MESODERMAL DERIVATIVES

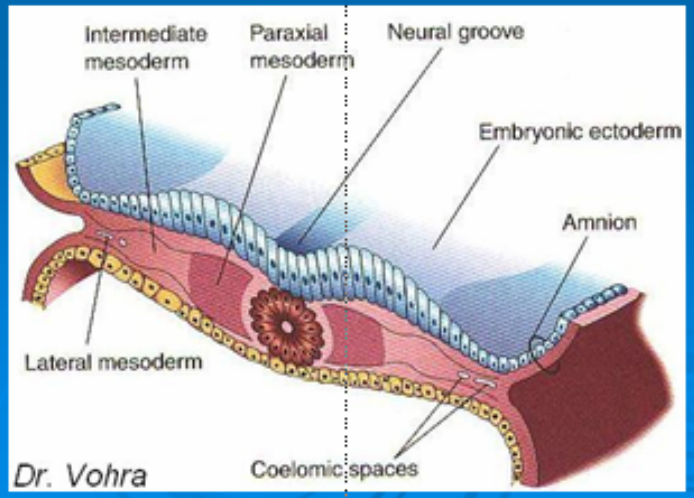
By: Dr. Saeed Vohra

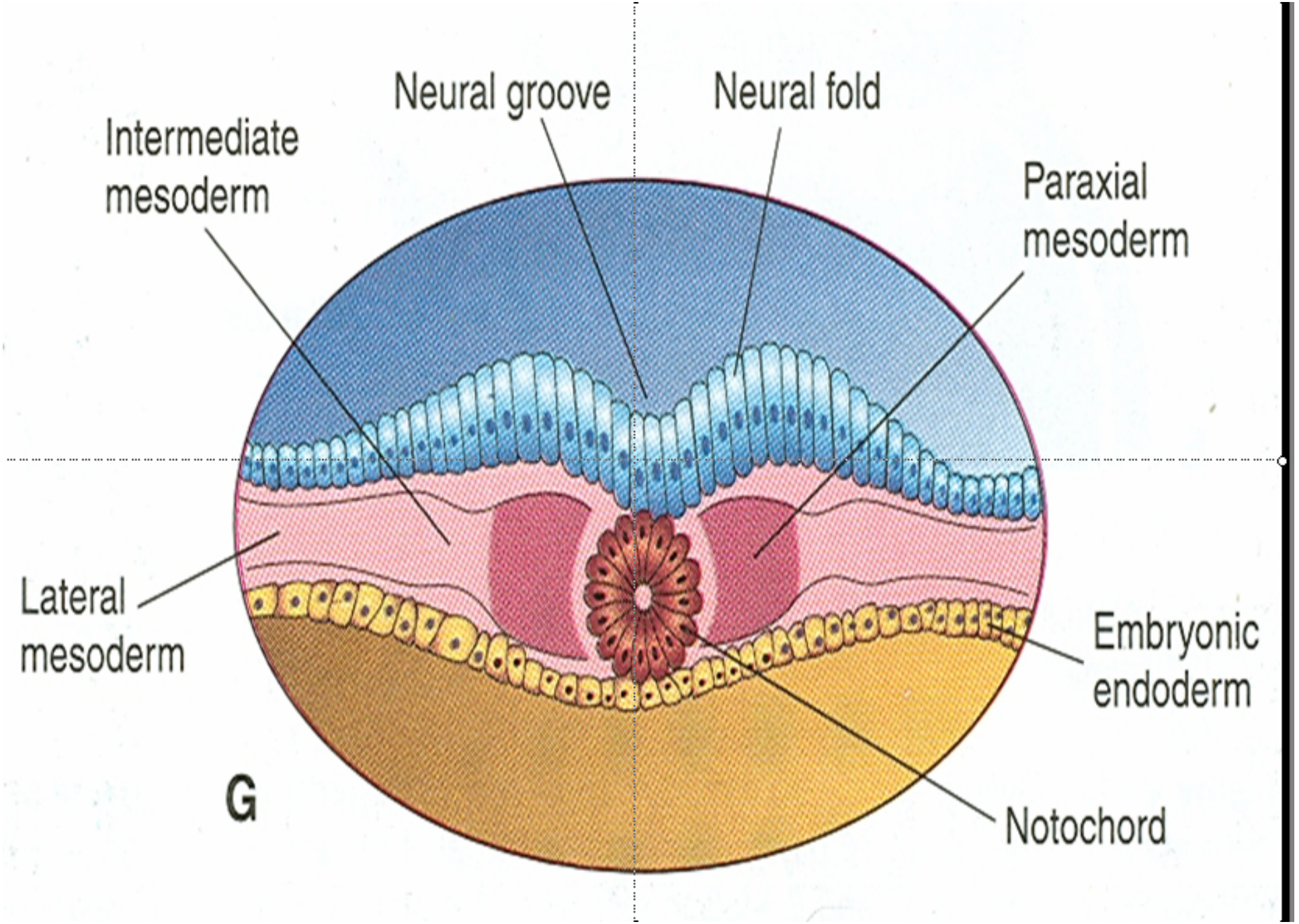
Derivatives

- Connective tissue
- Cartilage
- Bone
- Striated & smooth muscles
- Heart
- Blood & lymphatic vessels
- Kidneys, ovaries, testes & genital ducts
- Serous membrane lining the body cavities
- Spleen & cortex of the supra renal gland

Story of mesodermal germ layer

When the embryo is 17 day old, a layer is formed of thin sheet of loose tissue between the endodermal & ectodermal germ layers is called as **MESODERMAL GERM LAYER**

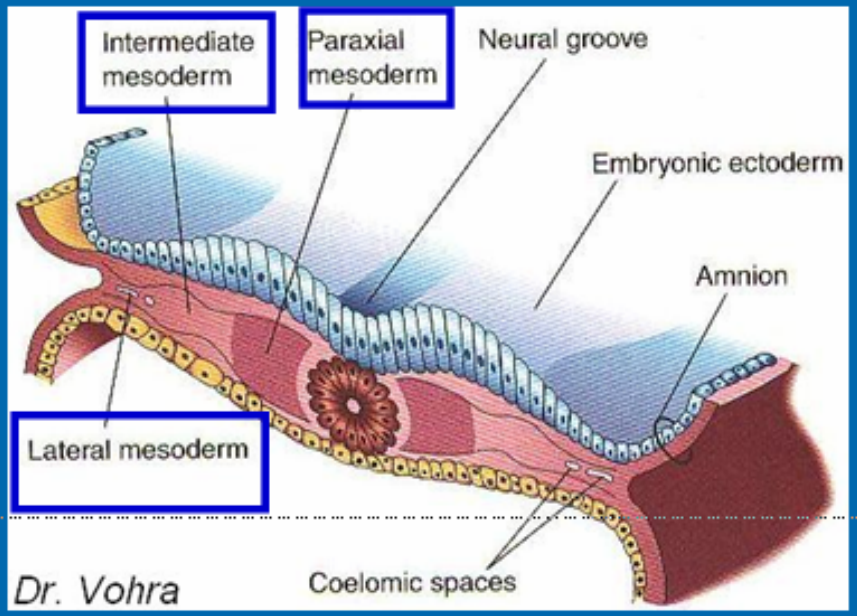



Neural groove
Neural fold
Intermediate mesoderm
Paraxial mesoderm
Lateral mesoderm
Embryonic endoderm
Notochord
G

The mesodermal germ layer

DIVISIONS & DERIVATIVES

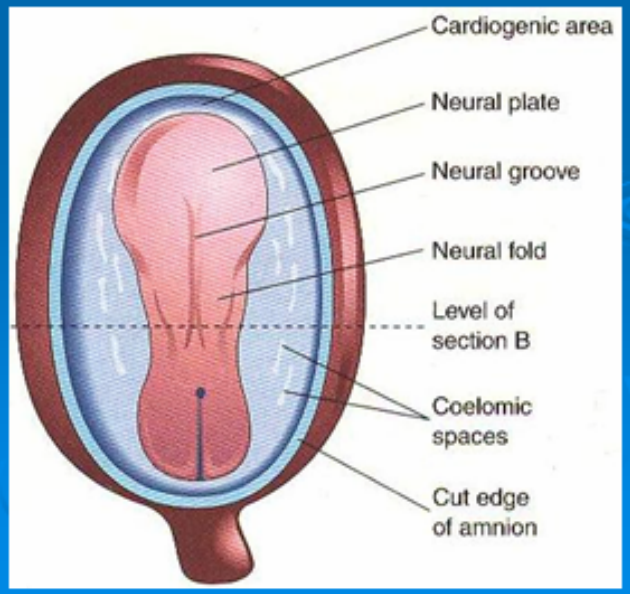
As the development progresses the mesodermal germ layer divided into 3 parts:
(1) Paraxial (2) Intermediate (3) Lateral plate



1. Paraxial mesoderm

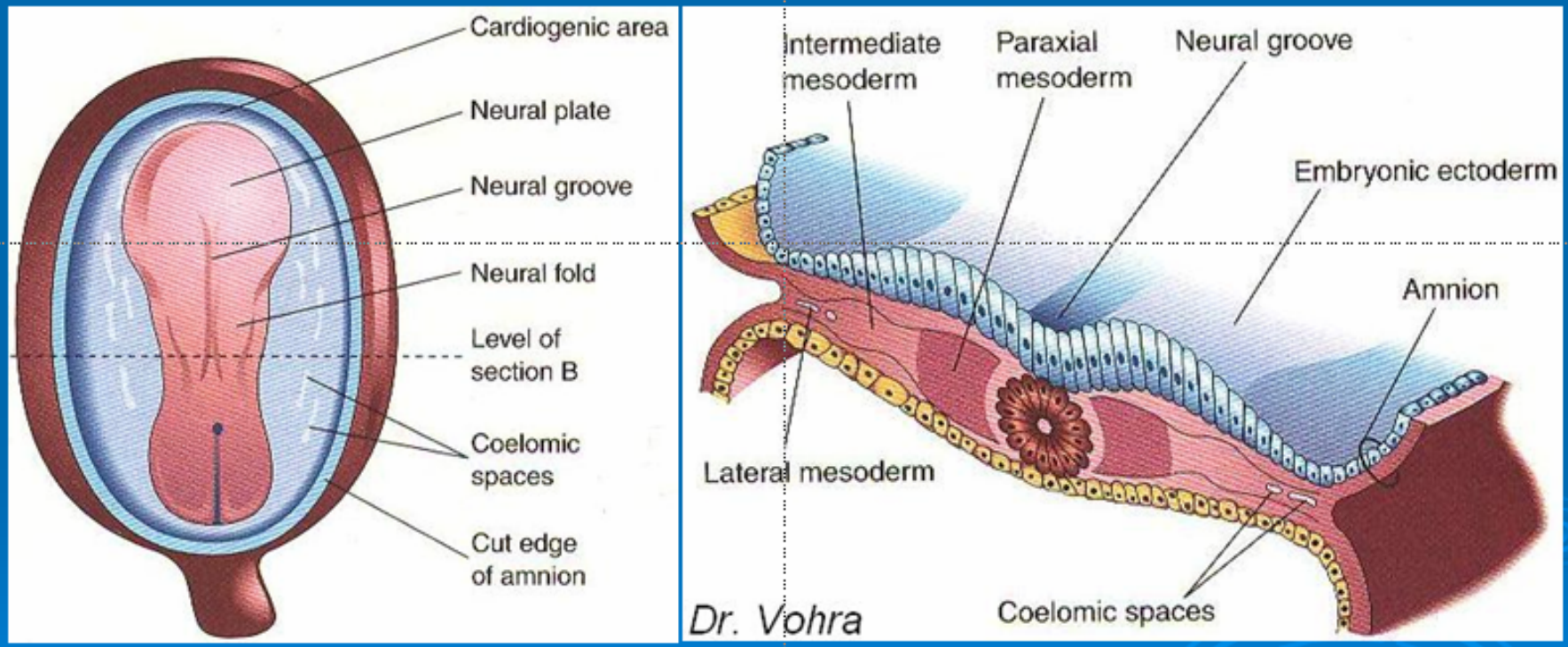
Thickened mass of mesoderm lie on either side of notocord

The paraxial mesoderm will be later divided into small mesodermal blocks called ***somites***



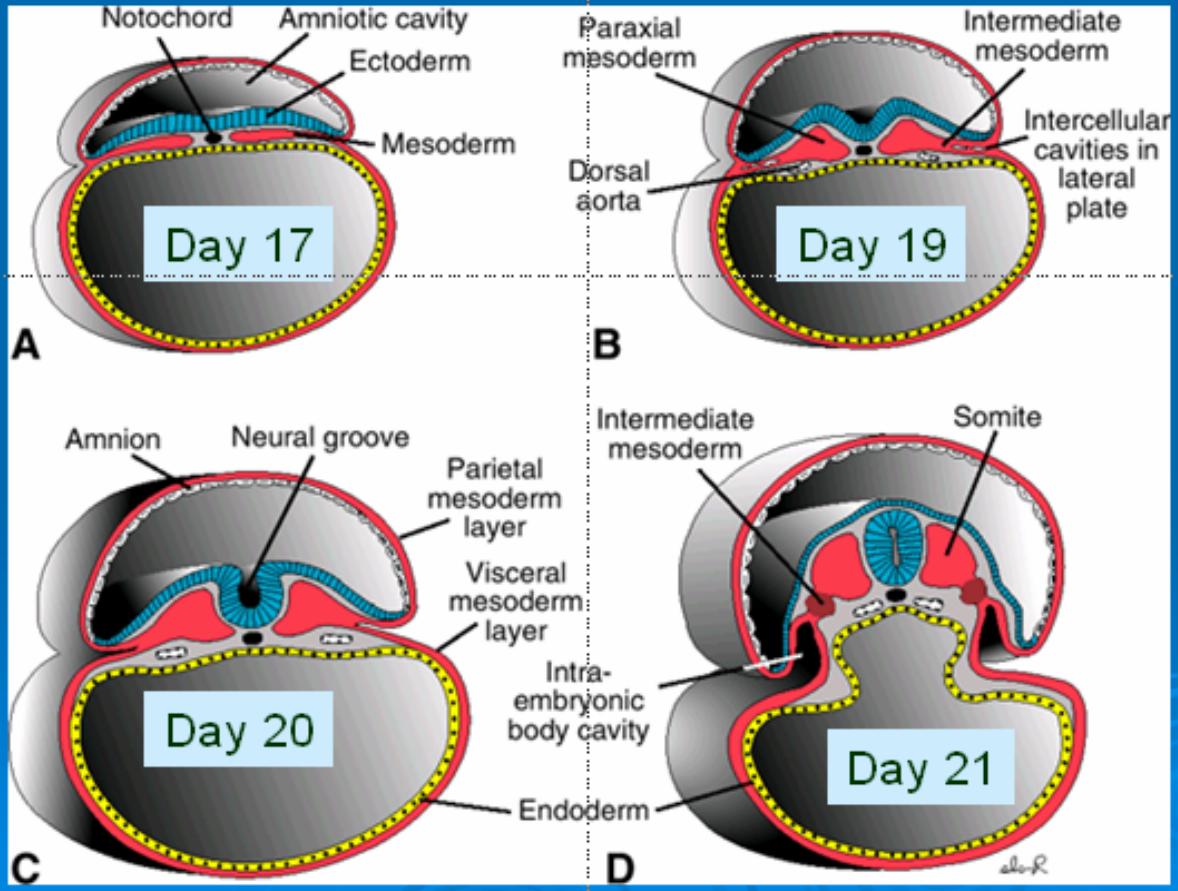
2. Intermediate mesoderm

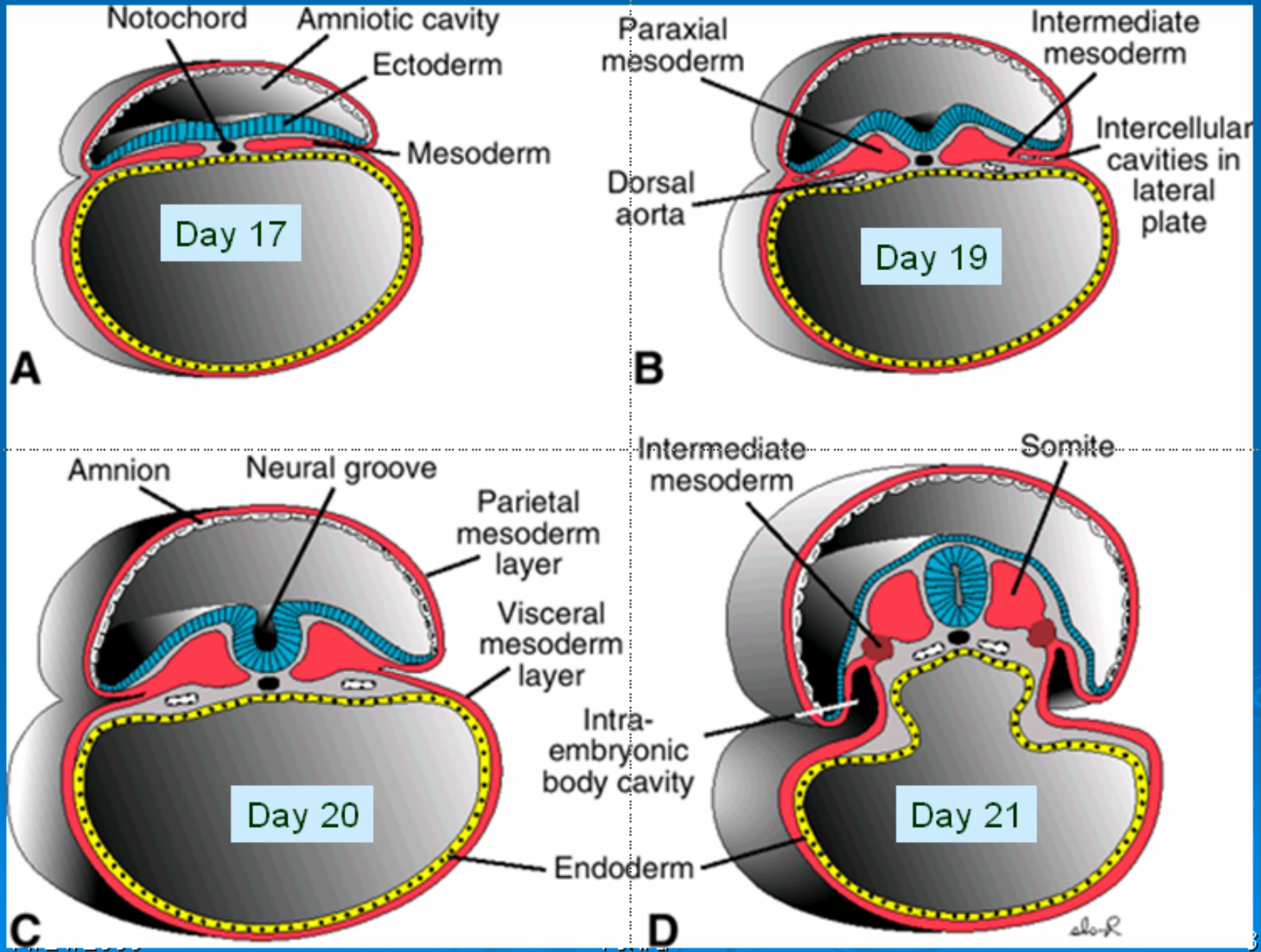
This part of mesoderm lies between paraxial & lateral plate mesoderm give rise to cortex of adrenal glands, kidneys & gonads (ovary & testes)



3. Lateral plate mesoderm

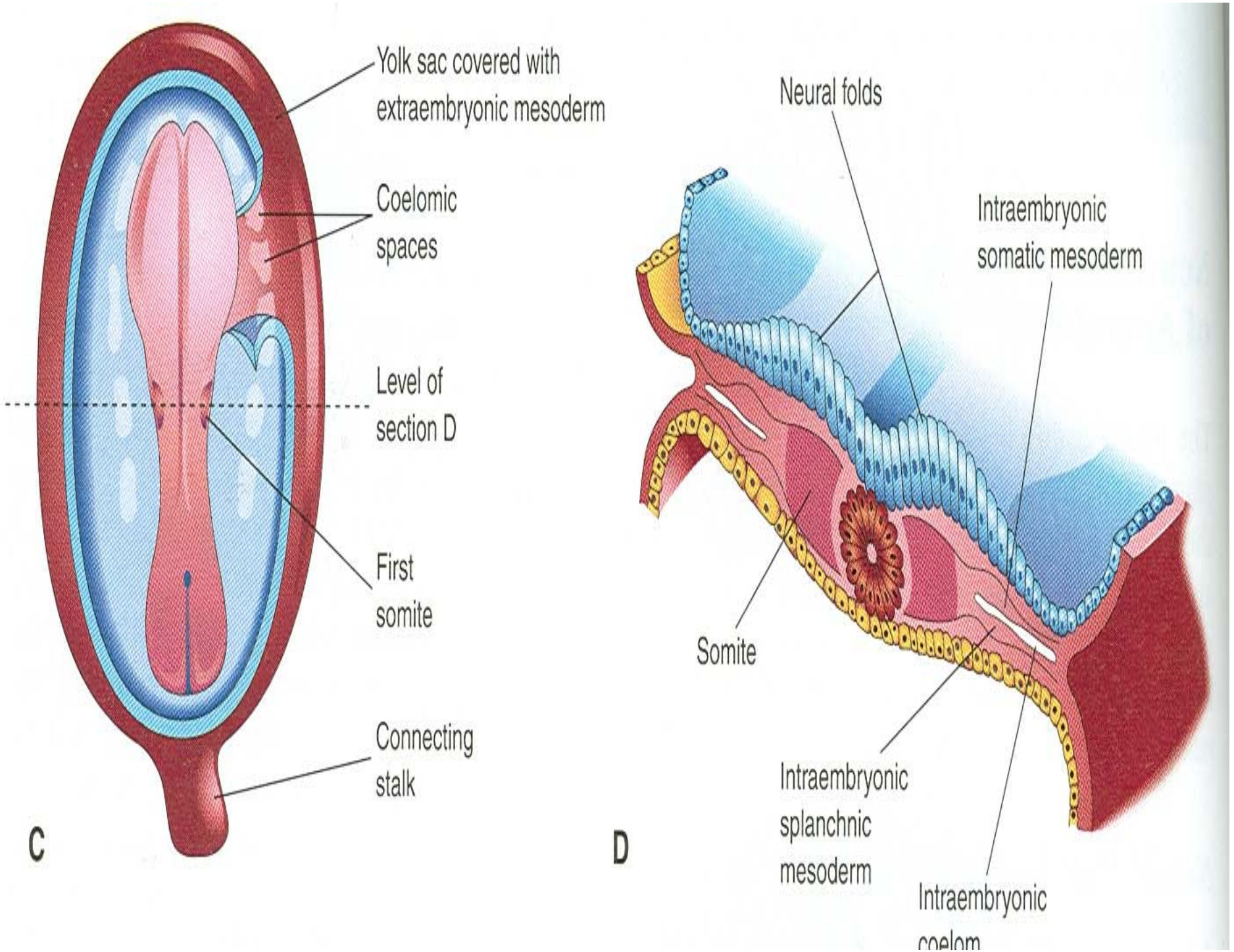
This is the most lateral part of mesoderm & extents laterally & continuous with the extra embryonic mesoderm covering the yolk sac & amnion




Notochord
Amniotic cavity
Ectoderm
Mesoderm
Day 17
A
Paraxial mesoderm
Intermediate mesoderm
Intercellular cavities in lateral plate
Dorsal aorta
Day 19
B
Amnion
Neural groove
Parietal mesoderm layer
Visceral mesoderm layer
Day 20
Endoderm
C
Intermediate mesoderm
Somite
Intra-embryonic body cavity
Day 21
D

Development of Somites

- Paraxial mesoderm differentiates and begins to divide into cuboidal bodies called somites by the end of 3rd week
- These blocks of mesoderm are located on each side of developing neural tube
- About 38 pairs of somites form during the somite period of human development (20-30 days)


Yolk sac covered with extraembryonic mesoderm
Coelomic spaces
Level of section D
First somite
Connecting stalk
C
Neural folds
Intraembryonic somatic mesoderm
Somite
Intraembryonic splanchnic mesoderm
Intraembryonic coelom
D

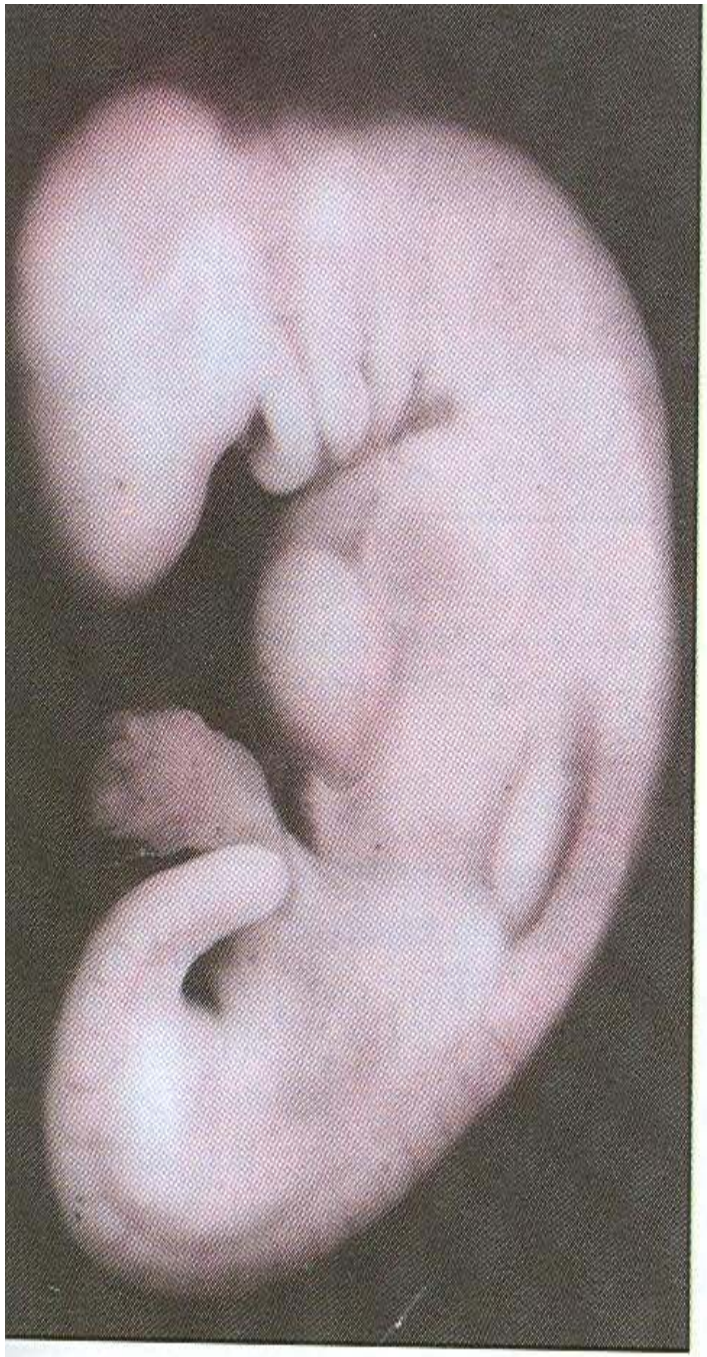
Somites

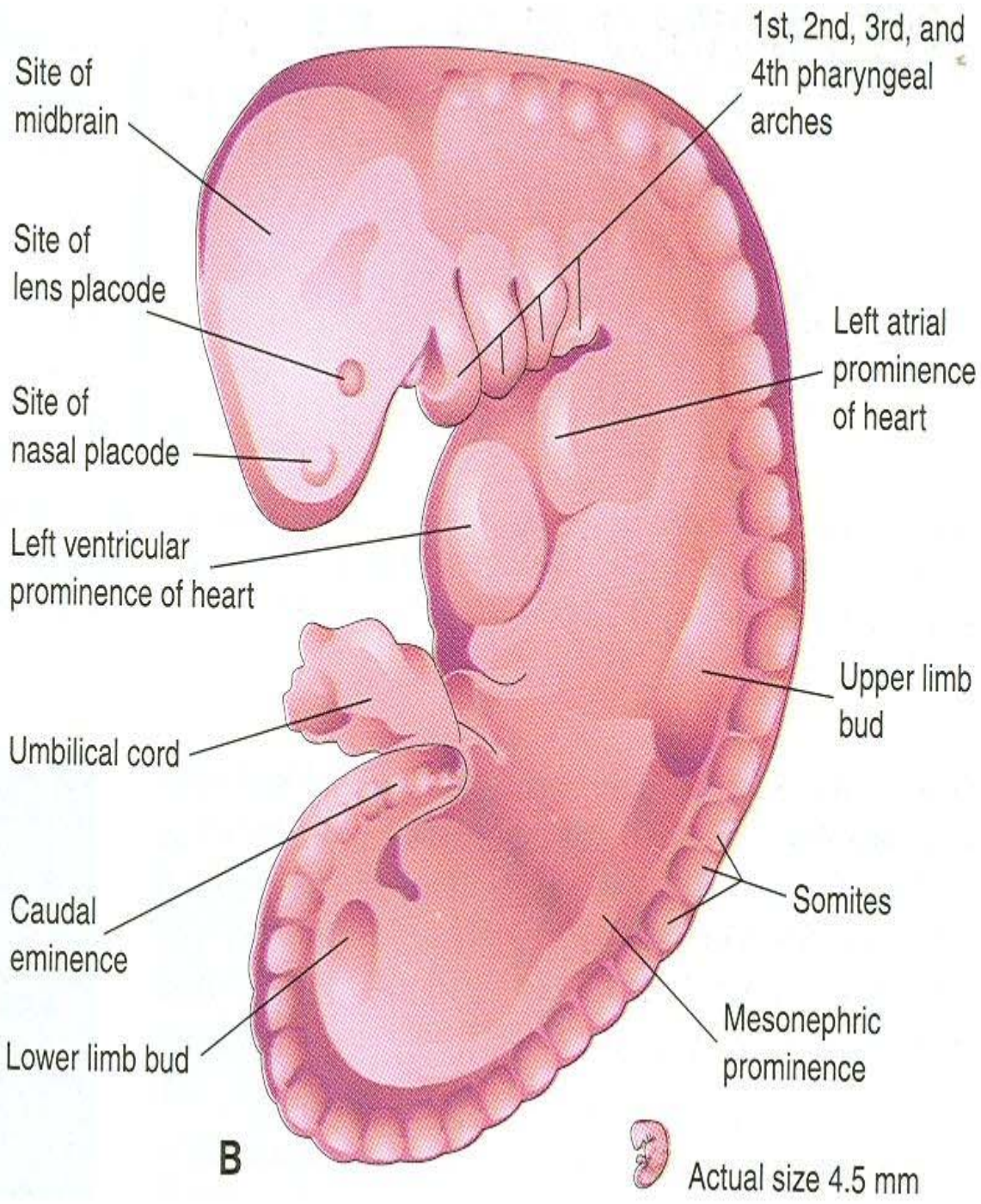
- About 42-44 pairs of somites are present by the end of 5th week
- Form distinct surface elevations on the embryo
- Are used as one of the criteria to know the age of the embryo at this stage

Age determination in the “somite period”

- During the ‘somite period’ (day 20-30) the age of the embryo can be roughly estimated by counting the # of somites according to the following table:

Number of somites	1	3	7	10	13	16	19	22	25	28	31
Age in days	20	21	22	23	24	25	26	27	28	29	30



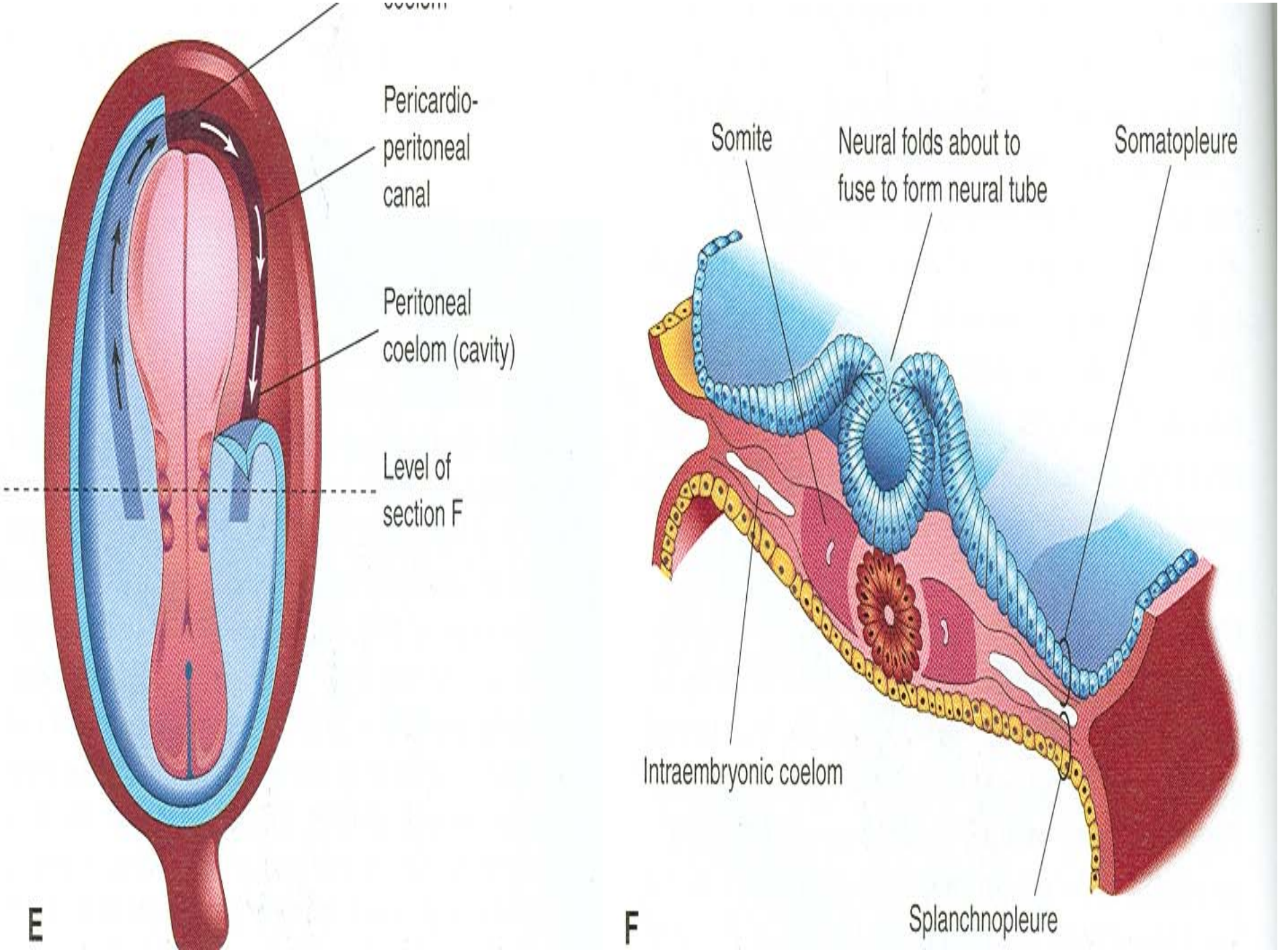

Site of midbrain
Site of lens placode
Site of nasal placode
Left ventricular prominence of heart
Umbilical cord
Caudal eminence
Lower limb bud
1st, 2nd, 3rd, and 4th pharyngeal arches
Left atrial prominence of heart
Upper limb bud
Somites
Mesonephric prominence
B
Actual size 4.5 mm

Somites

- First appear in the future occipital region
- Soon develop craniocaudally
- Gives rise to the axial skeleton and associated musculature
- Also forms adjacent dermis of the skin

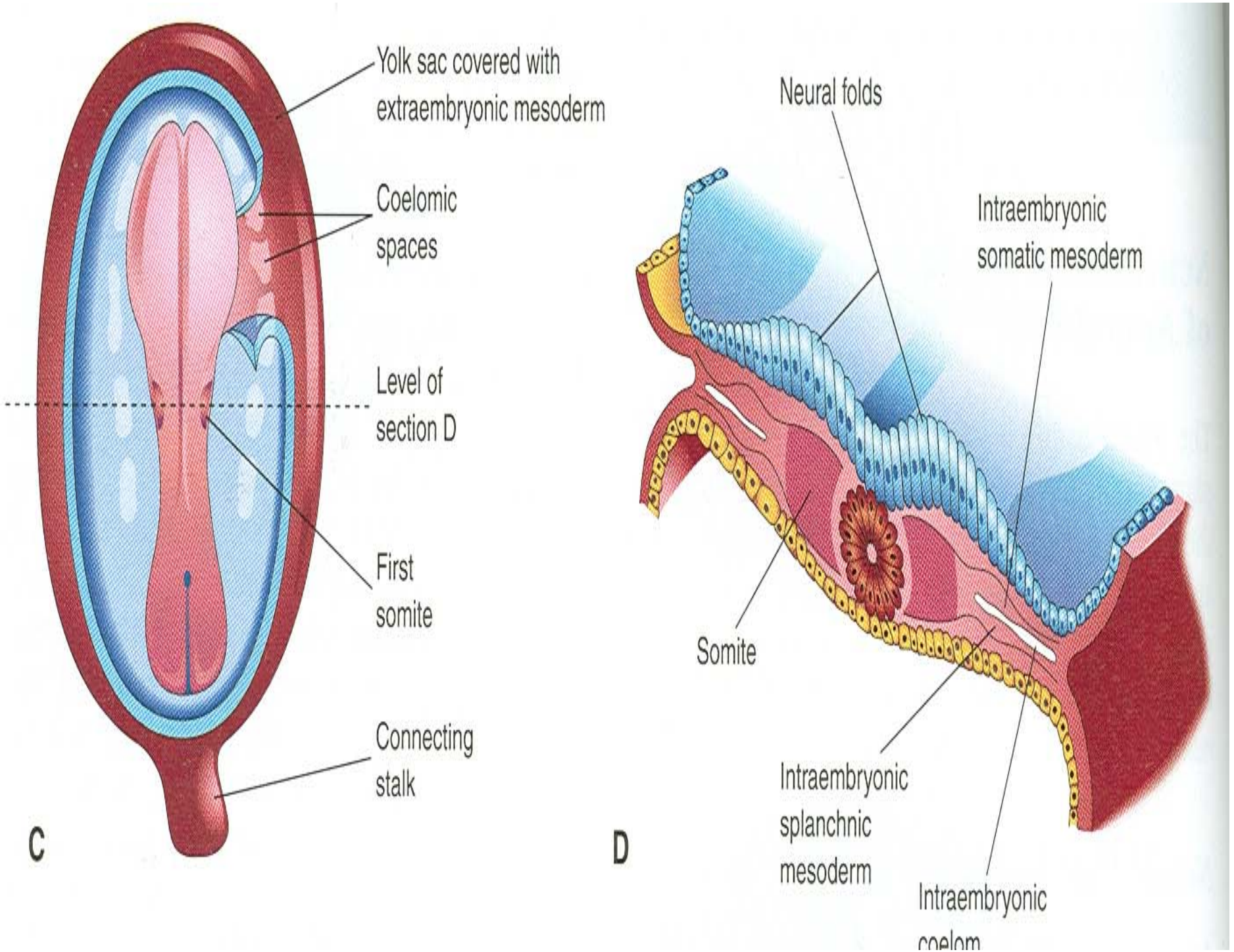
Somites

- First appear at a short distance caudal to the cranial end of the notochord
- Subsequent pairs form in a craniocaudal sequence


Pericardio-
peritoneal
canal
Peritoneal
coelom (cavity)
Level of
section F
E
Somite
Neural folds about to
fuse to form neural tube
Somatopleure
Intraembryonic coelom
Splanchnopleure
F

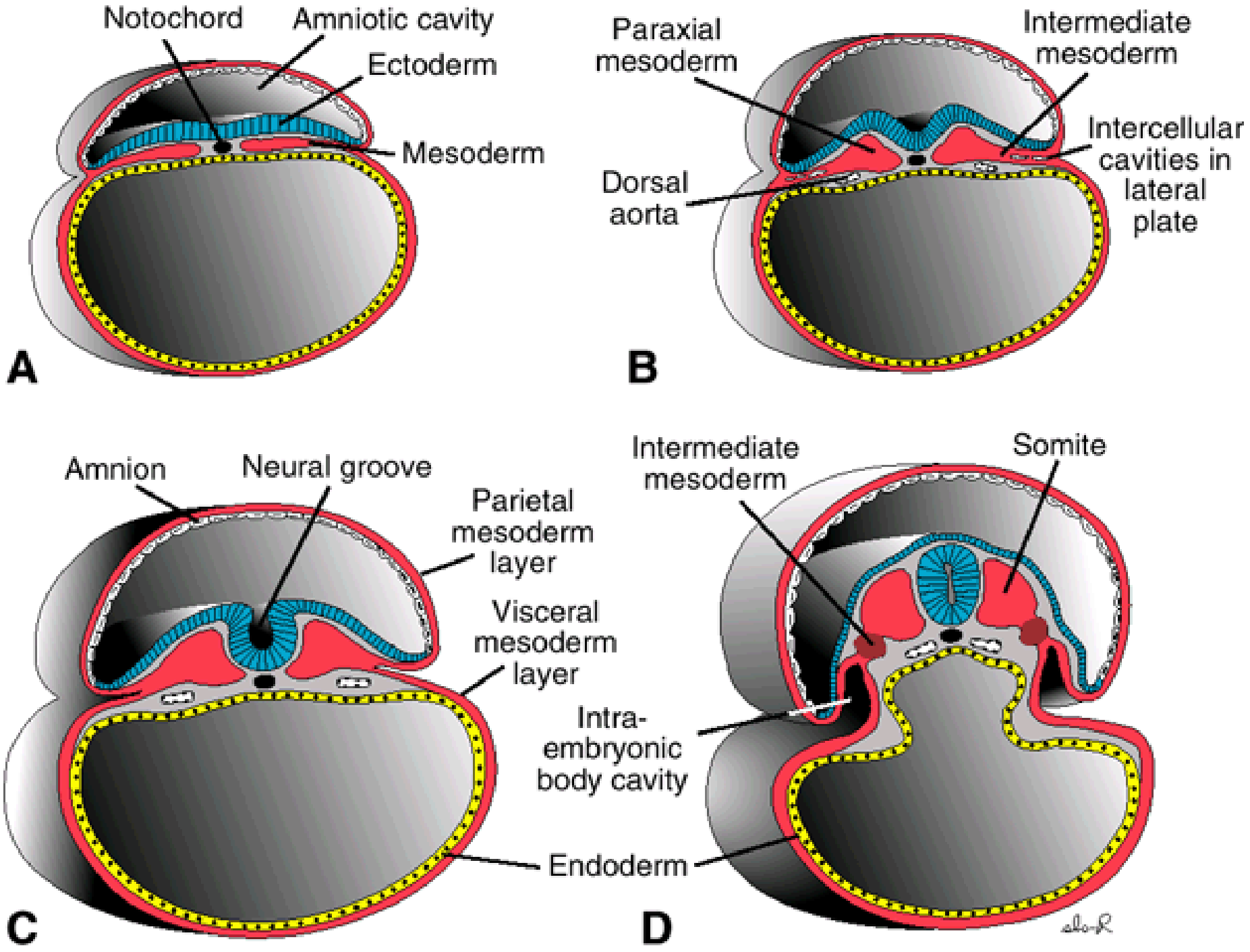
Lateral Plate mesoderm Intraembryonic Coelom

- Also known as primordium of embryonic body cavity
- Appears as isolated coelomic spaces in the lateral mesoderm and cardiogenic mesoderm
- These spaces soon combine to form a single horseshoe shaped cavity called intraembryonic coelom


Yolk sac covered with extraembryonic mesoderm
Coelomic spaces
Level of section D
First somite
Connecting stalk
C
Neural folds
Intraembryonic somatic mesoderm
Somite
Intraembryonic splanchnic mesoderm
Intraembryonic coelom
D

Parietal & Visceral Layers

- Somatic or parietal layer continuous with the extraembryonic mesoderm covering the amnion
- Splanchnic or visceral layer continuous with the extraembryonic mesoderm covering the yolk sac


Notochord
Amniotic cavity
Ectoderm
Mesoderm
A
Paraxial mesoderm
Intermediate mesoderm
Intercellular cavities in lateral plate
Dorsal aorta
B
Amnion
Neural groove
Parietal mesoderm layer
Visceral mesoderm layer
Endoderm
C
Intermediate mesoderm
Somite
Intra-embryonic body cavity
D

Parietal & Visceral Layers

- Somatic mesoderm with overlying embryonic ectoderm form the embryonic body wall or somatopleure
- Splanchnic mesoderm with underlying embryonic endoderm form the embryonic gut or splanchnopleure

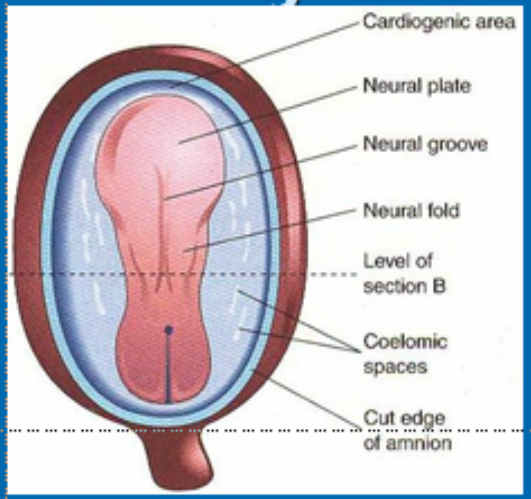
Fate of Intraembryonic Coelom

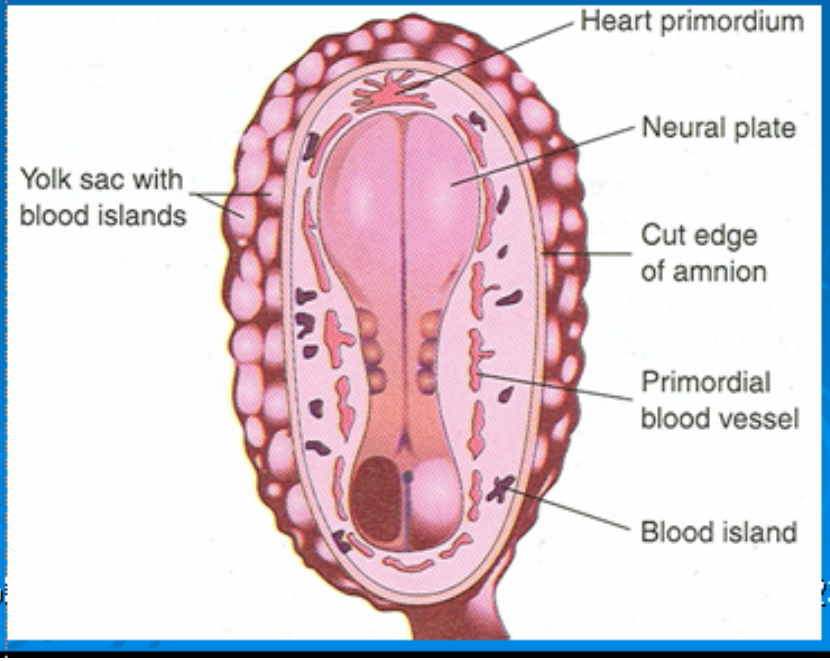
During the 2nd month, the intraembryonic coelom is divided into 3 body cavities:

- Pericardial cavity
- Pleural cavity
- Peritoneal cavity

Early Development of Cardiovascular System

- Starts at the beginning of the 3rd week
- Vasculogenesis and angiogenesis begins in the extraembryonic mesoderm of the yolk sac, connecting stalk and chorion
- Embryonic blood vessels begin to develop about 2 days later





Early Development of Cardiovascular System

- The urgent need for blood vessels to bring nourishment and oxygen to the embryo from mother causes the early formation of the cardiovascular system
- A primordial uteroplacental circulation develops during the 3rd week
- Until then the embryonic nutrition is obtained from maternal blood by diffusion

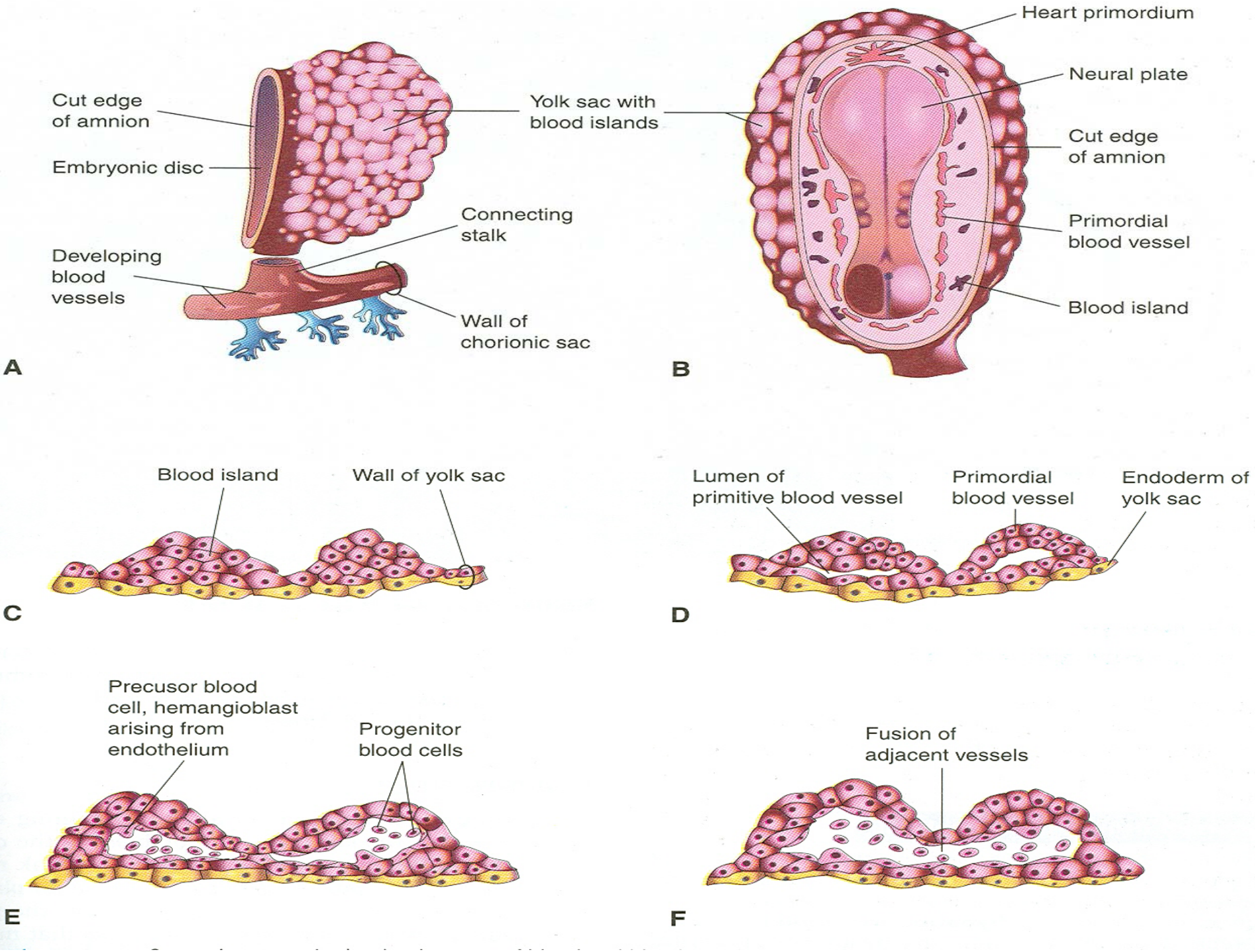
Vasculogenesis & angiogenesis

Formation of embryonic vascular system involves 2 processes:

- Vasculogenesis
- Angiogenesis

Vasculogenesis

- Mesenchymal cells differentiate into endothelial precursors called Angioblast
- Angioblast aggregate to form isolated angiogenic cell clusters or blood islands
- Small cavities appear within the blood islands
- Angioblasts flatten to form endothelial cells


Cut edge of amnion
Yolk sac with blood islands
Embryonic disc
Connecting stalk
Developing blood vessels
Wall of chorionic sac
A
Heart primordium
Neural plate
Cut edge of amnion
Primordial blood vessel
Blood island
B
Blood island
Wall of yolk sac
C
Lumen of primitive blood vessel
Primordial blood vessel
Endoderm of yolk sac
D
Precusor blood cell, hemangioblast arising from endothelium
Progenitor blood cells
E
Fusion of adjacent vessels
F

Vasculogenesis

- Endothelial cells arrange themselves around the cavities in blood island to form the endothelium
- These endothelium lined cavities soon fuse to form networks of endothelial channels called Vasculogenesis

Angiogenesis

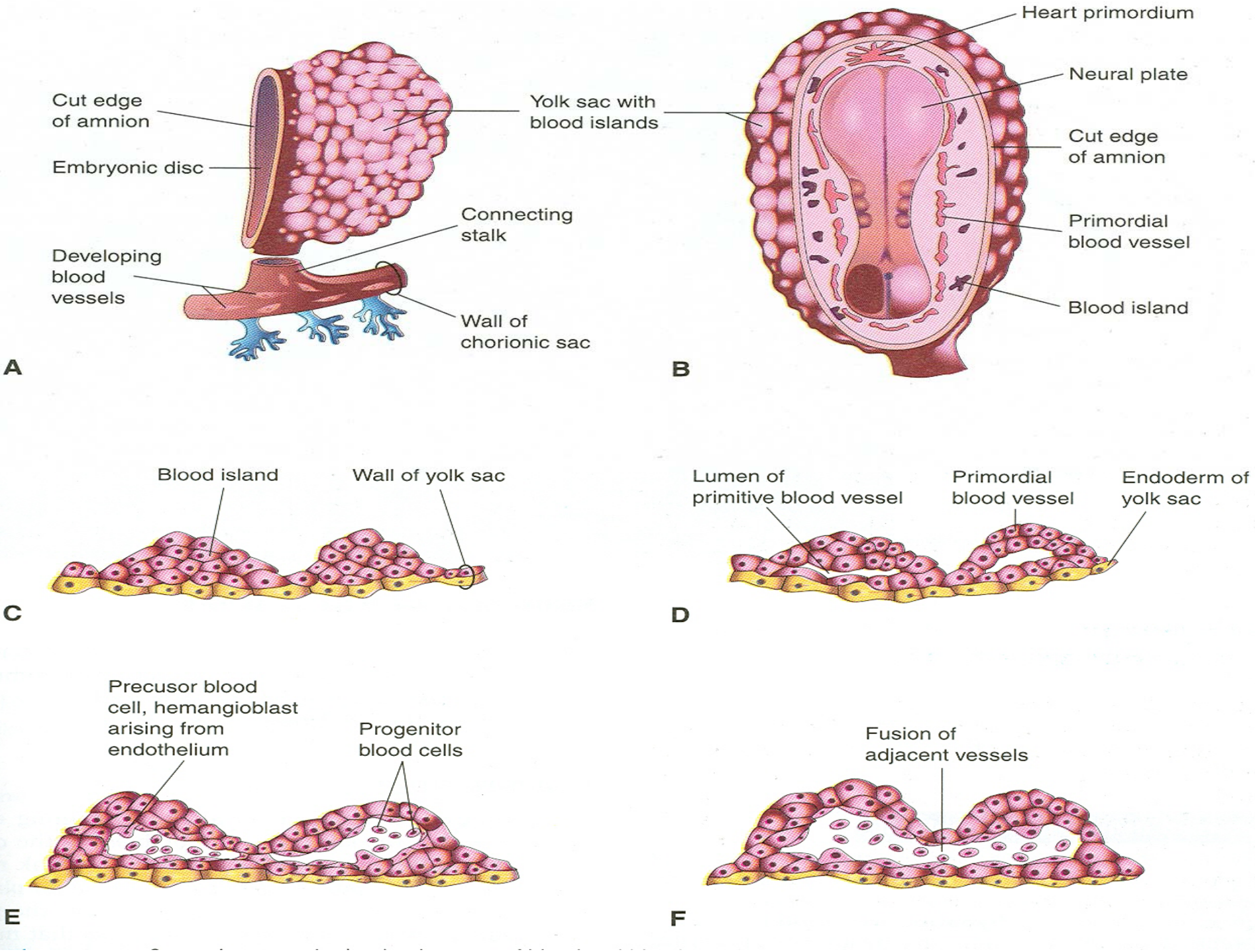
- Vessels develop into adjacent areas by endothelial budding and fuse with other vessels called Angiogenesis

Development of Blood Cells

- Blood cells develop from the endothelial cells of vessels called hemangioblasts
- Develop at the end of 3rd week on the yolk sac and allantois
- Hematogenesis does not begin until 5th week
- It occurs first in liver and later in spleen, bone marrow & lymph nodes

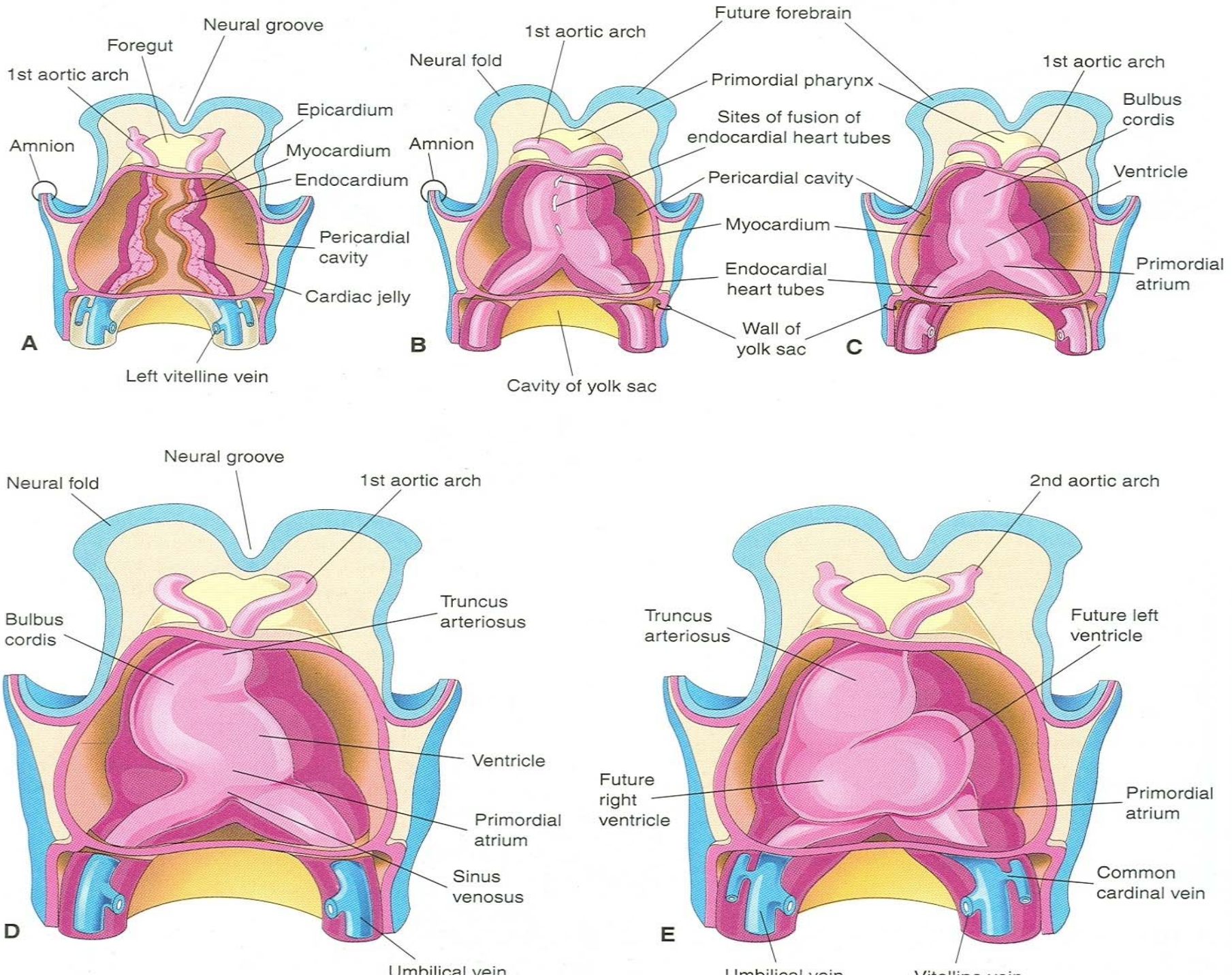
Development of Blood Cells

- Fetal and adult erythrocytes are derived from different hematopoietic progenitor cells (hemangioblasts)
- Mesenchymal cells surrounding the primordial endothelial blood vessels differentiate into the muscular and connective tissue elements of the vessels


Cut edge of amnion
Yolk sac with blood islands
Embryonic disc
Connecting stalk
Developing blood vessels
Wall of chorionic sac
A
Heart primordium
Neural plate
Cut edge of amnion
Primordial blood vessel
Blood island
B
Blood island
Wall of yolk sac
C
Lumen of primitive blood vessel
Primordial blood vessel
Endoderm of yolk sac
D
Precusor blood cell, hemangioblast arising from endothelium
Progenitor blood cells
E
Fusion of adjacent vessels
F

Primordial Cardiovascular System

- Heart & great vessels develop from mesenchymal cells in the cardiogenic area
- Paired longitudinal endothelial lined channels or endocardial heart tubes develop during the 3rd week
- These tubes fuse to form the heart tube


Neural groove
Foregut
1st aortic arch
Epicardium
Amnion
Myocardium
Endocardium
Pericardial cavity
Cardiac jelly
A
Left vitelline vein
Future forebrain
1st aortic arch
Neural fold
Primordial pharynx
Sites of fusion of endocardial heart tubes
Amnion
Pericardial cavity
Myocardium
Endocardial heart tubes
Wall of yolk sac
B
Cavity of yolk sac
1st aortic arch
Bulbus cordis
Ventricle
Primordial atrium
C
Neural groove
Neural fold
1st aortic arch
Truncus arteriosus
Bulbus cordis
Ventricle
Primordial atrium
Sinus venosus
D
Umbilical vein
2nd aortic arch
Truncus arteriosus
Future left ventricle
Future right ventricle
Primordial atrium
Common cardinal vein
E

Primordial Cardiovascular System

- The tubular heart joins with blood vessels in the embryo, connecting stalk, chorion and yolk sac to form a primordial cardiovascular system
- Heart begins to beat on 21-22 days and blood circulates
- CVS is the first organ system to reach a functional state

Further Development of Chorionic Villi

- Primary chorionic villi becomes secondary chorionic villi as they acquire mesenchymal cores
- Before the end of third week capillaries develop in the secondary chorionic villi
- Now it is called tertiary chorionic villi

Further Development of Chorionic Villi

- Cytotrophoblastic extensions from these stem villi join to form a cytotrophoblastic shell that anchors the chorionic sac to the endometrium
- The rapid development of chorionic villi during the third week greatly increases the surface area of chorion
- This causes exchange of oxygen and nutrients between the maternal and embryonic circulations


Thank you