Development and teratology of cardiovascular systems

19.2.2024

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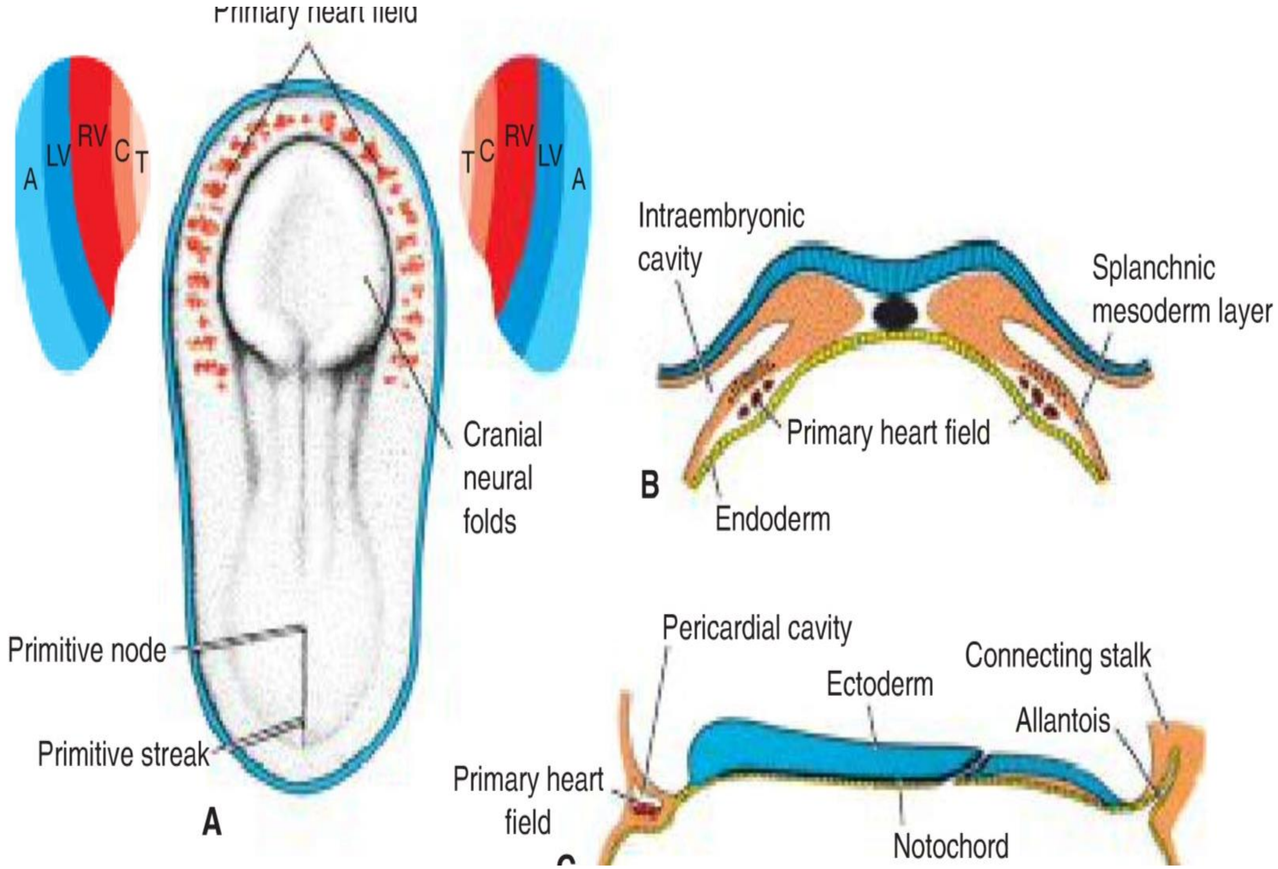
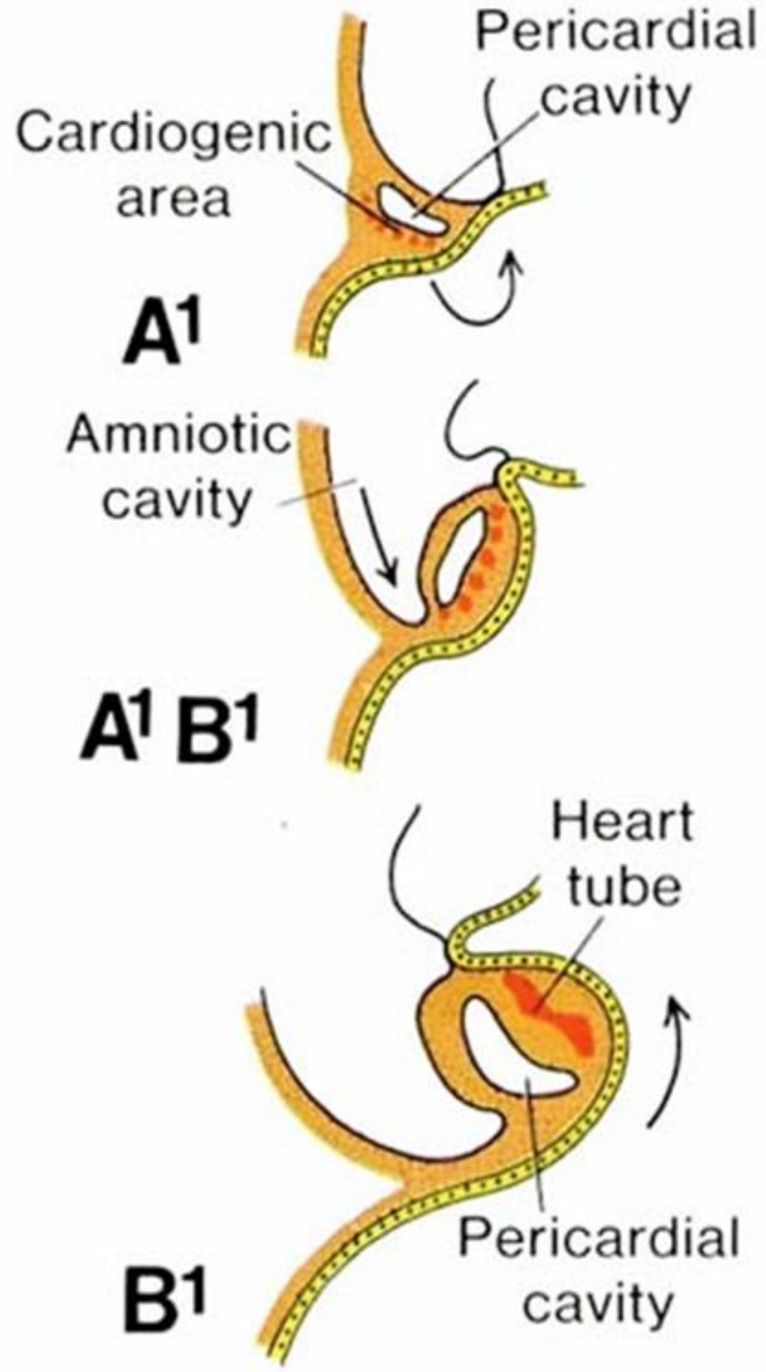
Formation of primary heart field

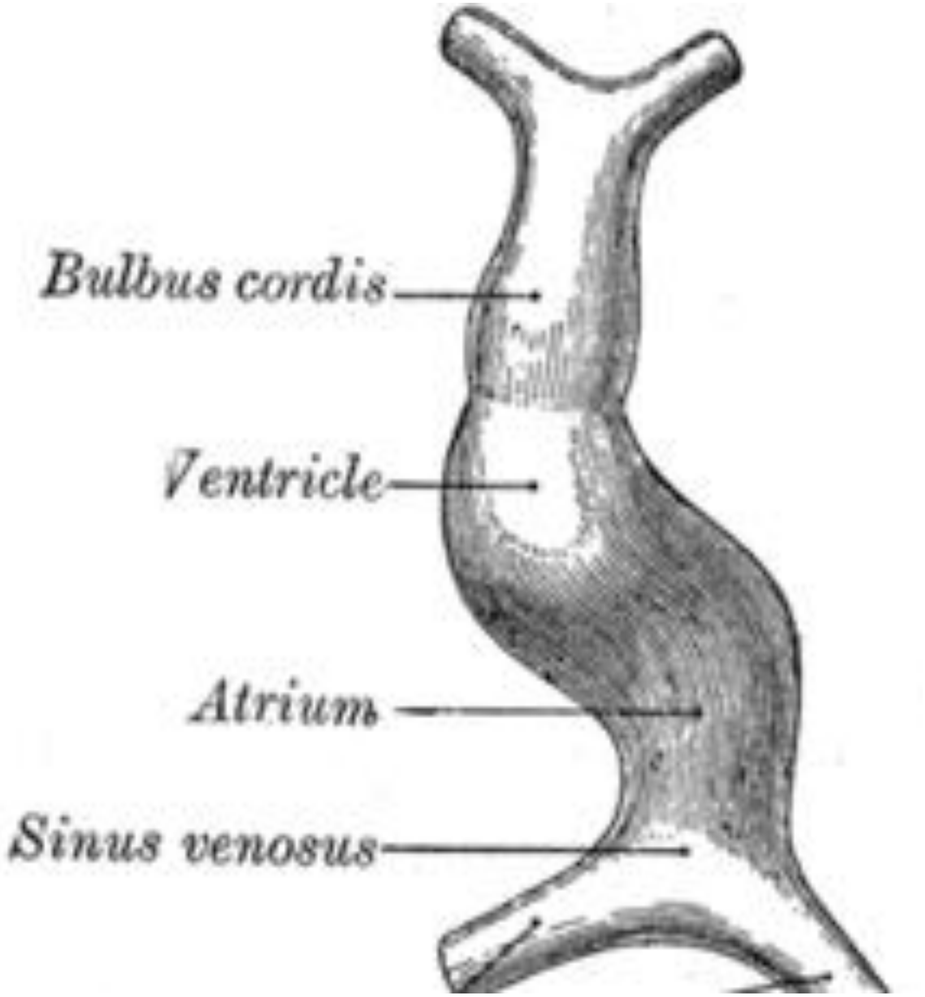


- WHEN? - middle of the 3rd week (day 16)
- WHAT? - progenitor heart cells
- WHERE? - from epiblast through the primitive streak to the visceral layer of lateral plate mesoderm
- DO WHAT? - form PHF

T.W. Sadler, Langman´s medical embryology, 14th edition

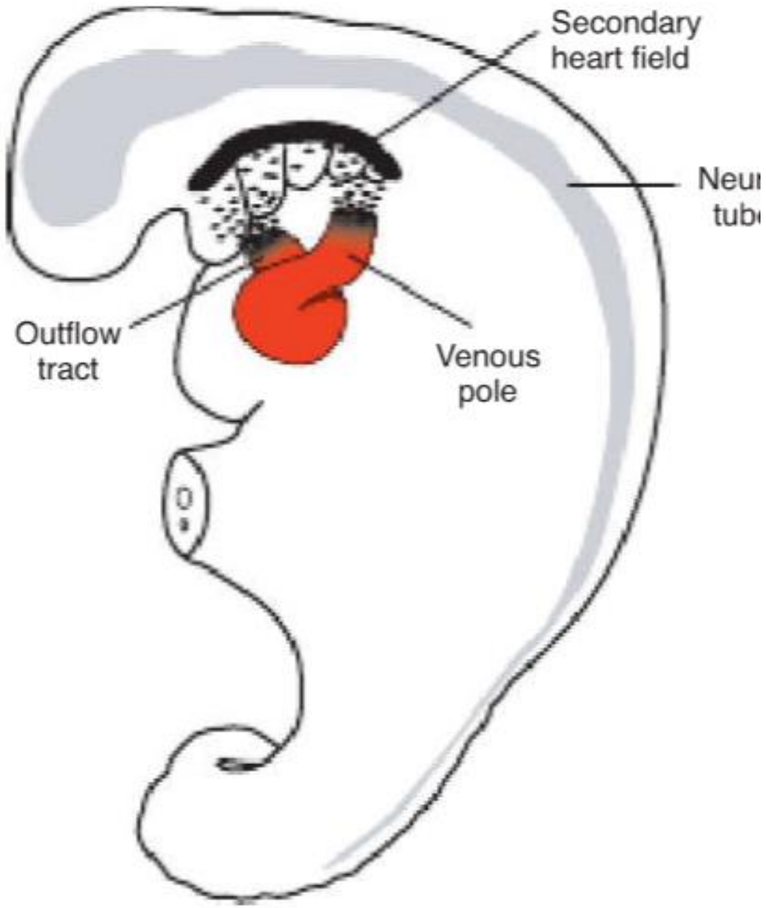

Pericardial cavity
Cardiogenic area
A1
Amniotic cavity
A1 B1
Heart tube
Pericardial cavity
B1

Formation of the heart tube



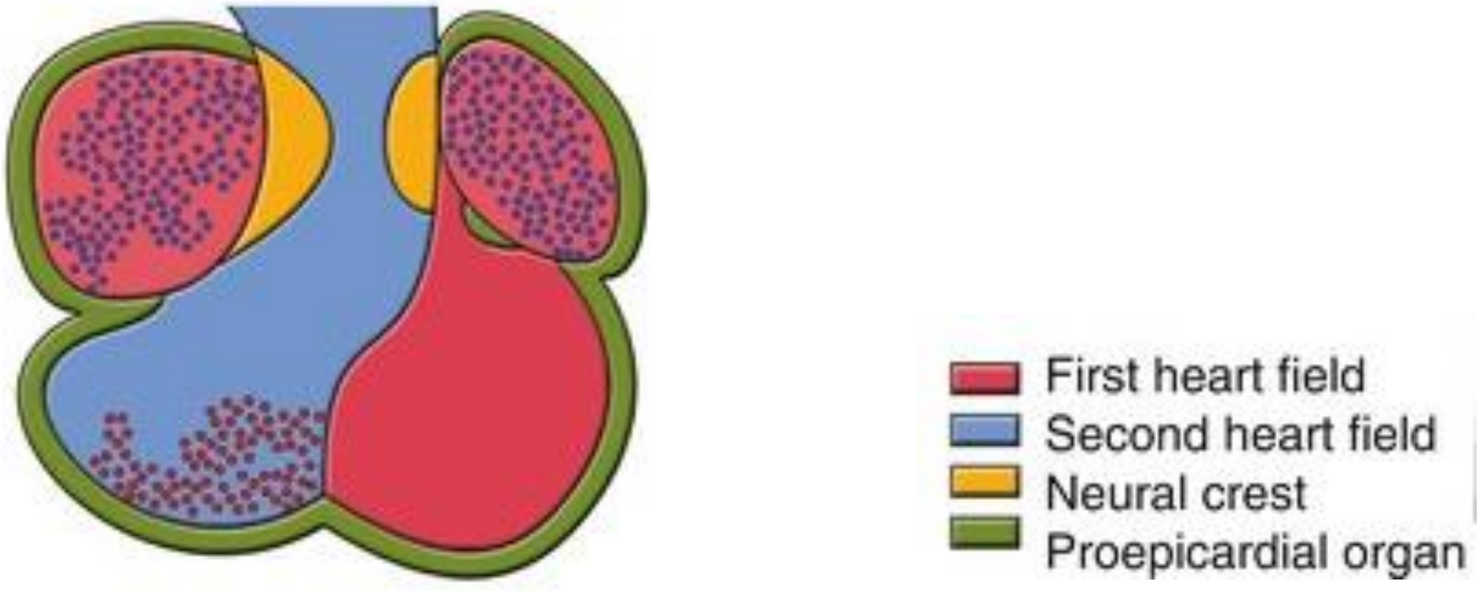
- WHEN? - day 22-28
- WHAT? – cells of the PHF
- DO WHAT? – form cardiac myoblasts and the blood islands ---> the horseshoe-shaped endothelial-lined tube surrounded by myoblast (=cardiogenic region/field), further the caudal portion fuse except for the caudal most part

The heart tube lengthening



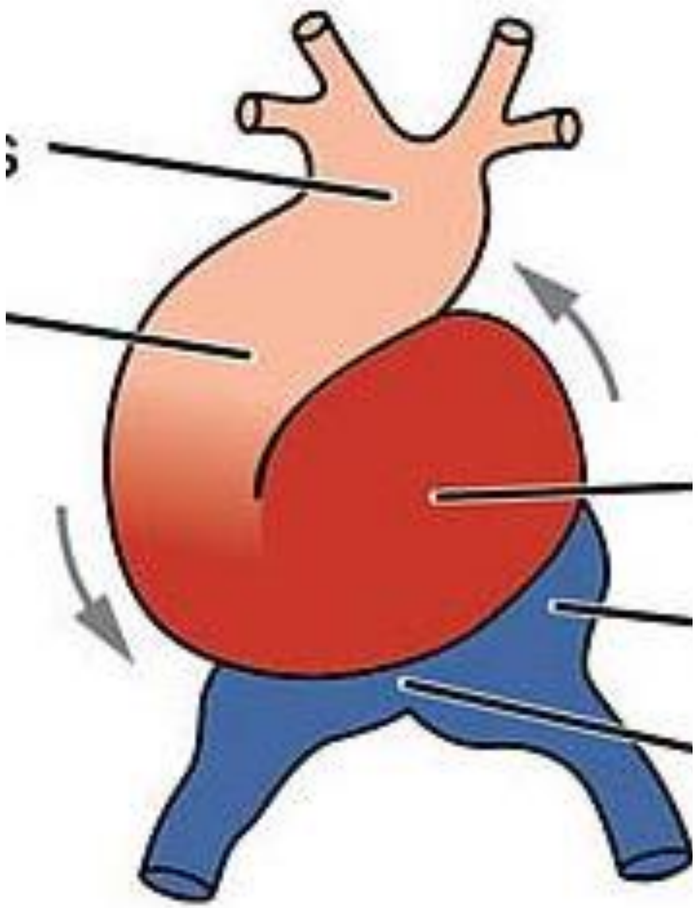
- WHEN? - day 22-28
- WHAT? – SHF in splanchnic mesoderm ventrally to the posterior pharynx
- WHERE? - thoracic region
- DO WHAT? – provides cells to lenghten both poles of the heart tube: atria and sinus venosus, right ventricle, conus cordis and truncus arteriosus

T.W. Sadler, Langman´s medical embryology, 14th edition



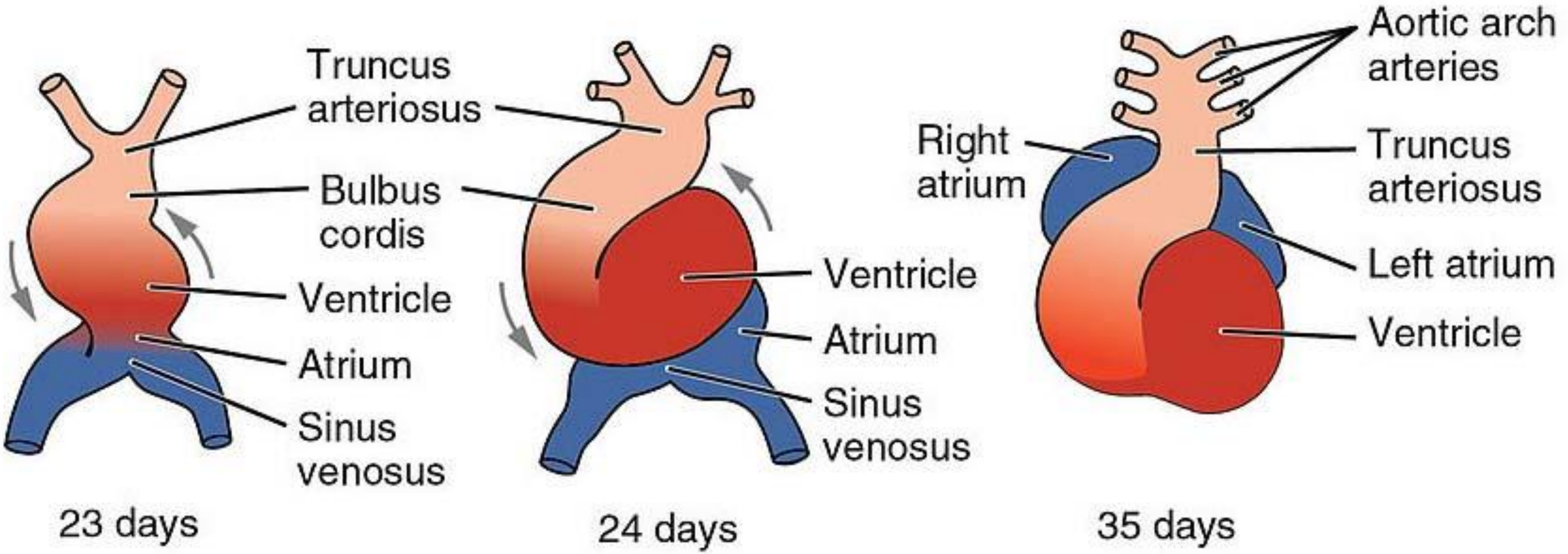
https://radiologykey.com/embryology/

Looping of the heart

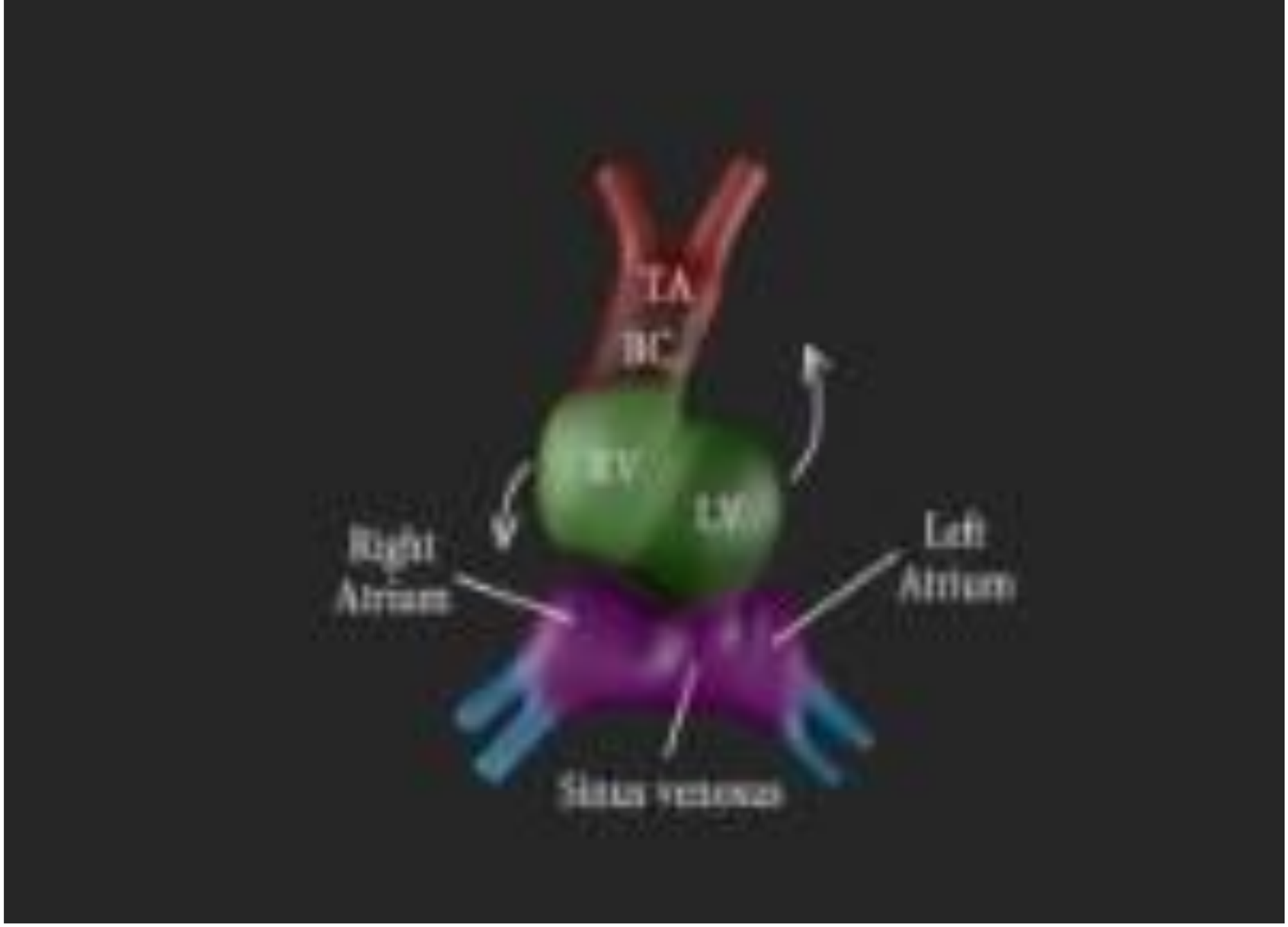


24 days

- WHEN? - day 23-28
- WHAT? - the primitive heart tube
- DO WHAT? - cephalic portion bends ventrally, caudally and to the right**;** caudal portion bends dorsally, cranially and to the left



https://teachmeanatomy.info/the-basics/embryology/cardiovascular-system/

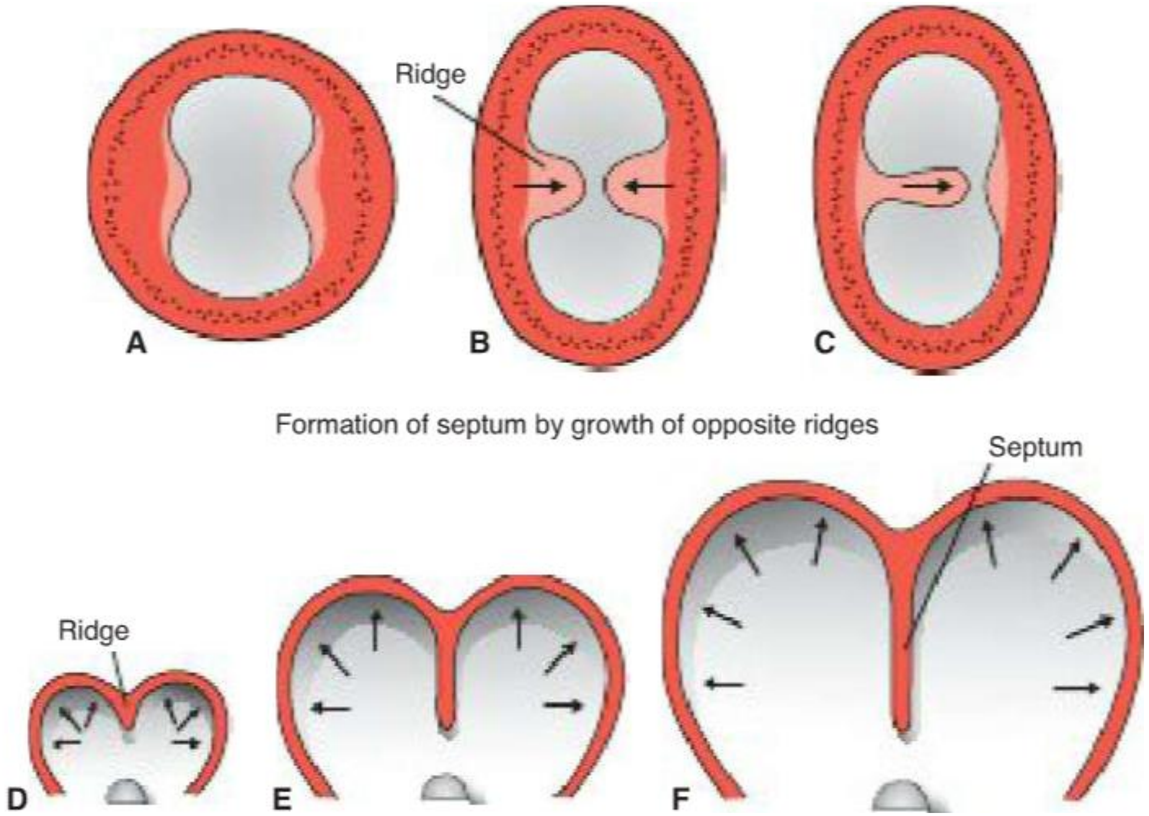


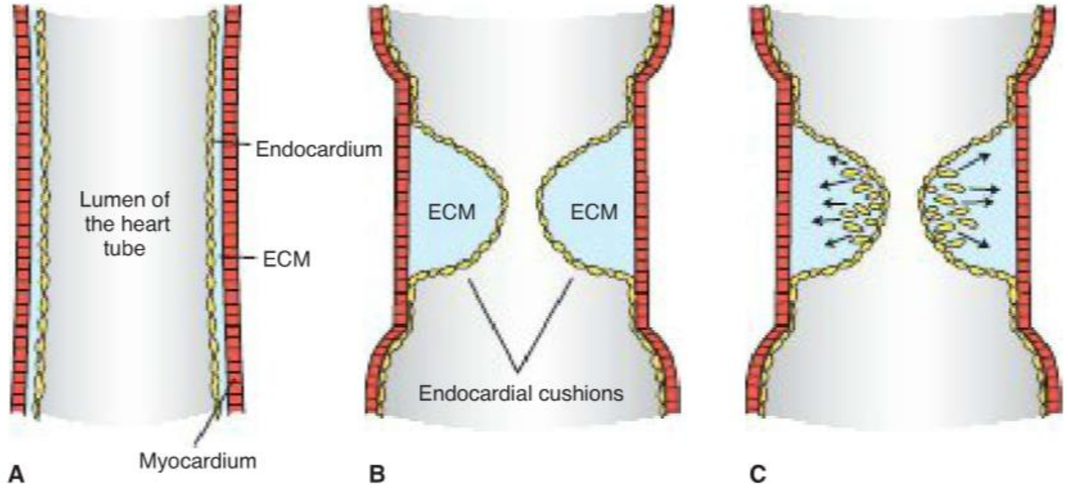
https://youtu.be/a0qyagIgBPw

Formation of the cardiac septa

- WHEN? - day 27-37 (size of the embryo 5-16 mm!)
- WHAT? – septum in the common atrium
  - septum in the atrioventricular canal
  - septum in the truncus arteriosus and conus cordis
  - septum in ventricles

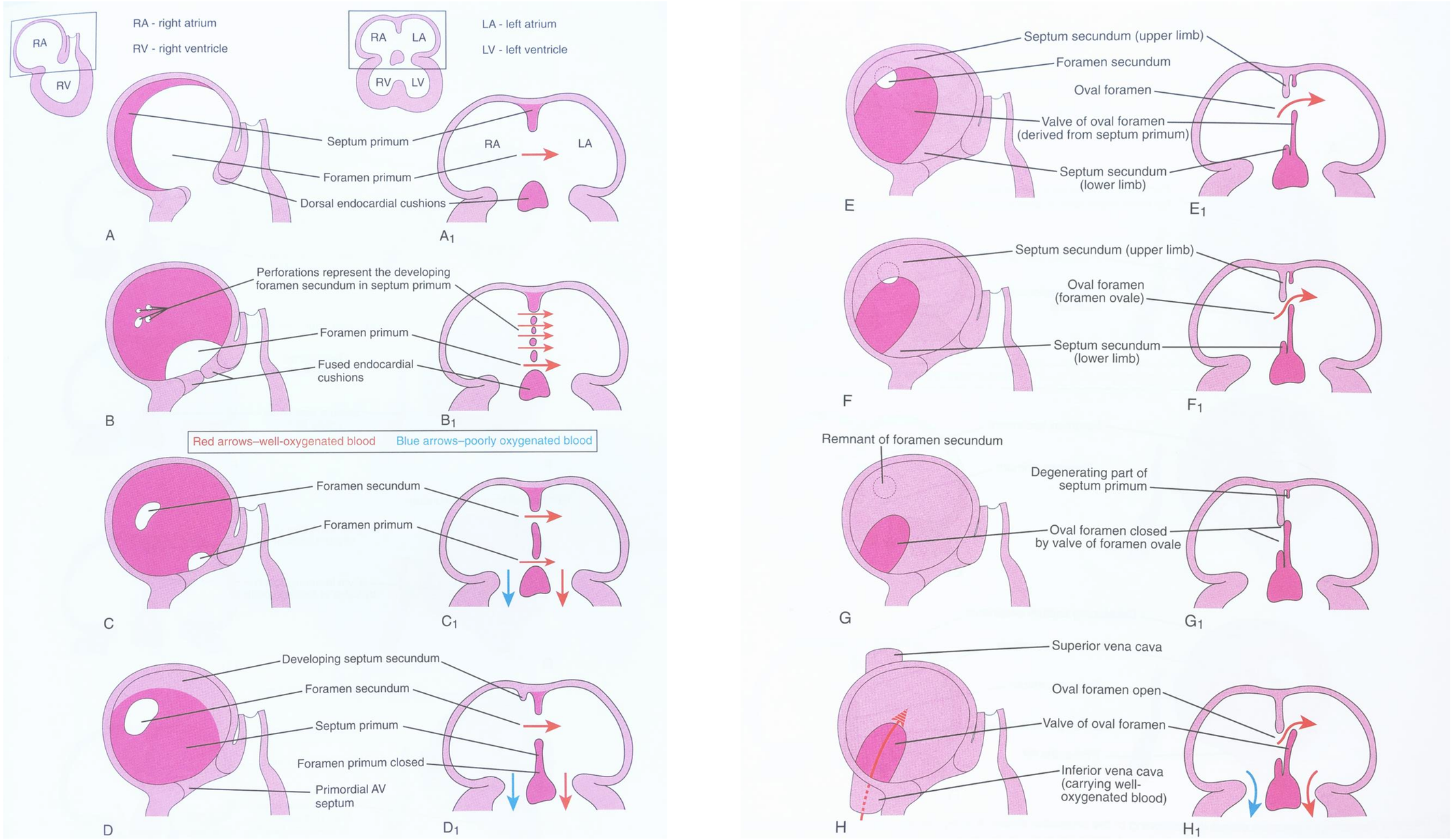
Formation of the cardiac septa





T.W. Sadler, Langman´s medical embryology, 14th edition

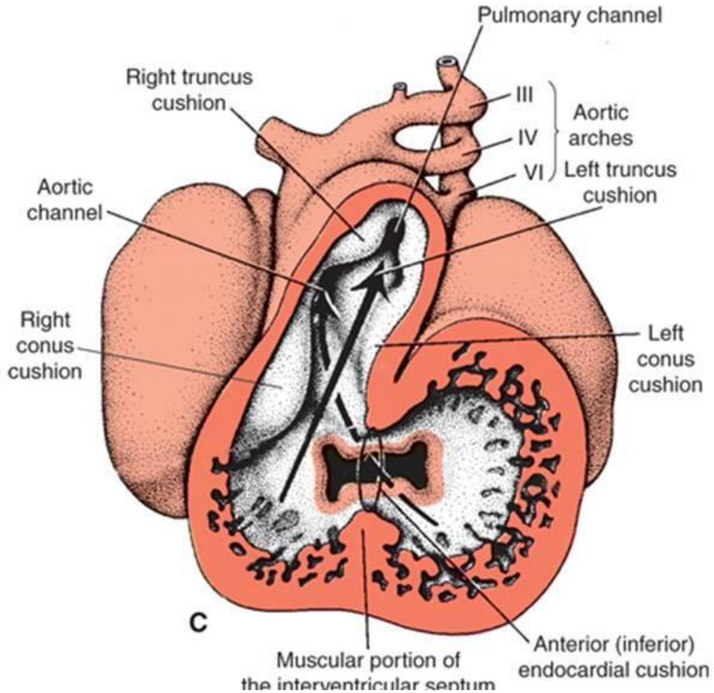
Septum in the common atrium

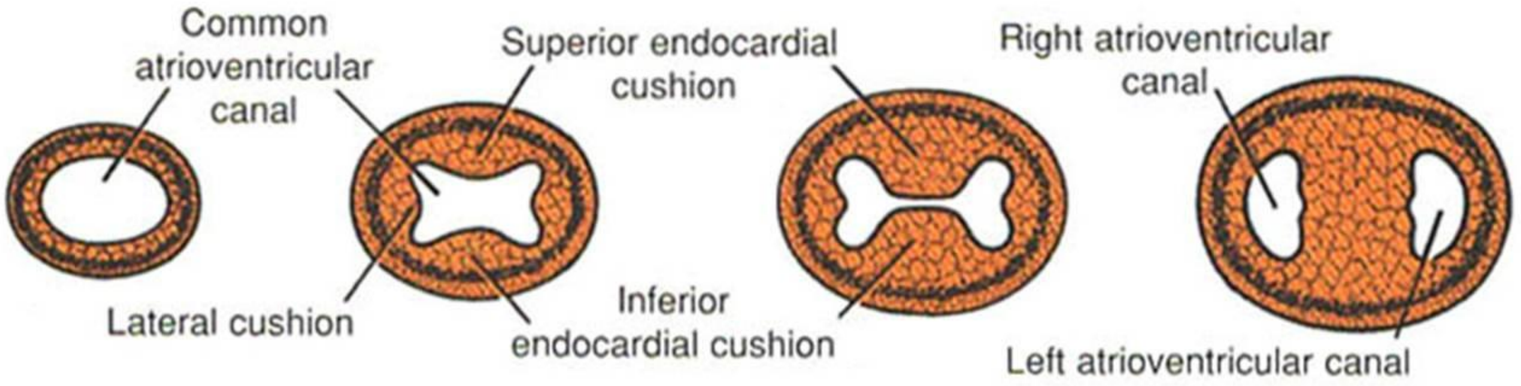


K. Moor, Before we are born

Septum in the atrioventricular canal

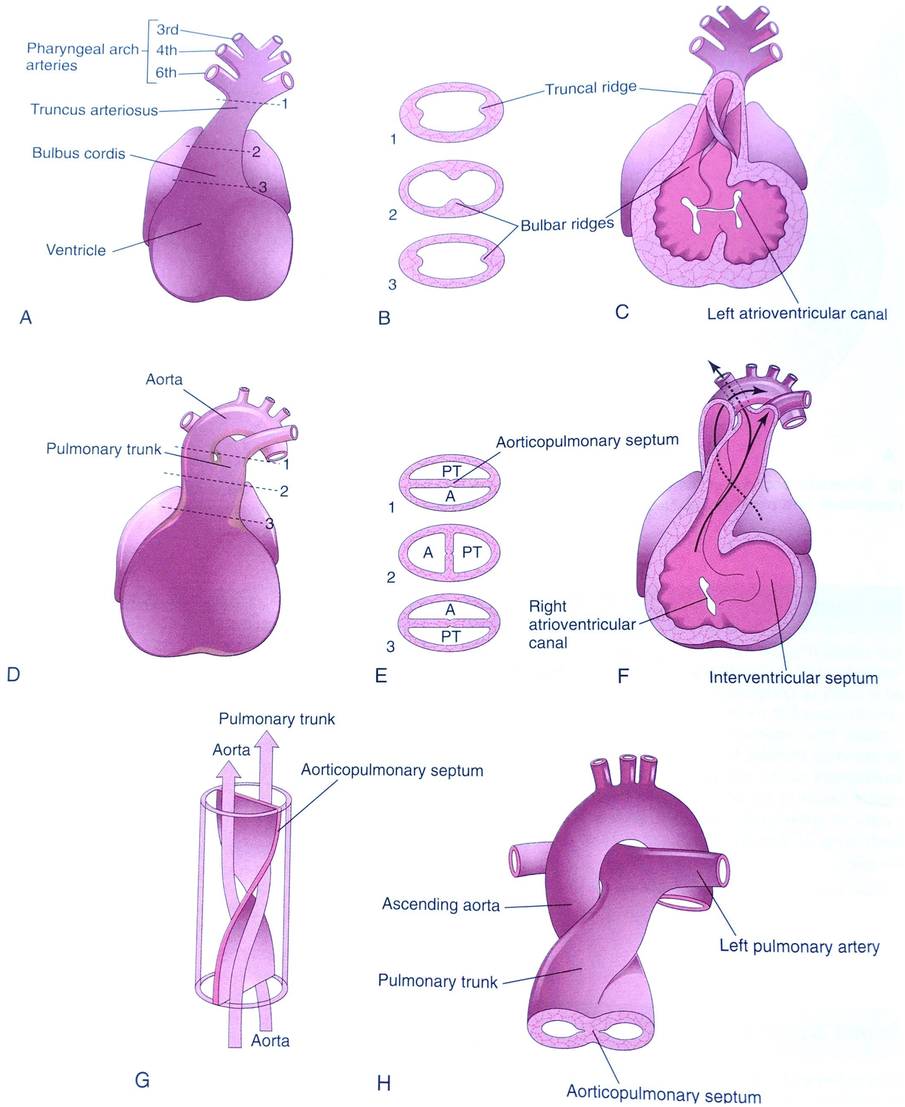
End of the 4th till end of the 5th week





T.W. Sadler, Langman´s medical embryology, 12th edition

Septum in the truncus arteriosus and conus cordis



K. Moor, Before we are born

5th week – **truncus swellings**: **right superior** –grows distally to the left
left inferior – grows distally to the right

conus swellings – grow towards each other and distally to fuse with the truncus swellings

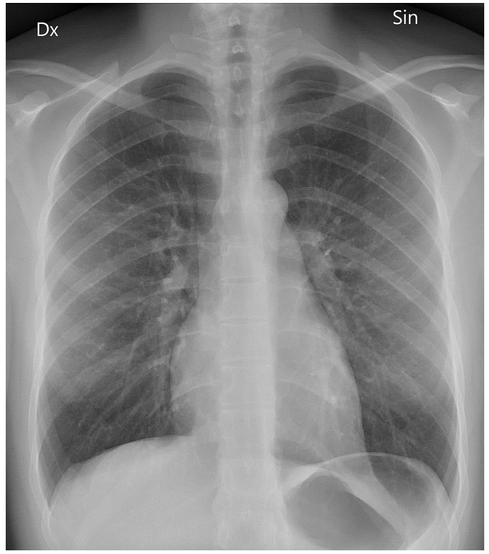
NEURAL CREST CELLS

Congenital heart defects (CHDs)

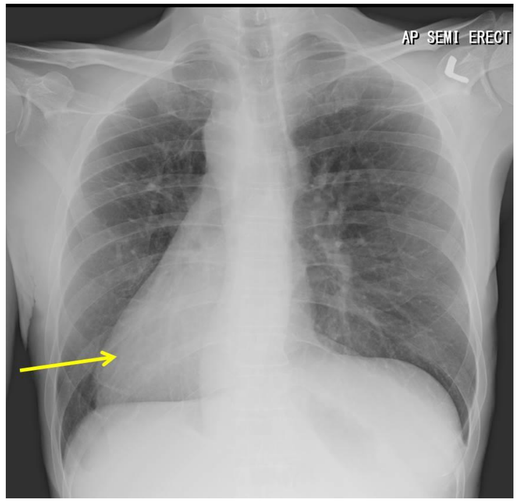
in 1% of live born infants; Rubella, thalidomide, RA, alcohol, maternal insulin-dependent diabetes

Laterality – during the gastrulation, signaling cascade includes serotonin, thus the SSRI class antidepressants are linked to the increase in heart defects:

- dextrocardia (situs inversus, heterotaxy)
- ventricular septal defects (VSDs)
- atrial septal defects (ASDs)
- double outlet right ventricle (DORV)
- transposition of the great vessels
- pulmonary stenosis
- atrial/ventricular isomerism
- inversions



https://en.wikipedia.org/wiki/Chest_radiograph



http://radiologycases.my/2020/08/08/isolated-dextrocardia/

Atrial septal defects (ASDs)

6,4/10 000; 2:1 prevalence in F to M; acyanotic

Patent foramen ovale in 10-20% of population

4 clinically significant ASD:

- **ostium sekundum ASDs** (90% cases; 10-15% of all CHDs)

- **endocardial cushion defects with a foramen primum** (in 25% of patients with Down syndrome)

- **sinus venosus ASDs**

- **common atrium** (*cor triloculare biventriculare*) - combination of the above

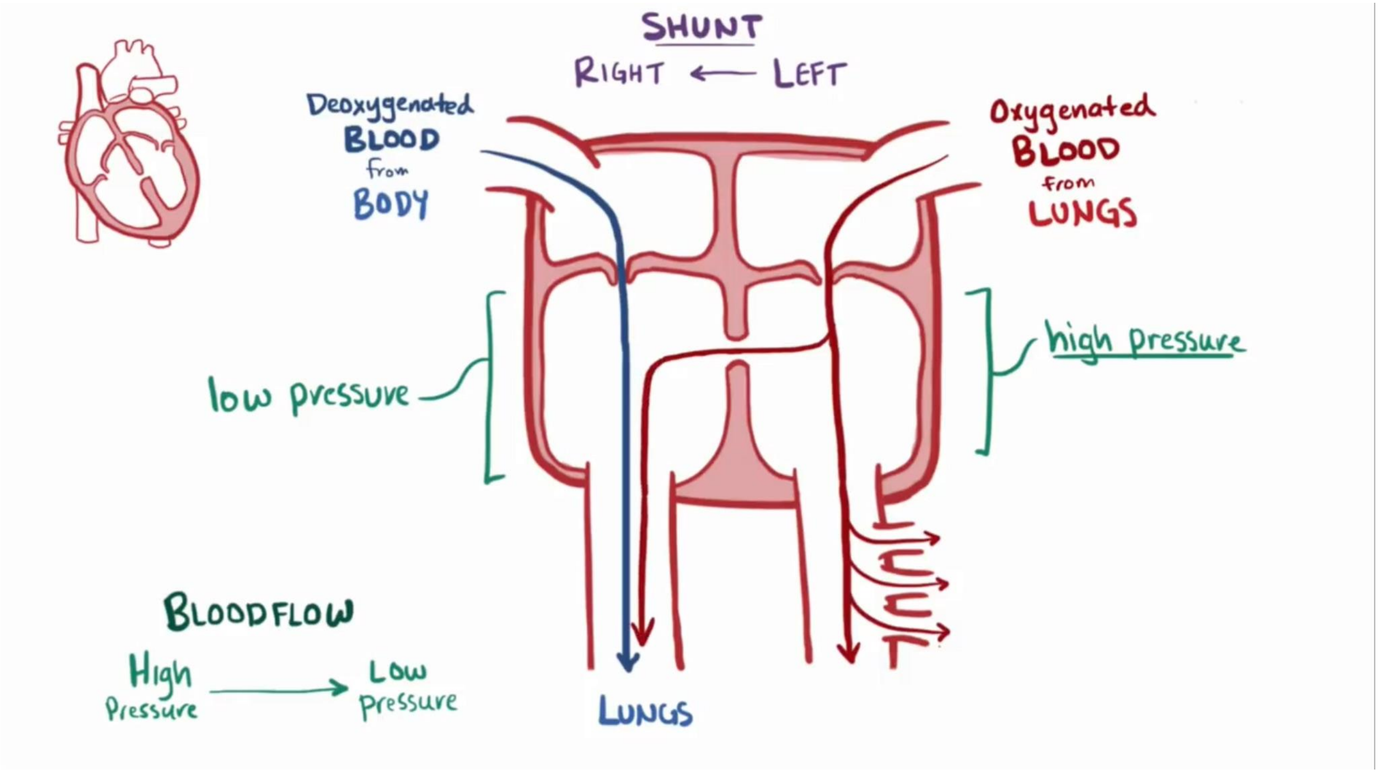
extra blood volume goes to the right side of the heart (delay in the pulmonary valve closure – splitting of the S2 sound), paradoxical embolism

Ventricular septal defects (VSDs)

most common CHDs 12/10 000; acyanotic; 80% in the muscular region and resolve during the childhood

membranous part defects are more severe and associated with other abnormalities

the blood volume carried by pulmonary artery increases (can be 1,2-1,7 times more than aorta) leading to the pulmonary hypertension and can cause Eisenmenger syndrome



https://youtu.be/e7ObXrdtXek

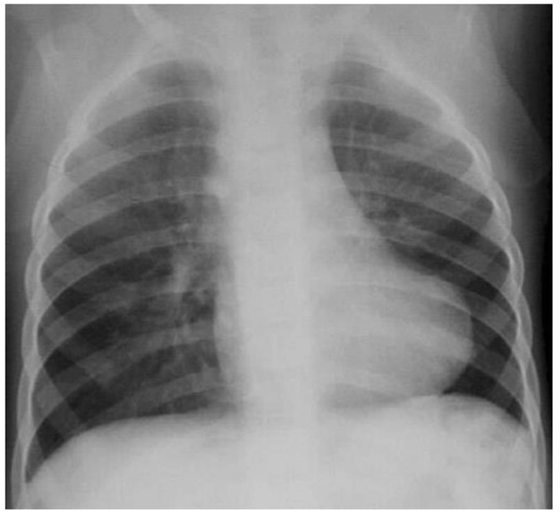
Tetralogy of Fallot (TOF)

results from anterior displacement of conotruncal septum

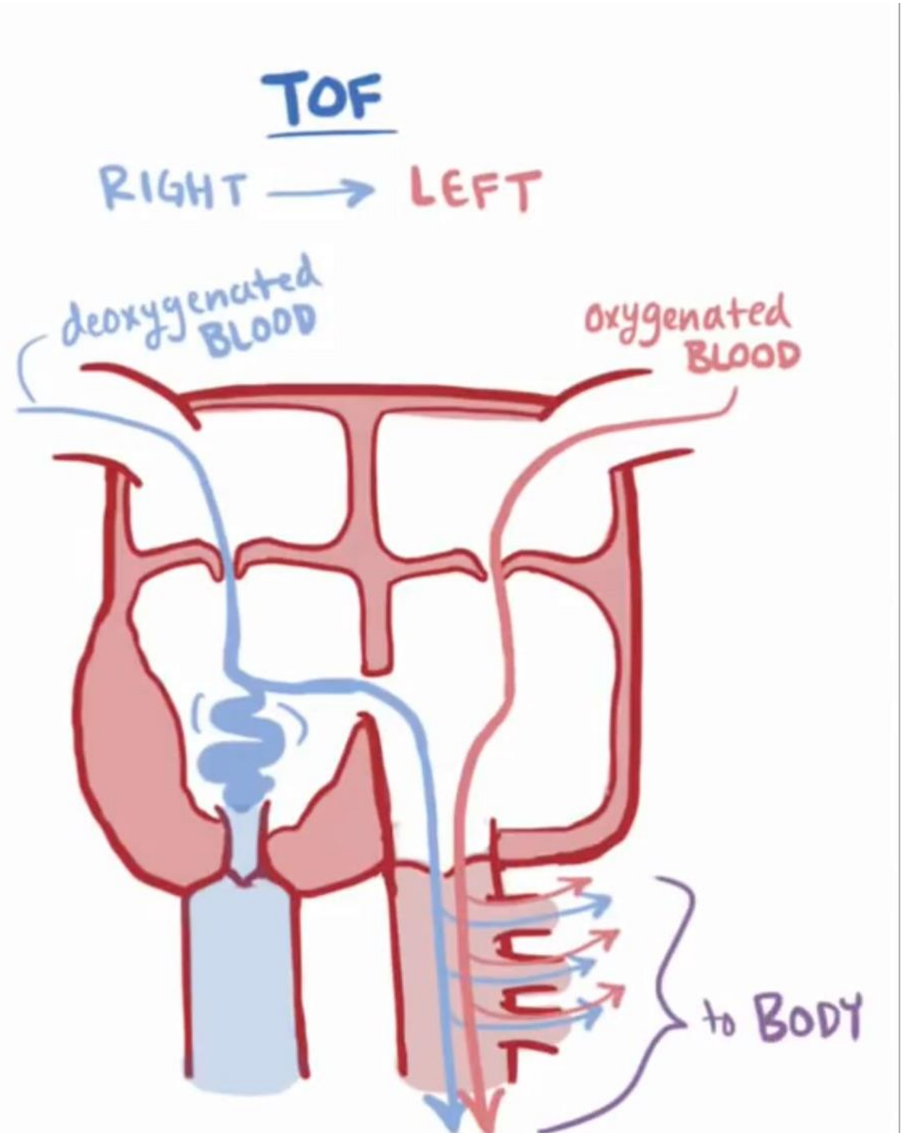
9,6/10000; 10% of all CHDs; cyanotic

leading to 4 abnormalities:

1. Pulmonary infundibular stenosis
2. VSD
3. overriding aorta
4. hypertrophy of the right ventricle



https://link.springer.com/article/10.1186/s12872-018-0996-9



https://youtu.be/JKpVlPFGjaQ

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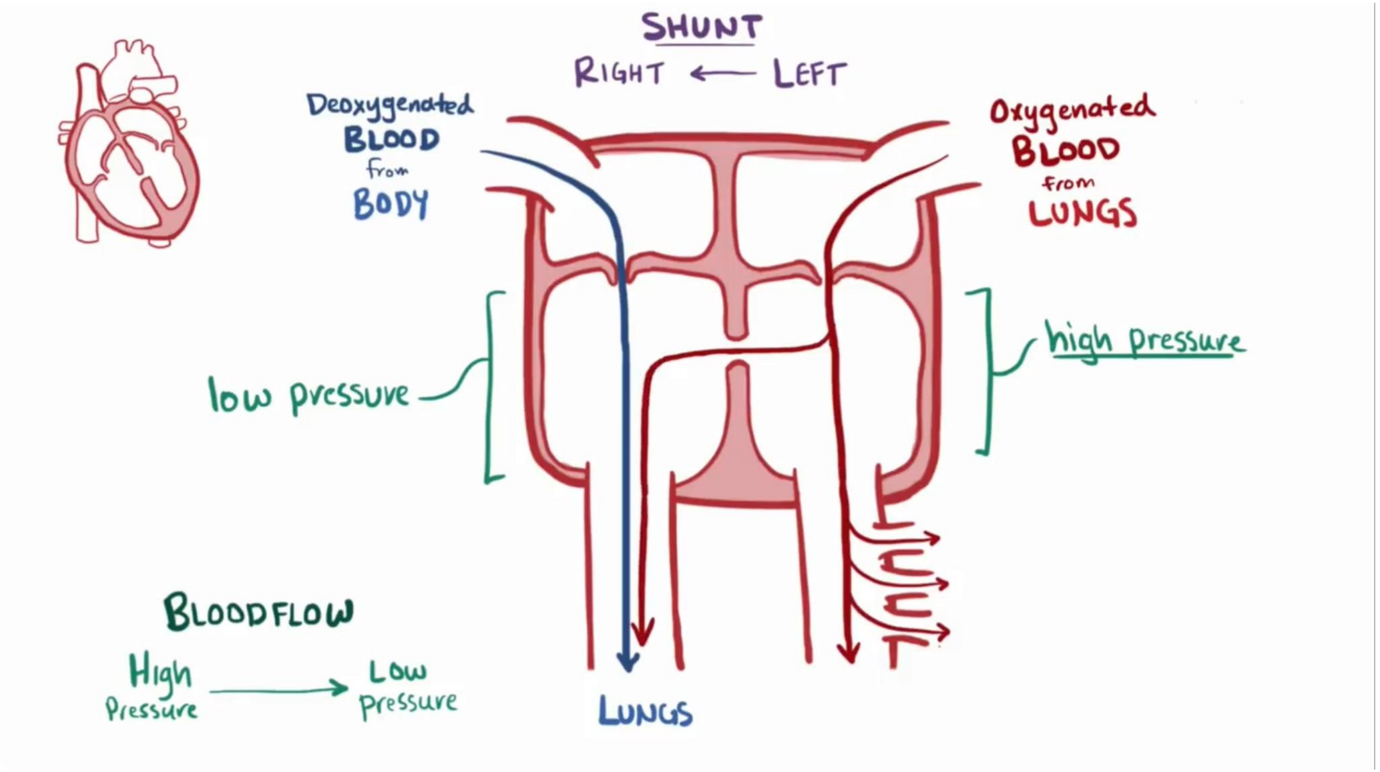


https://youtu.be/e7ObXrdtXek

Congenital heart defects (CHDs)

Ectopia cordis – ventral body wall defect

Persistent truncus arteriosus – (0,8/10 000) – always present with VSD

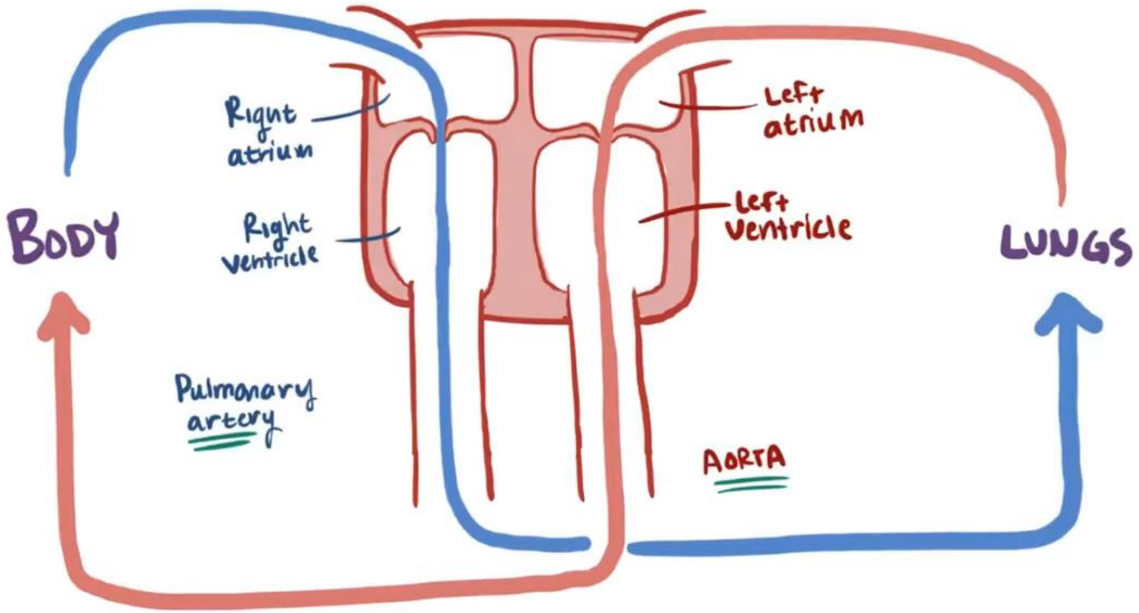
Transposition of great arteries (4,8/10 000)

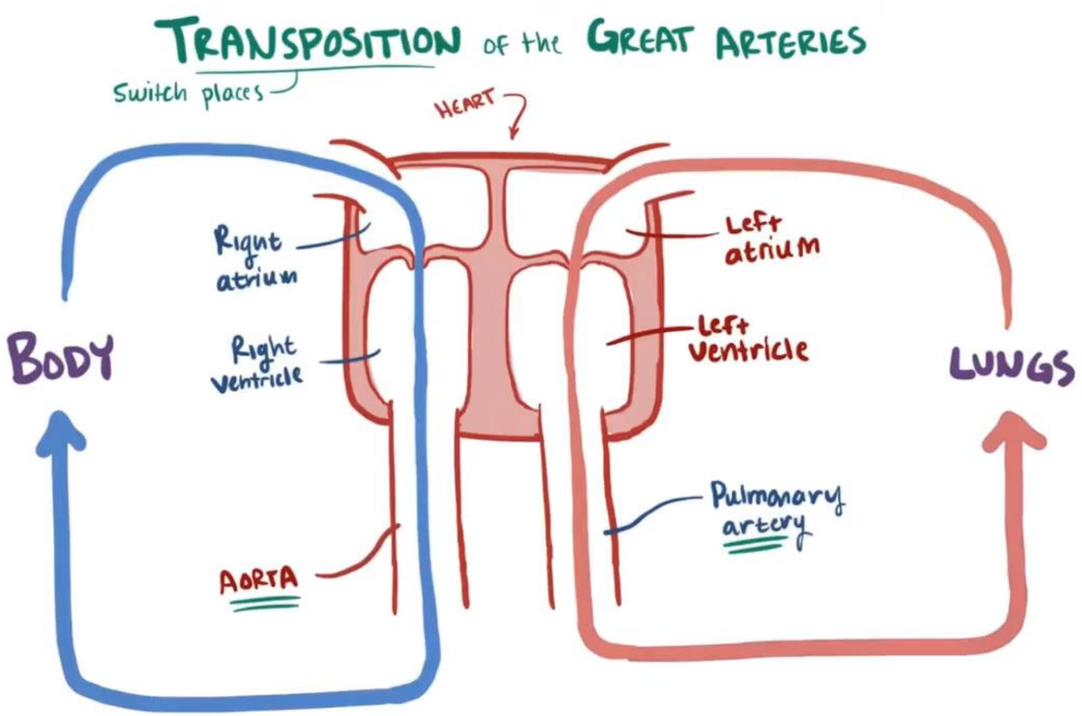
Aortic stenosis and aotric atresia

Pulmonary stenosis and pulmonary atresia

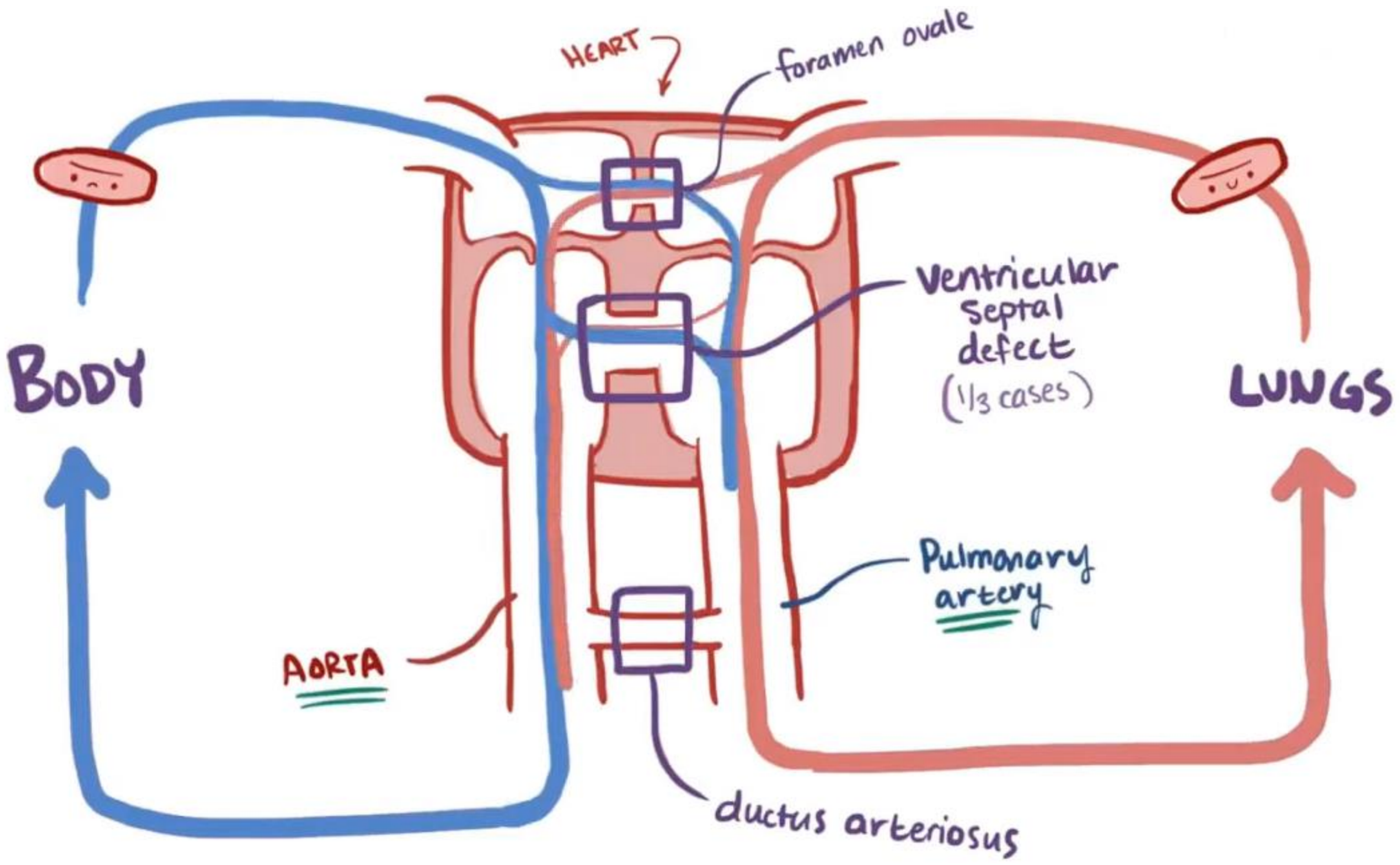
Unequal division of TA

Transposition of great arteries

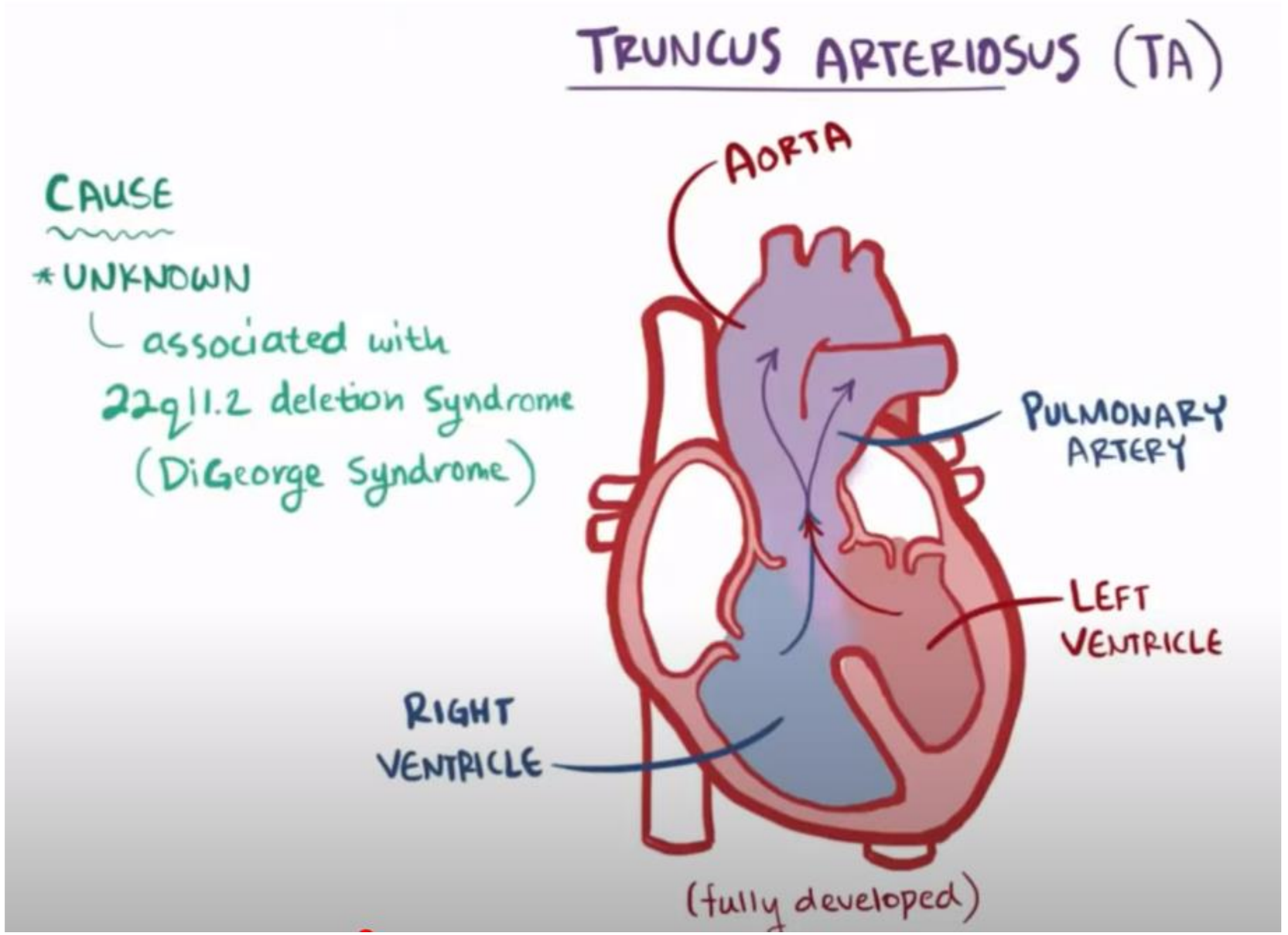


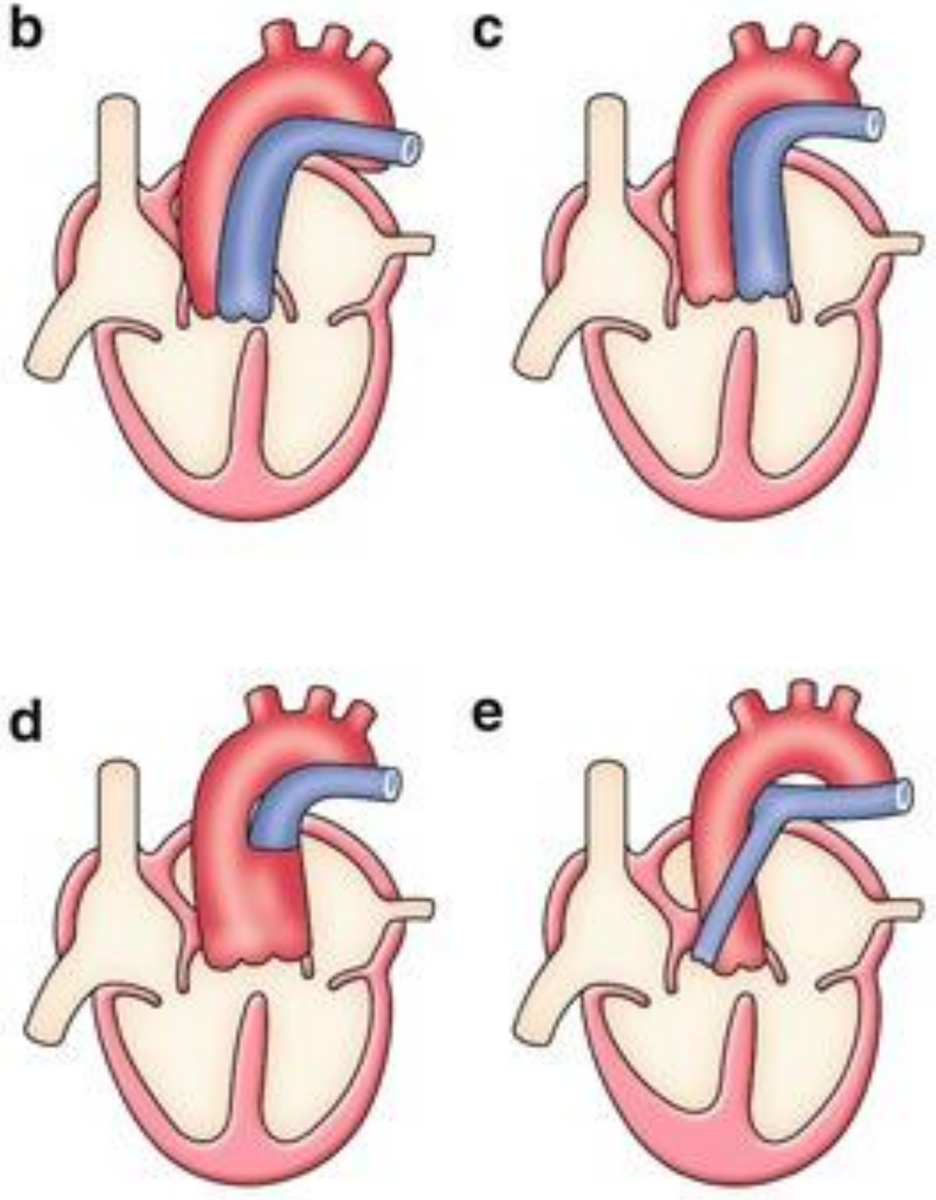


Transposition of great arteries

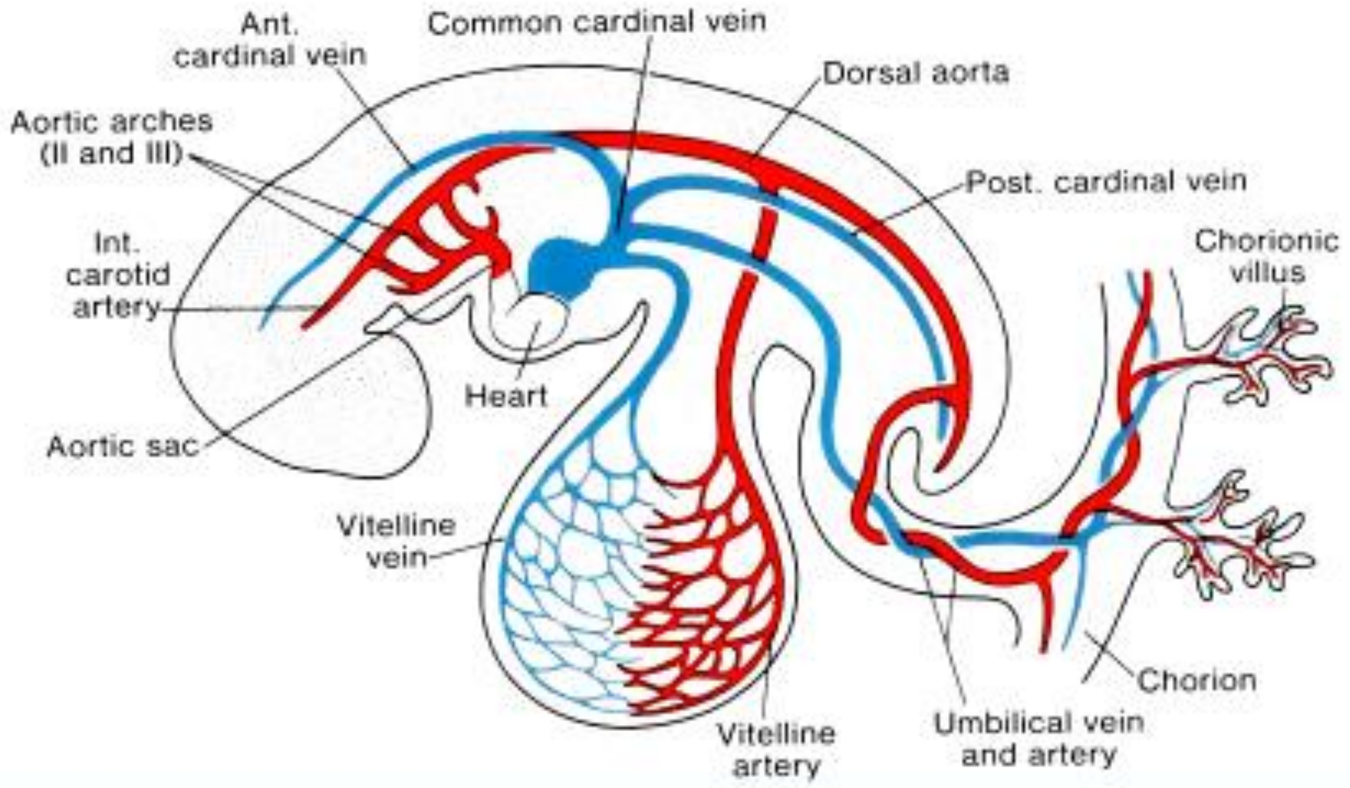


Persistent truncus arteriosus




b
c
d
e

Primitive blood circulation



- ⇨ in the wall of yolk sac (aa. et vv. omphalomesentericae)
- ⇨ in the chorion and connecting stalk (aa. et vv. umbilicales)
- ⇨ in embryo (primary blood circulation – *heart tube, dorsal aortae, cardinal veins*)

Foetal blood circulation