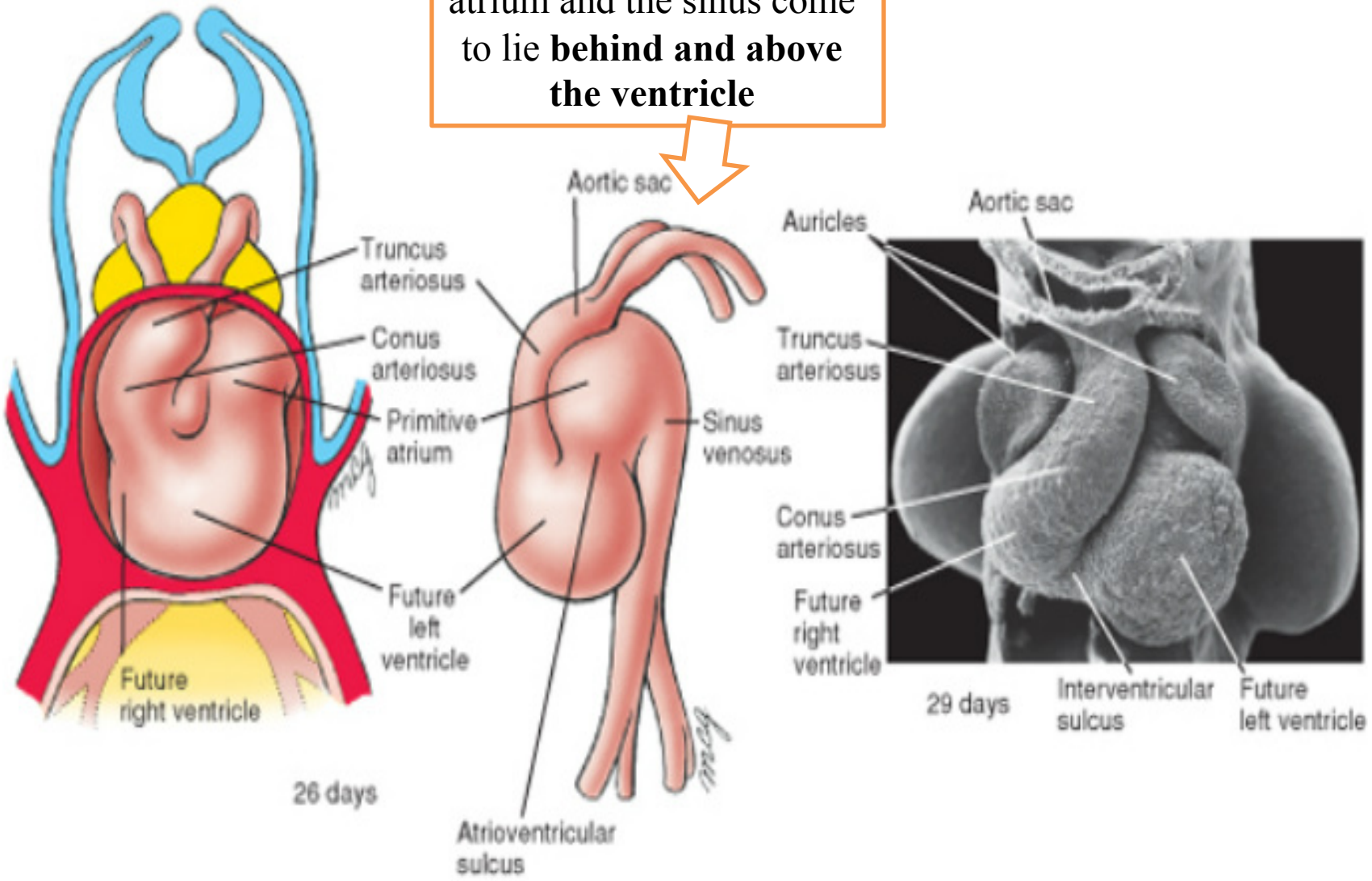
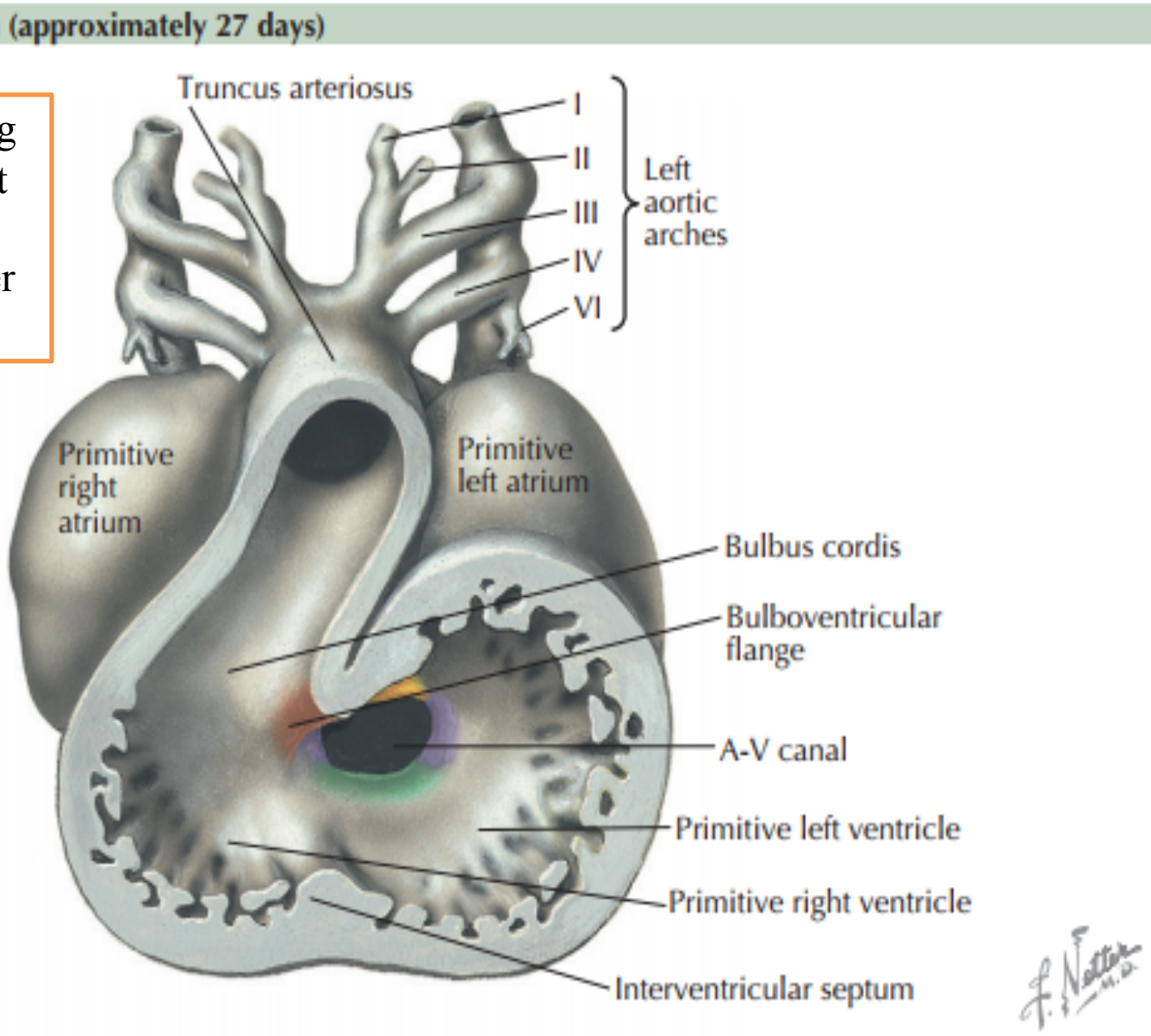
CVS Embryology - 2

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



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



Circulation through Primordial Heart

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

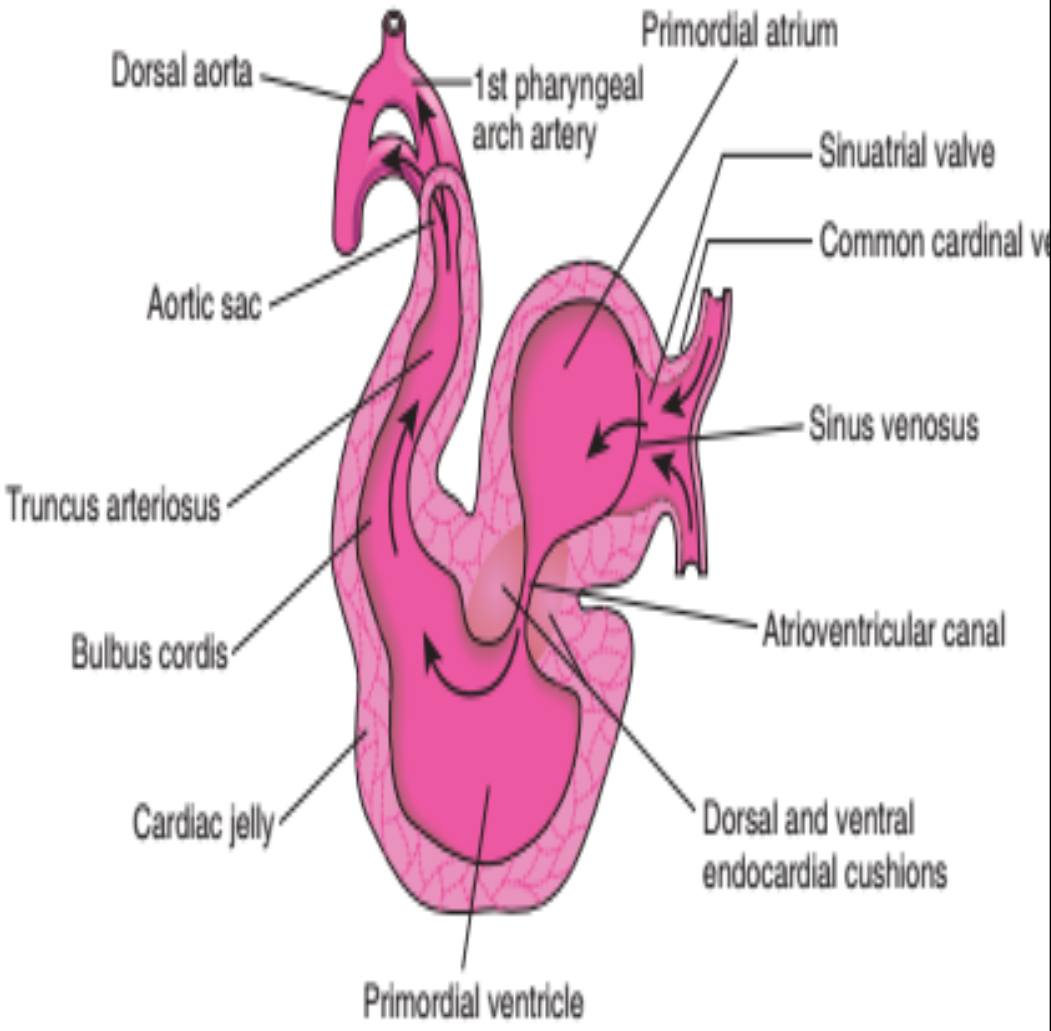
Blood enters
The Primordial Atrium

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



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

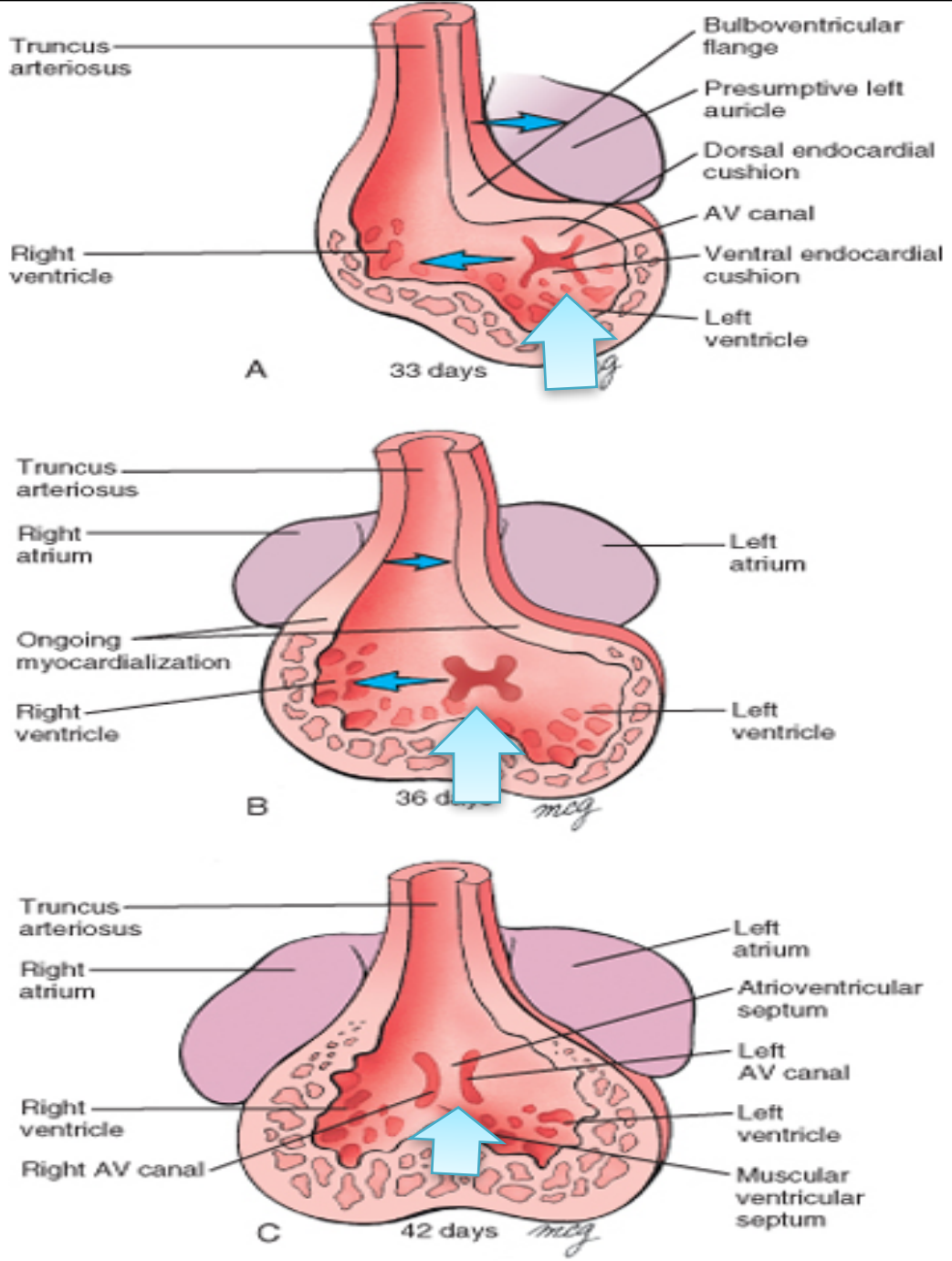
lasts about 10 days

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

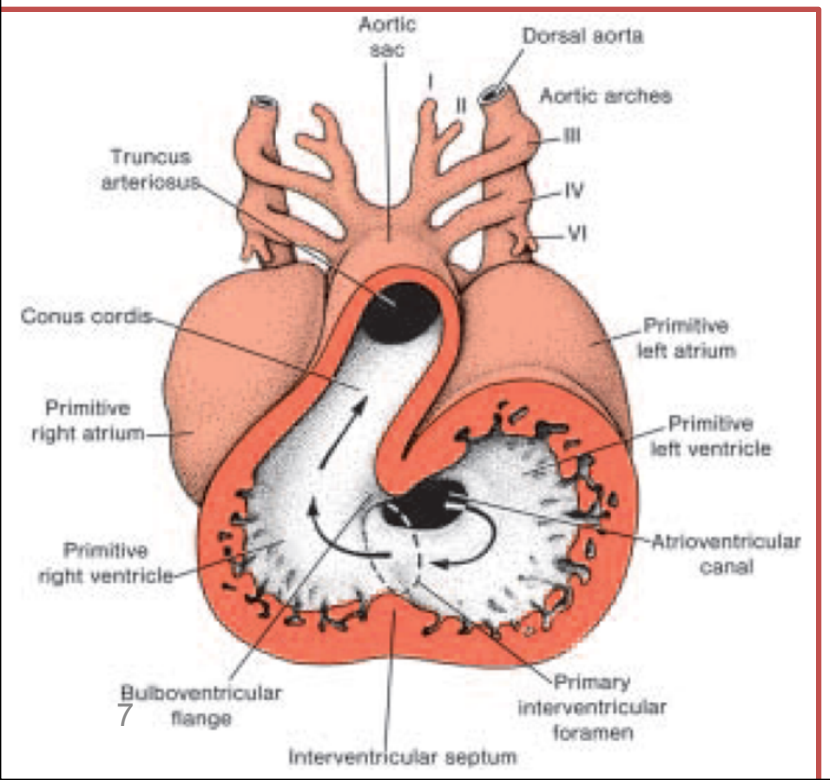
1- First it has a round opening then it becomes transverse.

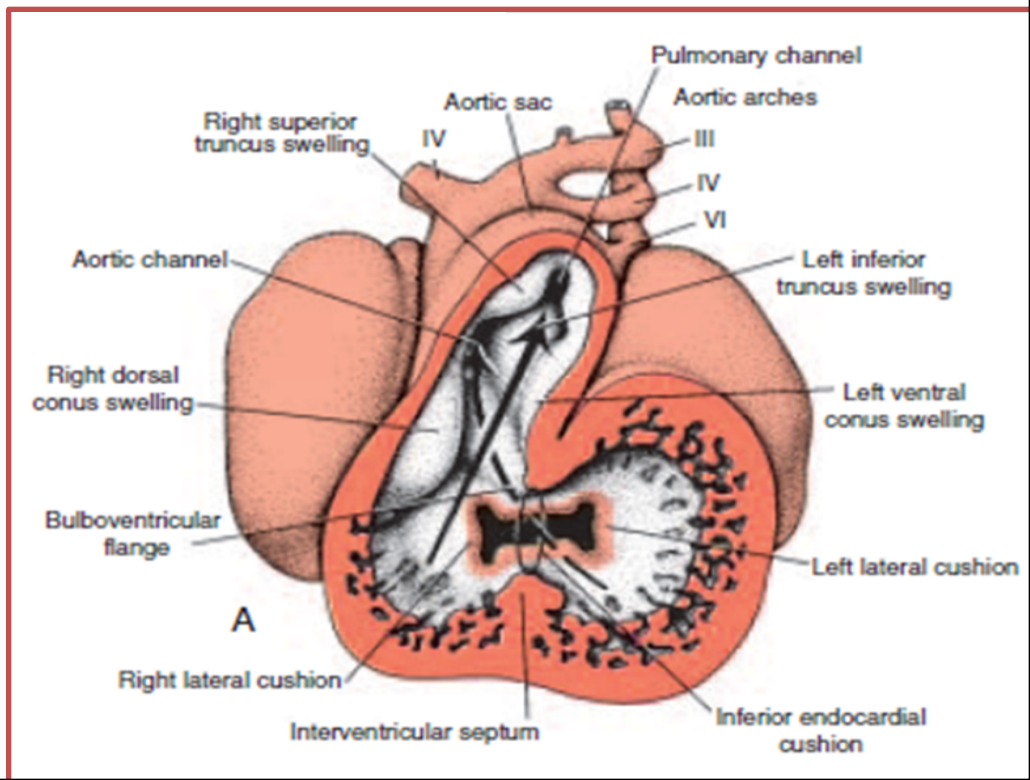
2- Two thickenings (the atrio-ventricular or endocardinal cushions) appear on its dorsal and ventral walls.

3- They grow towards each other and fuse forming

THE SEPTUM INTERMEDIUM

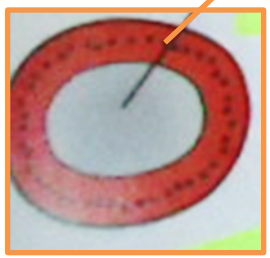
Thus dividing the canal into right and left halves

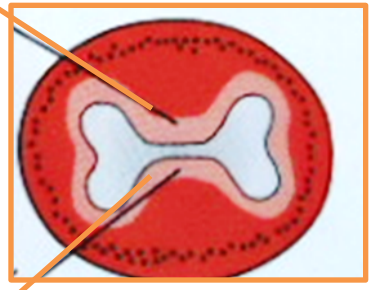


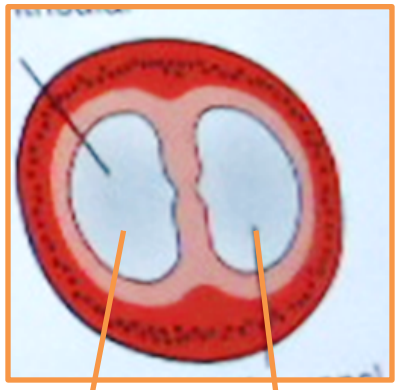


Common atrioventricular canal

Superior endocardinal cushion







Lateral cushion

Inferior endocardinal cushion

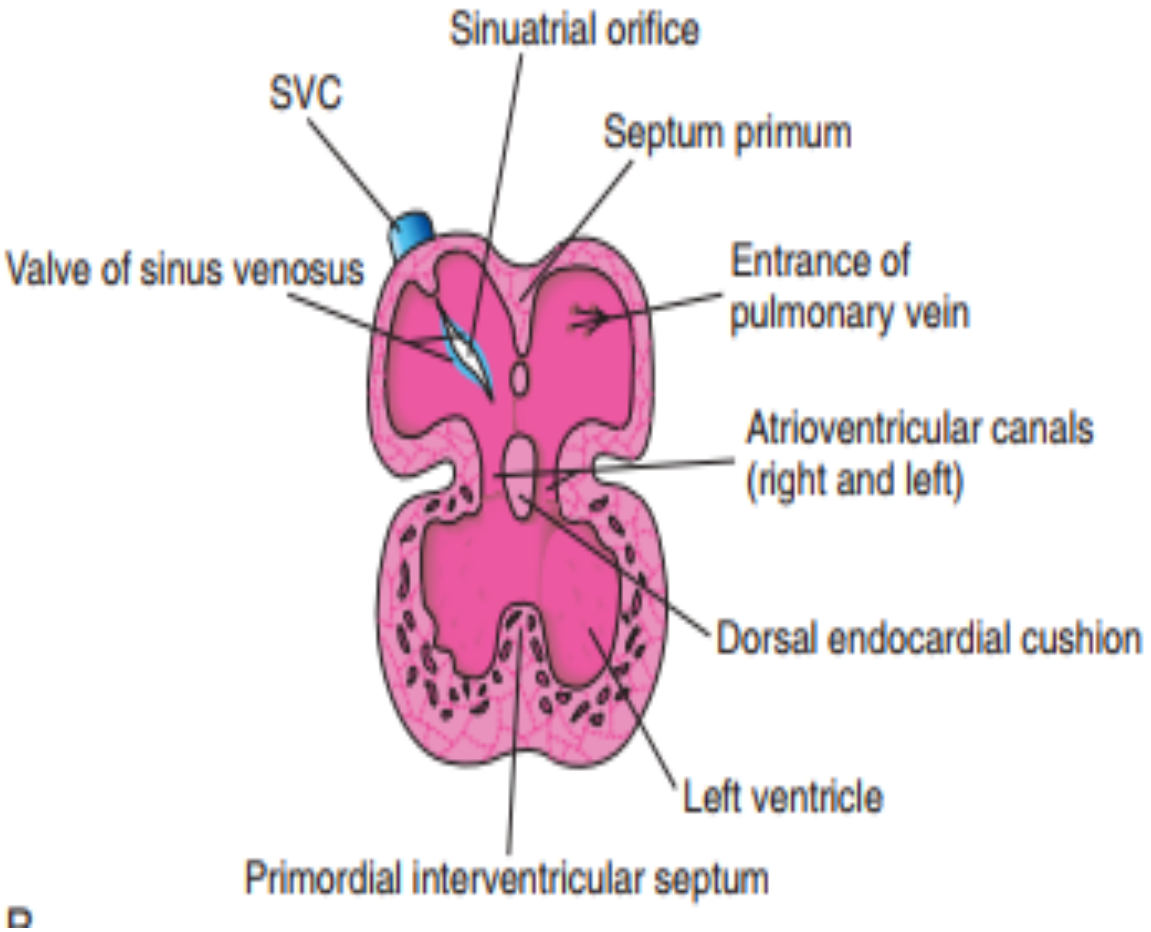
Right and left atrioventricular canals

Round atrio-ventricular canal

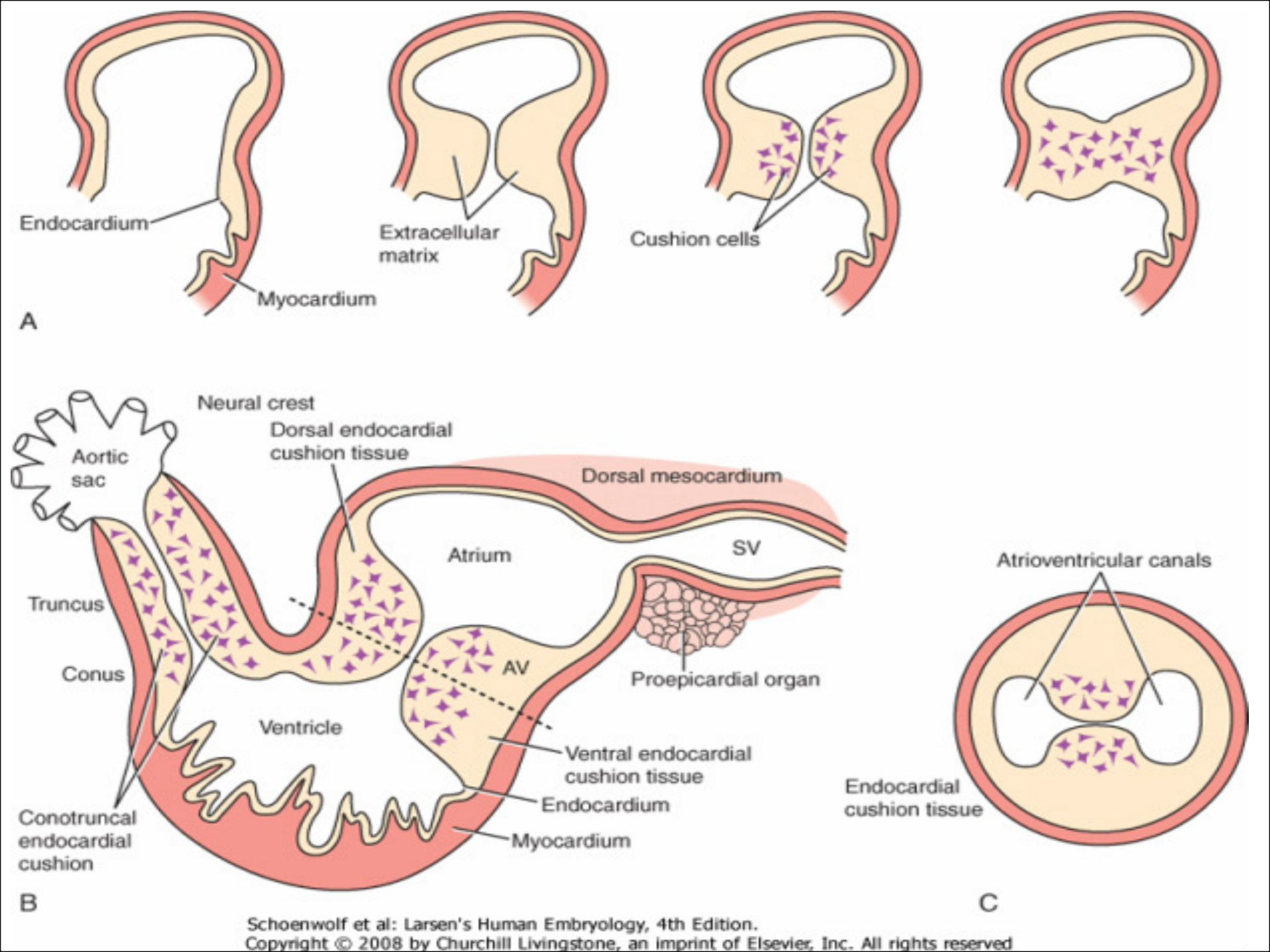
Canal becomes transverse

Dorsal and ventral endocardial cushions

Now we have Right and left atrioventricular canals



These canals partially separate
the primordial atrium from the ventricle

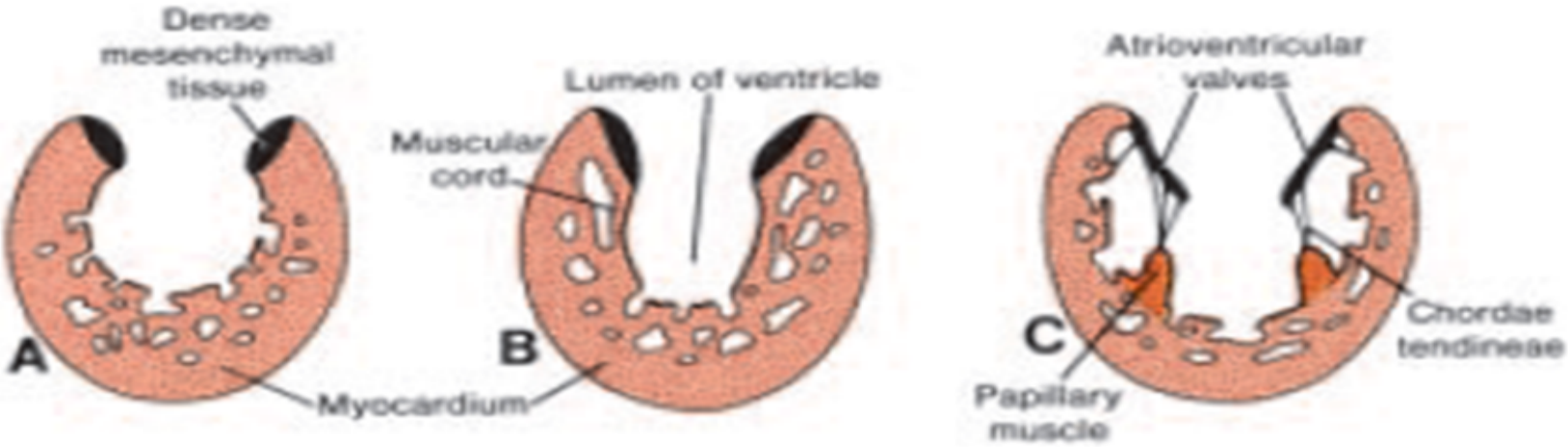


SEPTUM FORMATION IN THE ATRIOVENTRICULAR CANAL

- each atrioventricular orifice is surrounded by **local proliferations of mesenchymal tissue derived from the endocardinal cushions**.

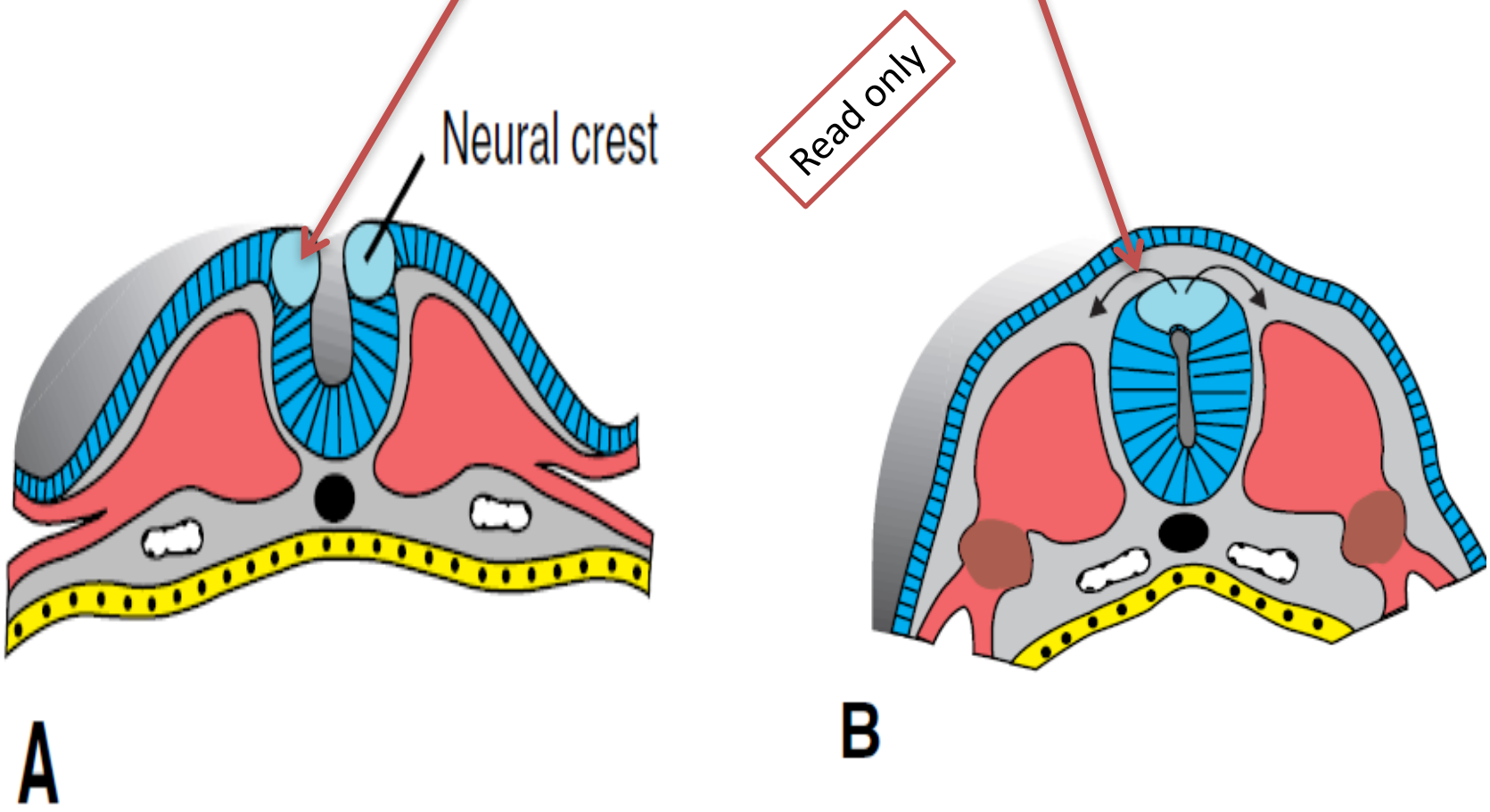
- when the blood stream hollows the surface of these proliferations, the mesenchymal tissue becomes fibrous and forms ***the valves*** which remain attached to the ventricular wall by muscular cords which will degenerate and being replaced by dense connective tissue → **chordae tendineae.**

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



It should be noted that the ***endocardinal 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.**

<u>Cells at the lateral border</u> or crest of the neuroectoderm begin to dissociate from their neighbors AND **undergo an epithelial-to-mesenchymal transition as it leaves the neuroectoderm by active migration and displacement to enter the underlying mesoderm**



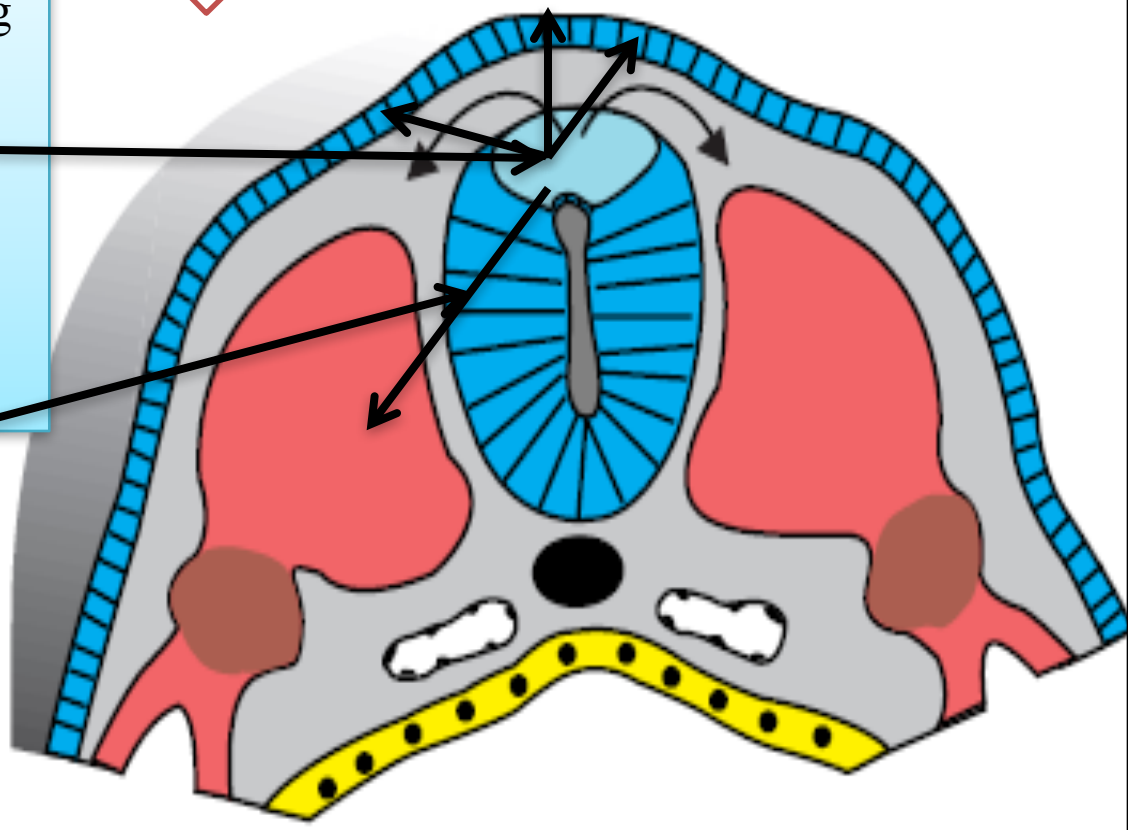
Read only

NEURAL CREST cells migrate along one of two pathways:
a dorsal pathway through the (1 dermis, where they will enter the ectoderm to form

melanocytes

In the skin and hair follicles

2) a ventral pathway through the anterior half of each somite to become **sensory ganglia, sympathetic and enteric neurons , Schwann cells, and cells of the adrenal medulla**



B

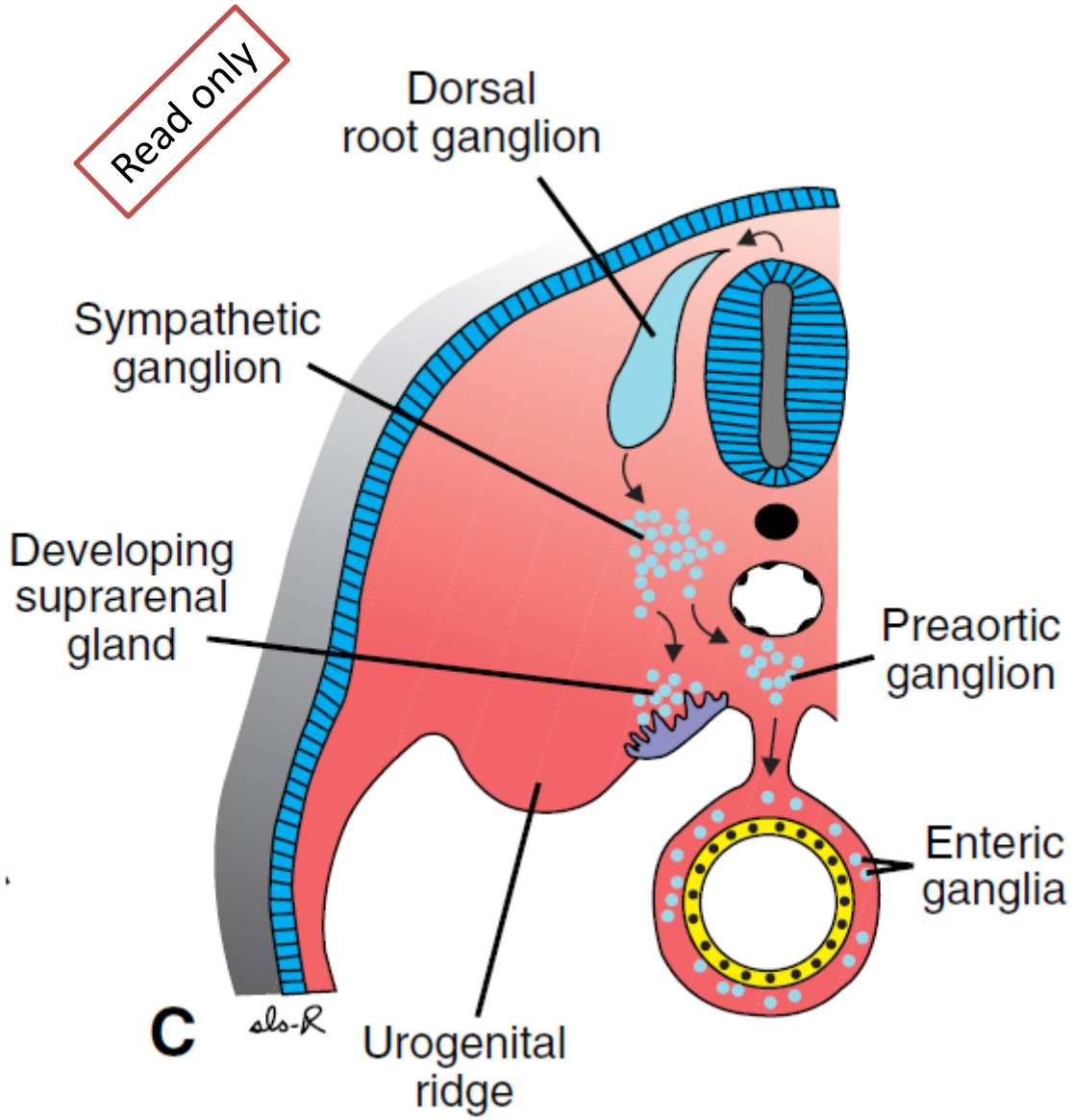
Neural crest cells

also

form and migrate from

cranial neural folds,

leaving the neural tube before closure in this region These cells contribute to the **craniofacial skeleton as well as neurons for cranial ganglia**



Neural Crest Derivatives

Read only

1-Connective tissue and ***bones of the face and skull***

2-Cranial nerve ganglia

3-C cells of the thyroid gland

4-Conotruncal septum in the heart

5-Odontoblasts

6-Dermis in face and neck

7-Spinal (dorsal root) ganglia

8-Sympathetic chain and preaortic ganglia

9-Parasympathetic ganglia of the gastrointestinal tract

10-Adrenal medulla

11-Schwann cells

12-Glial cells

13-Arachnoid and pia mater (leptomeninges)

14-**Melanocytes**

Formation of the interatrial septum

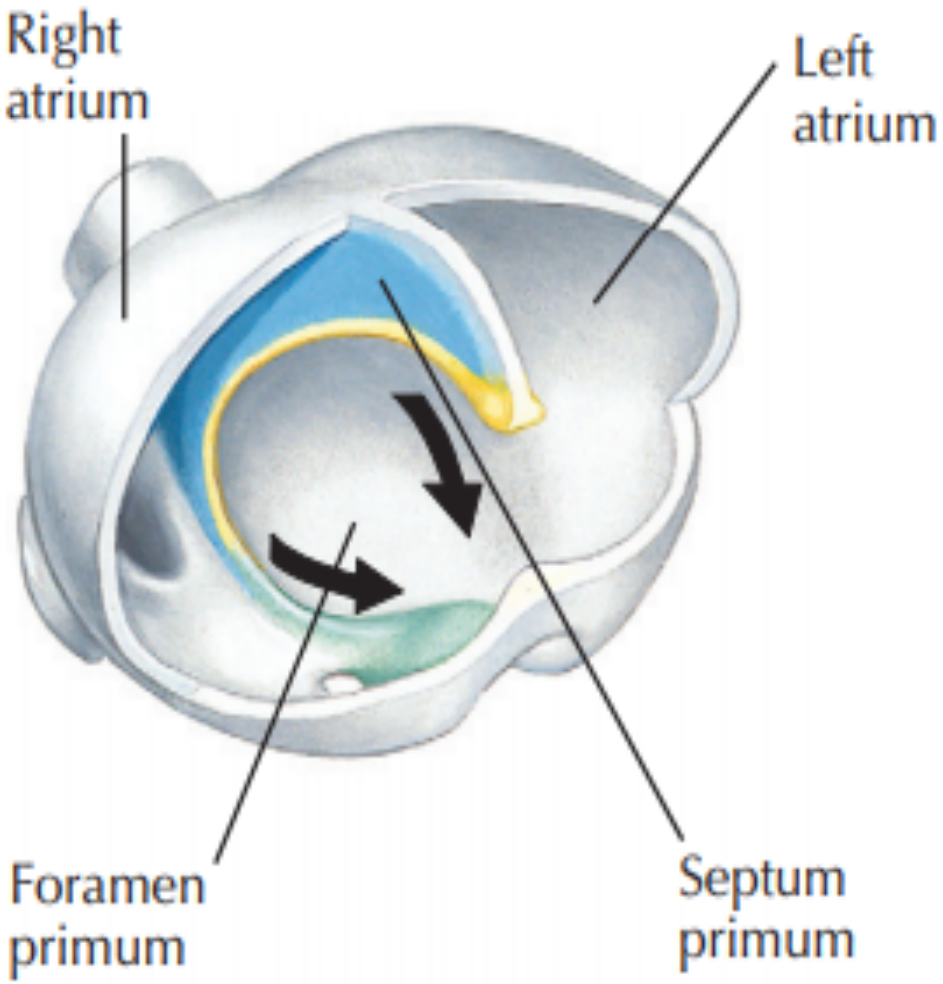
Atrial septation

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

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

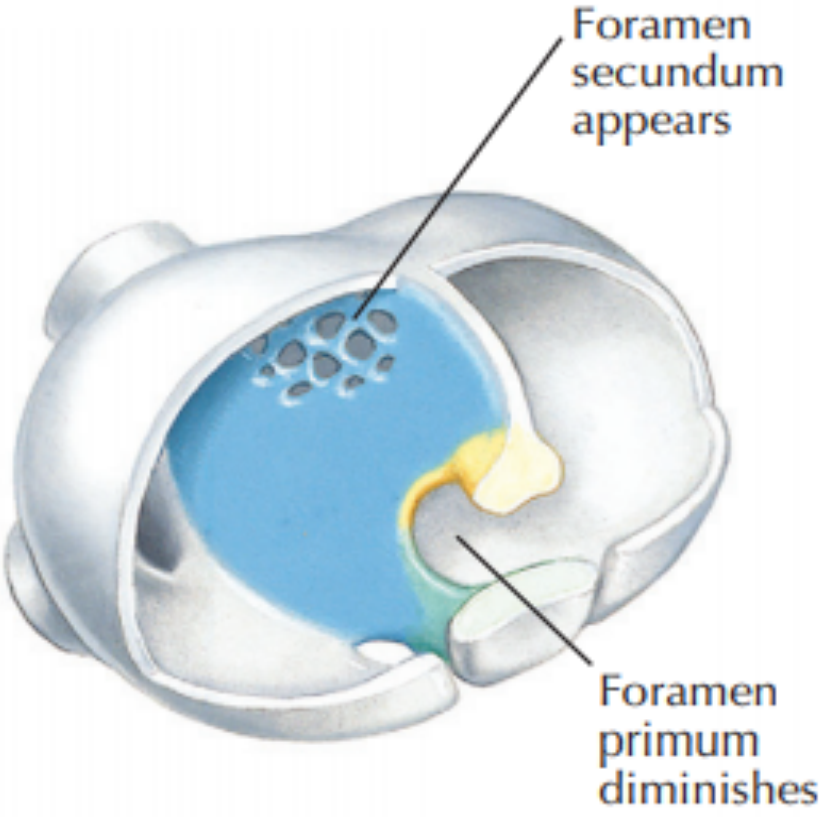
This opening is called

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).**

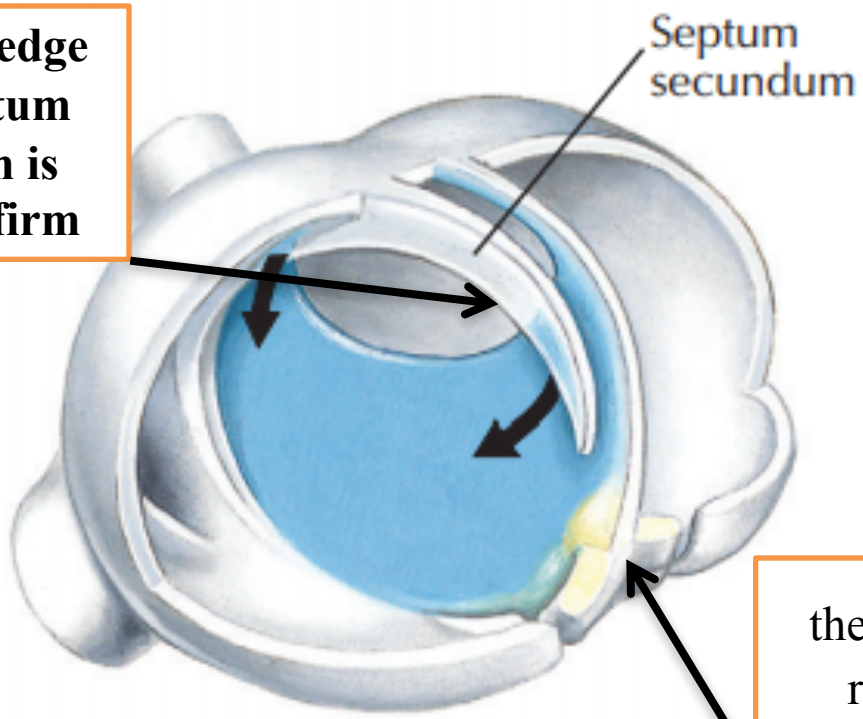


<u>The foramen primum</u>

Disappears as the septum primum fuses with the endocardial cushions

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



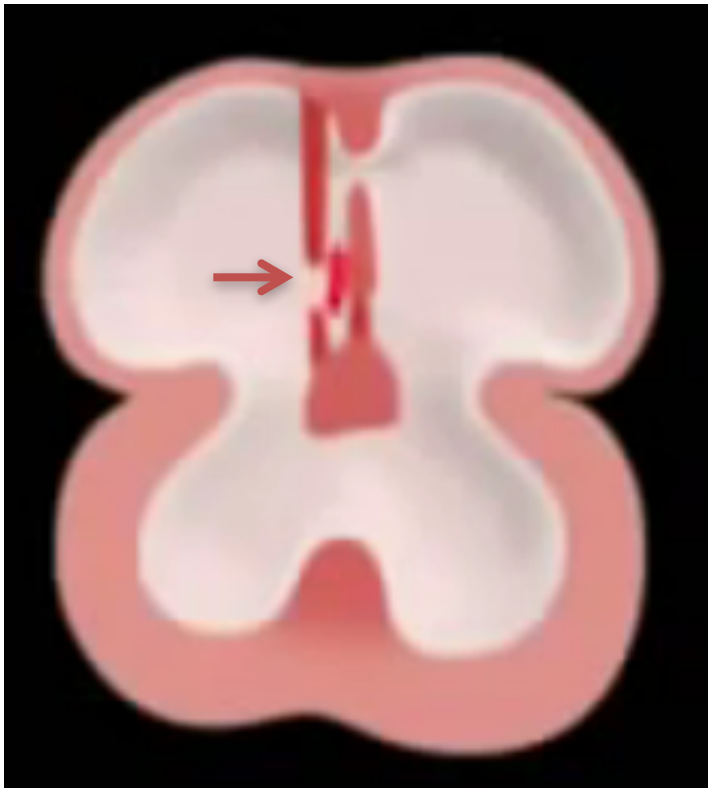
the septum secundum **does not** reach the endocardinal cushions

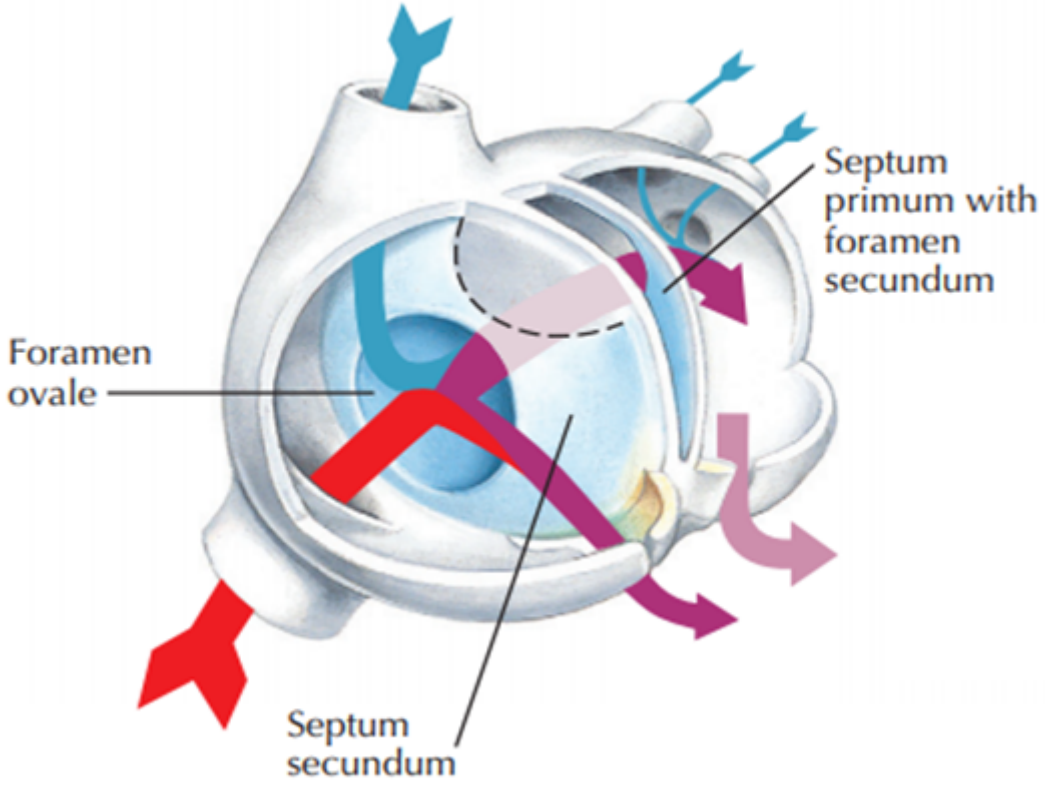
it gradually overlaps the **foramen secundum** in the septum primum

The opening between
septum secundum and the septum primum
Is called

(foramen ovale)

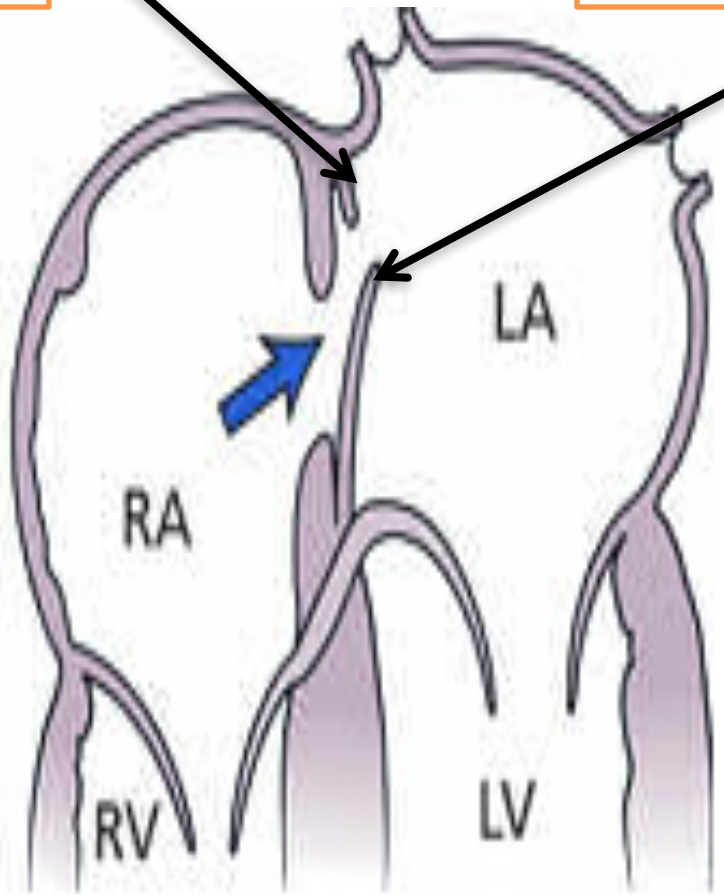
which persist throughout fetal life



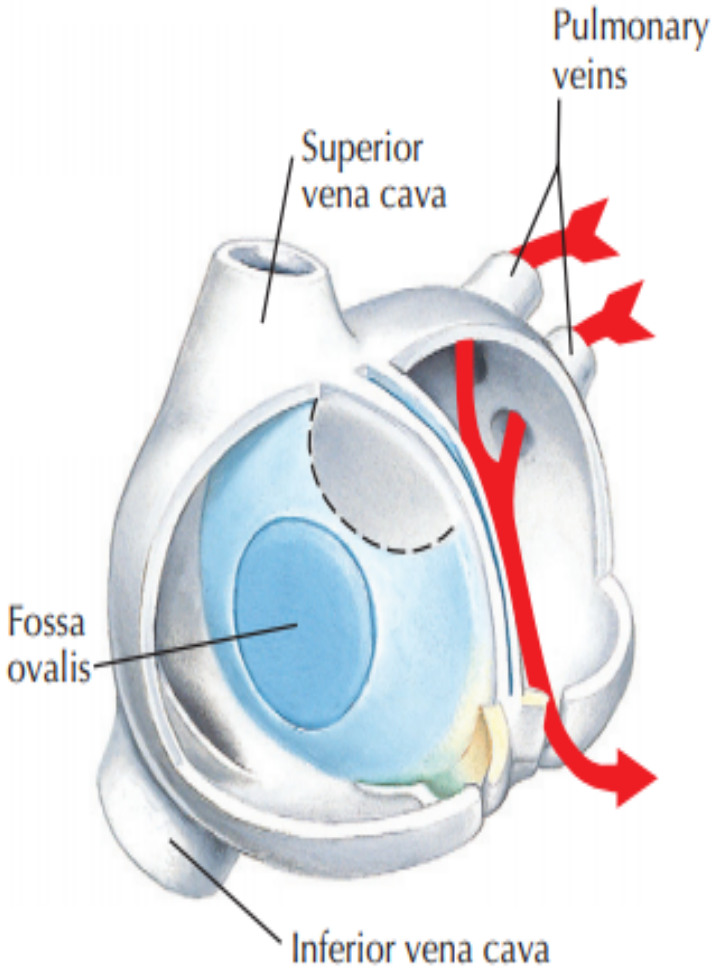


The cranial part of the septum primum gradually disappears

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.

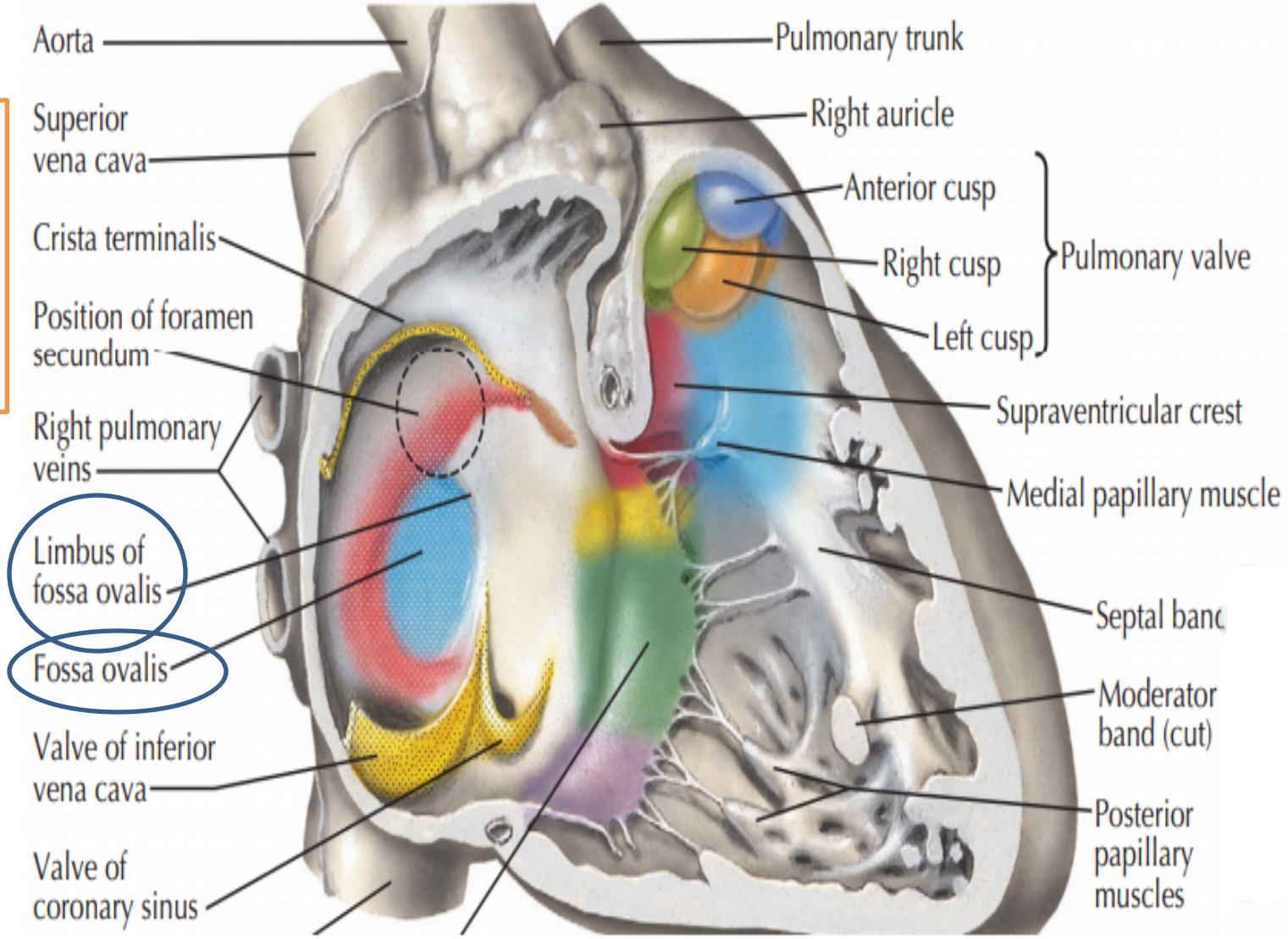


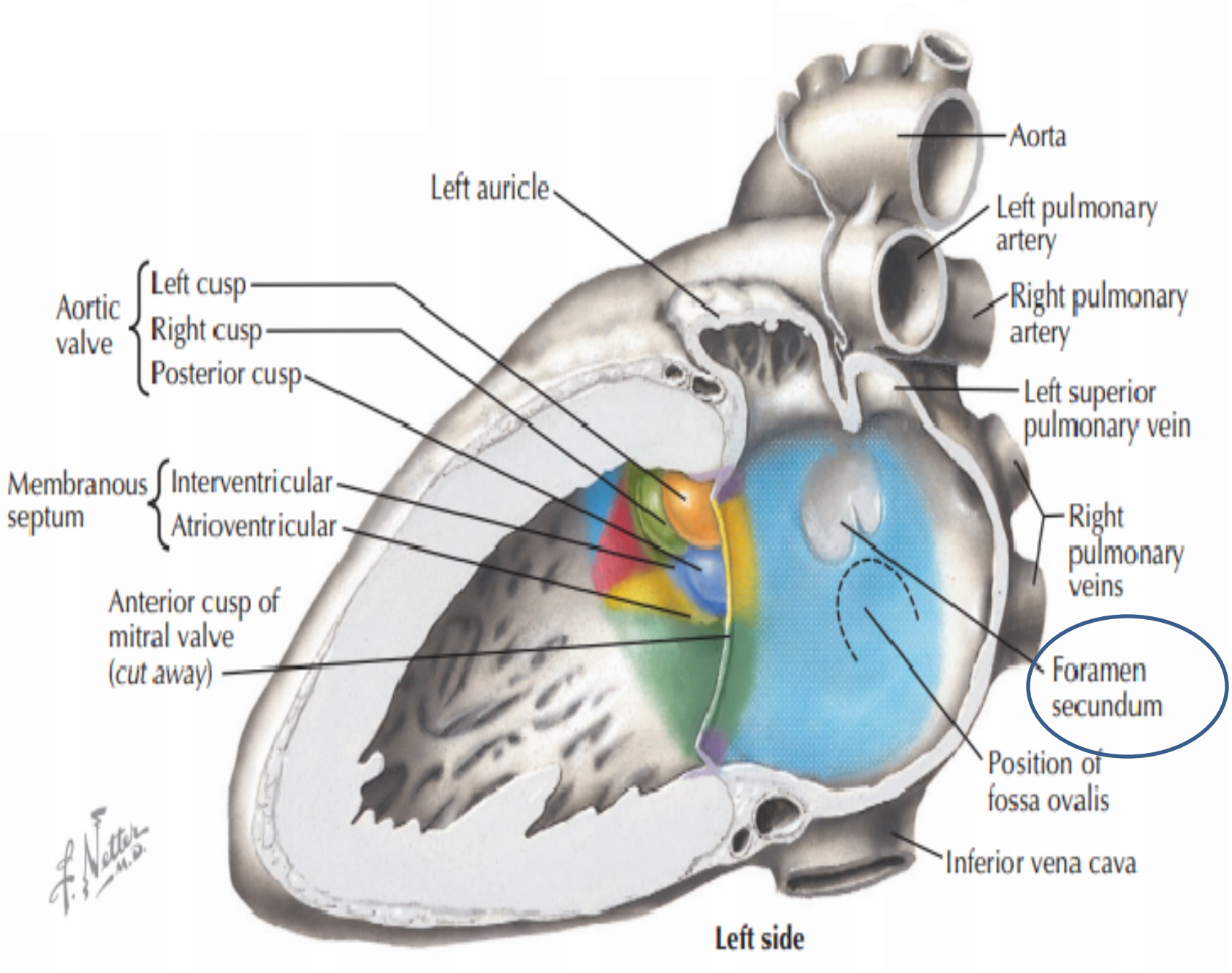
Foramen ovale closed after birth with increased pulmonary flow

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.

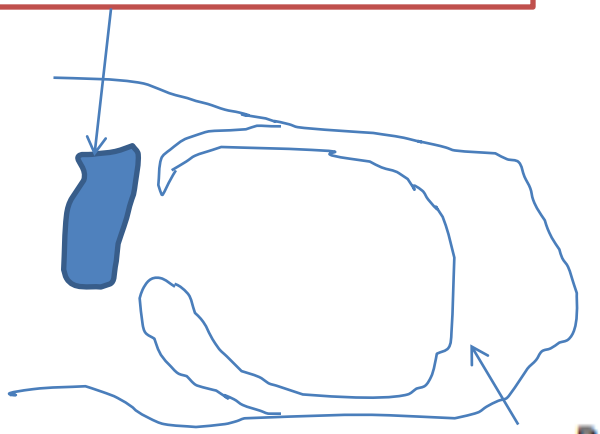


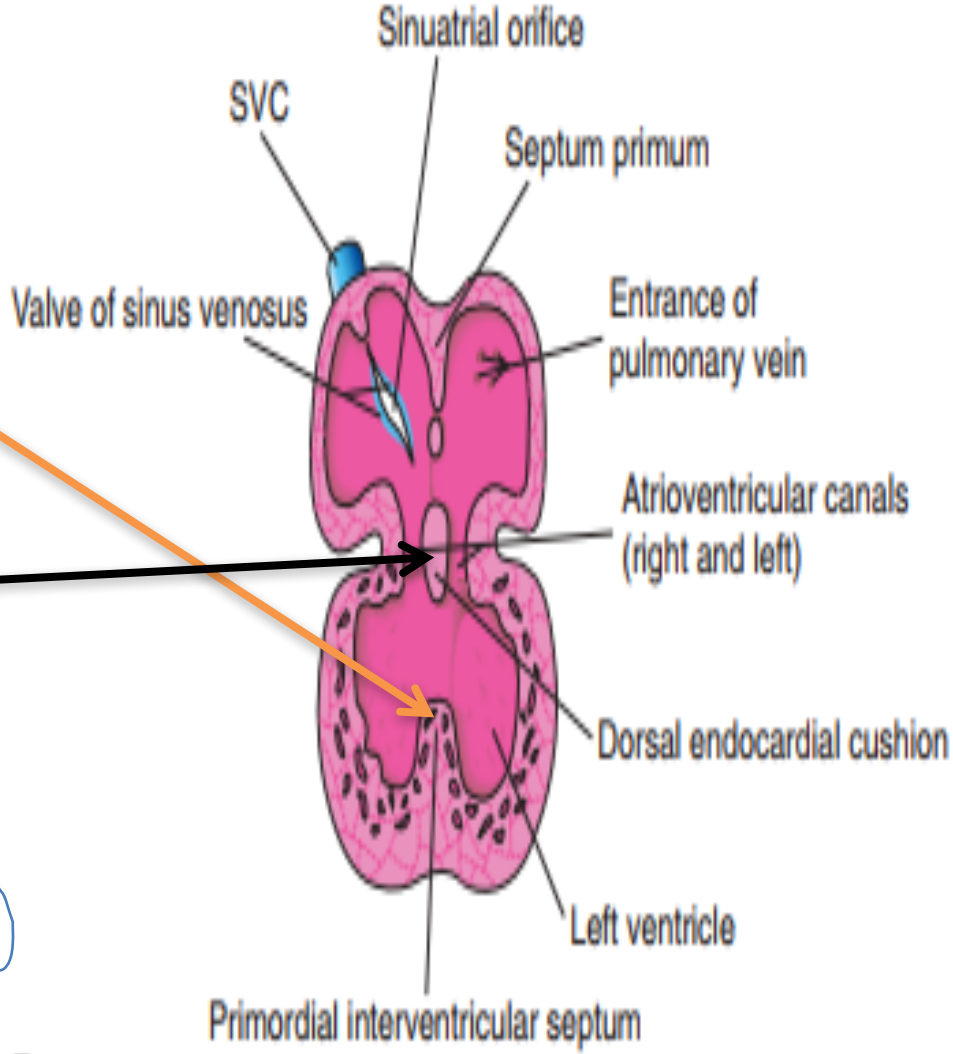

Aorta
Left auricle
Left pulmonary artery
Right pulmonary artery
Aortic valve
Left cusp
Right cusp
Posterior cusp
Left superior pulmonary vein
Membranous septum
Interventricular
Atrioventricular
Right pulmonary veins
Anterior cusp of mitral valve (cut away)
Foramen secundum
Position of fossa ovalis
Inferior vena cava
Left side

Separation of the two 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 endocardinal cushions

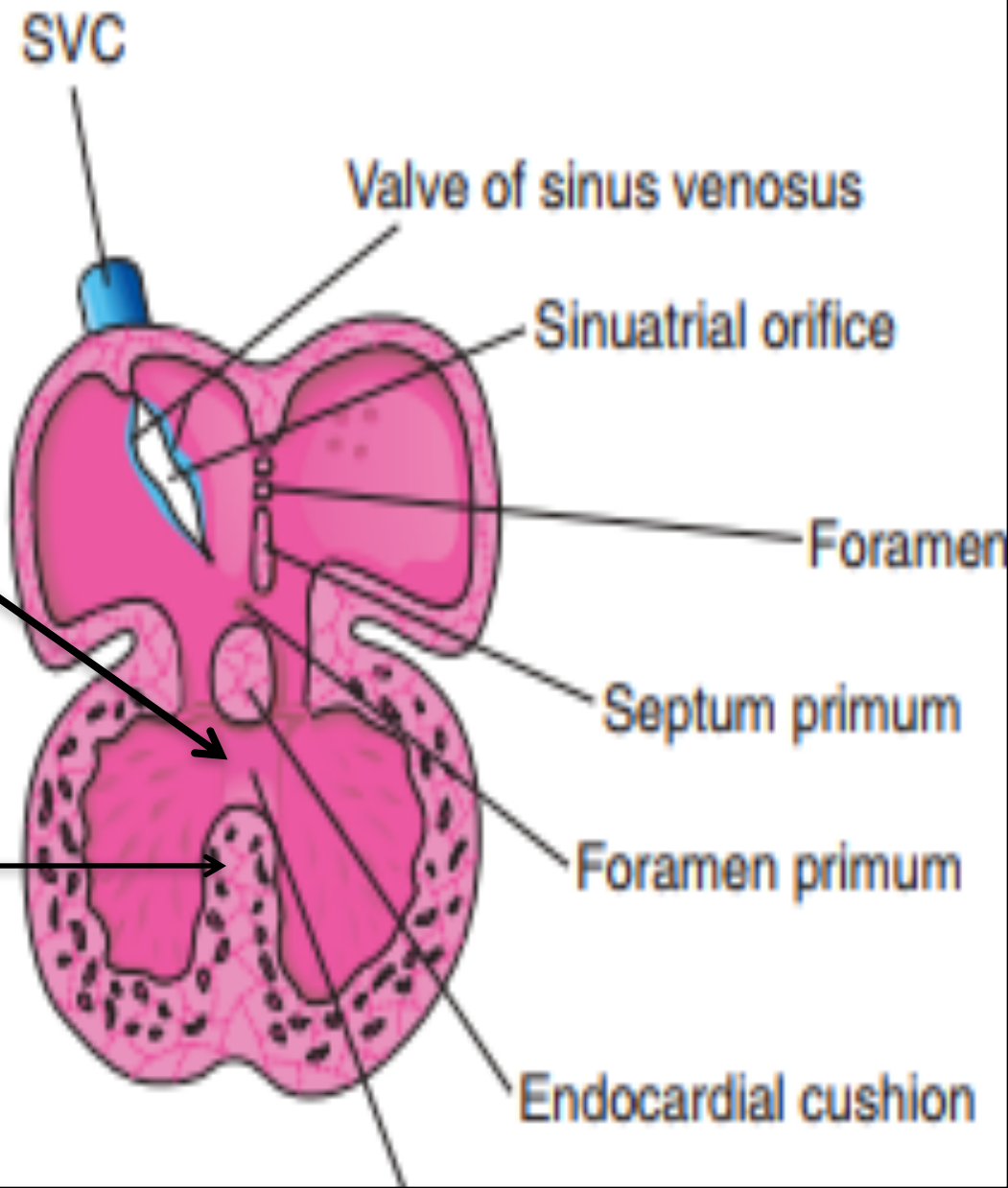




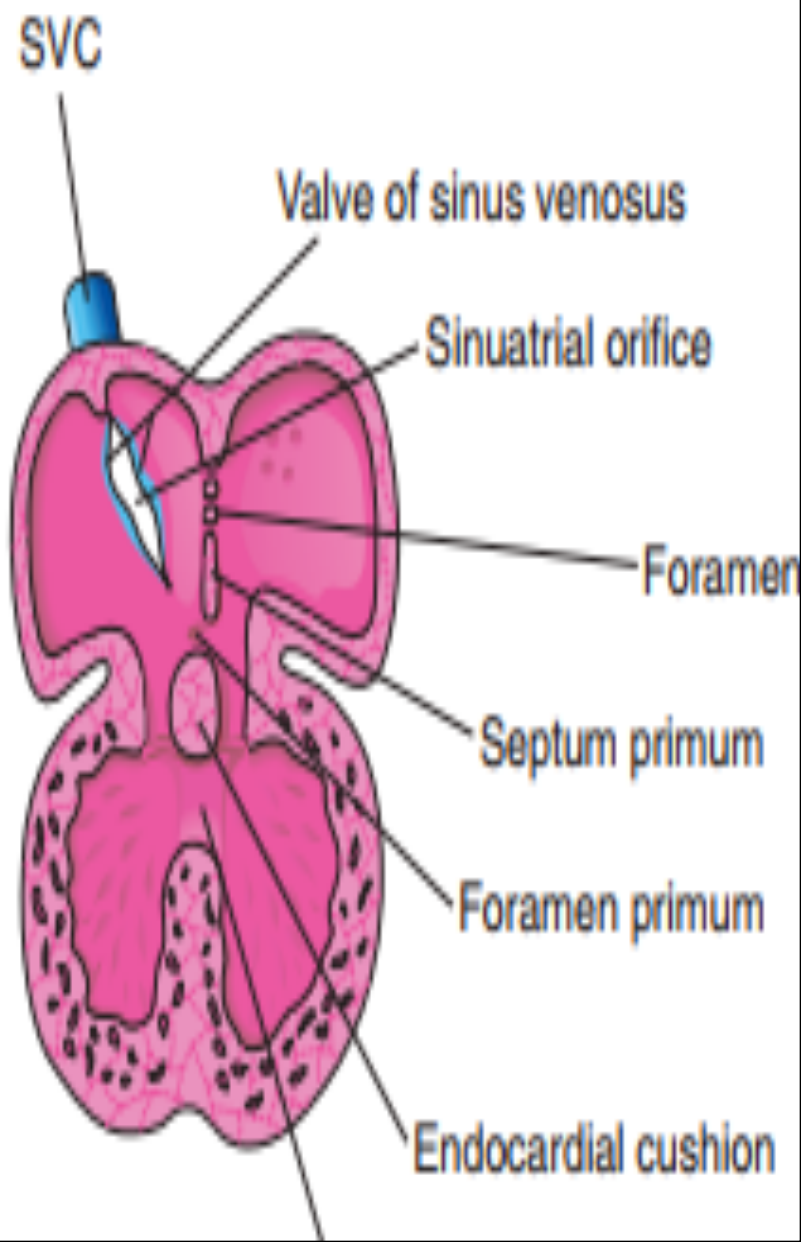
ventricular septum

- The upper cresentric 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 *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

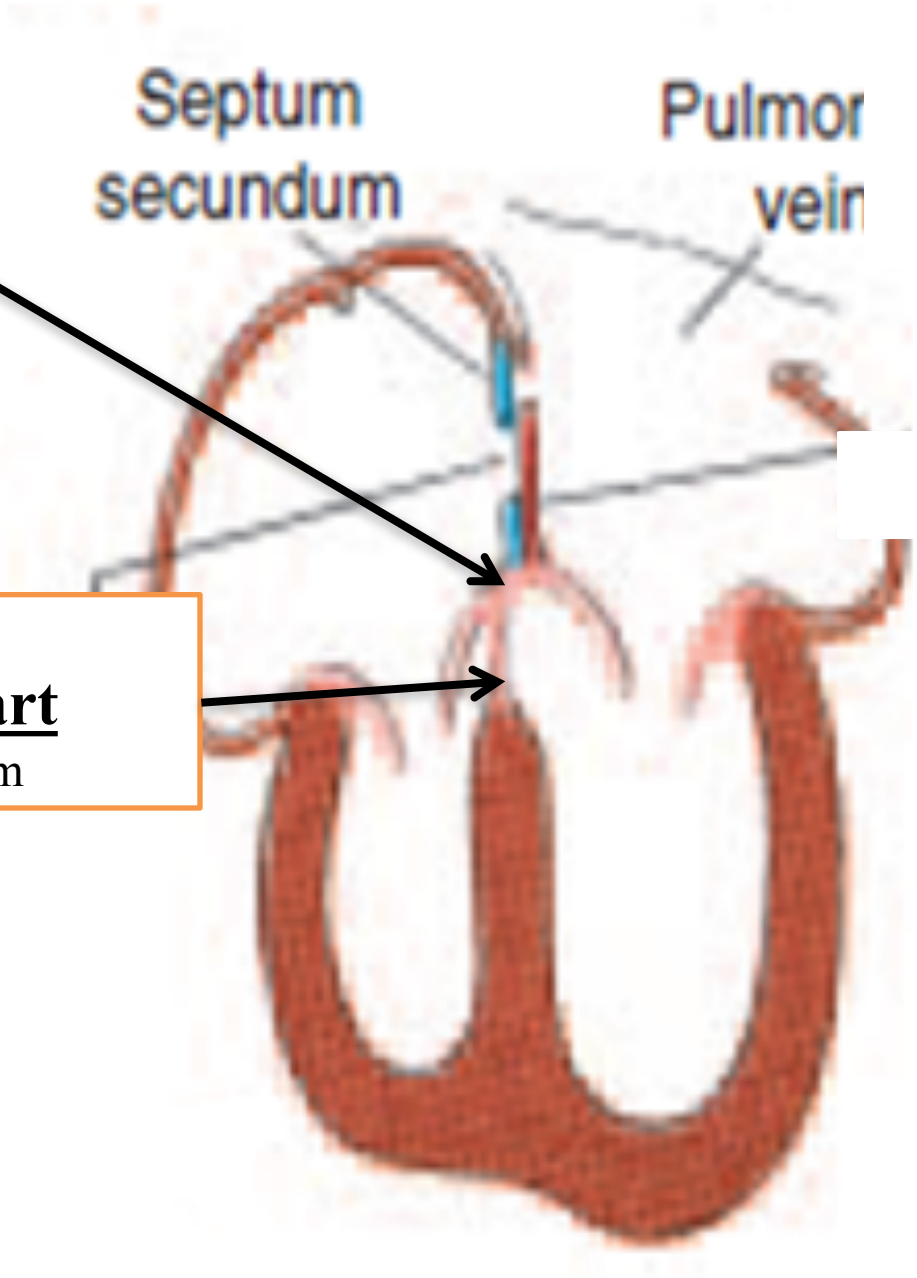


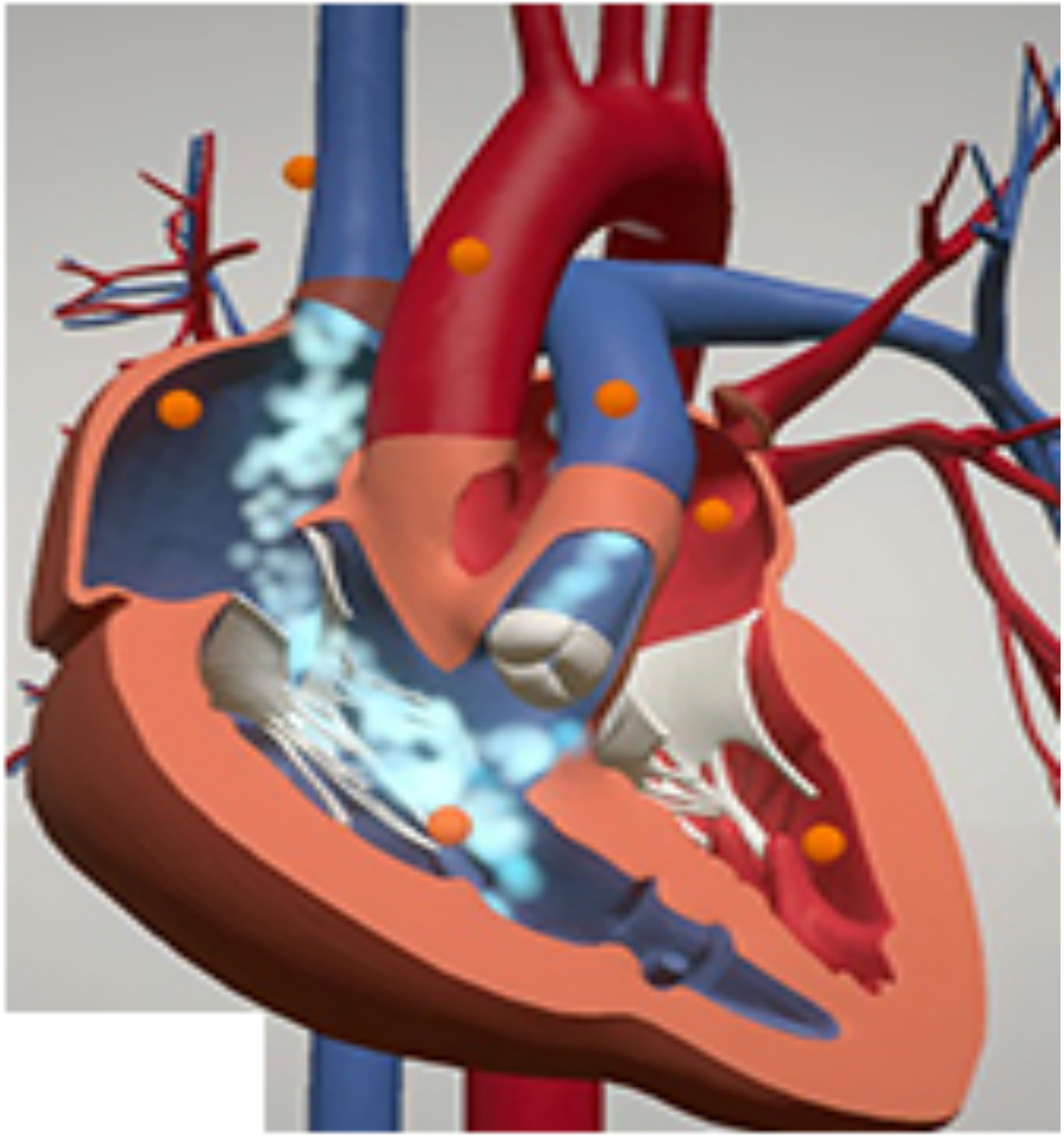
- At the end of the seventh week, a downward **extension occurs from the right margins of the a-v endocardial** septum (septum intermedium) to close the interventricular foramen.

- This extension forms

<u>The Membranous Part</u>

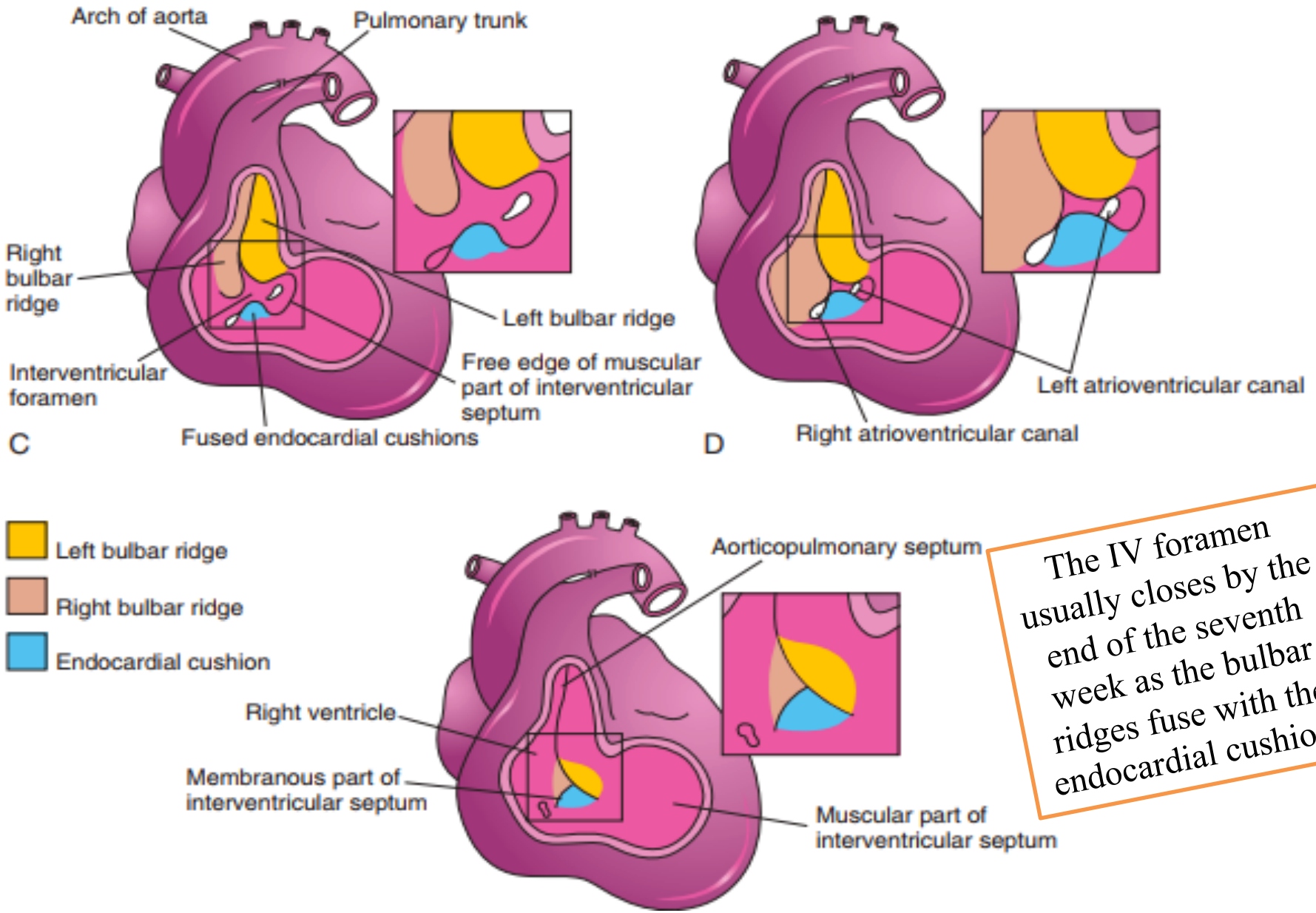
of the interventricular septum





- 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

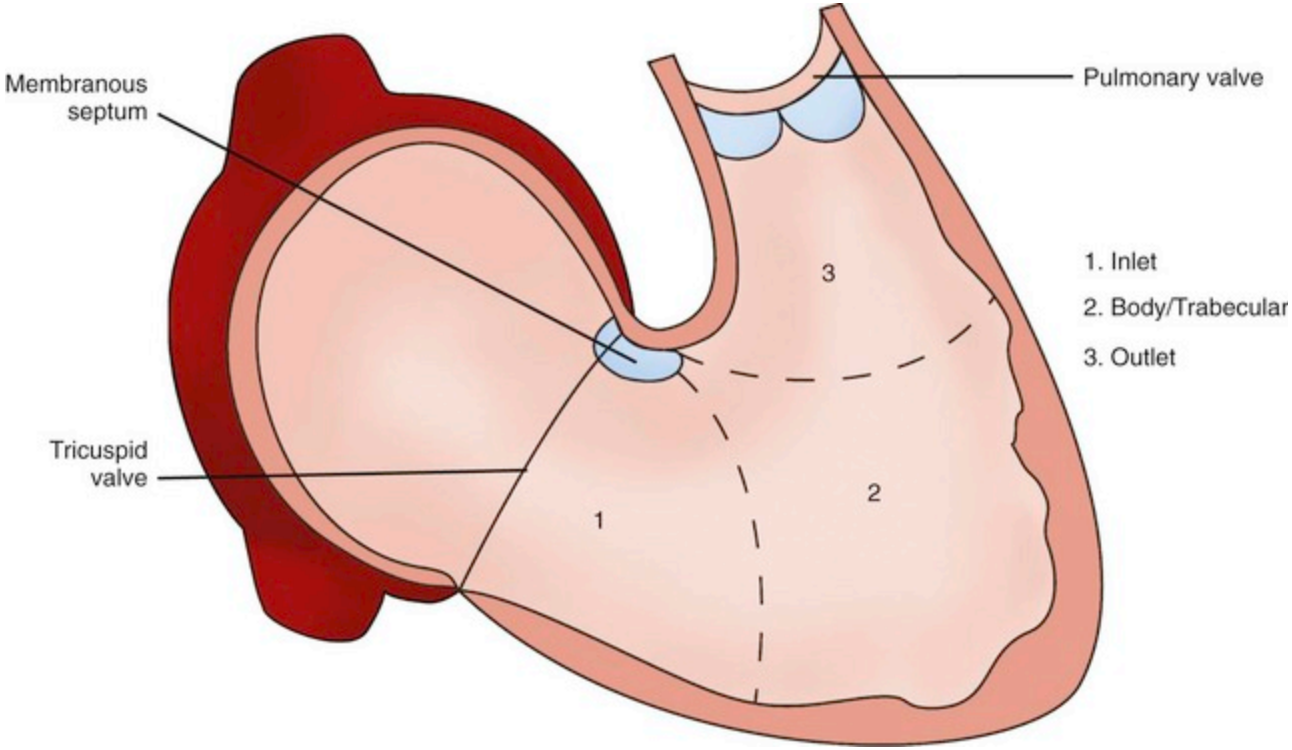
Three distinct structures contribute to the formation of the postnatal ventricular septum:

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**

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

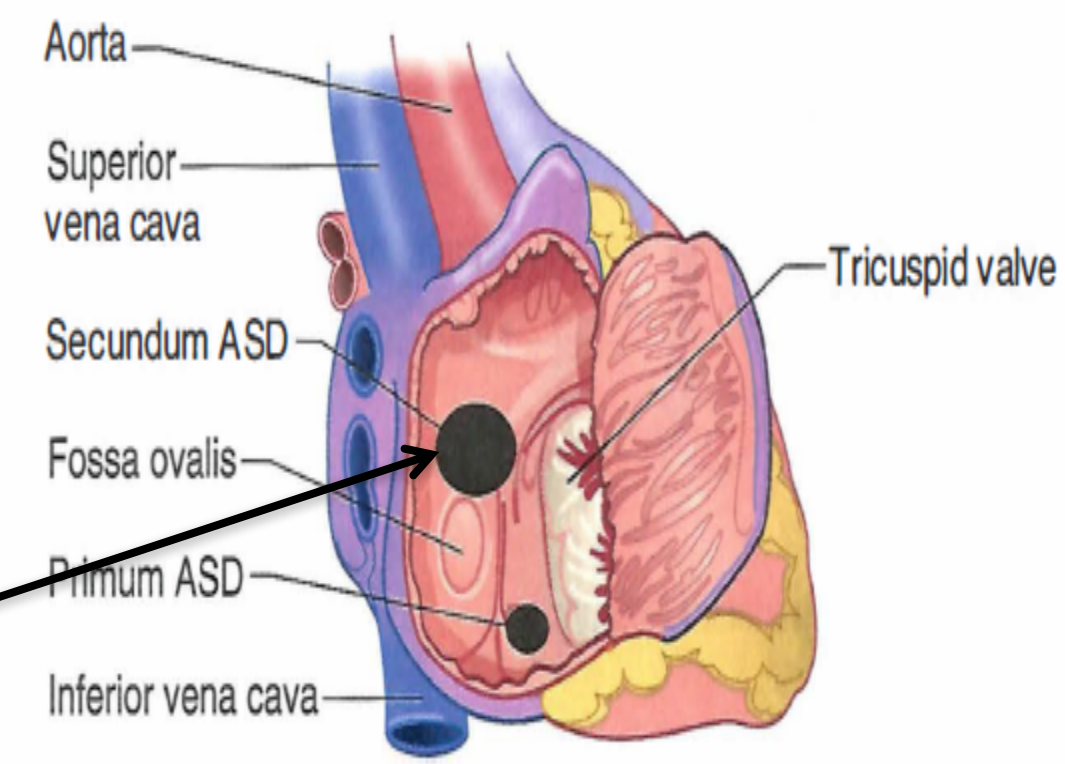


Figure III-2-15. Secundum and Primum Atrial Septal Defect

Postnatal Shunts

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

Left-to-right shunts are non-cyanotic conditions

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.

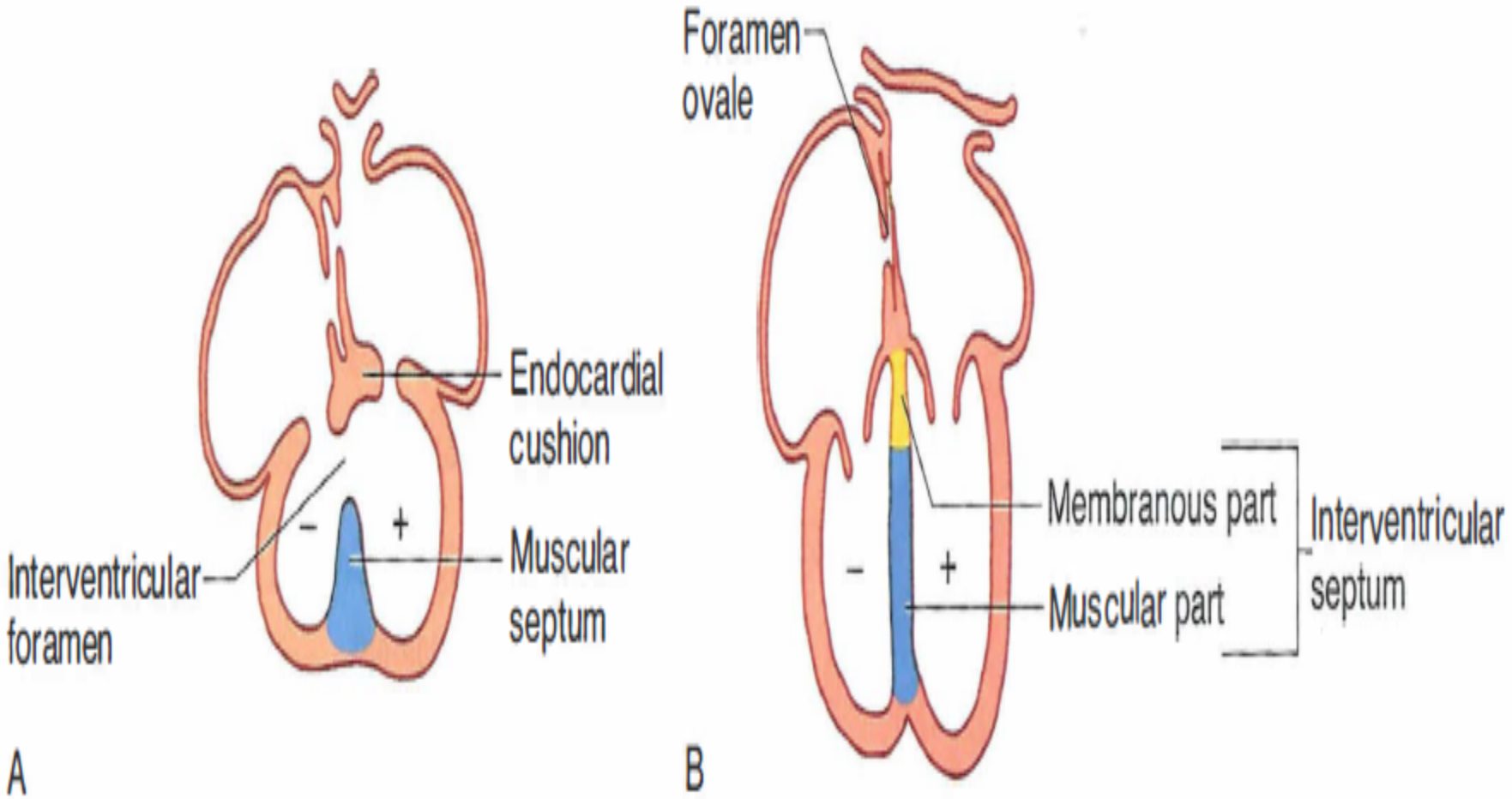
Ventricular septal defect (VSD)

- 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

Read only


Endocardial cushion
Interventricular foramen
Muscular septum
A
Foramen ovale
Membranous part
Muscular part
Interventricular septum
B