

ANATOMY / HISTOLOGY

☒ Sheet

☐ Slide

☐ Handout

Number

٦

Subject

CT scan & embryology

Done By

Maryam Al Jammal

Corrected by

Abdallah S. Sulaiman

Doctor

Faraj Bustami

Date: ٠٠/٠٠/٢٠١٦

Price:

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Today we are going to discuss two topics : CT scan and embryology . This sheet is too long in pages but full of pictures that we cannot exclude , because all are needed for the purpose of both midterm and final exams .

🔗 Radiology section

- 👉 CT-scan: (computerized tomography) it takes the images as cross sections from anterior to posterior. الصور المقطعية.
- 👉 Magnetic resonance imaging (MRI) الرنين المغناطيسي

Here we will discuss CT-scans at different levels:

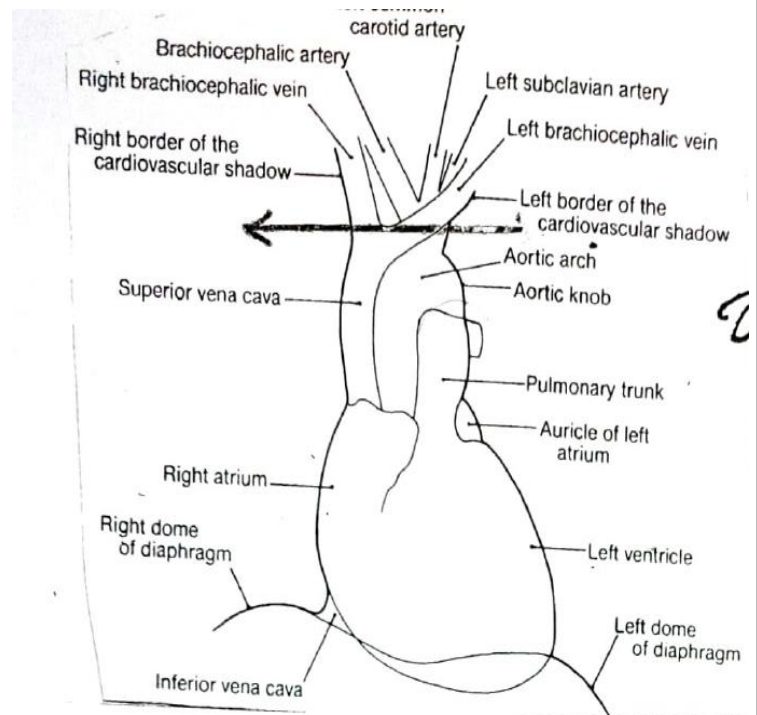
- I. above the arch's level
- II. through the arch
- III. at the aortic pulmonary window (directly beneath the arch)
- IV. at the level of the left pulmonary artery
- V. at the level of the right pulmonary artery
- VI. through the heart

First: CT-scan above the arch's level (at the level of the origin of the three branches of the aortic arch),

this section will pass through:

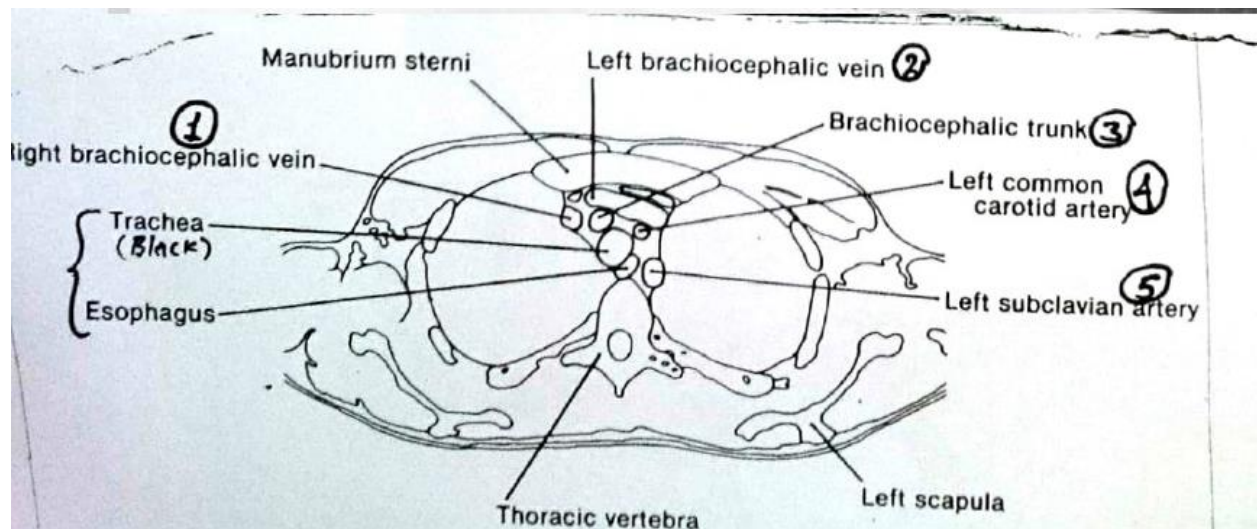
١. The three branches of the arch: (each one will appear as a ring)
 - a. Brachiocephalic
 - b. Left common carotid
 - c. Left subclavian
٢. The veins: (This section is above the arch, so **these two veins haven't united yet**)
 - a. Left brachiocephalic vein
 - b. Right brachiocephalic vein

Note : The arrow in the picture shows the level of the CT-scan.



☞ Look at the picture that describes the CT-scan, at the level of the origin of the three branches of the aortic arch (the doctor said that he will ask about it):

١. Lungs
٢. Manubrium (anteriorly)
٣. Vertebral column (posteriorly)
٤. The three branches of the aortic arch
٥. The trachea (posterior)
٦. Esophagus (posterior, hardly seen)
٧. Right brachiocephalic vein (anterior to the branches of the arch)
٨. Left brachiocephalic vein (anterior to the branches of the arch)



- ١- Right brachiocephalic vein
- ٢- Brachiocephalic artery
- ٣- Left brachiocephalic vein
- ٤- Left common carotid artery
- ٥- Left Subclavian artery

• Look at the following CT-scan and notice the following:

- Two lungs (black)
- The structures in the middle (in the mediastinum):
 - The manubrium sterni (anteriorly)
 - The vertebral column (posteriorly)

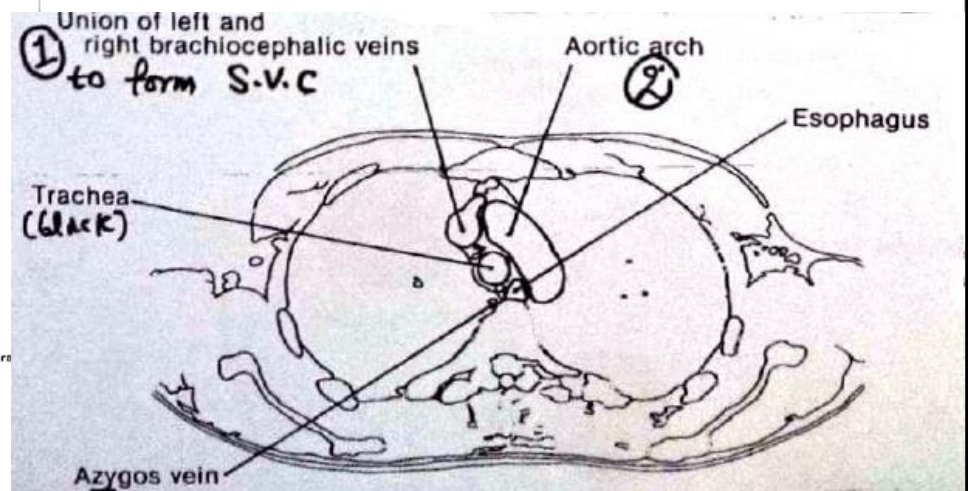
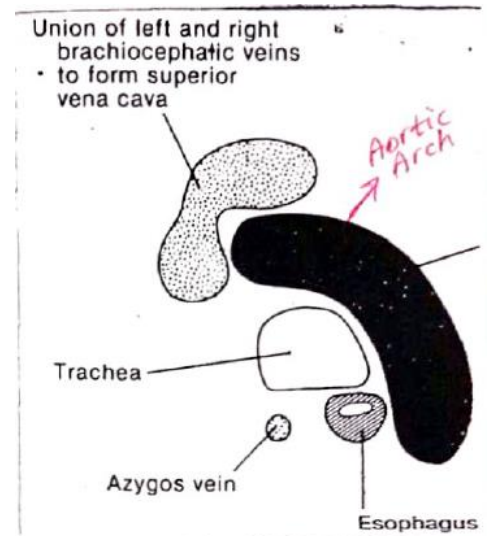
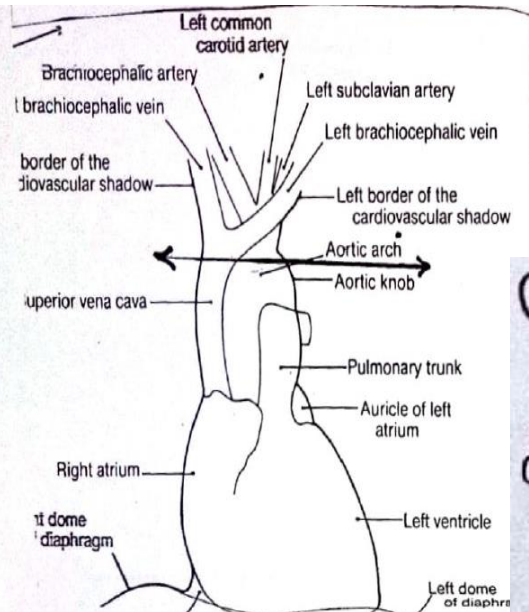


- The three branches of the aortic arch: (each artery appears as a ring)
 - Brachiocephalic.
 - Left common carotid
 - Left subclavian (posterior)
- Left brachiocephalic vein (anterior to the branches of the aortic arch)
- Right brachiocephalic vein
- ✚ **The right and left brachiocephalic unite together to form the superior vena cava. (If the section was taken from a lower level we can see the superior vena cava)**
- Trachea (posteriorly)
- Esophagus (posteriorly) ----- it is hard to be seen, because of the collapsed lumen.

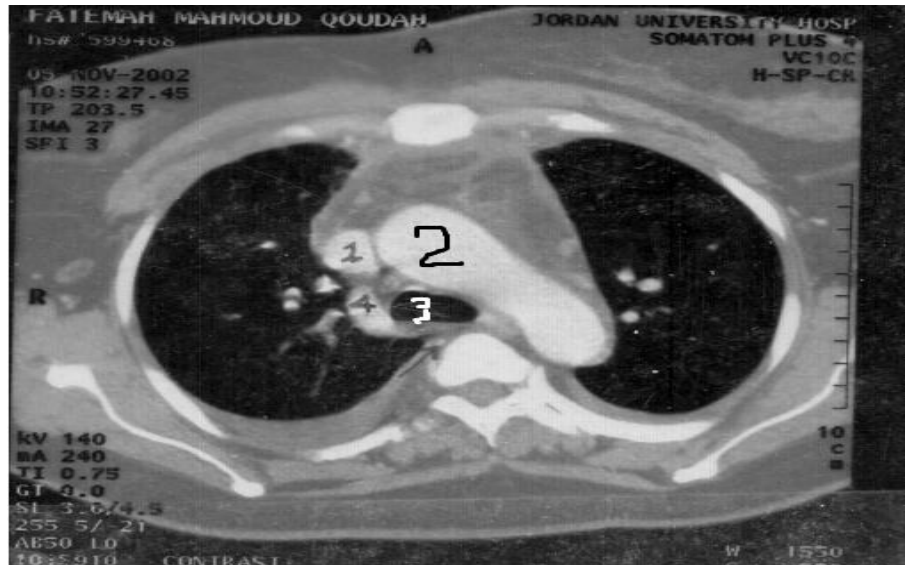
Second: CT-scan at the level of the arch of the aorta (the section passes through the arch)

We can see:

1. The arch itself (the branches do not appear)
2. Trachea (posterior to the arch)
3. Esophagus (posteriorly)
4. **The azygos vein**
5. The superior vena cava (on the right side of the arch),
the union of the right and left brachiocephalic veins.
6. The lungs on both sides



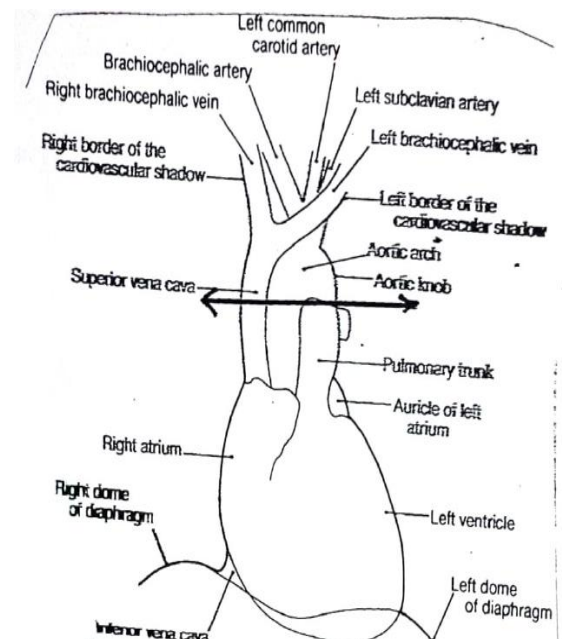
- ١- Superior vena cava
- ٢- Aortic arch
- ٣- Trachea
- ٤- Azygos vein



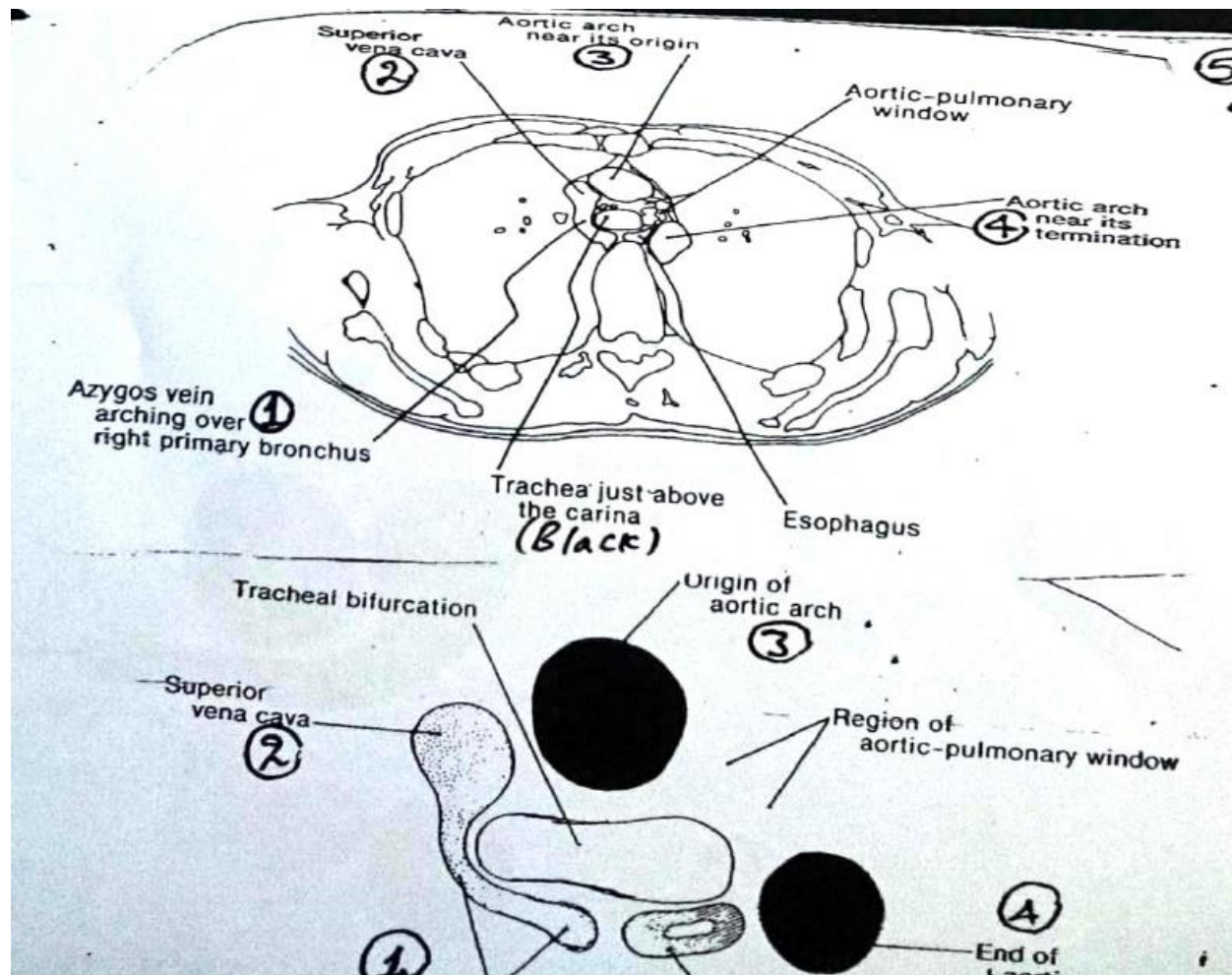
Third :CT-scan at the level of the aortic pulmonary window (directly beneath the arch):

We can see:

- Origin of the arch (anteriorly)
- The end of the arch (posteriorly)
(The arch is originated from anterior to posterior)
- Trachea (posteriorly) ----- in this section it is widened (bifurcation), so that it can be divided into the right and left bronchi. Esophagus (hardly seen)
- The superior vena cava (on the right side of the arch), it is the union of the right and left brachiocephalic veins.
- The azygos vein (might be seen. It opens into the superior vena cava)

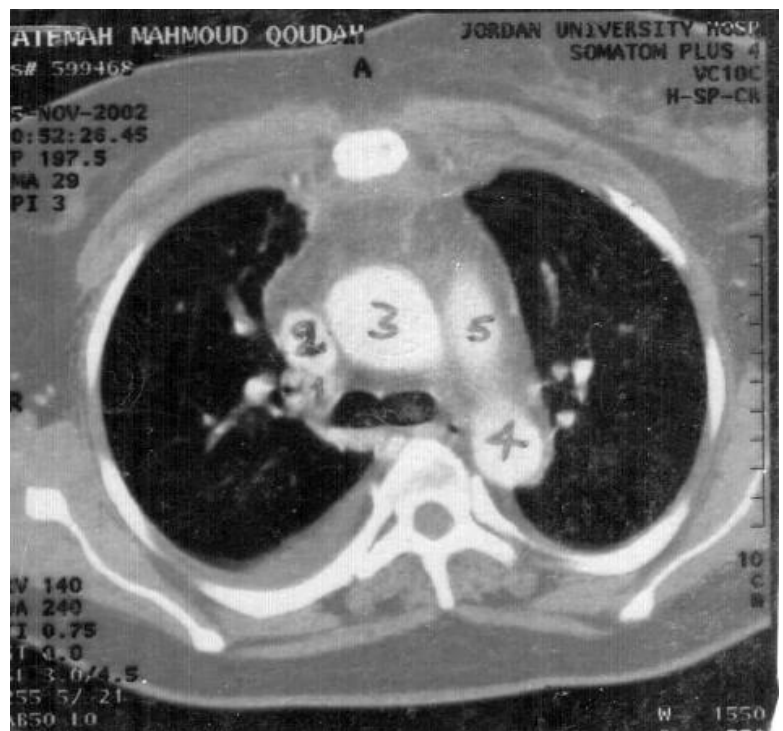


In this section, we cannot say: ascending or descending aorta, because the pulmonary trunk does not appear here. So we call them the origin and the end of the arch.



- ١- Azygos vein
- ٢- Superior vena cave
- ٣- Origin of the aortic arch
- ٤- End of the aortic arch
- ٥- Region of aortic-pulmonary window

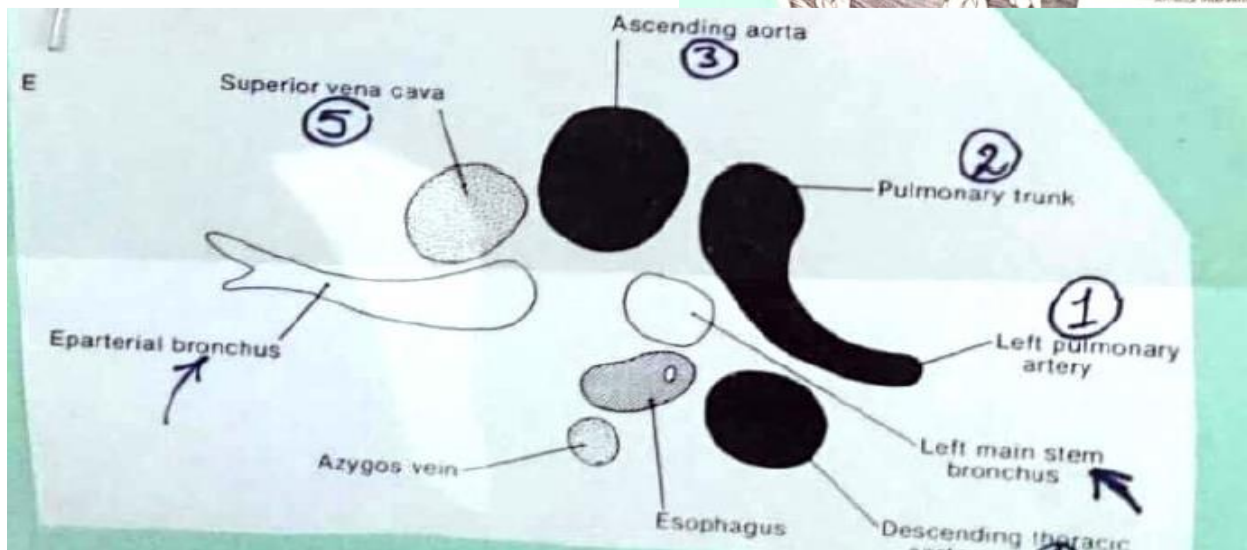
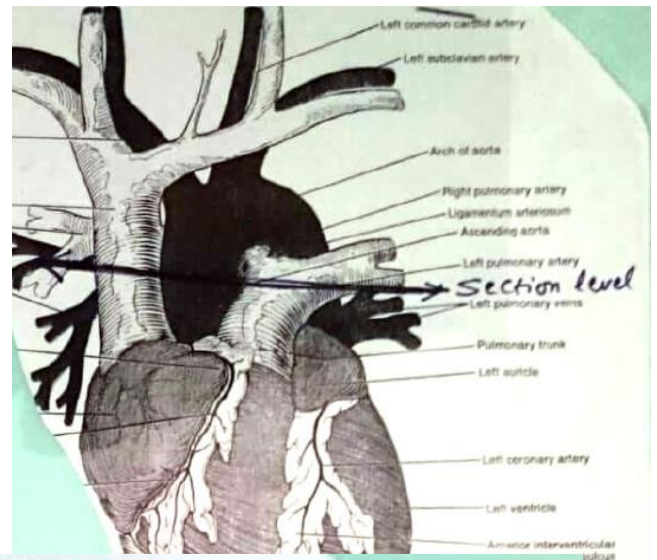
Notice the tracheal bifurcation.



Fourth : CT-scan at the level of the left pulmonary artery:

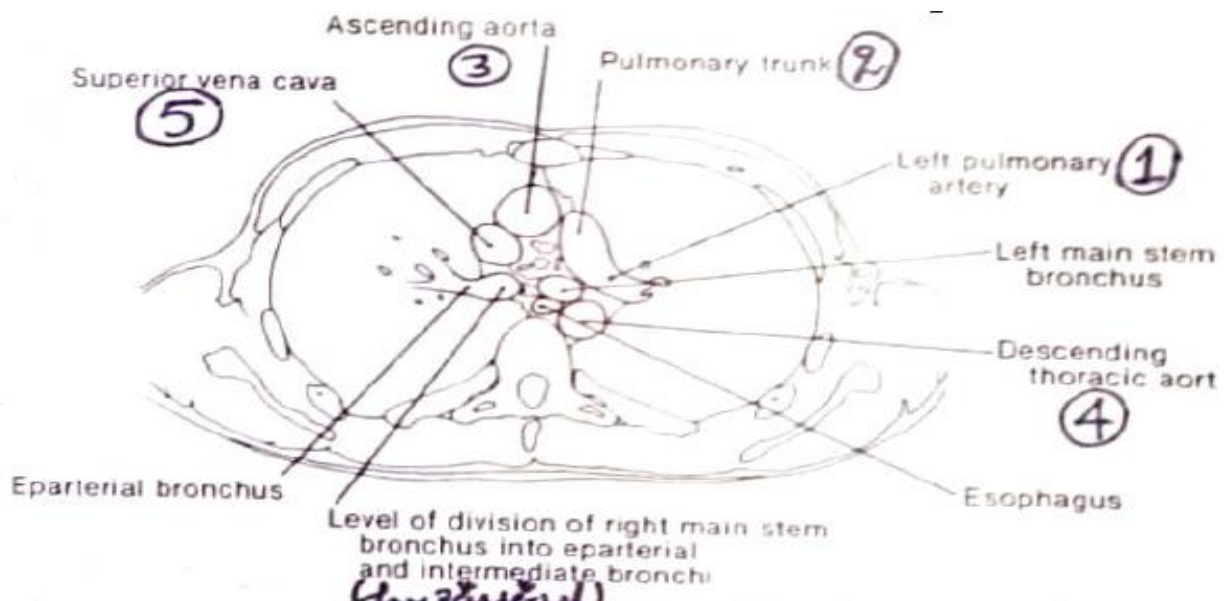
We can see:

- The ascending aorta
- The descending aorta (posterior)
- The pulmonary trunk
- Superior vena cava
- Right and left main bronchi (the trachea has divided)
- Esophagus (posteriorly)
- Azygos vein



- The superior vena cava, the ascending aorta, and the pulmonary trunk are all next to each other.
- When the pulmonary trunk passes beneath the aortic arch it divides, giving the right and left pulmonary arteries.
- In this CT-scan we have seen only the left pulmonary artery. However we can see the right too, and that depends on the position of the lungs, as they change their position during respiration (exhale and inhale)
- This is a CT-scan at the level of the left pulmonary artery.

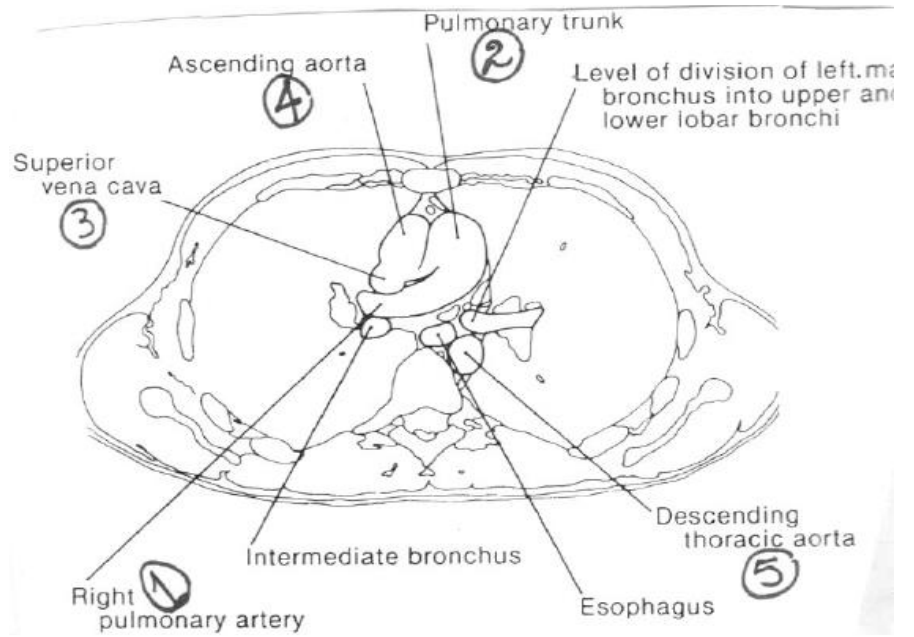
- ١- Left pulmonary artery
- ٢- Pulmonary trunk
- ٣- Ascending aorta
- ٤- Descending aorta
- ٥- Superior vena cava



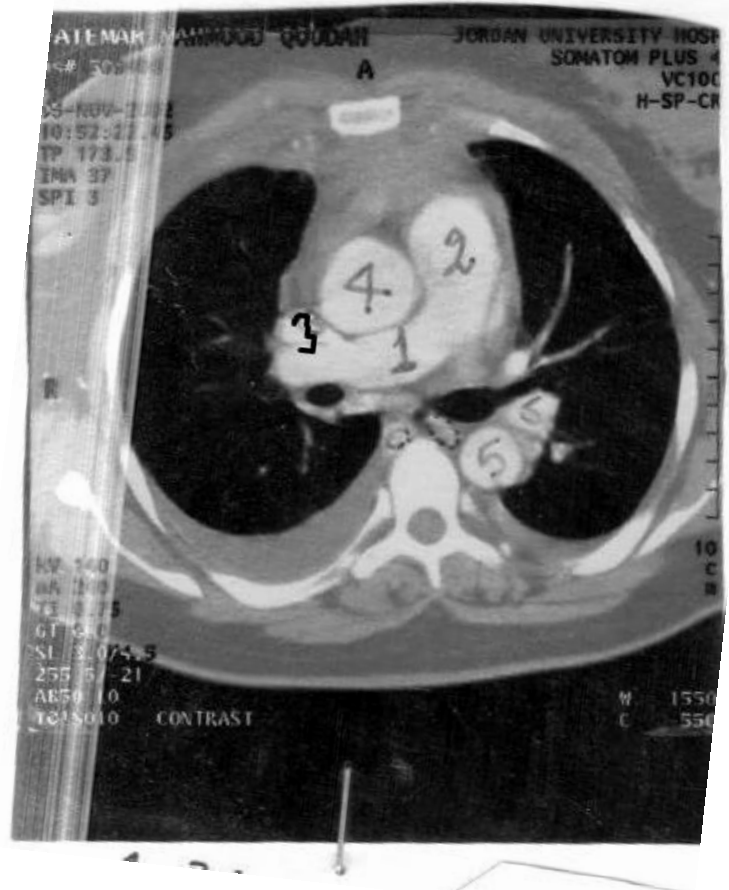
Fifth: CT-scan at the level of the right pulmonary artery: (we are going downward with every new section)

We can see:

- The pulmonary trunk, with Right pulmonary artery which is longer than the left.
- The ascending aorta (anterior)
- The descending aorta (posterior)
- The two bronchi (the trachea has divided into left and right bronchi, and each one of them will give branches)
- Esophagus
- Azygos vein



- ١- Right pulmonary artery
- ٢- Pulmonary trunk
- ٣- Superior vena cava
- ٤- Ascending aorta
- ٥- Descending aorta
- ٦- I think it's one of the left pulmonary veins.

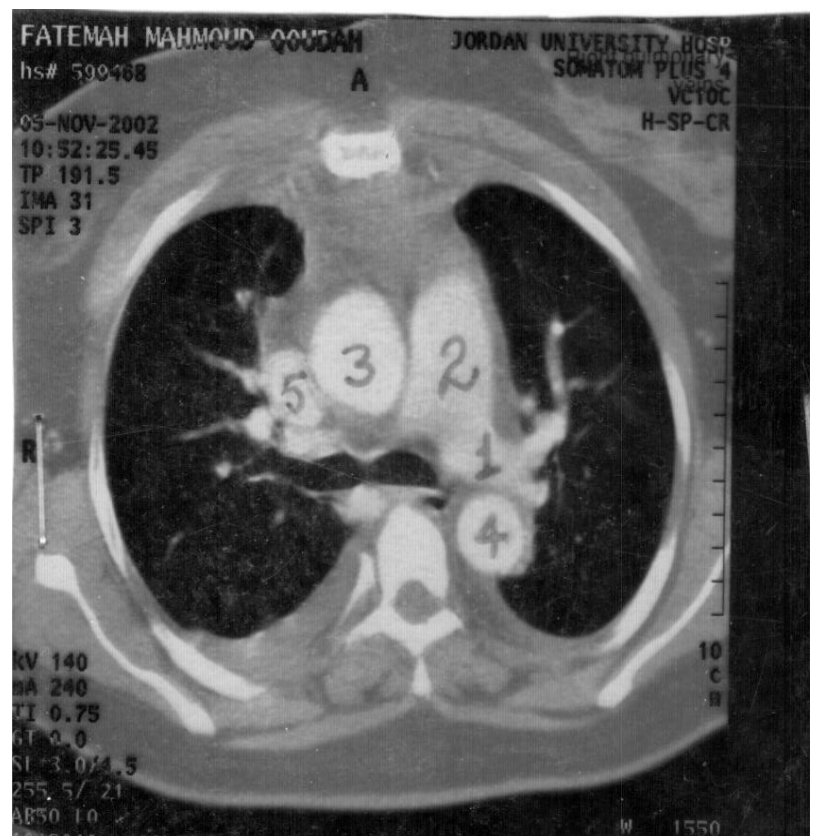


- If I can see the pulmonary trunk, then I can see the ascending aorta and the descending aorta.
- At this level, we can see the main pulmonary trunk; however, the left branch has disappeared, because it is at a higher level of the section.
- On the other hand, the right branch can be seen in this section.
- The right pulmonary artery is longer than the left one.
- The right pulmonary artery passes posterior to the ascending aorta and posterior to the superior vena cava.
- As mentioned before, we can see the pulmonary trunk, the ascending aorta, and the superior vena cava next to each other.
- Again, we cannot see the ascending aorta or the descending aorta except when we see the pulmonary trunk alone or with its branches.

Let's describe the following CT-scan:

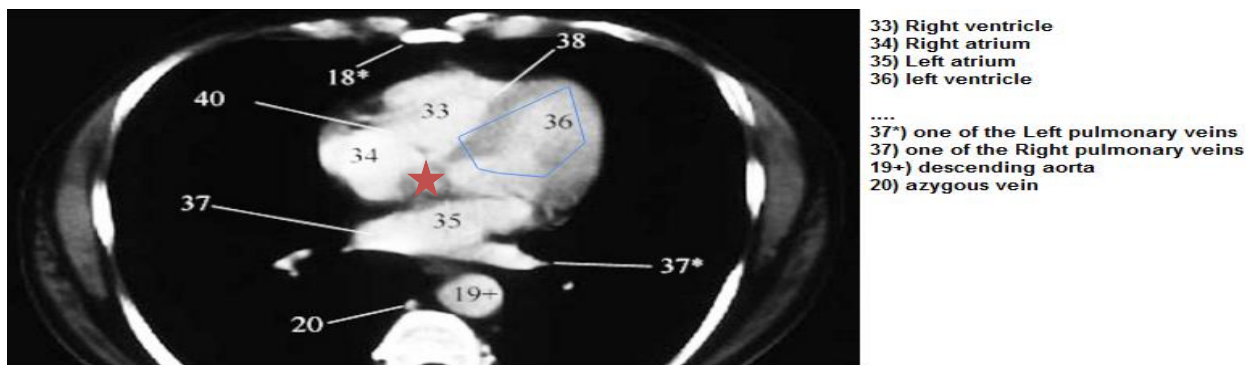
We can see:

- ✓ The pulmonary trunk. --- #٧ on the image.
- ✓ Ascending aorta --- #٧
- ✓ Superior vena cava ----#٥
- ✓ The left pulmonary artery ---- #١
(the pulmonary trunk in this section has divided, the left artery is clear in the image, while the right is not)
- ✓ The descending aorta --- #٤
- ✓ The two black rings in the middle are bronchi.
- ✓ Hardly seen esophagus posteriorly
- ✓ There are branches inside the lungs --- they are the branches of the pulmonary arteries inside the lungs
- ★ We can now describe the image as a CT-scan at the level of the left pulmonary artery.
- ✓ The left branch was clear



- ✓ If a branch of the pulmonary trunk appears then the pulmonary trunk can be seen.
- ✓ Next to the pulmonary trunk there are the ascending aorta and the superior vena cava.
- ✓ The ascending aorta appears, so the descending aorta must appear posteriorly.
- ✓ We cannot see the ascending aorta except if the pulmonary trunk appears
- ✓ As mentioned, sometimes we can see the pulmonary trunk with its two branches (the left and the right)
- ✓ The right is longer than the left. And it passes posterior to the ascending aorta and posterior to the superior vena cava.
- ✓ The left and the right bronchi can be seen.

Sixth : CT-scan that passes through the heart:



The star indicates the **ascending aorta**

- ✦ The right atrium is anterior and to the right of the left atrium.
- ✦ The right ventricle is anterior and to the right of the left ventricle.
- ✦ The pulmonary veins enter into the left atrium.
- ✦ Anteriorly, we can see the ribs and the sternum.
- ✦ Posteriorly, there is the vertebral column.
- ☞ The ascending aorta is located in the middle of this section. Why?
 The ascending aorta is originated from the left ventricle (the left side of the heart).
 It goes toward the right side. While passing in this way, a part of the ascending aorta passes posterior to the right ventricle.

(We can see the ascending aorta from the left ventricle, by locating one finger on the first part of the aorta, and the other finger in the upper part of the right ventricle (infundibulum))

- ✦ The descending aorta is posterior to the heart and separated from the heart by the pericardium.
- ✦ **Next to** the descending aorta there is the esophagus, which is hardly seen, because of the collapsed lumen that doesn't open except during swallowing.

- ✦ The anterior surface of the heart: the sternocostal surface, it is composed of:
 - i. Mainly the right ventricle.
 - ii. The left border of the heart is from the left ventricle.
 - iii. The right border is from the right atrium.

At a certain level in CT-scans, the ascending aorta starts to disappear. However, the descending aorta stays clear, and next to it there is the esophagus.

Note:

The sagittal plane divides the body into right and left halves.

The coronal plane divides the body into anterior and posterior halves.

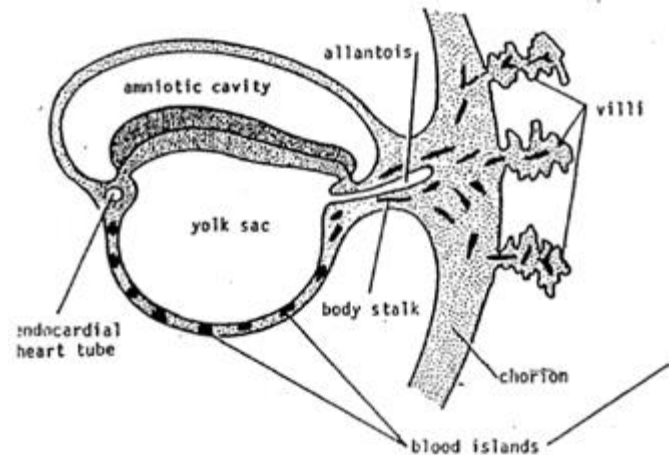
Again and again :

- ✦ If the CT-scan was taken so that the section was through the ascending aorta, it must pass through a part or more of the pulmonary trunk.
(If the pulmonary trunk appears, the ascending aorta will appear too)
- ✦ If the ascending aorta appears then the descending aorta will appear posteriorly. Their arrangement: (ascending aorta, arch, then the descending)
- ✦ Anatomically, there are three structures that pass next to each other:
 - Pulmonary trunk
 - Ascending aorta
 - Superior vena cava

Embryology

This is a section from the embryonic disc:

١. The amniotic cavity is located above it.
٢. The yolk sac is below it.
٣. The body stalk which is the future umbilical cord.
٤. The chorion which is the future placenta.



The formation of blood vessels starts at the beginning of the third week of development with the formation of the **blood islands** (clusters of angioblasts)

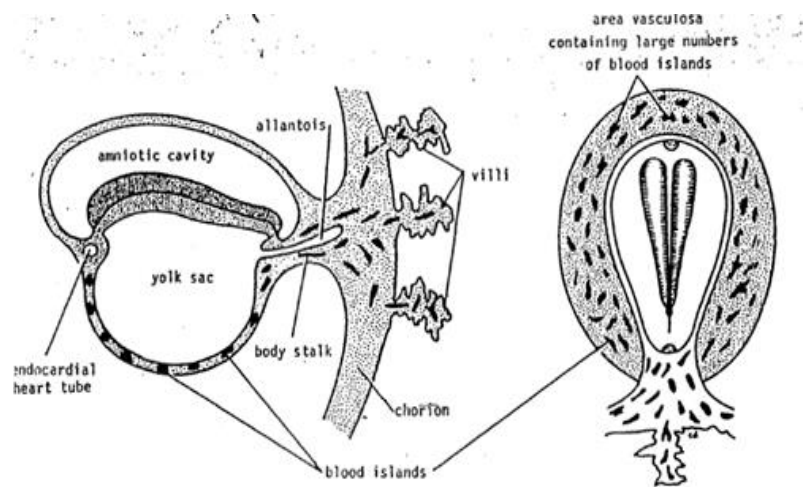
٥. What are the blood islands?

They are a group of mesenchymal cells (mesodermal cells)

٦. Where do they appear?

They first appear outside the embryo, in:

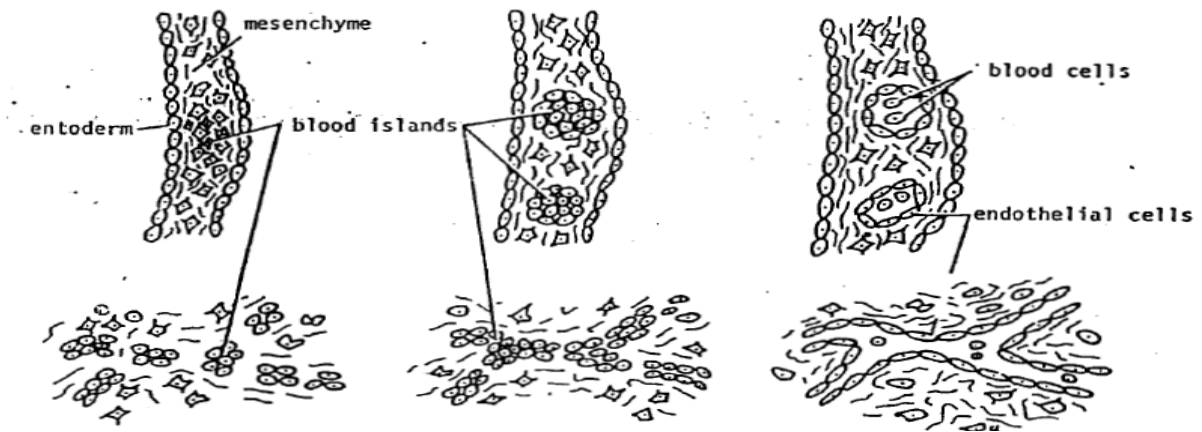
- The wall of the yolk sac
- The body stalk
- The chorion



Blood vessels generation:

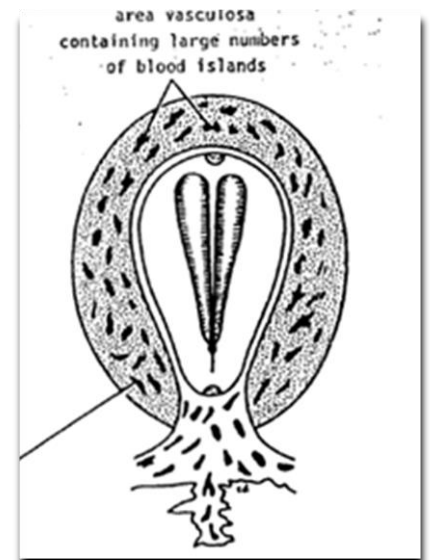
Inside the blood islands:

- The cells on the periphery will differentiate into simple squamous epithelium, so that they can continue their differentiation into the endothelium of blood vessels.
- The cells in the center will differentiate to form primitive blood cells.

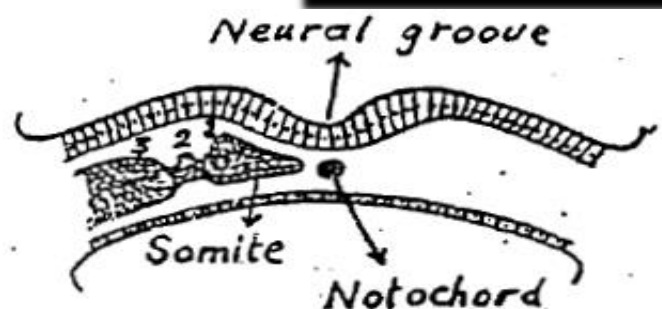


- ☞ These were the first steps of forming capillaries, which will enlarge gradually to form blood vessels.
- ☞ All these blood vessels, which are formed in the yolk sac, the body stalk, and the chorion, are called **extra embryonic vessels**.
- ☞ In the same manner, blood vessels will be formed in the embryo (embryonic disc) and are called **intra embryonic vessels**.
- ☞ Finally, the extra embryonic vessels will be joined and connected to the intra embryonic vessels.

✚ This is a cross section from the embryo in the 3rd week, and that is the dorsal view of it. (Removing the amniotic cavity and looking into it from above).



- ❖ The embryonic disc in the 3rd week is composed of three layers:
 - a. Ectoderm.
 - b. Intra embryonic mesoderm (mesenchyme) ---- located between the ectoderm and the endoderm.
 - c. Endoderm

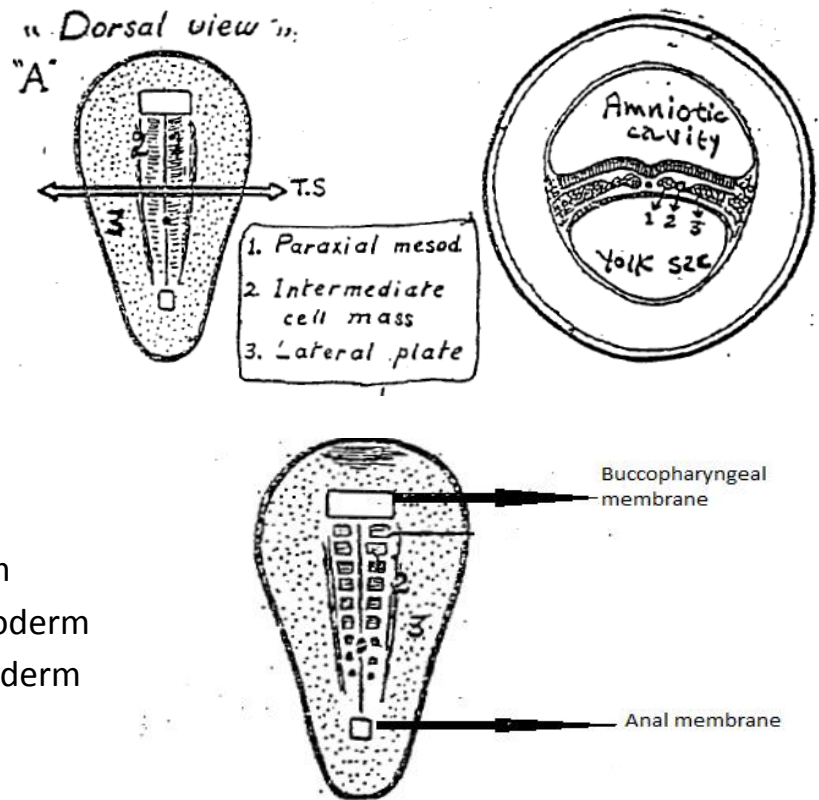


✓ The mesoderm: (from medial to lateral)

١. Paraxial mesoderm
٢. intermediate mesoderm
٣. Lateral plate mesoderm

Notice in this section:

- The ectoderm has started forming the neural tube.
(This will form CNS in the future).
- The endoderm.
- Notochord
- The mesoderm:
 ١. Paraxial mesoderm
 ٢. Intermediate mesoderm
 ٣. Lateral plate mesoderm



- As mentioned before,
the embryonic disc is composed of three layers (ectoderm, mesoderm, and endoderm). However, there are two areas that do **not** contain **mesoderm**:
١. The precordial/procordial plate (buccopharyngeal membrane) ----- the future mouth.
 ٢. The anal/ cloacal membrane ----- the future anus.

(These areas will rupture to form the mouth and the anus).

The mesoderm:

١. Paraxial mesoderm ----- will form body somite.
٢. Intermediate mesoderm ----- will form parts of the urogenital system.

٢. Lateral plate mesoderm ----- in this part many cavities will appear and then fuse together to form a single cavity called **intra embryonic coelom**.

- The intra embryonic coelom will form: (look at the image below)

١. The pericardial cavity ----- from the top of the coelom.

٢. The pleural cavity ----- the second part of the coelom.

٣. The peritoneal cavity ---- the last part of the coelom.

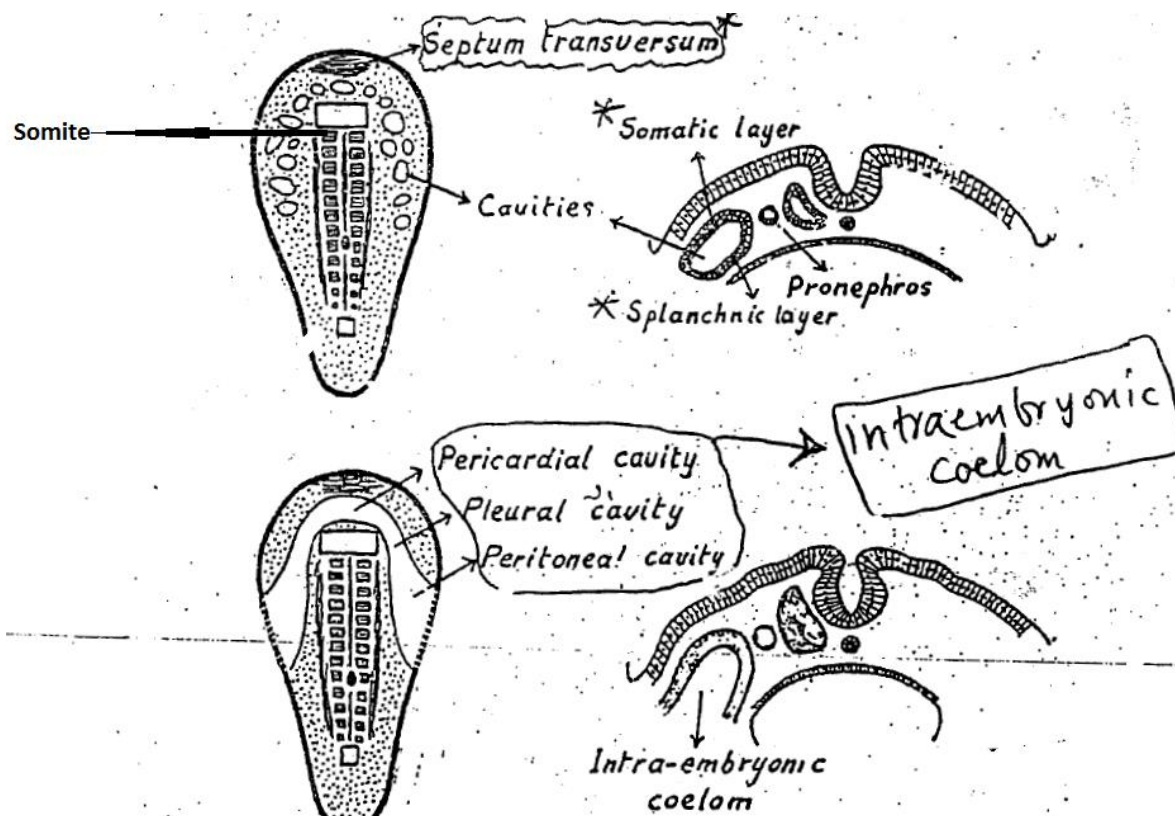
(That means that all the cavities in our body where one single cavity called intra embryonic coelom.)

- ❖ When this coelom is formed, the lateral plate mesoderm will be divided into: (what is written in *Italic* wasn't mentioned by the doctor)

١. Somatic layer(*outer parietal*) .

٢. Splanchnic layer. (*inner visceral*)

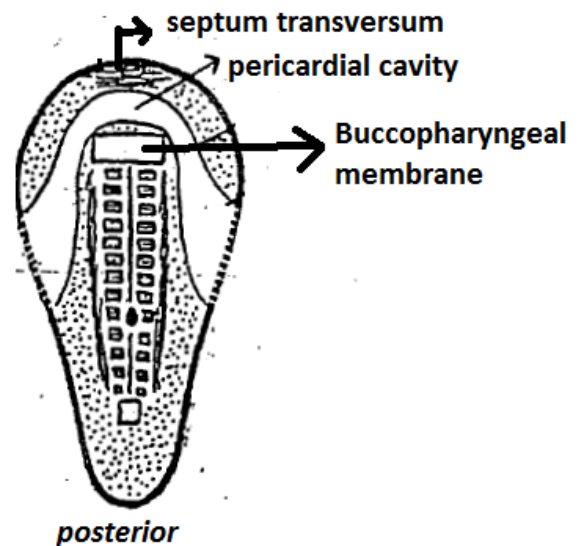
- In the anterior part of the embryonic disc, there is a mass of mesoderm called **septum transversum**.



Notice in the previous sections:

- The ectoderm has started forming the neural tube.
- The paraxial mesoderm.
- Intermediate mesoderm.
- The lateral plate mesoderm ---- it has started forming body cavities.

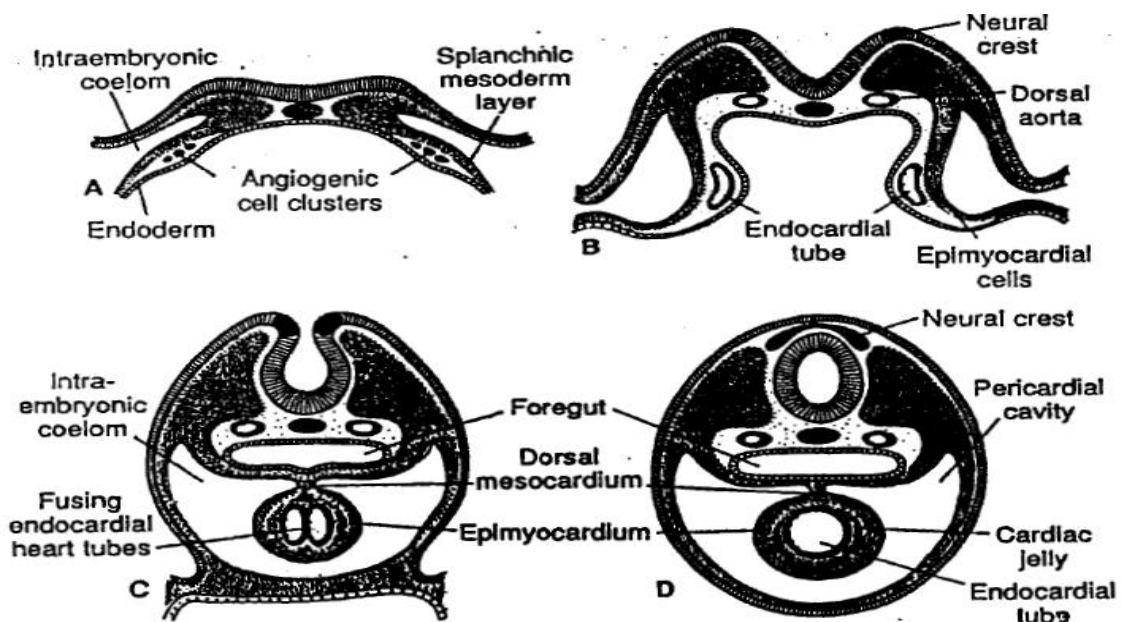
Anterior



- ❖ The embryonic disc is composed of:
(from anterior to posterior)
 1. Septum transversum (a mass of mesoderm).
 2. The pericardial cavity.
 3. Buccopharyngeal membrane.

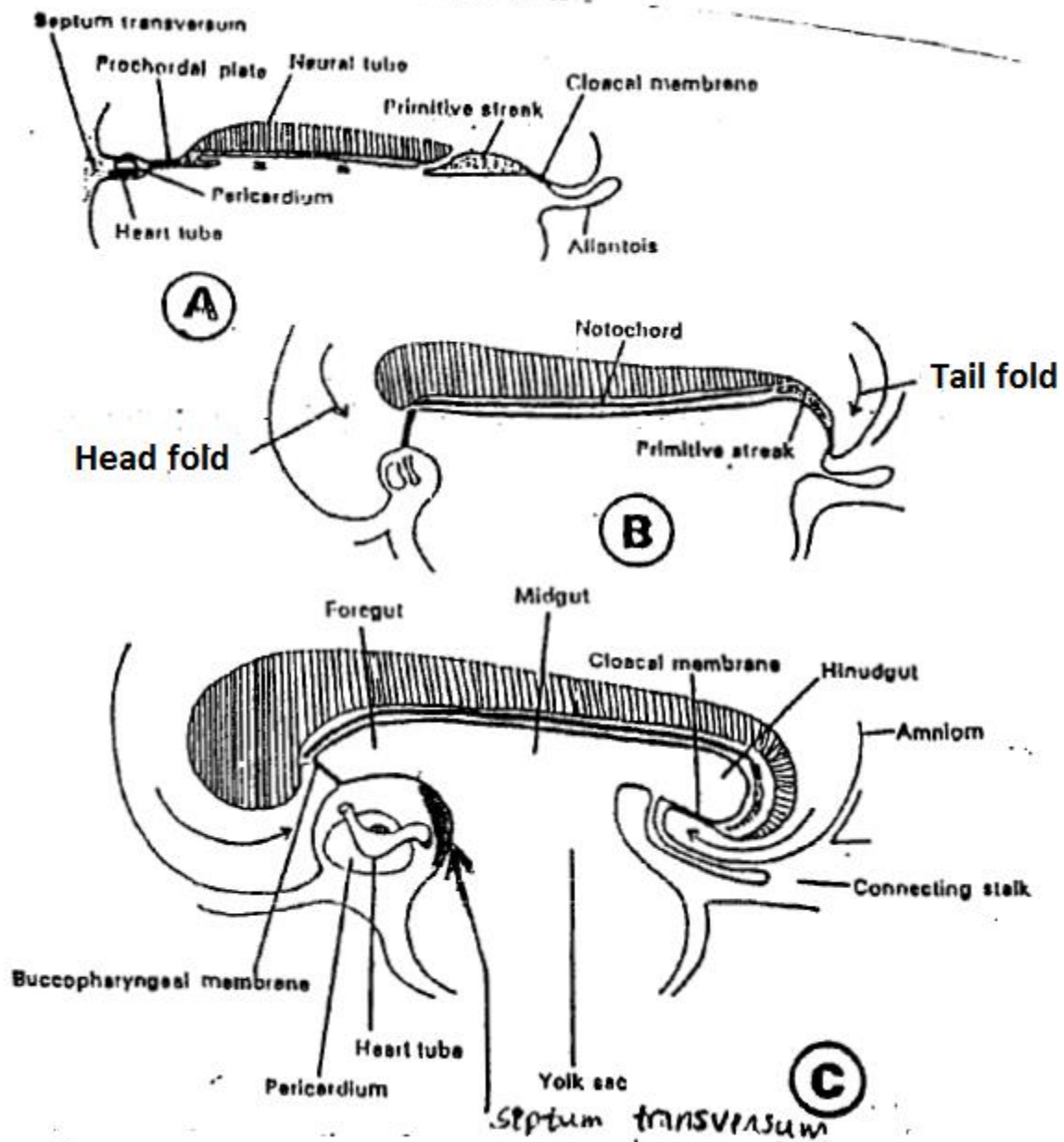
Note : the doctor here didn't mention the neural tube and the cloacal membrane, but I think they are also components of the embryonic disc.

- ❖ As we know, the embryonic disc will be folded two times:
 1. Lateral folding. ----- will form a single pericardial cavity.



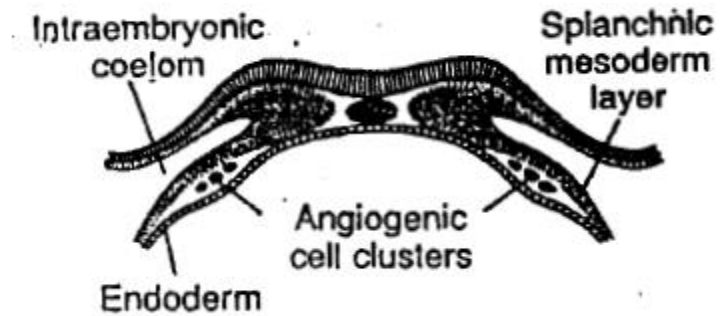
۲. Cephalocaudal folding (longitudinal). ----will form:

- An anterior fold ---- **Head fold**.
- A posterior fold ---- **Tail fold**.




Heart formation:

- ❖ This is a cross section in the embryonic disc. We can see:
 ١. Intra embryonic coelom (on both sides)
 ٢. The endoderm
 ٣. The ectoderm
 ٤. The splanchnic mesoderm



- ❖ The heart is formed at the beginning as a blood vessel in the form of **two primitive heart tubes**.
- ✓ Where do these two tubes appear? In the **splanchnic mesoderm** ----- (on **both** sides of the embryonic disc). **(but they are from endoderm)**

Note: you can see the cell clusters that will form the heart tubes in the splanchnic mesoderm in the previous picture

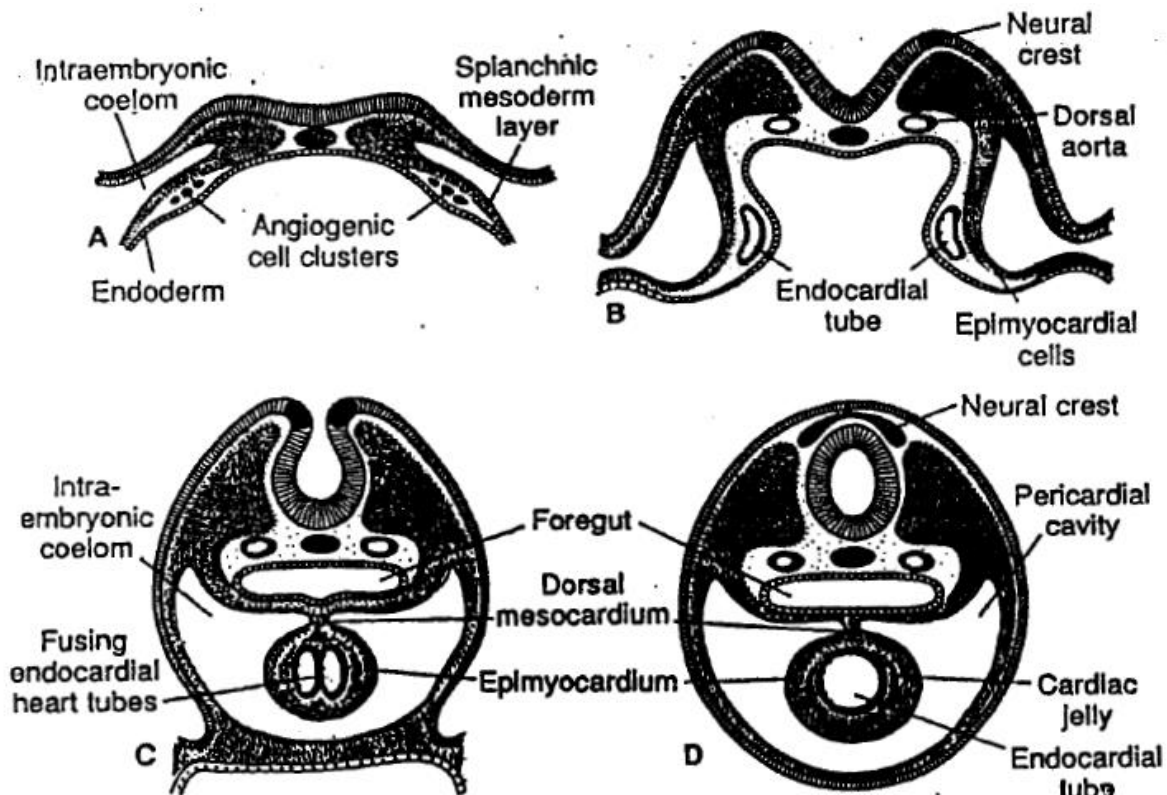
- ❖ After the formation of the heart tubes, the folding will take occur:
 ١. The longitudinal (cephalocaudal) folds ---- from anterior to posterior , will form the head and tail folds.
 ٢. Two lateral folds. ---- will cause:
 - The two primitive heart tubes will get closer to each others. Then fuse to form **a single heart tube**.
 - The intra embryonic coelom on both sides (two cavities) will get closer to each other's.  The two cavities will fuse to form the pericardial cavity, which will surround the primitive heart tube.

- ☞ Notice in the following picture that before the folding;
 ١. Above the embryonic disc there is the amniotic cavity.
 ٢. Below the embryonic disc there is the yolk sac.

After the folding, the yolk sac will form the gut.

- ❖ You can see the foregut (a part of the gut) posterior to the heart. Anatomically, posterior to the heart we can see a part of the gut which is

the **esophagus** (part of the foregut). ----- And in the embryo, the foregut was formed from the wall of the yolk sac just behind the heart.



- ❖ Also, you can see in the previous picture that the heart was hanged by a mesentery (shown in the figure as the **dorsal mesocardium**).

This mesentery will degenerate in the future, and we will have the **transverse sinus** of pericardium instead. (posterior to the heart).

Heart formation:

- The two primitive heart tubes were formed in the splanchnic mesoderm. **(remember from endoderm)**
- The two primitive heart tubes will fuse to form a single heart tube.

This fusion occurs with **differential growth**, which means that a part of the heart tube will grow faster than the other.

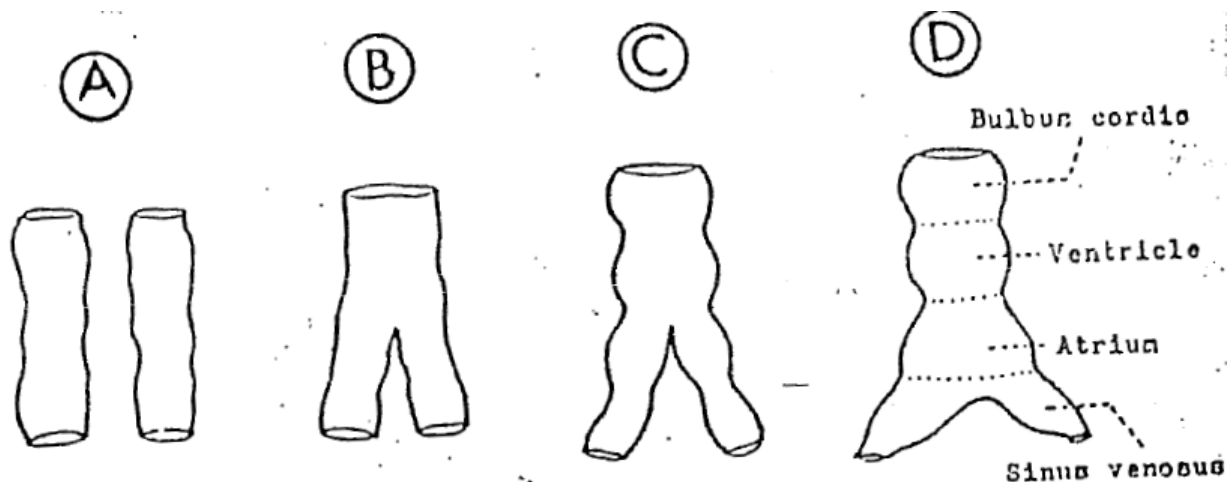


Fig. 15.1 Fusion of endothelial heart tubes.

❖ The heart tube is composed of segments :

They will be mentioned from posterior to anterior, which means according to the blood entrance (from the venous end to the arterial end)

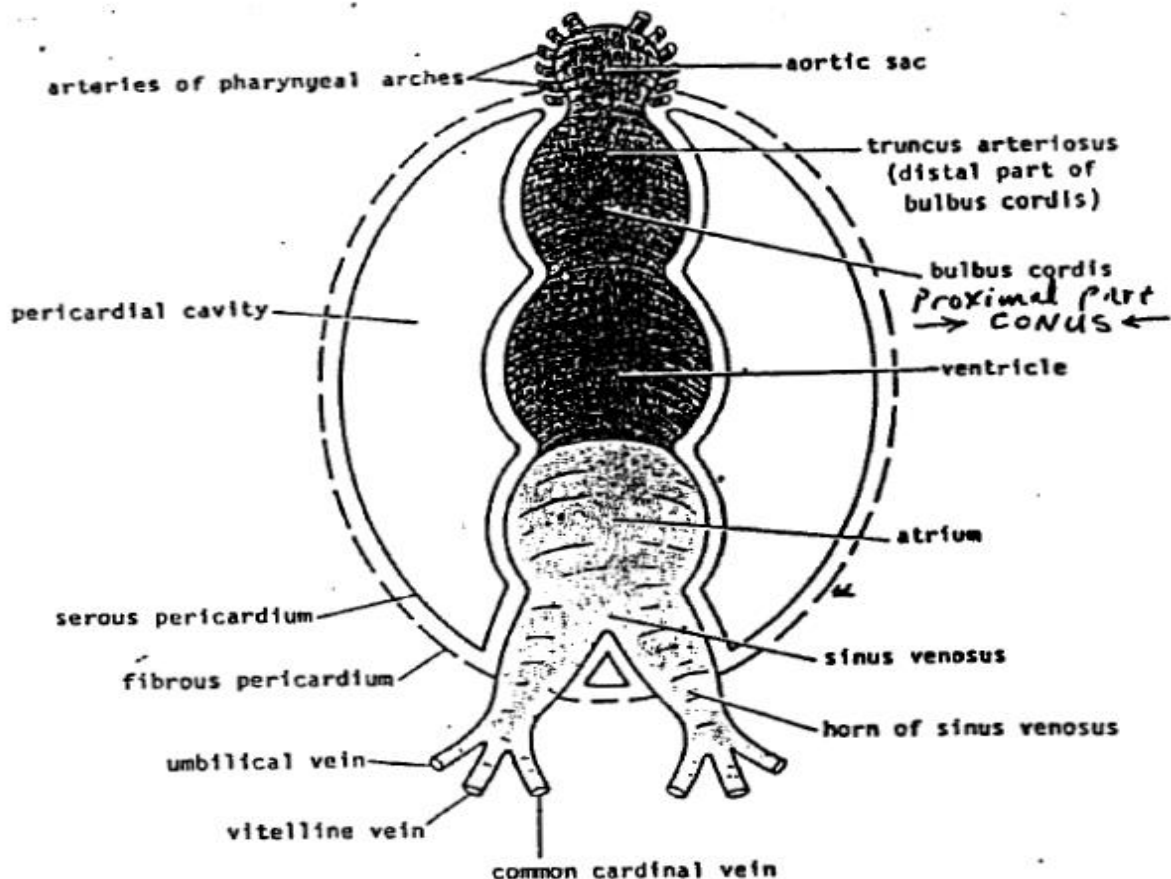
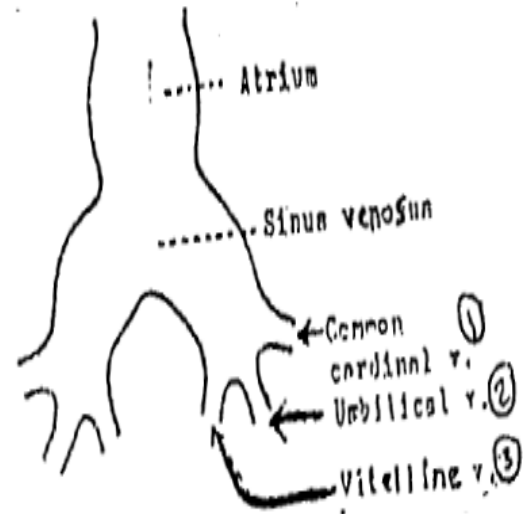
١. **The sinus venosus**, it has two horns. (the most posterior(caudal) end---- venous end)
٢. **Primitive atrium** (a single atrium in the heart tube) ---- has a single opening to the primitive ventricle.
٣. **Primitive ventricle** (a single ventricle in the heart tube) ---- opens to the bulbus cordis.
٤. **Bulbus cordis (conus)** ----- is attached to the **truncus arteriosus** (anterior end ---- arterial end).

❖ Each horn of the sinus venosus (right and left horns) will receive blood from three sources:

١. **Common cardinal vein** ----- which receives blood from the **body wall**.
٢. **The umbilical vein** ----- which receives blood from the **placenta**.
٣. **The vitelline vein** ----- which receives blood from **yolk sac** (the future gut).


- ❖ The next picture shows the primitive heart tube inside the pericardium.
- ❖ Notice (from posterior to anterior):
 ١. Sinus venosus (has two horns, right and left).
 ٢. Primitive atrium (a single chamber).
 ٣. Primitive ventricle (a single chamber).
 ٤. Bulbus cordis (conus):

It is composed of two parts, distal and proximal.
The **distal** part is the **truncus arteriosus** (arterial end).



- ❖ In the previous picture there is something wrong :

In the early stages of the embryological development, the sinus venosus and the primitive atrium are outside the pericardium.

- It is shown that the arterial end (truncus arteriosus) is far from the venous end (sinus venosus), in the next stages they will get closer to each other.  Anatomically, in our hearts the arterial end is close to the venous end.

➤ The arterial end:

١. The ascending aorta.
٢. The pulmonary trunk.

➤ The venous end: atria.

And we can see the left and the right atria posterior to the ascending aorta and the pulmonary trunk. Which means that they are close to each other, however, in the early stages the arterial end is far from the venous end.

❖ What will these segments of the heart tube form in the future?

١. Truncus arteriosus will generate the arterial end, which is composed of two arteries:

- The ascending aorta.
- The pulmonary trunk.

To confirm this piece of information, you can see that the ascending aorta and the pulmonary trunk are surrounded by a single layer of visceral pericardium.

٢. The bulbus cordis (conus) and the primitive ventricle will fuse together and form a single cavity called **bulbo-ventricular chamber**.

- **The primitive ventricle** by its self will form the **trabeculated** part of the **left ventricle**.
- The bulbus cordis will form:
 - ✓ The aortic vestibule of the left ventricle.
 - ✓ The trabeculated part of the right ventricle.
 - ✓ Infundibulum of the right ventricle.
 - ✓ The pulmonary valve in the right ventricle.
 - ✓ The aortic valve in the left ventricle.

*VERY
IMPORTANT
PAGE*

٢. The atria-ventricular canal (AV canal) ----- between the atrium and the ventricle.

In the wall of this canal, there will be formation of two prominences, each one is called **endocardial cushion**.

These endocardial cushions will divide the AV canal into :

- ✓ The right AV canal.
- ✓ The left AV canal.

The AV endocardial cushions form septum intermedium.

Each ventricle is composed of:

- ١. A rough part (trabeculae carnae ---- like the papillary muscle)
- ٢. A smooth part.

The left ventricle:

- The lower part is trabeculated
- The upper part is the aortic vestibule (smooth) ----- while on the right there is the infundibulum.

٤. The primitive atrium will form :

- ✓ The rough anterior part of the right atrium and its auricle
- ✓ The auricle of the left atrium.

The right atrium is composed of:

- Anterior rough part
- Posterior smooth part

They are separated by the crista terminalis.

The pectinate muscles are anterior to the crista terminalis.

٥. The sinus venosus:

- The right horn will form the smooth posterior part of the right atrium.
- The left horn will form a great part of the coronary sinus (on the posterior surface of the heart) ---- it is the vein that receives blood from the cardiac muscle.

To sum up the atria:

❖ The right atrium:

١. The anterior rough wall and the auricle is originated from the primitive atrium.
٢. The posterior smooth wall is from the right horn of the sinus venosus.

❖ The left atrium:

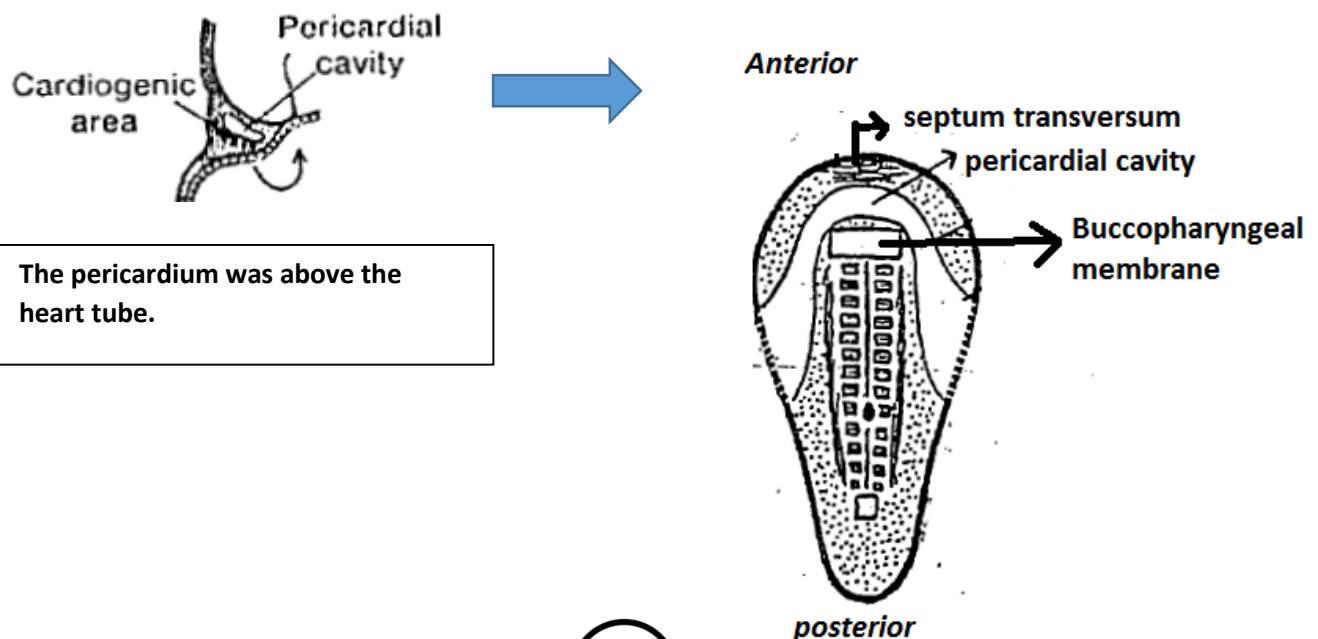
١. The left auricle is from the primitive atrium
٢. **MOST OF THE LEFT ATRIUM is smooth and is derived from the primitive pulmonary vein, which develops as an evagination(incorporation) from the dorsal wall of the atrium in the sinoatrial region. (Italic not needed)**

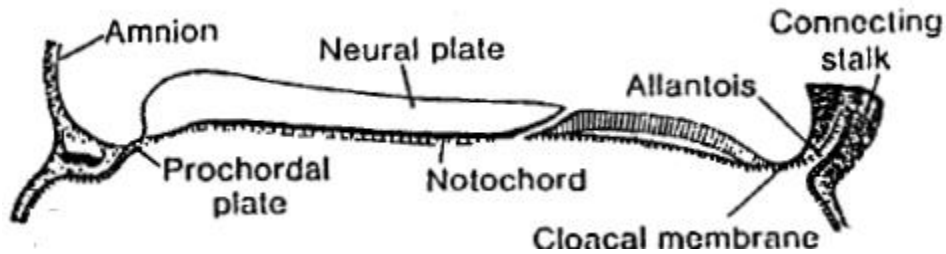
- ✦ Why does the cephalocaudal folding occur? (why does the embryo fold anterior and posterior?)

Because of the fast growth of the nervous system (ectoderm) to form the brain and the spinal cord.

❖ Before the cephalocaudal folding (before the formation of head and tail folds), the embryo was composed of : (from anterior to posterior)

- ✓ The septum transversum.
- ✓ Pericardium then the heart tube. (The pericardium is above the heart tube).
- ✓ Prochordal plate (buccopharyngeal membrane).

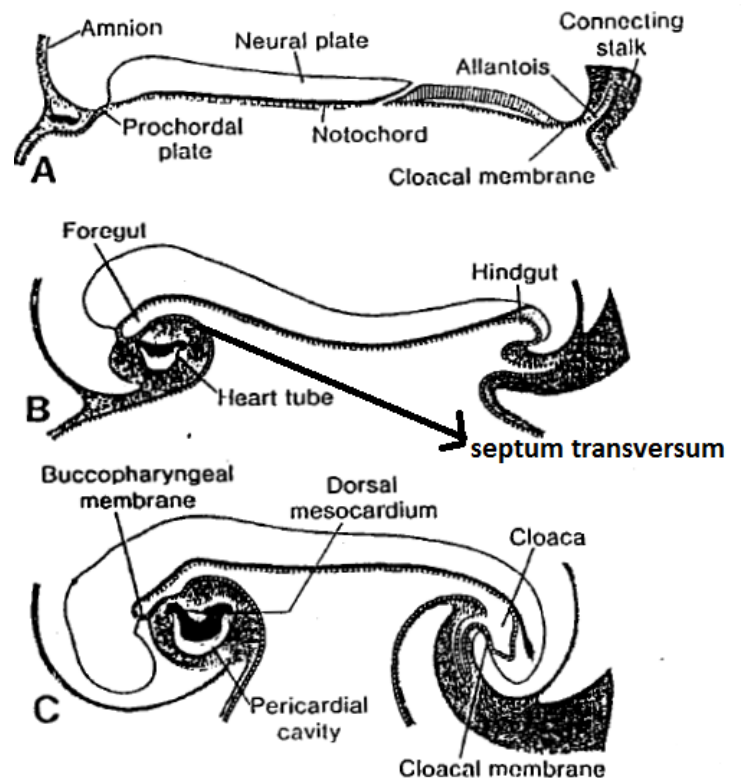
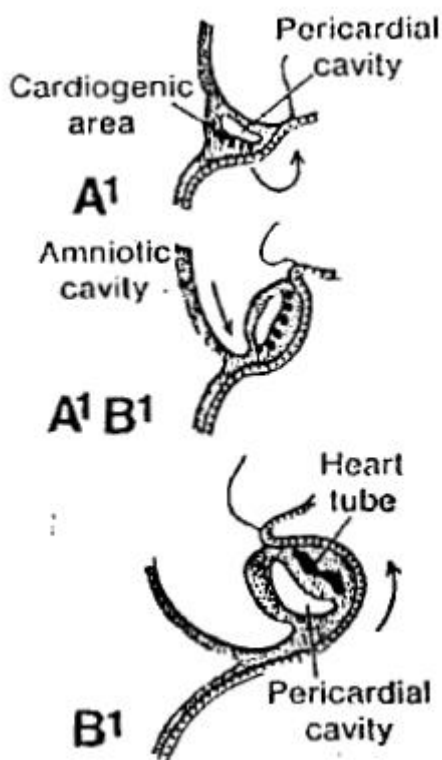




This is another section before folding.

❖ After the folding: (the arrangement will be the opposite)

- The septum transversum will be transported from anterior to posterior. It becomes the most posterior part.
- The heart tube and the pericardial cavity: the heart tube will become above the pericardium. Then the heart tube will invaginate into the pericardium.
- The buccopharyngeal membrane becomes the most anterior compartment.



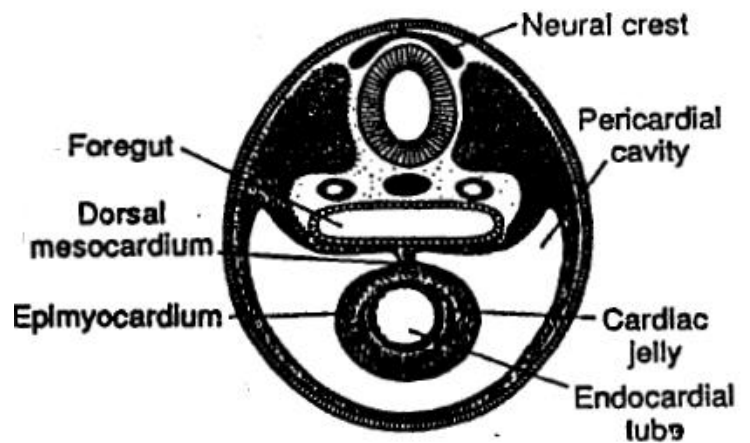
❖ An important note:

- Before folding, the heart tube was below the pericardial cavity.
- After folding, the heart tube will become above the pericardial cavity, then the heart tube will invaginate downward into the pericardium.

- ❖ The formation of the head and tail folds causes a part of the yolk sac to enter into the embryo. (that will form the gut --- foregut, midgut, and hindgut)
- ❖ As mentioned before, the part of the foregut that is located posterior to the heart is the esophagus.

➤ This section is after folding, and the final arrangement is:

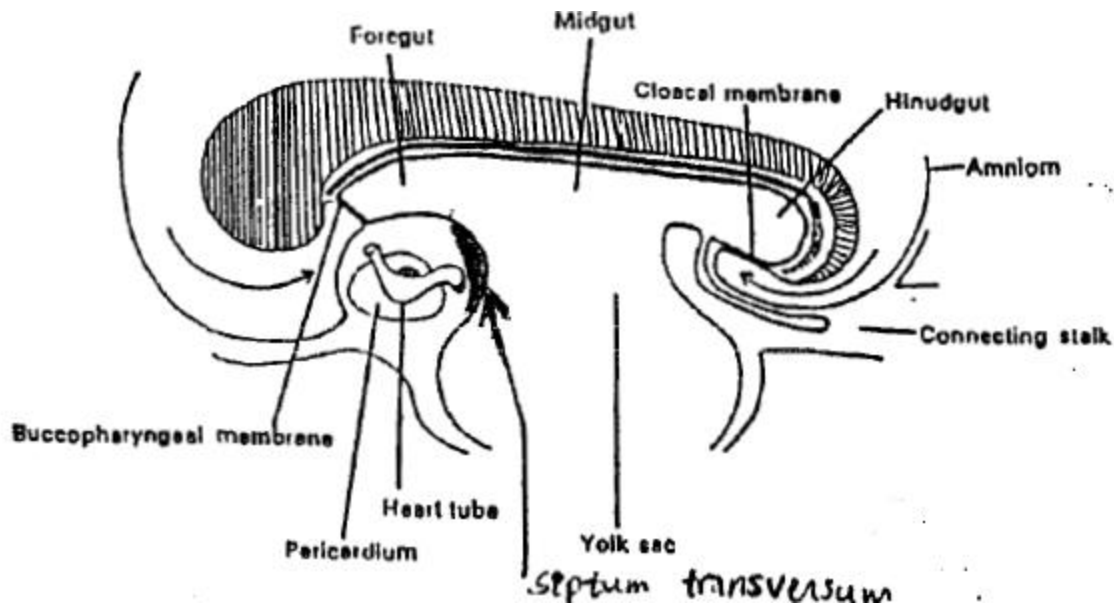
- a. Buccopharyngeal membrane (mouth) --- most anterior.
- b. Pericardial cavity with the heart tube.
- c. Septum transversum (most posterior)



The **septum transversum** is a mass of **mesoderm**, from **where the liver will be formed**.

The liver is **originated** as an **endodermal bulk** (from the endoderm of the yolk sac), then it grows into the septum transversum.

Briefly, the liver is an endodermal bulk that grows into a mesoderm (septum transversum).



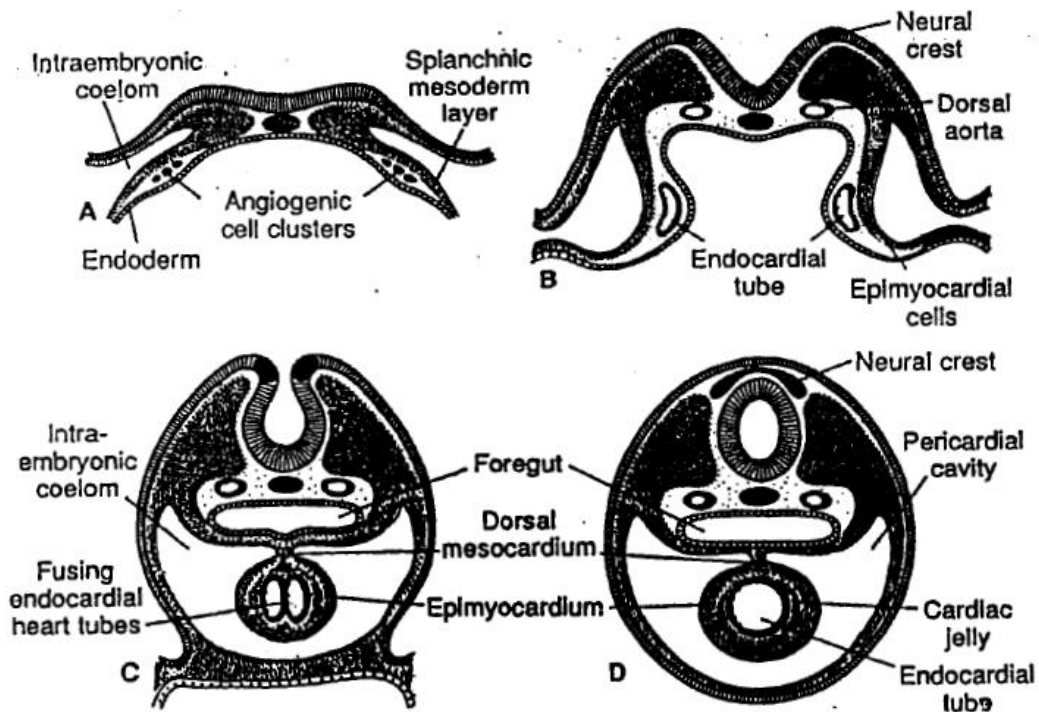
Notice that the septum transversum is not far from the heart tube.

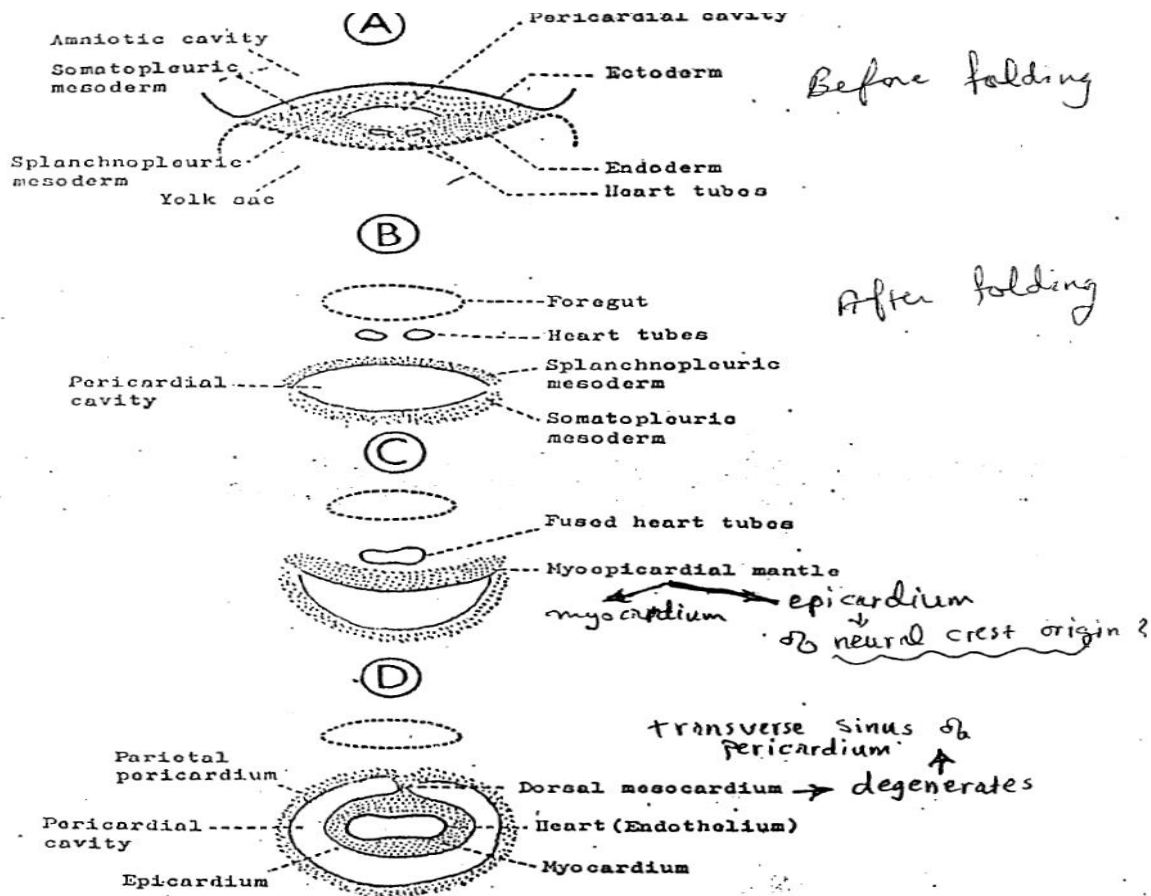
***there are blood vessels that have to pass into the liver toward the heart.----- will be discussed later.*

The relation of the heart tube with the pericardial cavity:

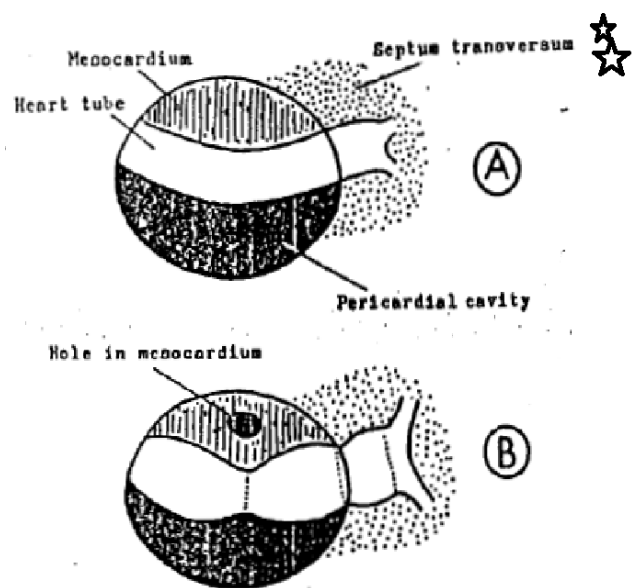
- ❖ The pericardial cavity was formed by the fusion of two pericardial cavities, as a result of the lateral folding.
- ❖ The two primitive heart tubes were fused to form a single heart tube, as a result of the lateral folding.
- ❖ The heart tube was **ventral** to the pericardium, and as a result of the cephalocaudal folding (the head and tail folds formation) the heart tube will become **above** the pericardial cavity.
- ❖ The heart tube will be invaginated into the pericardial cavity.
- ❖ **The primitive heart tube is an endoderm.** It will get a mesoderm from the wall of the pericardial cavity. This mesoderm will form;
 - a. The myocardium.
 - b. The epicardium.

- ❖ As shown in the following picture :
- The two heart tubes will fuse together.
- Invagination of the heart tube into the mesoderm of the pericardial cavity.
- The mesentery of the heart. (It will be degenerated, and we will have the transverse sinus).
- Finally, the primitive heart tube **(endoderm) is surrounded by a mesoderm,** which will form:
 ١. Myocardium
 ٢. Epicardium





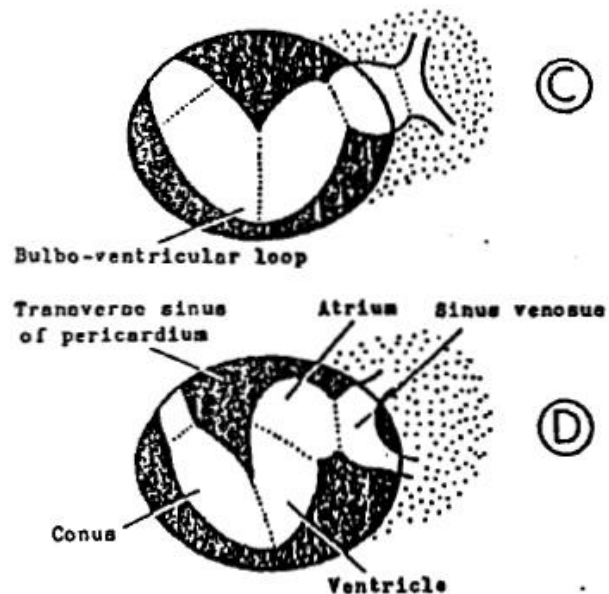
- The primitive heart tube is inside the pericardial cavity, hanged by a mesentery.
- ❖ At first(early stage) ,Inside the pericardial cavity:
 ١. The bulbus cortis
 ٢. The primitive ventricle.
- ❖ Outside the pericardial cavity, and **inside the septum transversum** ---- posterior to the pericardium (where the liver will be formed in the future)
 ١. The primitive atrium.
 ٢. Sinus venosus.



When the mesentery degenerates, the heart tube is going to be hanged from its lateral sides in the pericardial cavity.

- ❖ The heart tube is growing faster than the pericardium, so it is going to be looped ----- forming a U-shaped loop.
- ❖ The atrium and the sinus venosus will grow within the pericardial cavity. (they will enter the cavity)
- ❖ When the cavity was containing the bulbus cordis and the ventricle the heart tube was **U-shaped**.
- ❖ With the entry of the atrium and the sinus venosus, the tube is now **S-shaped**.
- ❖ Notice in the picture:
 - a. The conus (bulbus cordis).
 - b. The truncus arterionus
 - c. The primitive ventricle.
 - d. The atrium and the sinus venosus --- they are now above and behind the ventricle

✚ Anatomically, both the right and the left atria are above and behind the ventricles.
(see also the next picture which is more clear)



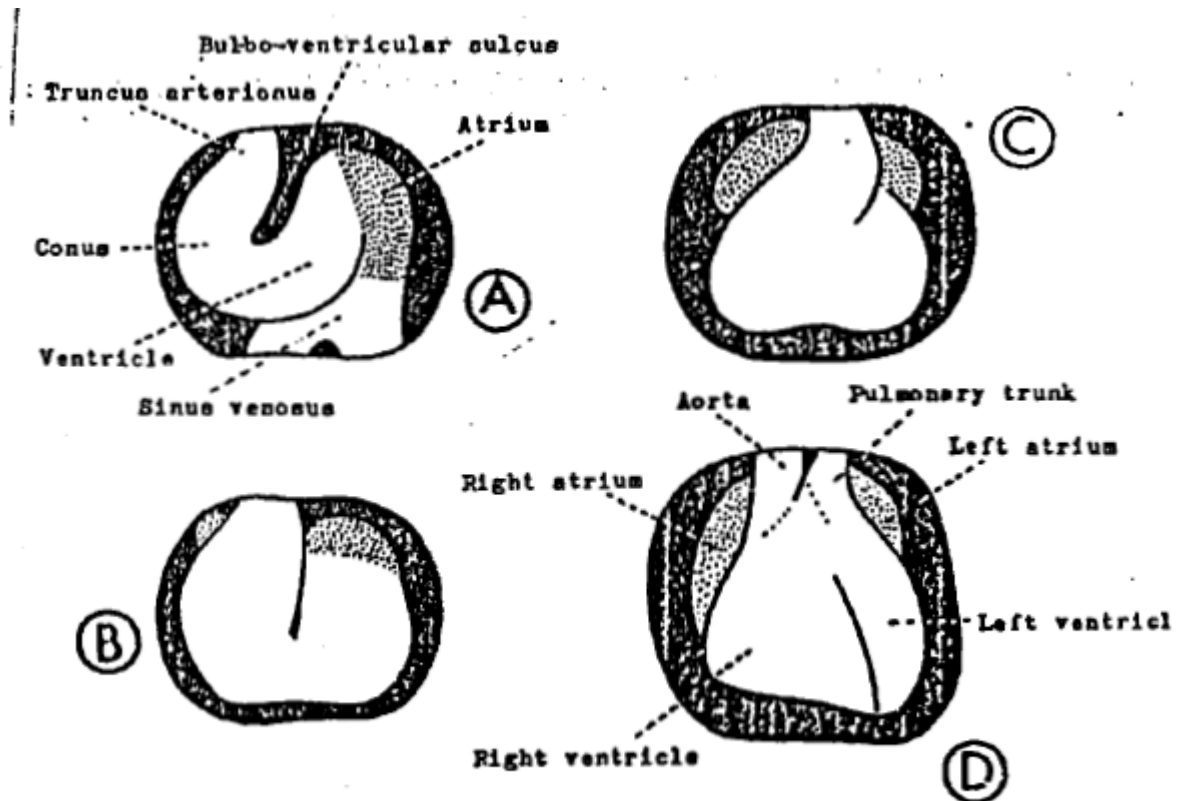


Fig. 15.7 Establishment of external form of the heart.

- ✓ Establishing the final shape of the heart: (look at the previous picture)
 ١. Between the bulbus cordis and the ventricle there was a **sulcus** (groove), this sulcus will degenerate and they will form a single chamber called the **bulbo-ventricular chamber**.
 ٢. The atrium will grow horizontally, notice:
 - ✓ The truncus arteriosus
 - ✓ The bulbus cordis and the ventricle (which will form one chamber)
- ❖ Now, the heart is establishing its final shape:
 ١. The truncus arteriosus gives rise to the ascending aorta and the pulmonary trunk. (arterial end)
 ٢. The atria (venous end) goes posterior to the ascending aorta and the pulmonary trunk.

٣. The right and the left ventricles will be formed (the mechanism will be explained later) and arranged so that the right ventricle will be anterior to the left ventricle. And the right atrium will be anterior to the left atrium.

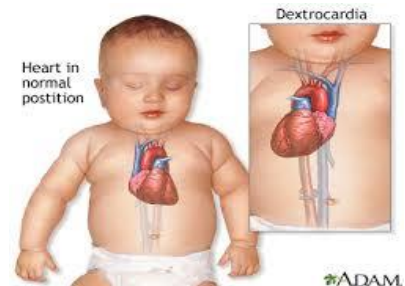
To sum up:

١. The primitive heart tube is inside the pericardium. U-shaped.
 ٢. The atrium and the sinus venosus enter inside the cavity. S-shaped.
 ٣. The bulbo-ventricular sulcus degenerates gradually.
 ٤. The atrium is above and behind the ventricle.
 ٥. Fast horizontal growth of the atrium.
 ٦. The bulbo-ventricular chamber is formed when the sulcus is totally degenerated.
 ٧. The arterial end (truncus arteriosus) gets closer to the venous end (atrium).
- ❖ **Notice the looping of the primitive heart tube toward the right side.**

That is why ٢/٣ of the heart is toward the left

And the apex is toward the left.

- ❖ If the looping was to the **left**, we get **dextrocardia**, the apex will be toward the right.



Important :

to sum up :

- ١) The truncus arteriosus will form:
 - ✓ Pulmonary trunk
 - ✓ Ascending aorta
- ٢) The bulbus cordis (conus):
 - ✓ The proximal part of the bulbus cordis will form the trabeculated part of the right ventricle.
 - ✓ The mid portion will form an outflow tract for both ventricles:
 - ١. The infundibulum of the right ventricle.
 - ٢. Aortic vestibule of the left ventricle.
 - ✓ The distal part will form:
 - ١. The pulmonary valve in the right ventricle.
 - ٢. The aortic valve in the left ventricle.
- ٣) The primitive ventricle will **only** form the rough part of the left ventricle (trabeculated part).
- ٤) The primitive atrium will form :
 - ✓ The rough anterior part of the right atrium and its auricle
 - ✓ The auricle of the left atrium.
- ٥) The sinus venosus:
 - The right horn will form the smooth posterior part of the right atrium.
 - The left horn will form a great part of the coronary sinus (on the posterior surface of the heart) ---- it is the vein that receives blood from the cardiac muscle.
- ٦) **MOST OF THE LEFT ATRIUM is smooth and is derived from the primitive pulmonary vein, which develops as an evagination(incorporation) from the dorsal wall of the atrium in the sinoatrial region.**

Sorry for any mistakes