DEVELOPMENT OF HEART

(A seminar report for partial fulfillment of M.sc. degree in zoology)

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DEVELOPMENT OF HEART

- CONTENT-

  1 Stages of the development of heart

  2 Fetal circulation

DEVELOPMENT OF HEART

- **General Facts:**
- • First system to start functioning in embryo ---------- Cardiovascular system
- • First organ of the body to start functioning ---------- Heart (end of 3rd week, i.e., on day 22).
- • blood flow begins during ---------- 4th week of IUL
- • entire cardiovascular system is of ----------***mesodermal origin***
- • cardiac wall is made up of ------- ---------- three layers. From in side to outside:
- 1. Endocardium
- 2. Myocardium
- 3. Epicardium
- • endocardium forms from---------- ----------Primitive heart tube
- • Primitive heart tube forms from ---------- mesenchyme in the cardiogenic area of the embryo
- • myocardium and epicardium form from ---------- splanchnic mesoderm surrounding the primitive heart tube

Development of heart

- **Stages of the development of the heart:**
- A) Appearance of cardiogenic field
- B) Formation of two endocardial tubes
- C) Formation of primary heart tube
- D) Formation of five dilatations
- E) Formation of cardiac loop
- F) Differentiation of dilatations of cardiac loop
- G) Development of Various Chambers of the Heart (Septation of the heart)

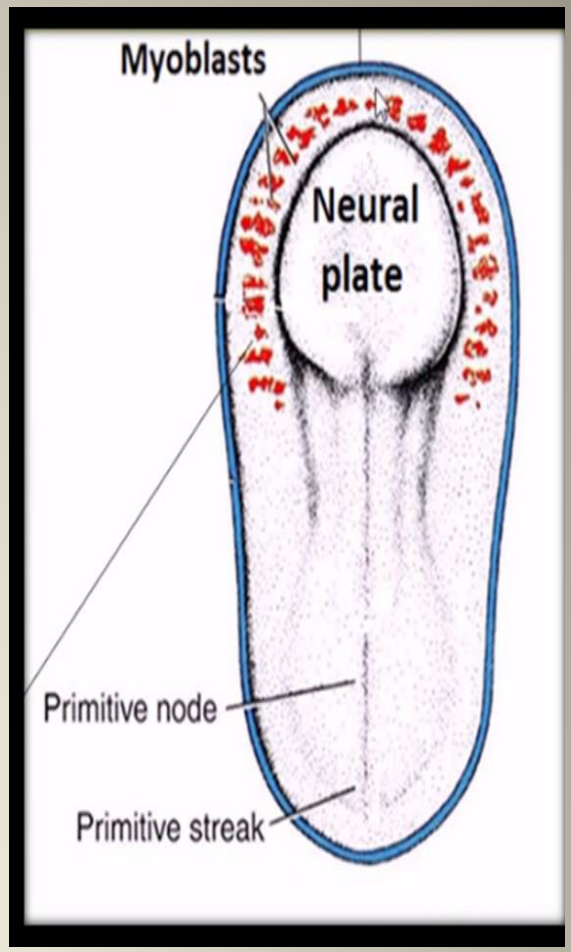
DEVELOPMENT OF HEART

- **Stages of the development of the heart:**
- ***A)Appearance of cardiogenic field***
- ***1)Heart development starts before folding***

2) Migration of cardiac progenitors cells lying in the epiblast, lateral to primitive streak to lie caudal to buccopharyngeal memb

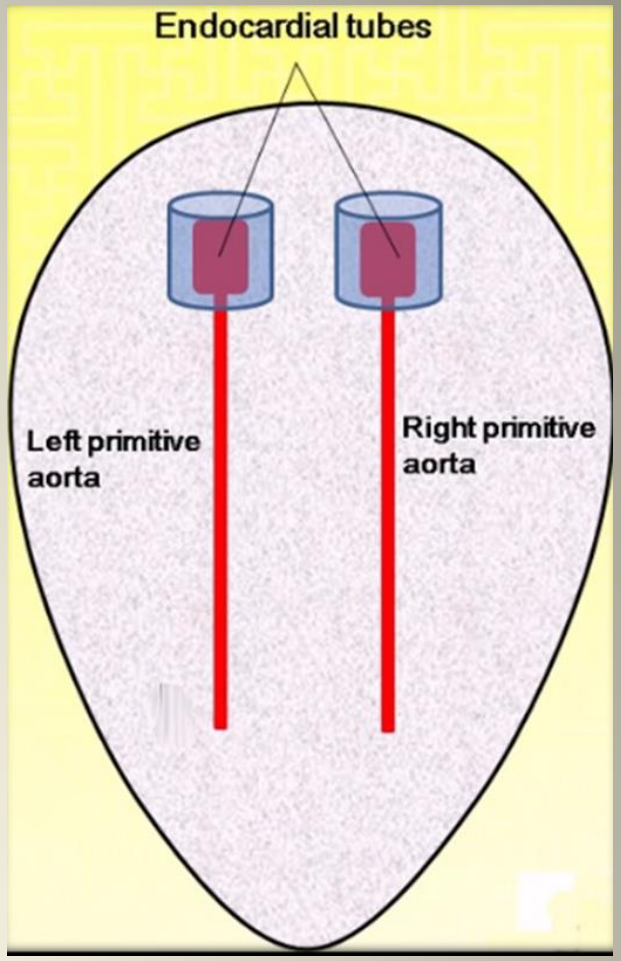
- 3) Differentiation of these cell forming islands of cardiac myoblasts
- 4) Union of the islands results in formation of a horseshoe-endocardial tube
- 5) This region is known as cardiogenic field

- buccopharyngeal



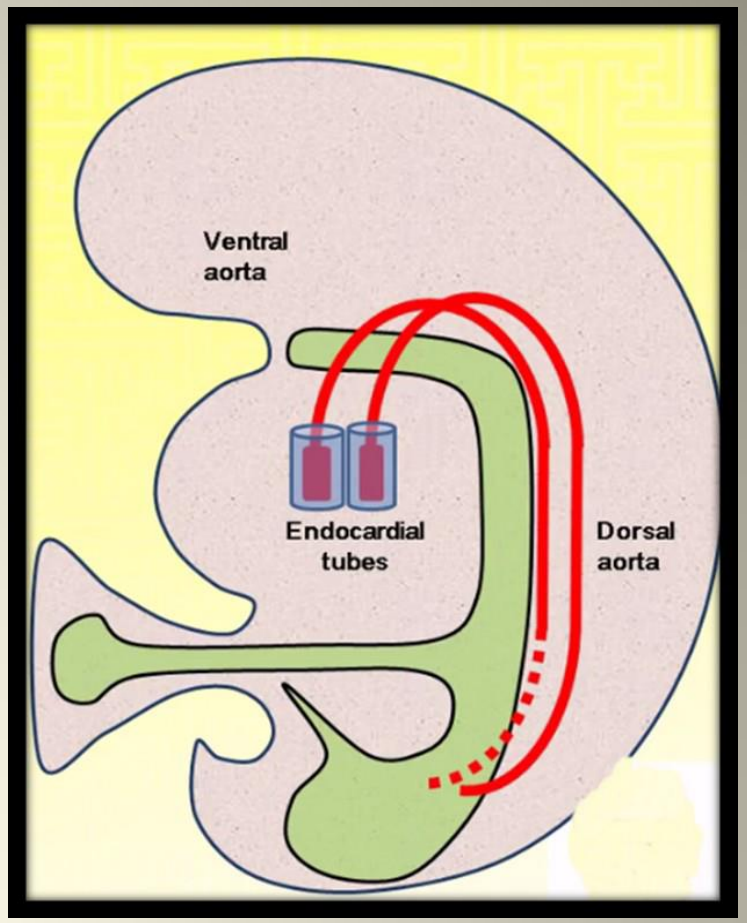
DEVELOPMENT OF HEART

- **Stages of the development of the heart**:
- ***B)Formation of two endocardial tubes***
- 1) On 19th day ,
- 2) horseshoe-endocardial tube is changed to
- form a pair of endocardial tubes
- 3) These tubes connect with 2 primitive aortae
- develop at same time
- 4) Later on, pericardial cavity develop dorsal to
- tubes
- 5) This cavity develop from surrounding
- intraembryonic coelom
- (derived from Lat. Intraembryonic mesoderm



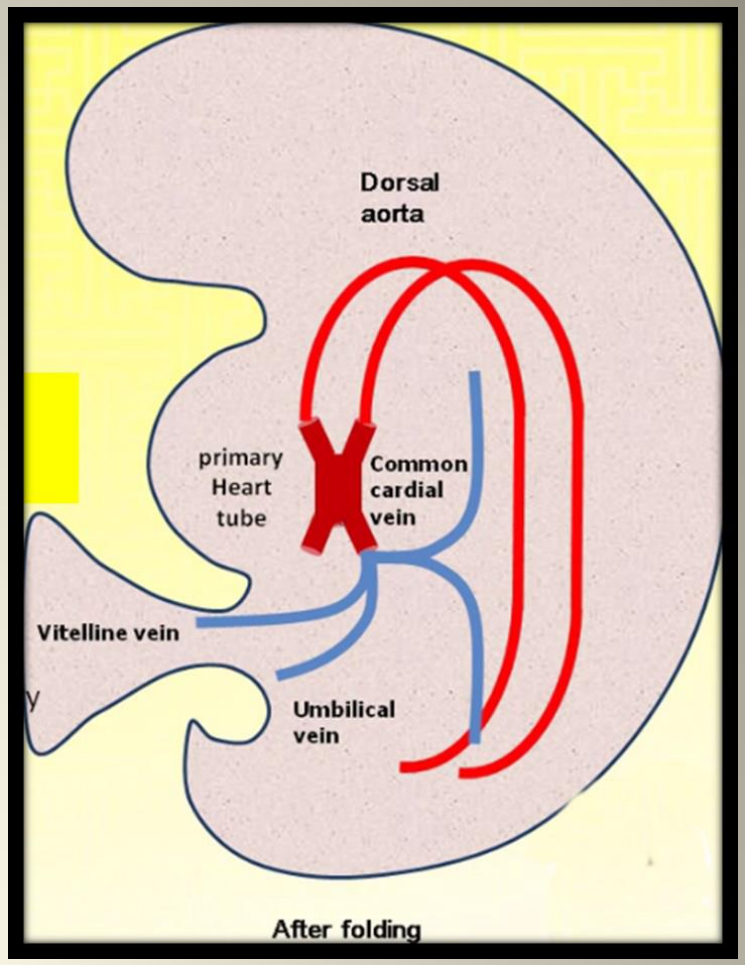
Development of heart

- **Stages of the development of the heart:**
- ***B)Formation of two endocardial tubes***
- At beginning of 4th wk
- 1) Cephalic & lateral foldings
- 2) 2 endocardial tubes move towards the thoracic region where they fuse forming single tube(***primary heart tube)***



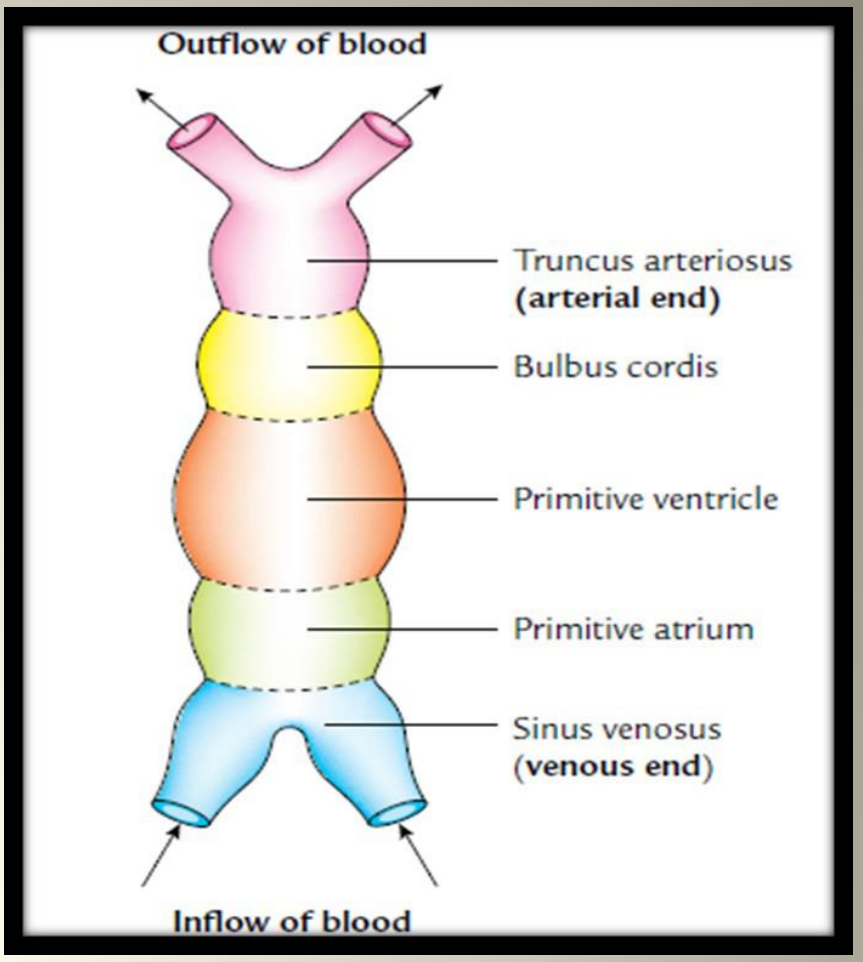
Development of heart

- **Stages of the development of the heart:**
- ***C)Formation of primary heart tube***
- At 4th wk
- 1) Cephalic & caudal ends still
- separate(arterial &venous ends)
- 2) each end has 2 horns .
- 3) blood passes through cephalic horns to 2 primitive aortae
- 4) Blood carried back by 6 veins,
- 1- pair of common cardinal V
- 2- pair of vitelline V
- 3- Pair of umbilical V



Development of heart

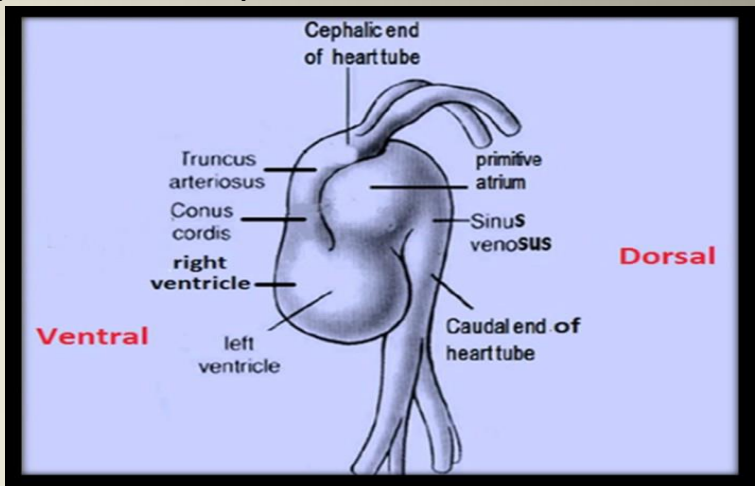
- **Stages of the development of the heart:**
- ***D) Formation of five dilatations***
- After 21 day



Development of heart

- **Stages of the development of the**
- **heart:**
- ***E)Formation of cardiac loop***

- 1) As the development progresses,heart tube particularly bulbus cordis &primitive ventricle grows rapidly in a limited space dorsal to the pericardial cavity.
- 2) Since the arterial and venous ends of the heart tube are fixed,
- 3) it gradually invaginates into thepericardial cavity in a 'U' shaped manner; forming a cardiac loop



Stages of the development of the heart:

F)Differentiation of dilatations of cardiac loop

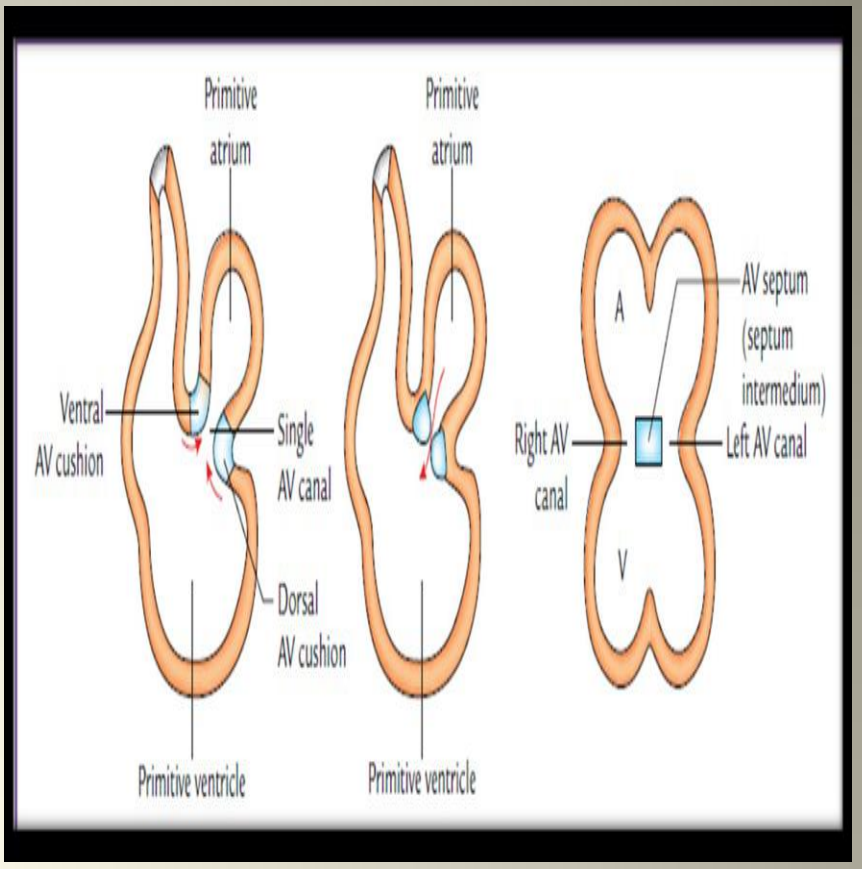
Table 18.1	Fate of the embryonic dilatations of the primitive heart tube
Embryonic dilatation	Adult derivatives
1. Truncus arteriosus	Ascending aorta Pulmonary trunk
2. Bulbus cordis	Smooth upper part of the right ventricle (conus arteriosus) Smooth upper part of the left ventricle (aortic vestibule)
3. Primitive ventricle	Trabeculated part of the right ventricle Trabeculated part of the left ventricle
4. Primitive atrium	Trabeculated part of the right atrium Trabeculated part of the left atrium
5. Sinus venosus	Smooth part of the right atrium (sinus venarum) Coronary sinus Oblique vein of the left atrium

Development of heart

- **Stages of the development of the heart:**
- ***G) Development of Various Chambers of the Heart***
- ***Septationof the heart***
- The primitive heart tube has a single lumen. This lumen is partitioned into
- four definitive chambers by the formation of four septa.
- These septa are:
- 1. Atrioventricular septum
- 2. Interatrial septum
- 3. Interventricular septum
- 4. Aorticopulmonary septum

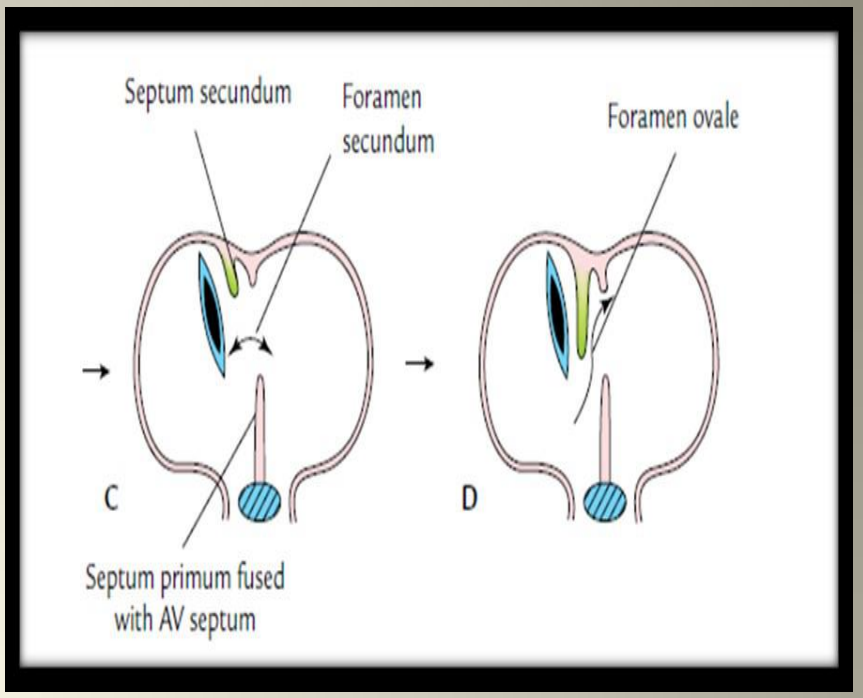
Development of heart

- **Stages of the development of the heart:**
- ***G) Development of Various Chambers of the Heart***
- **1. Atrioventricular septum(AV septum)**
- AV septum divides AV canal into right and left AV canals
- AV septum is formed by **the fusion of AV cushions (*endocardial cushions)***
- AV cushions are Two thickenings appear—one on dorsal wall and one
- on ventral wall of AV canal.
- These endocardial cushions grow towards each other and fuse together
- to form AV septum (septum intermedium) that divides the AV canal into right
- and left AV canals



Development of heart

- **Stages of the development of the heart:**
- ***G) Development of Various Chambers of the Heart***
- **2. Interatrial septum**
- The foramen thus formed is called foramen secundum (ostium secundum).
- b) septum secundum
- forms to the right of the septum primum.
- oblique passage between the upper margin of septum primum and lower margin of septum secundum. This passage is called foramen ovale
- c) During embryonic life, blood is shunted from the right atrium to the left atrium via the foramen ovale



Development of heart

- **Stages of the development of the heart:**
- ***G) Development of Various Chambers of the Heart***
- **2. Interatrial septum**
- d) Immediately after birth, functional closure of the foramen ovale is facilitated both
- by
- □ decrease in right atrial pressure from occlusion of placental circulation
- □ increase in left atrial pressure due to increased pulmonary venous return.
- e) Later in life, the septum primum and septum secundum anatomically fuse to
- complete the formation of the atrial septum.
- f) thus IA septum is formed by two septa:
- □ (a) septum primum that forms the lower part of interatrial septum **Fossa ovalis**
- □ (b) septum secundum that forms the upper part of interatrial septum **annulus**

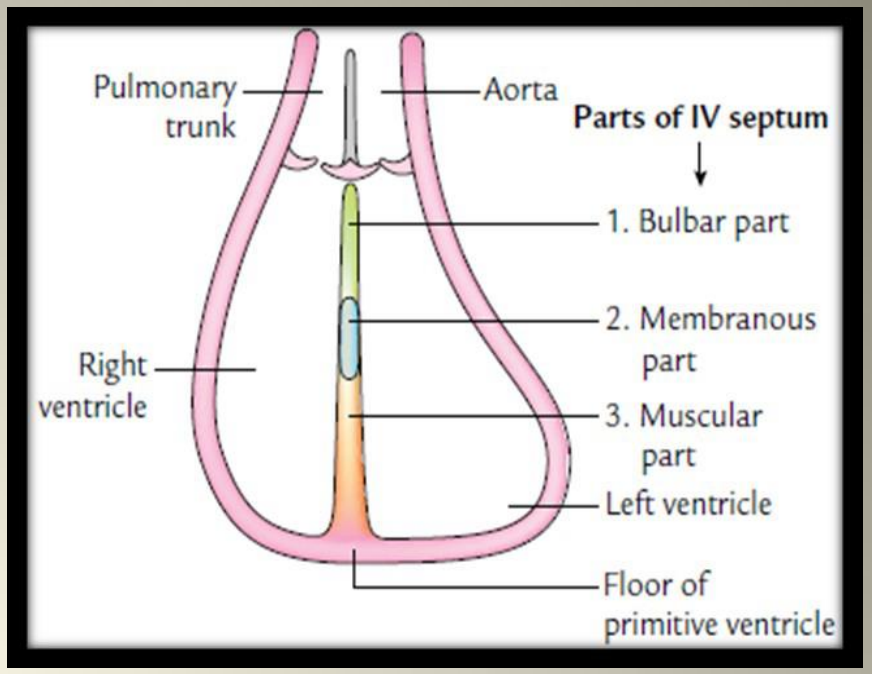
3.Interventricular septum

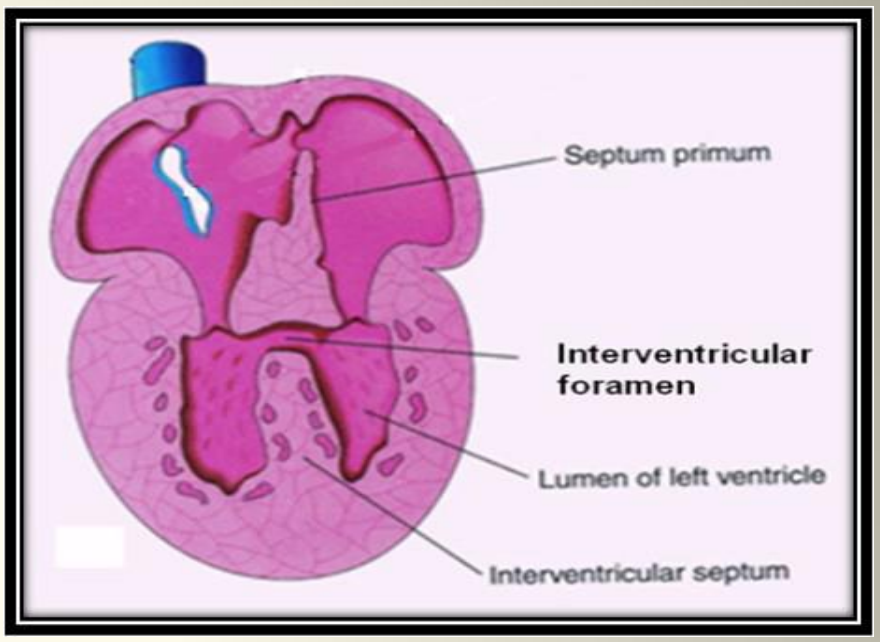
1. ***muscular IV septum*: A median muscular ridge grows upward from the floor of primitive ventricle** towards AV cushions.

2. IV foramen is located between the free edge of the muscular IV septum and the fused AV cushions. which closed by the membranous IV septum.

3. membranous IV septum forms by the proliferation and fusion of tissue from three sources:

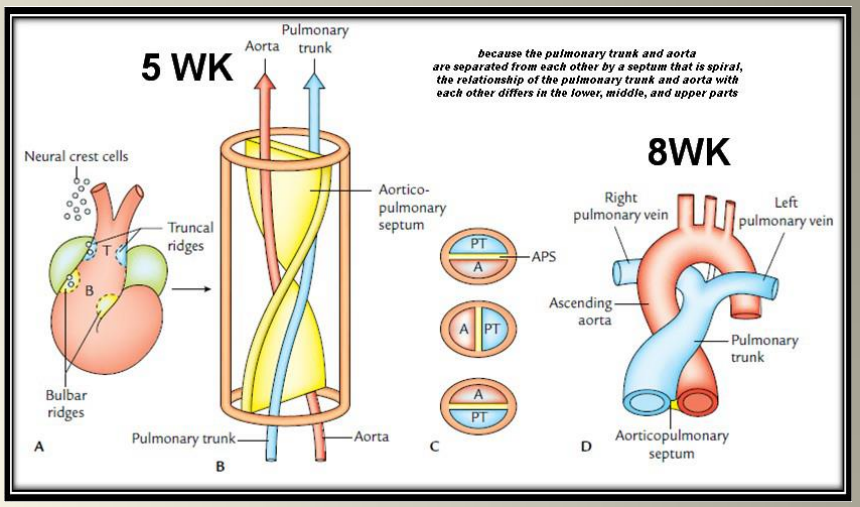
right bulbar ridge, left bulbar ridge, and AV cushions





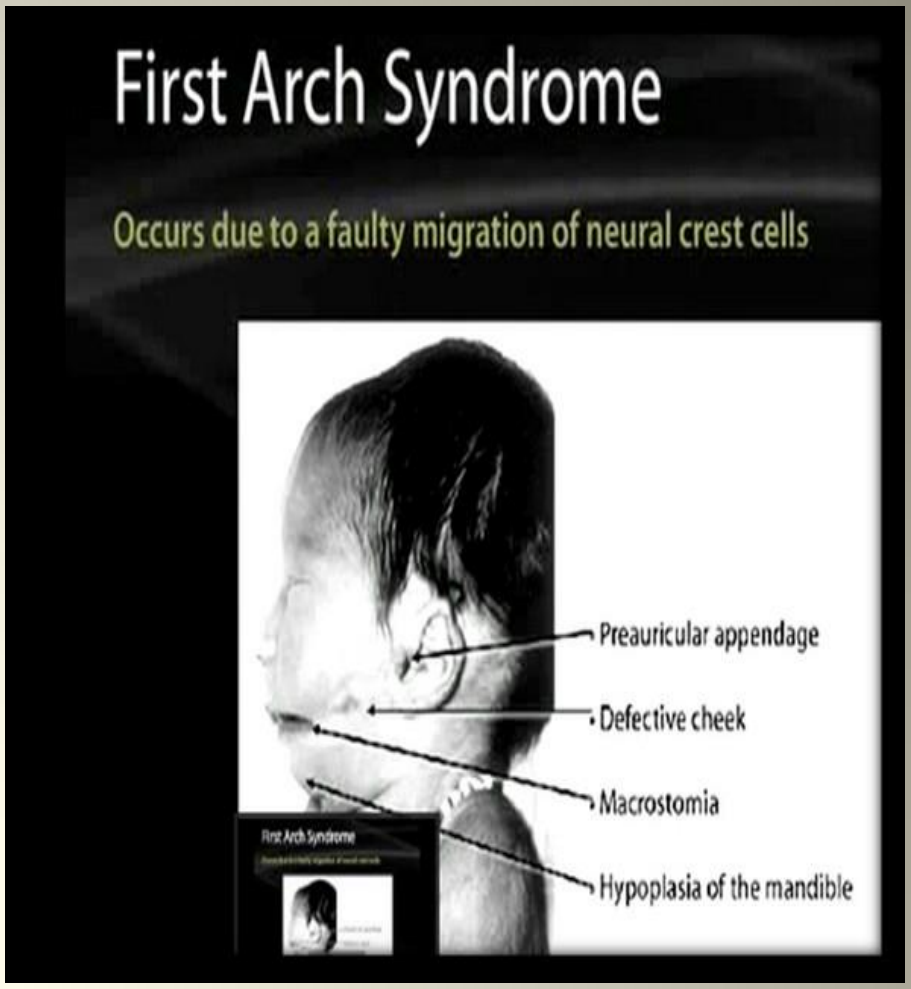
Development of heart

- • 4. Aorticopulmonary septum
- AP spiral septum divides the truncus arteriosus into the ascending aorta and pulmonary trunk
- Neural crest cells migrate from the hindbrain invade both the truncal ridges and bulbar ridges.
- Truncal and bulbar ridges grow and twist around each other in *a spiral fashion and eventually fuse to* form the AP septum.



Development of heart

- **4. Aorticopulmonary septum**
- ***Neural crest cells***
- □ contribute in the development of face and spiral aorticopulmonary septum
- □ Improper migration of neural crest cell scan cause craniofacial defects and transposition of the great
- blood vessels in the newborns.
- □ retinoic acid (vitamin A) is not given during pregnancy because it is a potent teratogen that targets
- Neural crest cells



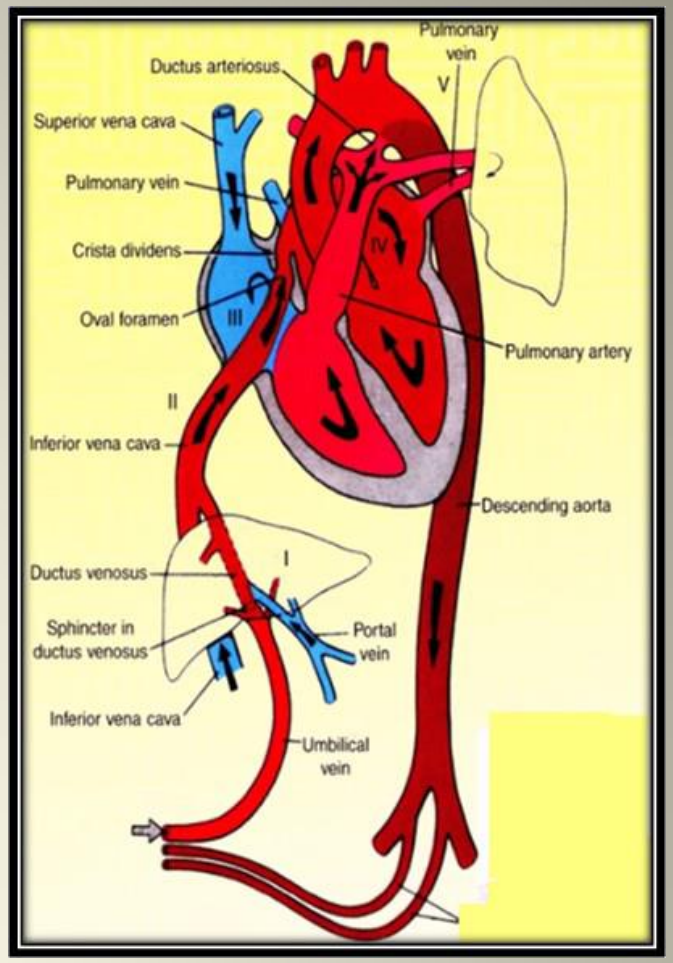
FETAL CIRCULATION

Fetal circulation

- The circulation of blood in the prenatal life is different from that of postnatal life
- **Unique Features of Fetal Circulation**
- • There are ***three shunts or bypass channels***
- *Ductus venosus,*
- *foramen ovale*
- *ductus arteriosus*
- • There are ***three blood vessels connected to placenta***
- *left umbilical vein*
- *left & right umbilical arteries*
- • placenta acts as fetal lungs

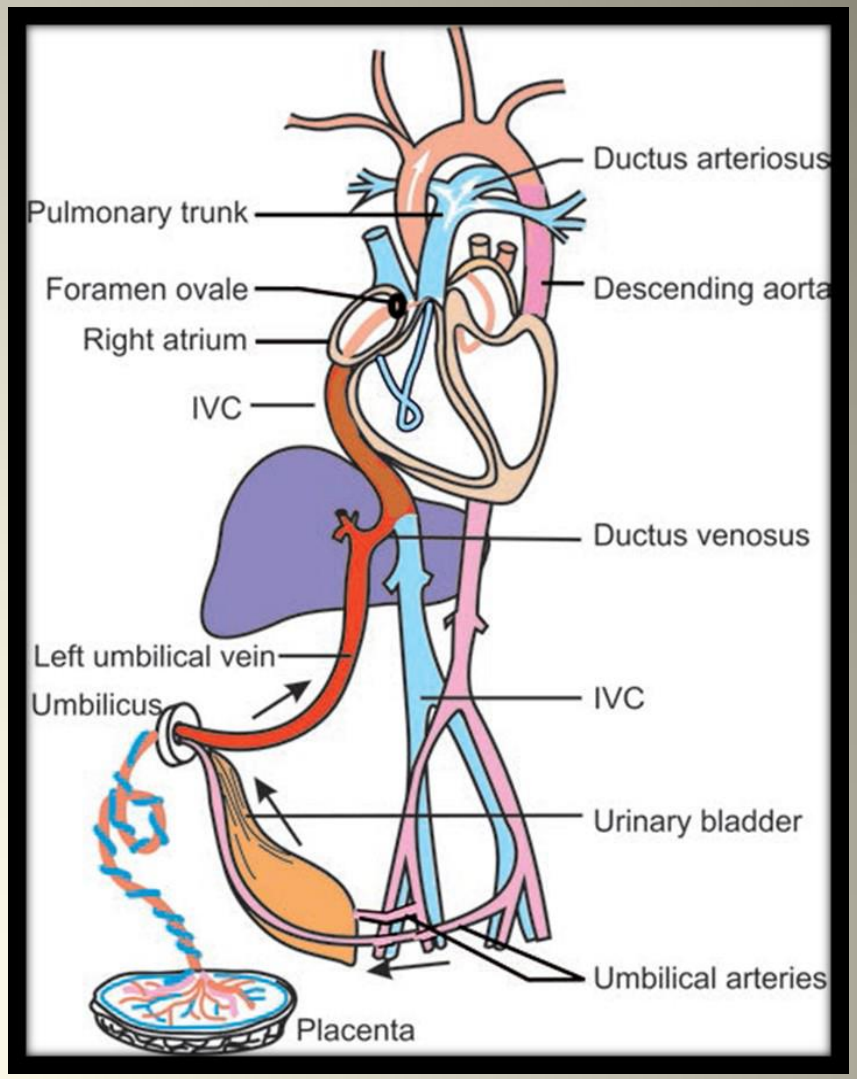
Fetal circulation

- Blood Circulation
- ***Oxygenated blood***
- • left umbilical vein supplies oxygenated blood.
- • It originates in the placenta(80% saturated)
- • It enters the fetus through the umbilical cord and umbilicus and reaches the liver, where it joins the left branch of portal vein
- **1) First Shunt in Liver**
- • The blood is diverted from the left branch of portal vein to the inferior vena cava by the ductus venosus (bypassing liver).
- • The inferior vena cava (IVC) brings this oxygenated blood to the right atrium



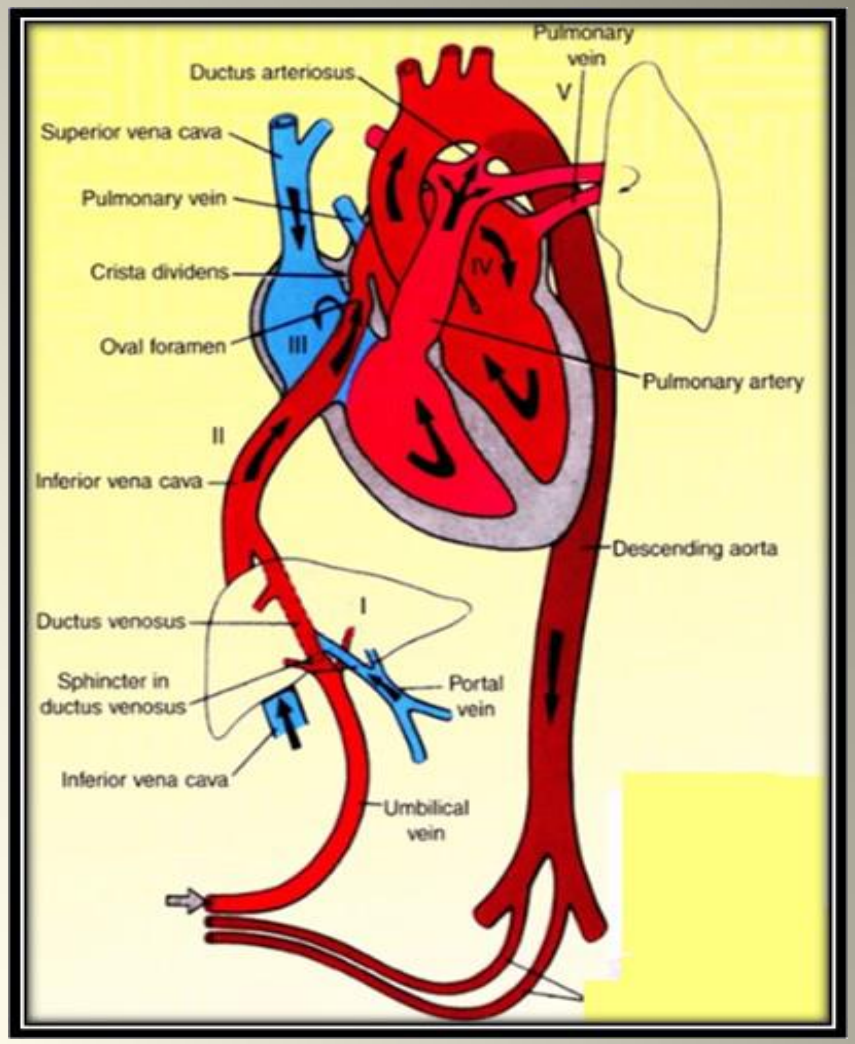
Fetal circulation

- Blood Circulation
- **2) Second Shunt in Liver**
- • From the right atrium, the oxygenated blood is directed through the foramen ovale to the left atrium without passing through the pulmonaryvessels and lungs.
- • From the left atrium, the blood enters the left ventricle and then into the ascending aorta



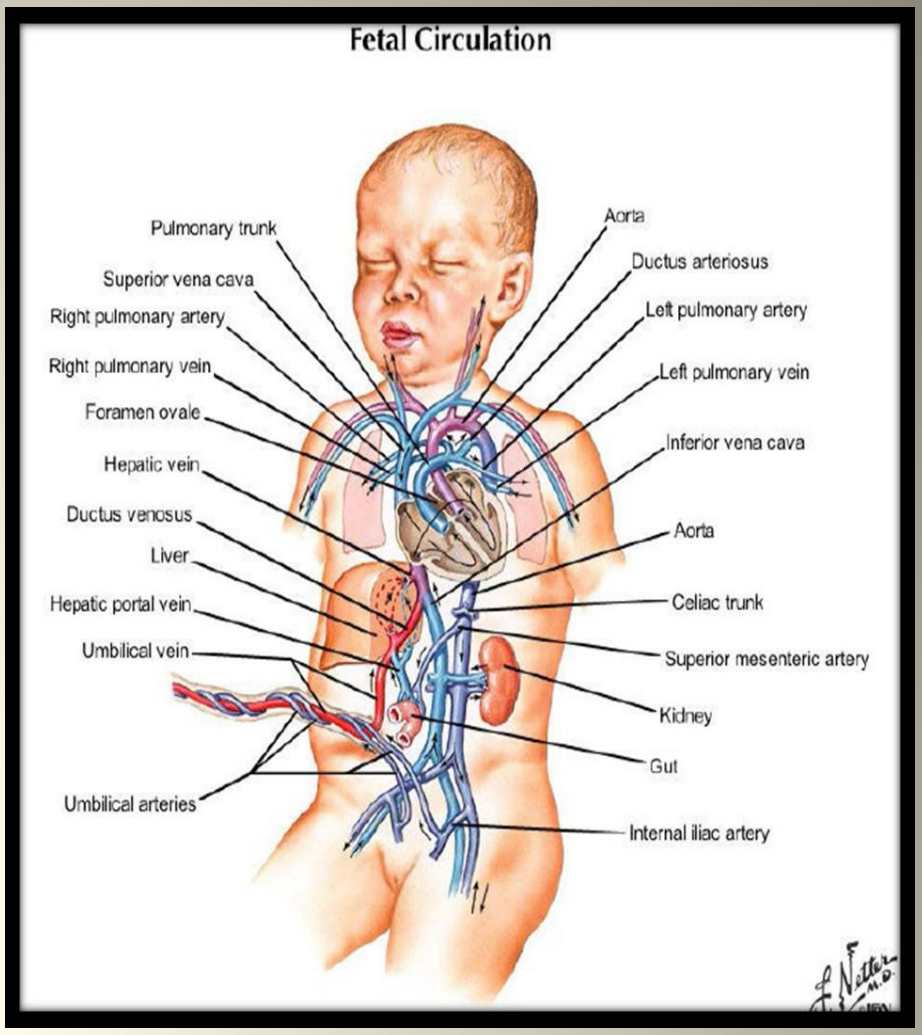
Fetal circulation

- Blood Circulation
- ***Deoxygenated blood***
- **Third Shunt in Liver**
- • Venous blood from right ventricle reaches arch of aorta (instead of reaching lungs) via shunt called ductus arteriosus,
- • Ductus arteriosus connects the aorta and the left pulmonary artery (at its beginning from pulmonary trunk)



Fetal circulation

- **Blood Circulation**
- • Thus, the upper part of the body receives more oxygenated blood compared to the lower part
- • because of mixing of venous blood in the aorta distal to the connection with the ductus arteriosus.
- • The right and left umbilical arteries carry deoxygenated blood from the lower end of abdominal aorta for purification to the placenta(58% saturated)



Fetal circulation

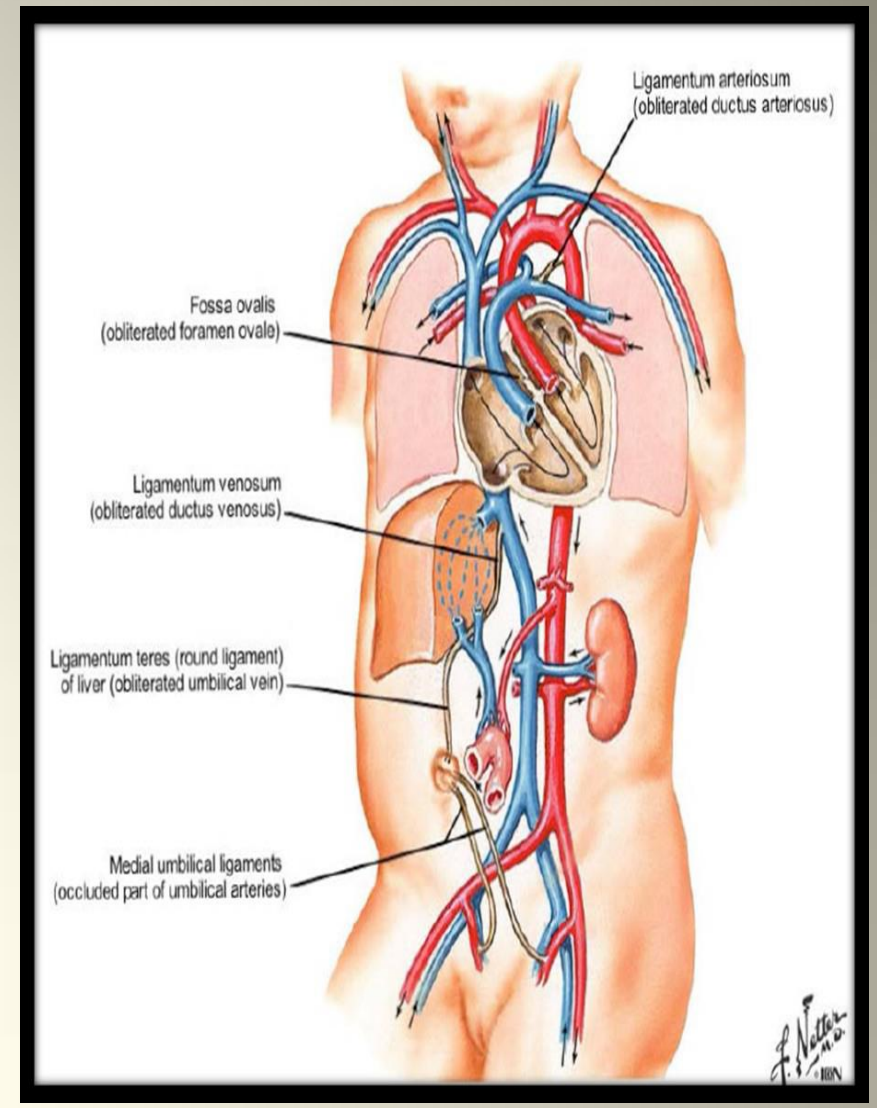
- **Postnatal Changes in Fetal Circulation**
- • physiological closure of the ***three shunts and three blood vessels occurs immediately after*** birth.
- • In the case of ***ductus arteriosus , the physiological closure is facilitated by release of bradykinin in lungs*** after first breath. Which stimulates the smooth muscle in the wall of ductus to contract.
- • In the case of ***foramen ovale, functionally closes almost immediately after birth as pressure in the*** right atrium decreases and pressure in the left atrium increases, thereby pushing the septum primum against the septum secundum

Fetal circulation

- **Time of Anatomical Closure**
- 1) Umbilical vessels and ductus venosus— 2- 3 months after birth.
- 2) Ductus arteriosus—---------- 1-3 months after birth
- 3) Foramen ovale—---------- 6 months after birth

Fetal circulation

- **Fate of Fetal Shunts and Umbilical Blood Vessels**
- **umbilical arteries undergo changes as**
- follows.
- proximal patent parts form
- ***superior vesical arteries***
- distal obliterated parts become
- ***lateral umbilical ligaments***
- **L. umbilical vein becomes**
- ***ligamentum teres of liver.***
- **ductus venosus becomes**
- ***ligamentum venosum.***
- **foramen ovale is indicated by**
- ***fossa ovalis & limbus fossa ovalis***
- ***in the interatrial septum.***
- **ductus arteriosus becomes**
- ***ligamentum arteriosum***



Fetal circulation

- **Postnatal Changes in Fetal Circulation**
- • ***In the case of ductus arteriosus***
- ***1) Before birth,***
- - the patency of the ductus arteriosus is controlled by the low oxygen content of the blood flowing through it, stimulates production of prostaglandins(cause smooth muscle to relax)
- 2) ***After birth,***
- - high oxygen content of the blood due to lung ventilation inhibits production of prostaglandins,causing smooth muscle contraction
- ***3) Premature infants***
- - can be treated with prostaglandin synthesis inhibitors (such as indomethacin) to promote closure of the ductus arteriosus.

THANK YOU

REFERENCE-

SCOTT F.GILBERT

INTERNET