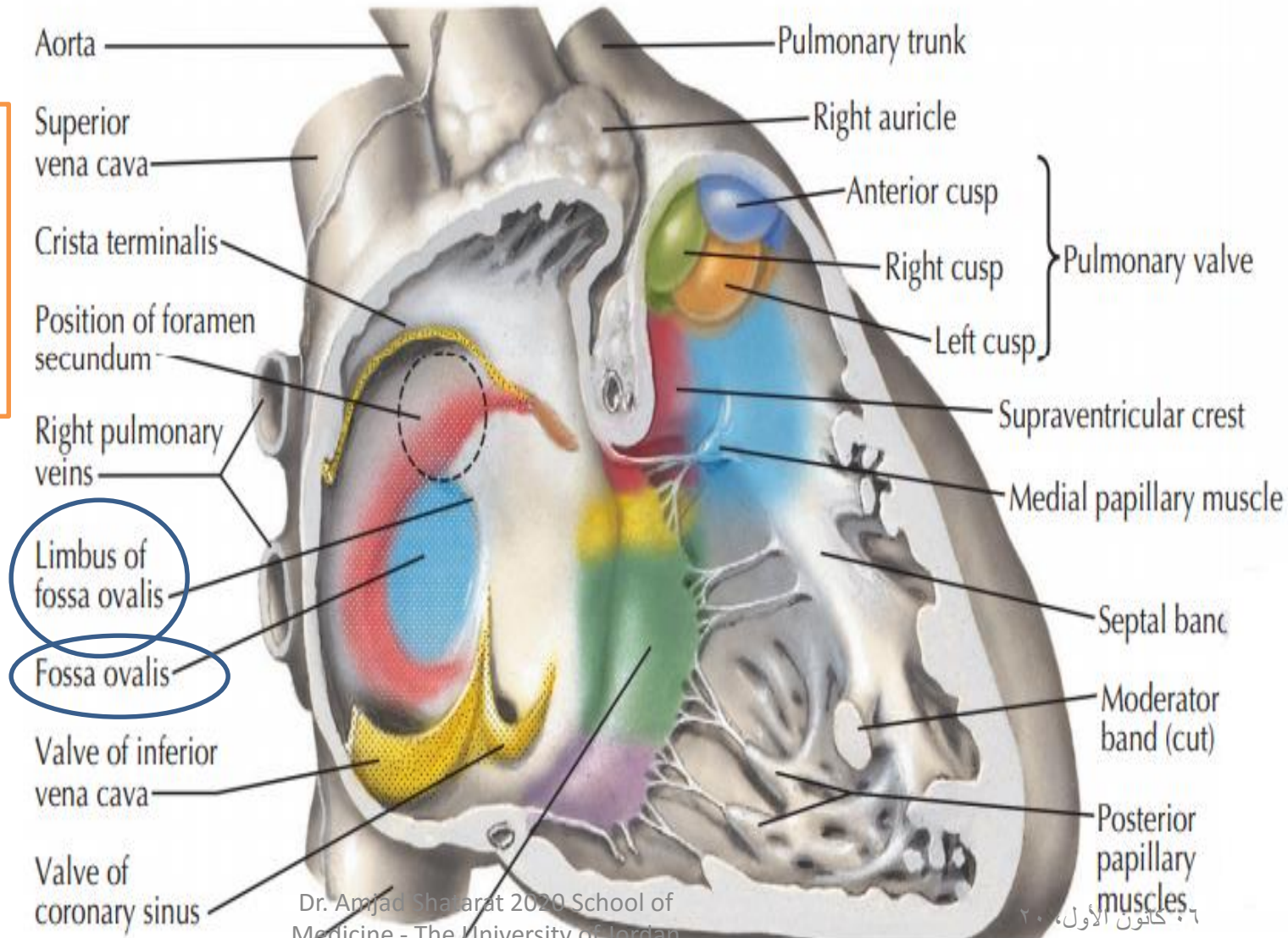


Foramen ovale closed after birth with increased pulmonary flow

After birth, when lung circulation begins and pressure in the left atrium increases, the valve of the oval foramen is pressed against the septum secundum, obliterating the oval foramen and separating the right and left atria.

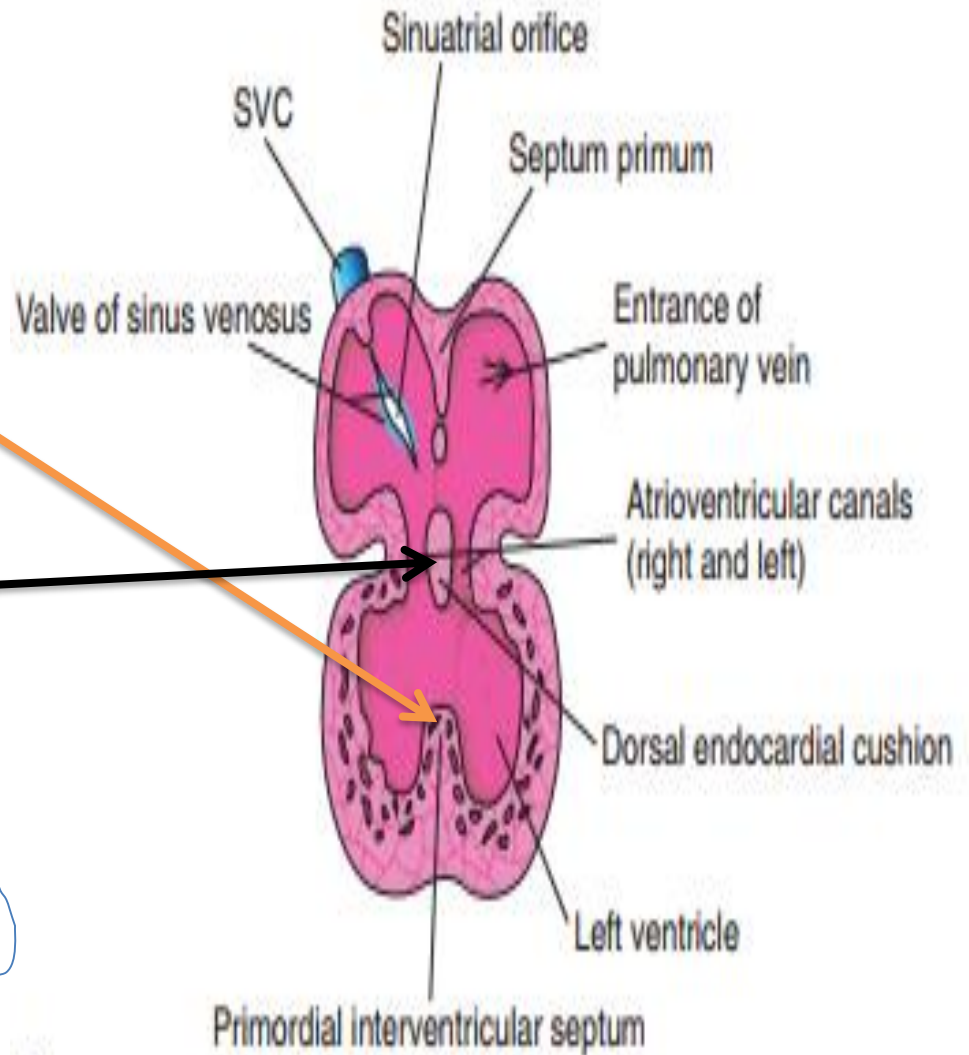
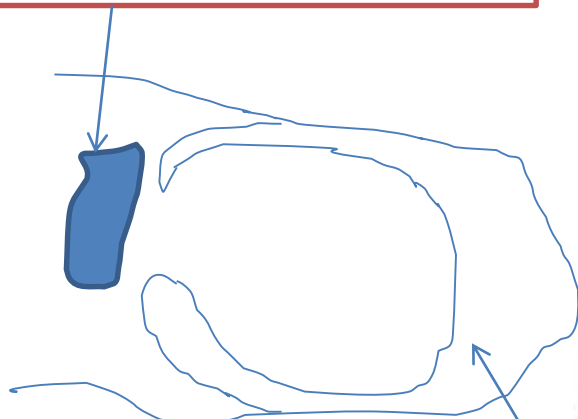
Annulus ovalis represents lower free edge of the septum secundum.

Floor of fossa ovalis represents the septum primum.



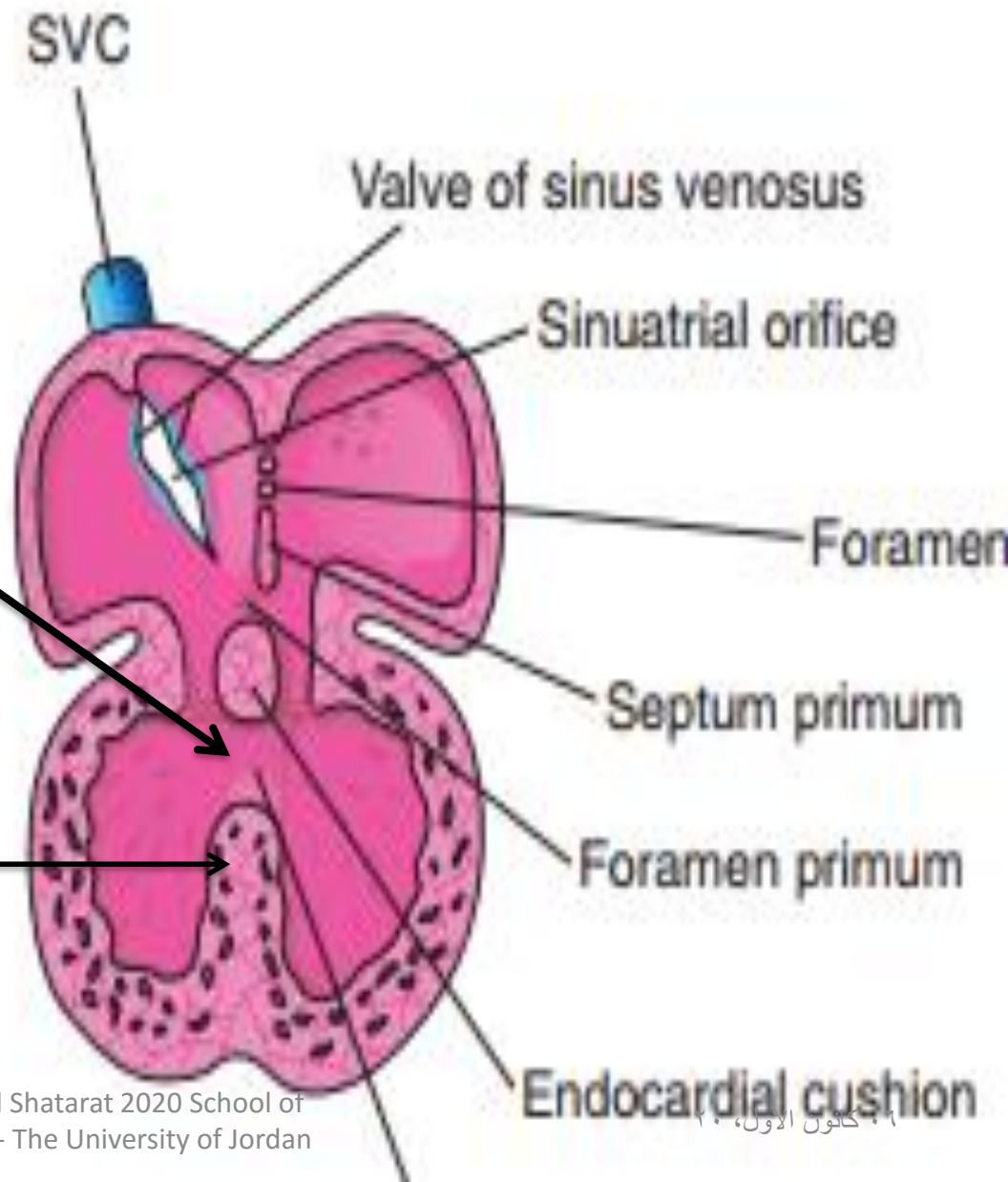
Separation of the ventricles

- The ***ventricular septum begins*** its development as a projection from the base or the inferior wall of the ventricle.
- As it enlarges, the septum forms two horns which reach up to the corresponding a-v endocardial cushions



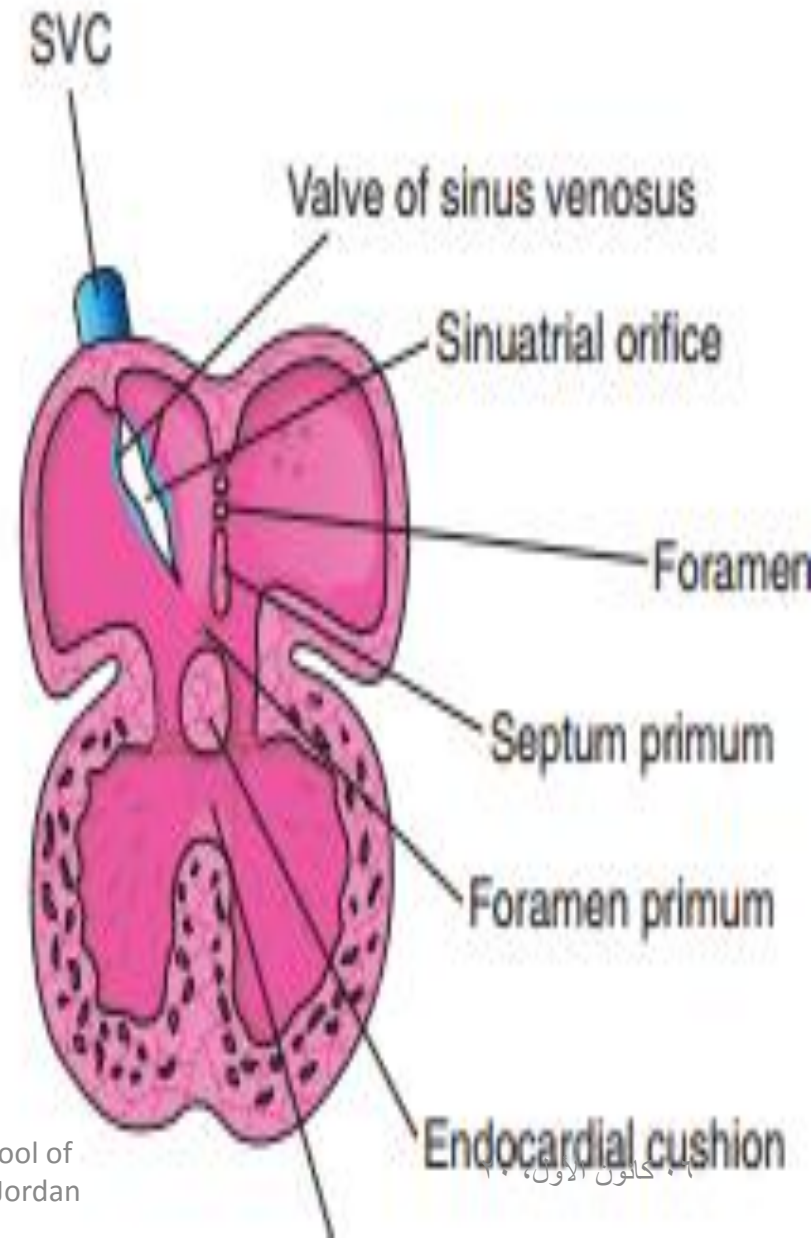
- The upper crescentic border of the septum bounds a temporary connection between the two ventricles called ***the interventricular foramen***

The ventricular septum forms **the muscular part** of the **the interventricular septum**



Until the seventh week, there is a crescent-shaped opening (IV foramen) between the free edge of the IV septum and the fused endocardial cushions.

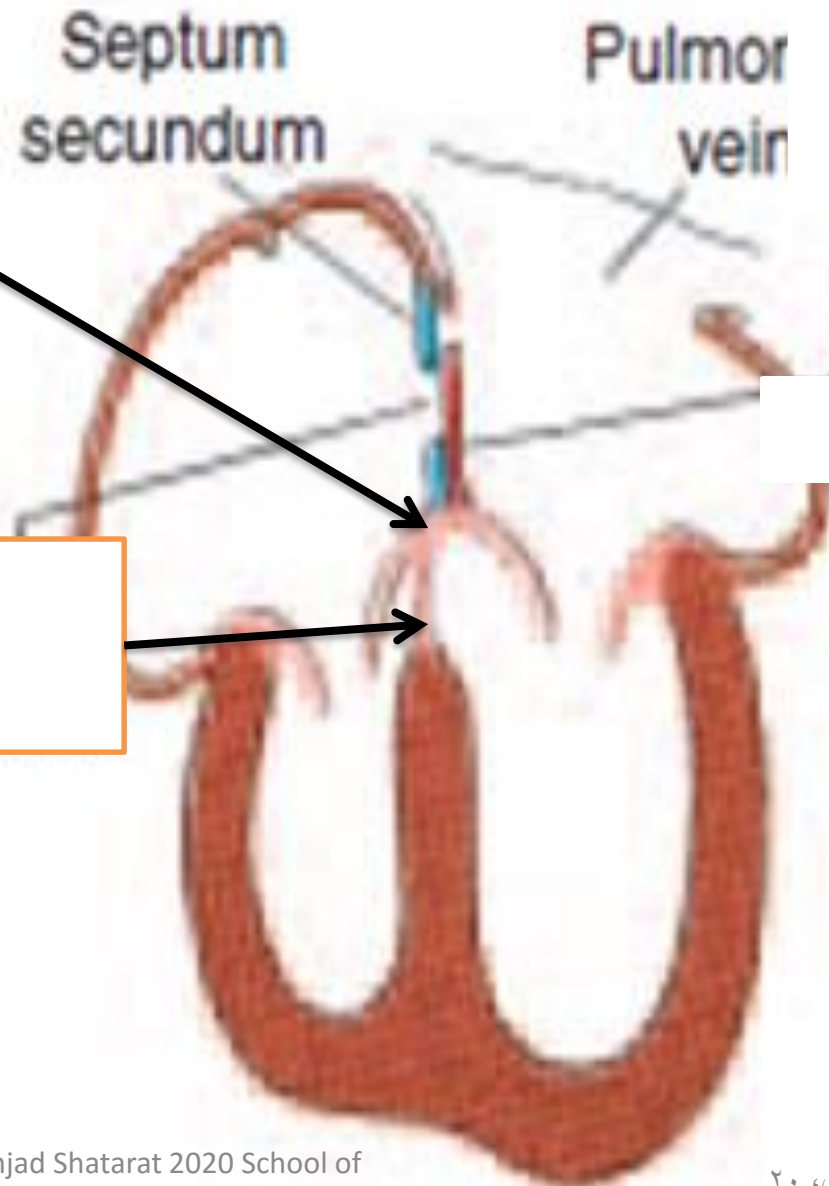
The IV foramen permits communication between the right and left ventricles



- At the end of the seventh week, a downward extension occurs from the right margins of the a-v endocardial septum (septum intermedium) to close the interventricular foramen.

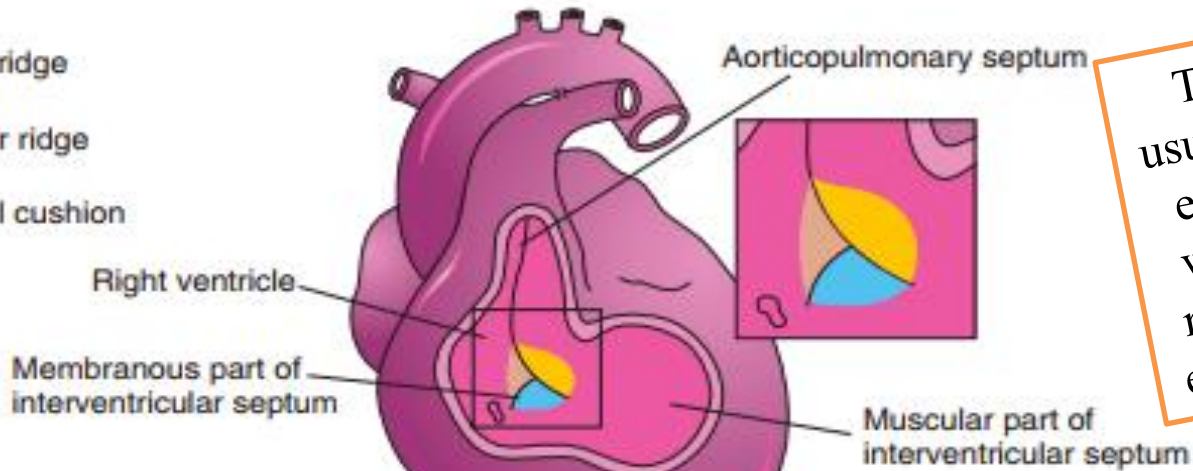
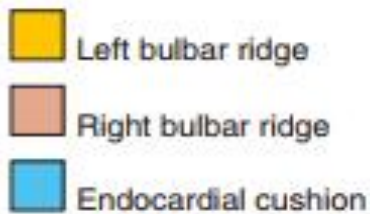
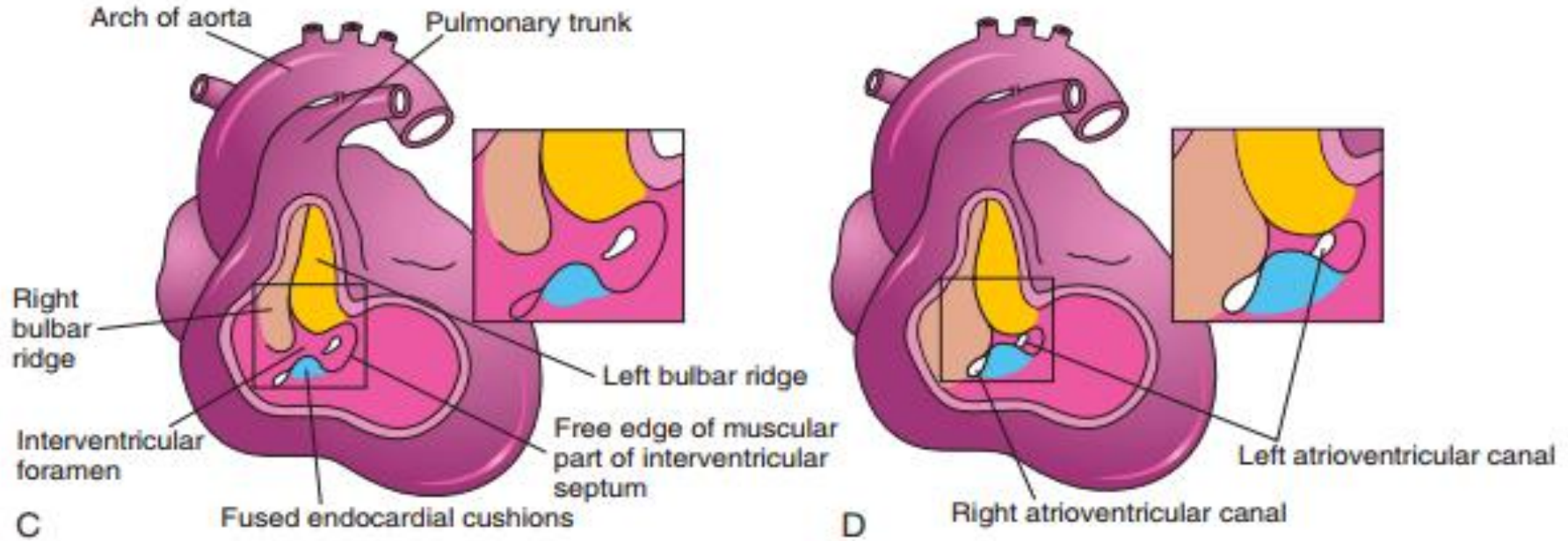


- This extension forms **The Membranous Part** of the interventricular septum



- The proximal bulbar septum

develops as two ridges which fuse together they share in closing the interventricular foramen.



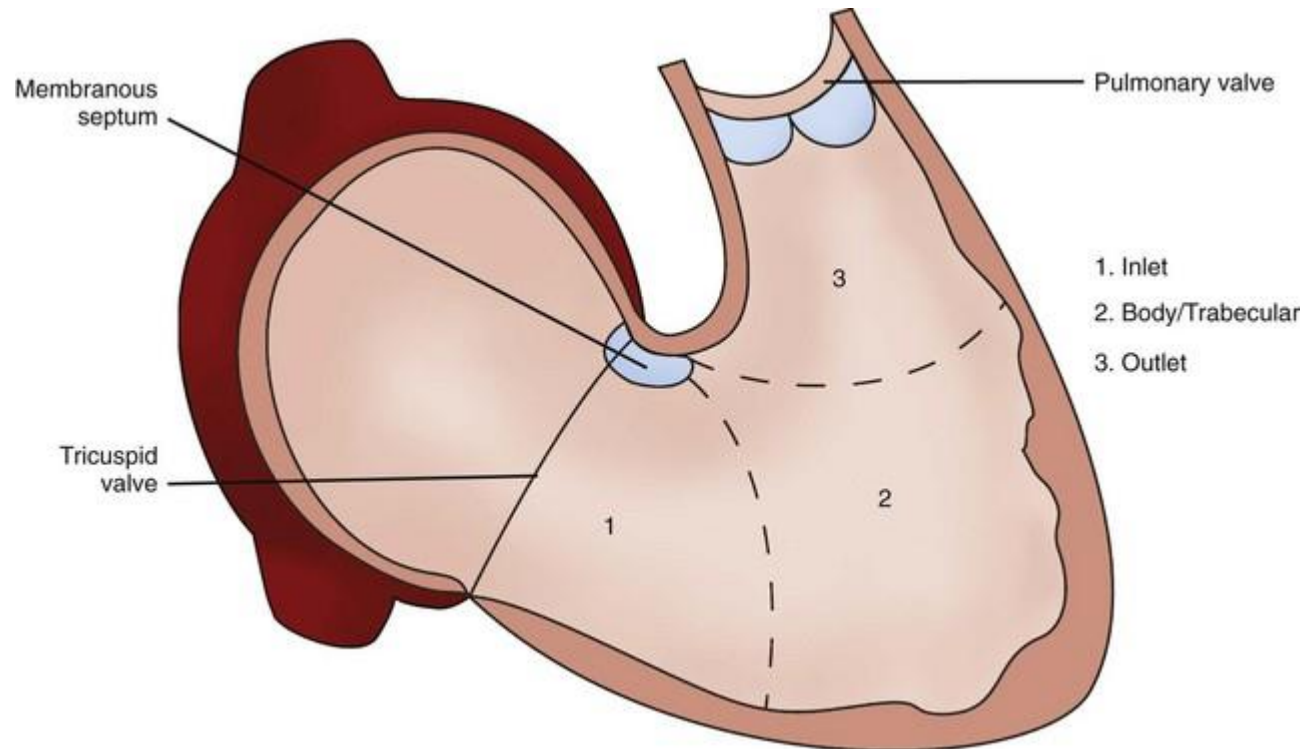
The IV foramen usually closes by the end of the seventh week as the bulbar ridges fuse with the endocardial cushion

Three distinct structures contribute to the formation of the postnatal ventricular septum:

1-The muscular ventricular septum

2-The proximal parts of the outflow cushions (spiral septum or the proximal bulbar septum)

3-The atrioventricular endocardial cushions.



Membranous septal defects are the most common heart defect (25% of all congenital heart defects), partly because three basic primordia (**interventricular septum, spiral septum, endocardial cushions**) are required to fuse in an area of very dynamic blood flow. There is considerable opportunity for a failure of fusion of these elements at the location of **the membranous interventricular septum**

Postnatal Shunts

Right-to-left shunts are **cyanotic conditions**

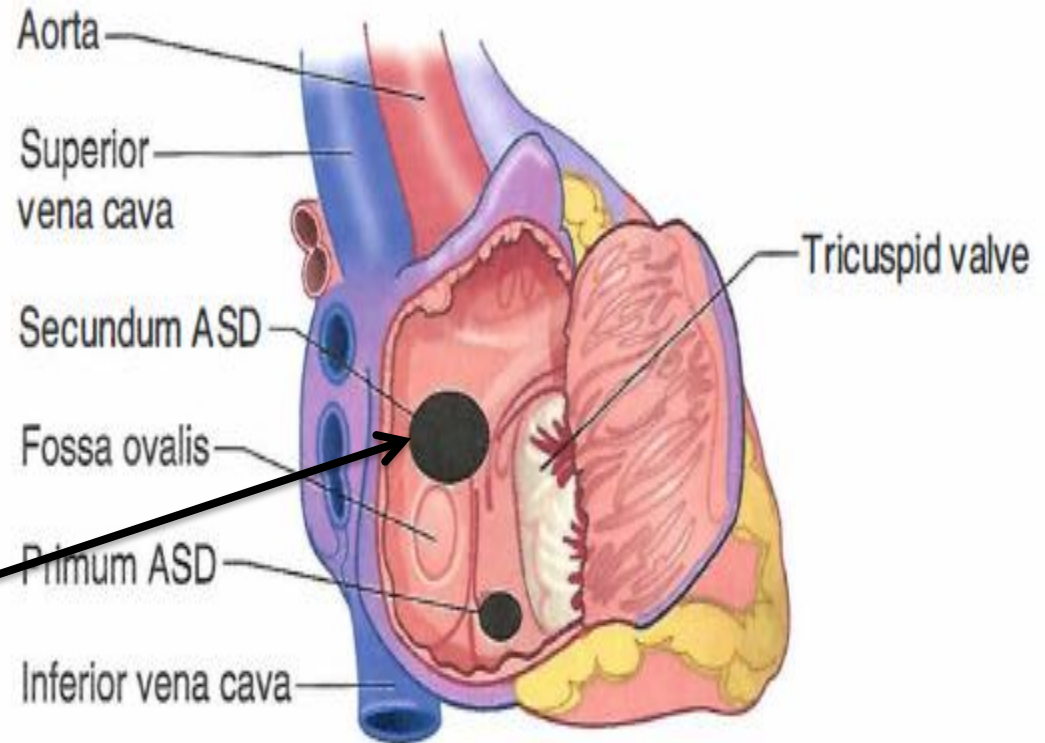
Left-to-right shunts are **non-cyanotic conditions**

Atrial Septal Defects Atrial septal defect (ASD)

- is one of several congenital heart defects
- It is more common in female births than in male
- Postnatally, ASDs result in ***left-to-right shunting*** and are. ***non-cyanotic conditions***.

Two clinically important ASDs are the secundum and primum types

- Secundum-type ASD is the most common ASD
- It is caused by either an excessive resorption of the SP or an underdevelopment and reduced size of the SS or both.
- This ASD results in variable openings between the right and left atria in the central part of the atrial septum **above the limbus**.
- If the ASD is small, clinical symptoms may be delayed as late as age 30

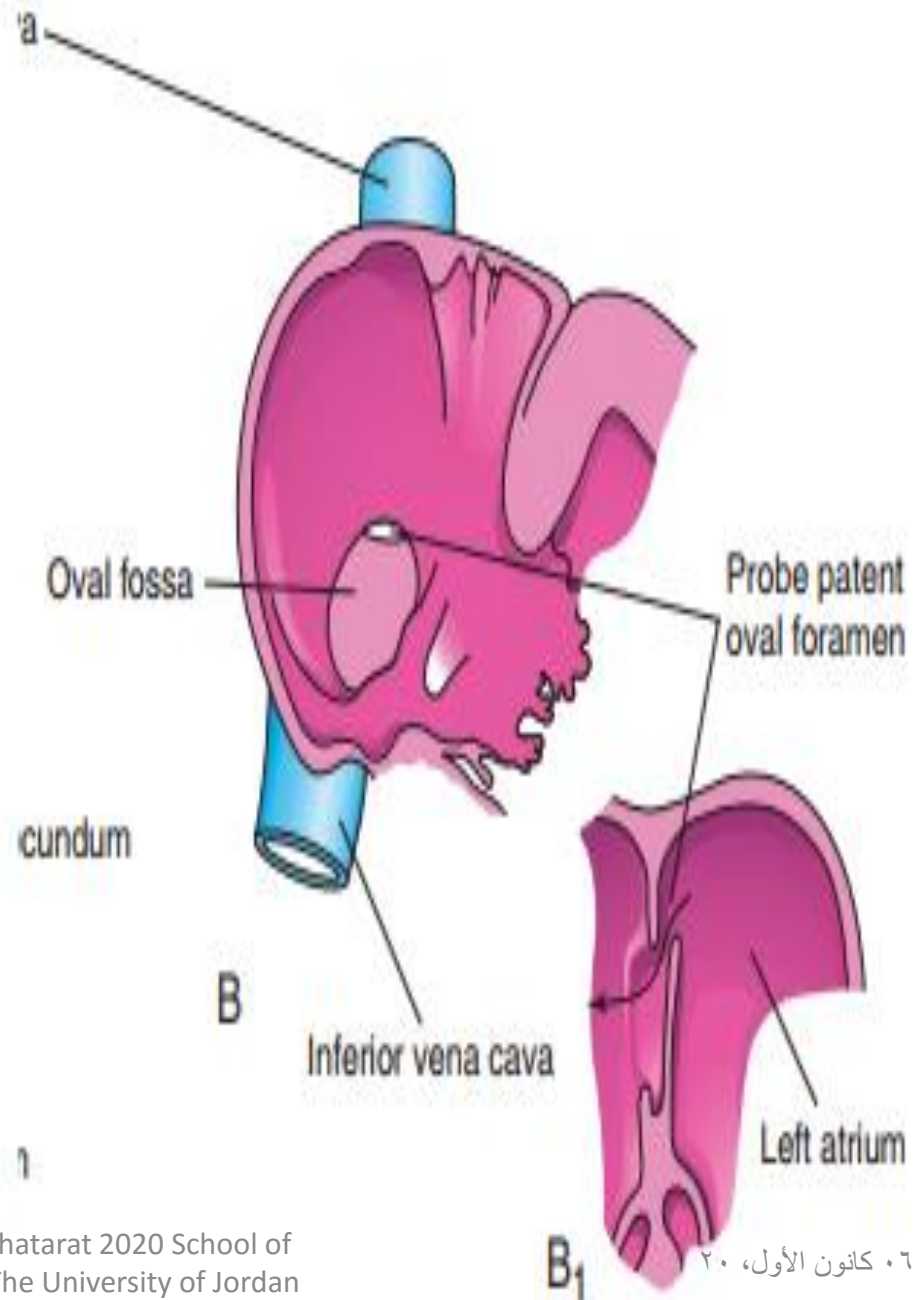


In about 20% of cases, fusion of the septum primum and septum secundum is incomplete, and a narrow oblique cleft remains between the two atria.

This condition is called

probe patency

of the oval foramen; it does not allow intracardiac shunting of blood.



Ventricular septal defect (VSD)

- It is the most common of the congenital heart defects
 - Being more common *in males than in females*
 - The most common **VSD is a membranous ventricular** septal defect, associated with the failure *of neural crest cells* to migrate into the endocardial cushions.

Ventricular septal defect (VSD)

- It results in **left-to-right shunting** of blood through the IV foramen.
- Patients with left-to-right shunting complain of excessive fatigue upon exertion.
 - Left-to-right shunting of blood is **noncyanotic**

- but causes increased blood flow and pressure to the lungs (pulmonary hypertension).
 - Pulmonary hypertension causes marked proliferation of the tunica intima and media of pulmonary muscular arteries and arterioles.Ultimately, the pulmonary resistance becomes higher than systemic resistance and causes right-to-left shunting of blood and late cyanosis. At this stage, the condition is called **Eisenmenger complex**

