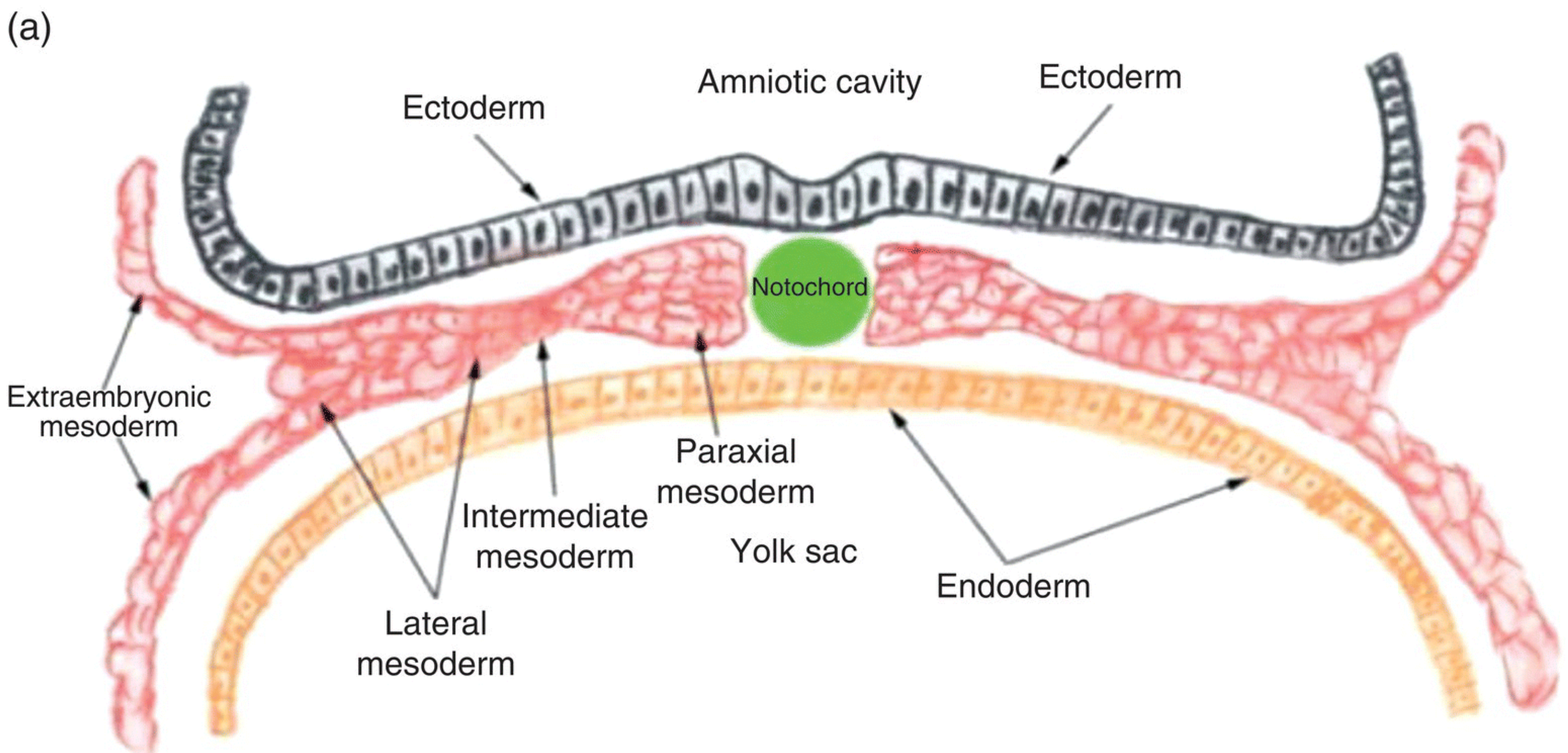
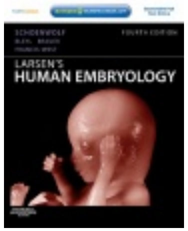
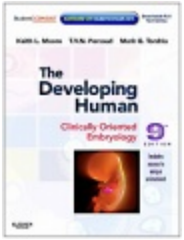
Mesoderm Development





Resources:
http://php.med.unsw.edu.au/embryology/
Larsen's Human Embryology
The Developing Human: Clinically Oriented Embryology



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Mesoderm Development Lecture

Gastrulation

Early Mesoderm Development

Notochord

Paraxial Mesoderm

Intermediate Mesoderm

Lateral Plate Mesoderm

Early Heart Development

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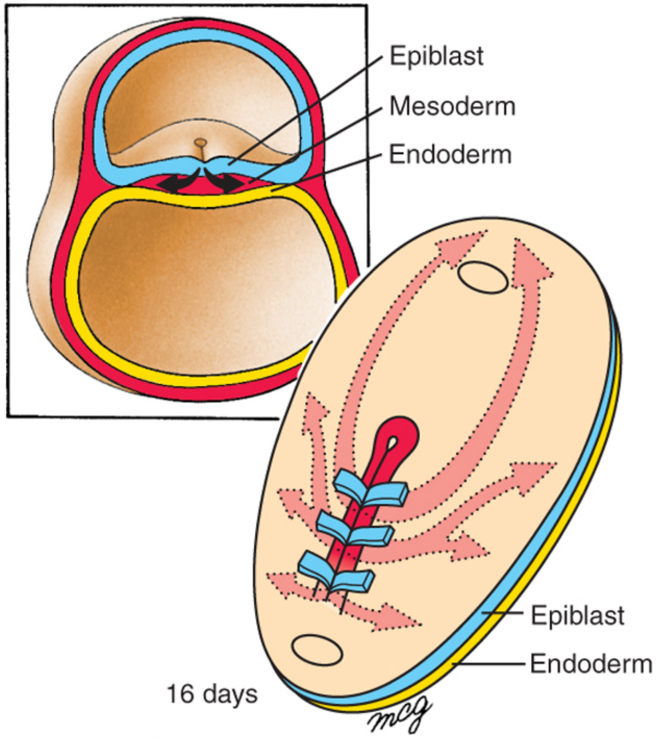
Gastrulation

Week 3

Ingression of epiblast cells: EMT transition
Generation of definitive endoderm
Generation of intra-embryonic mesoderm
Oropharyngeal and cloacal membrane
Embryonic ectoderm



http://php.med.unsw.edu.au/embryology/images/5/55/Mesoderm_001.mp4

End product gastrulation:

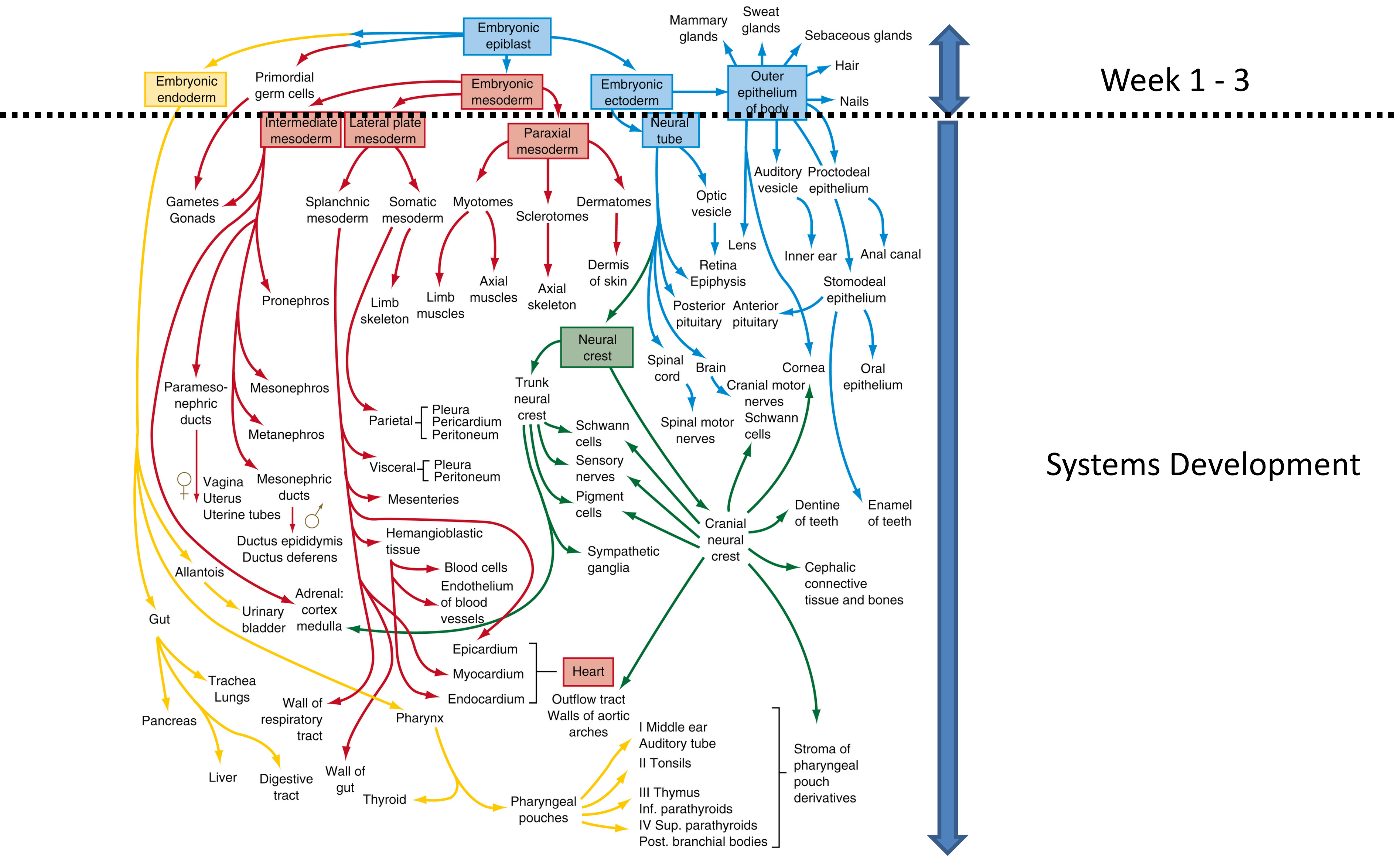
Trilaminar embryo

<u>Ectoderm *(Neural crest)*</u>
brain, spinal cord, eyes, *peripheral nervous system*
epidermis of skin and associated structures,
melanocytes, cranial connective tissues (dermis)

<u>Mesoderm</u>
musculo-skeletal system
limbs
connective tissue of skin and organs
urogenital system, heart, blood cells

<u>Endoderm</u>
epithelial linings of gastrointestinal and respiratory tracts

Embryonic development:



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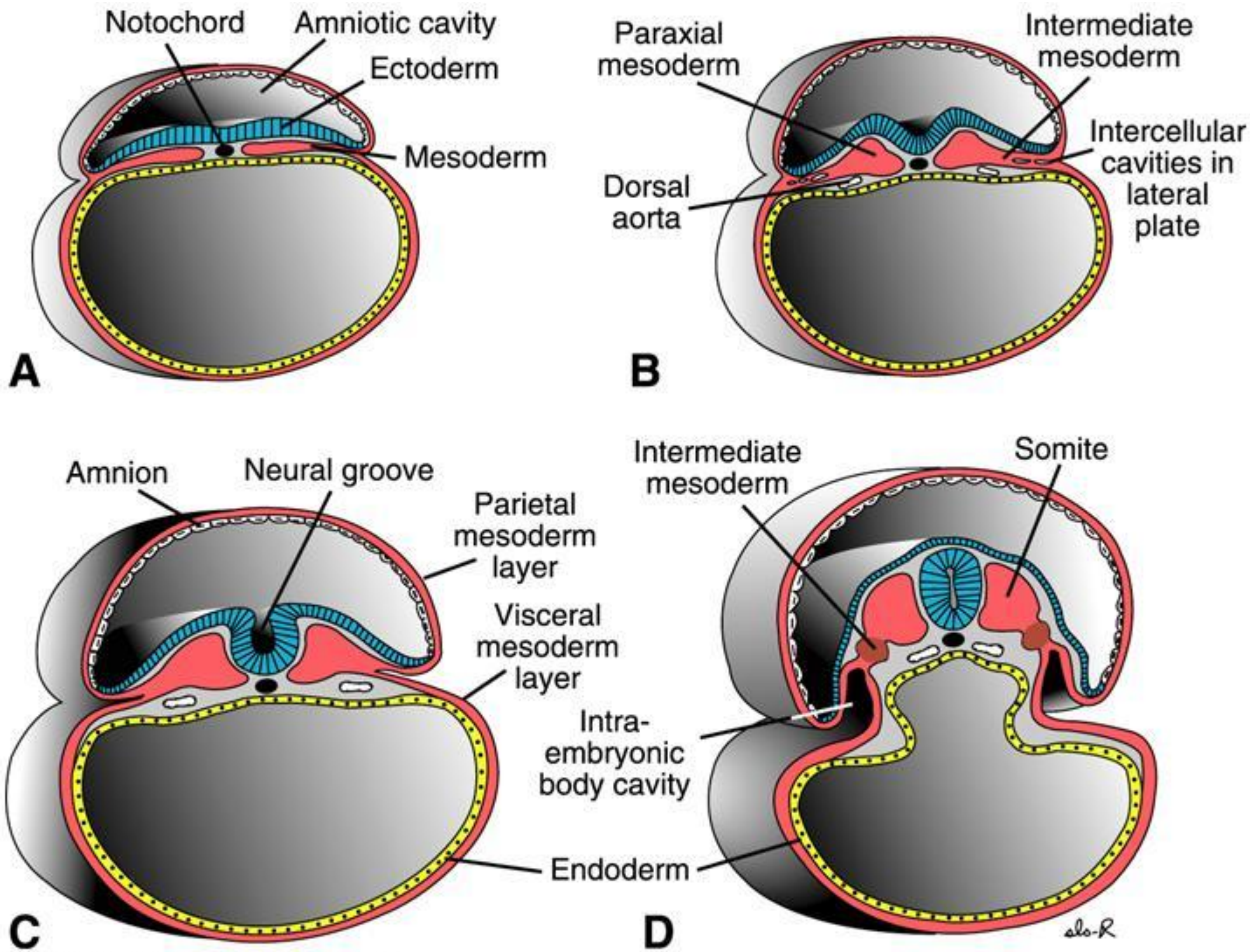
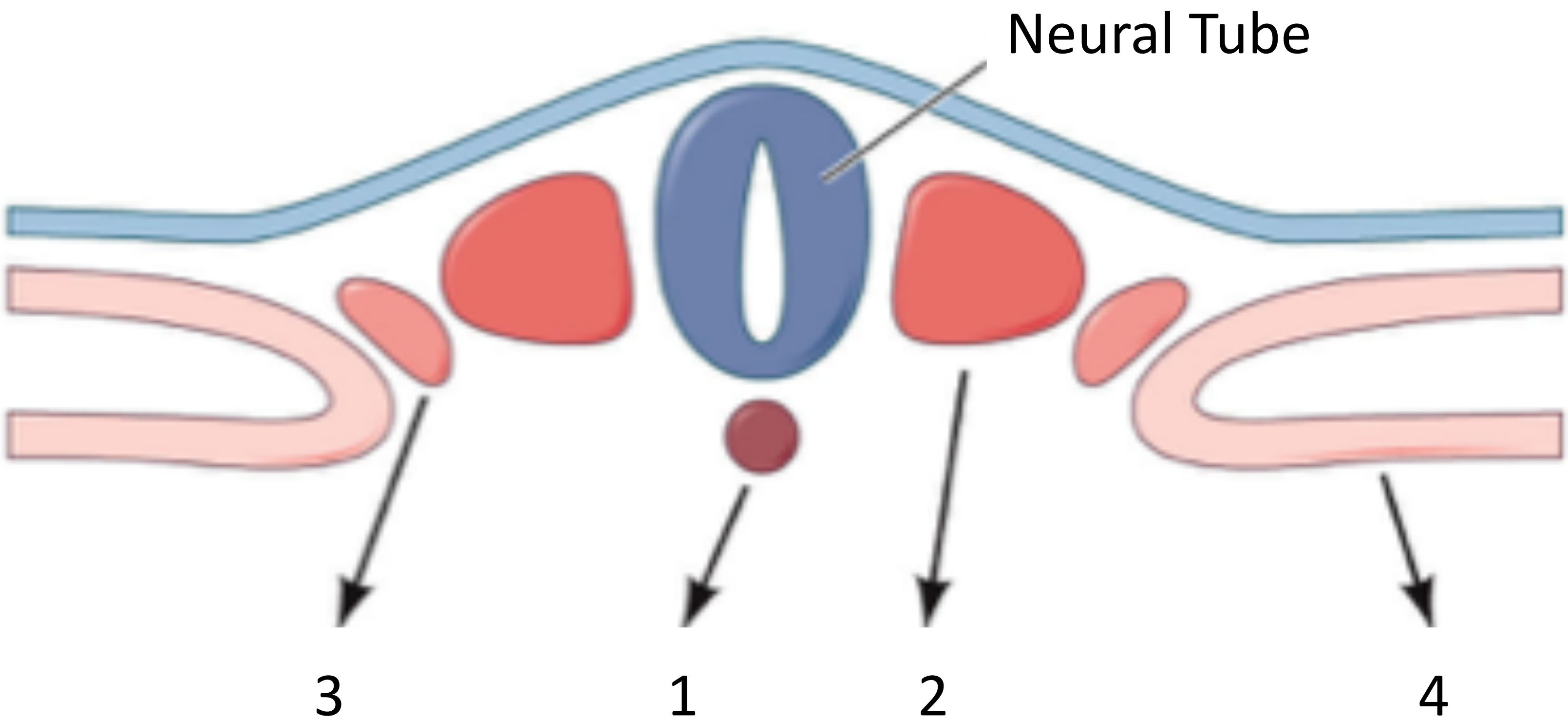


Early Mesoderm Development



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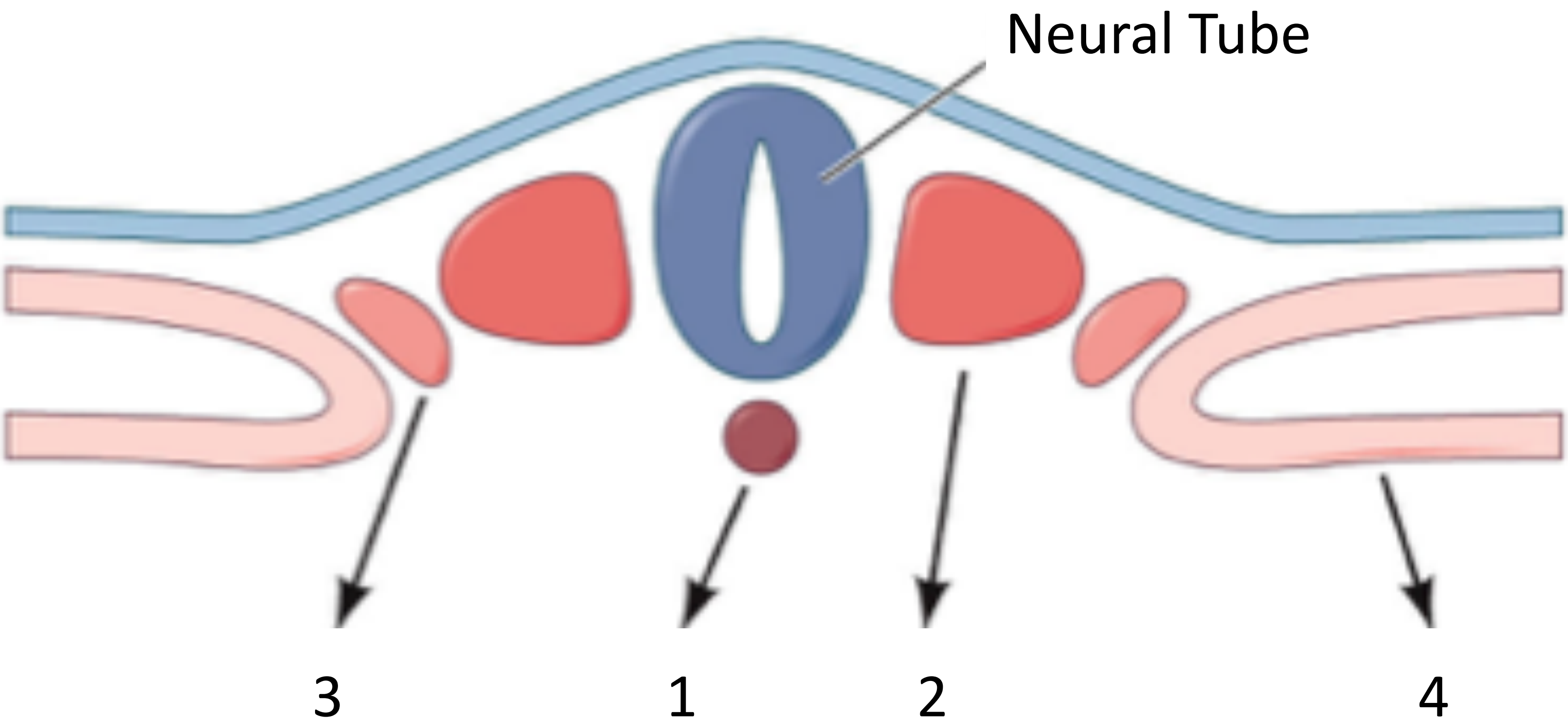

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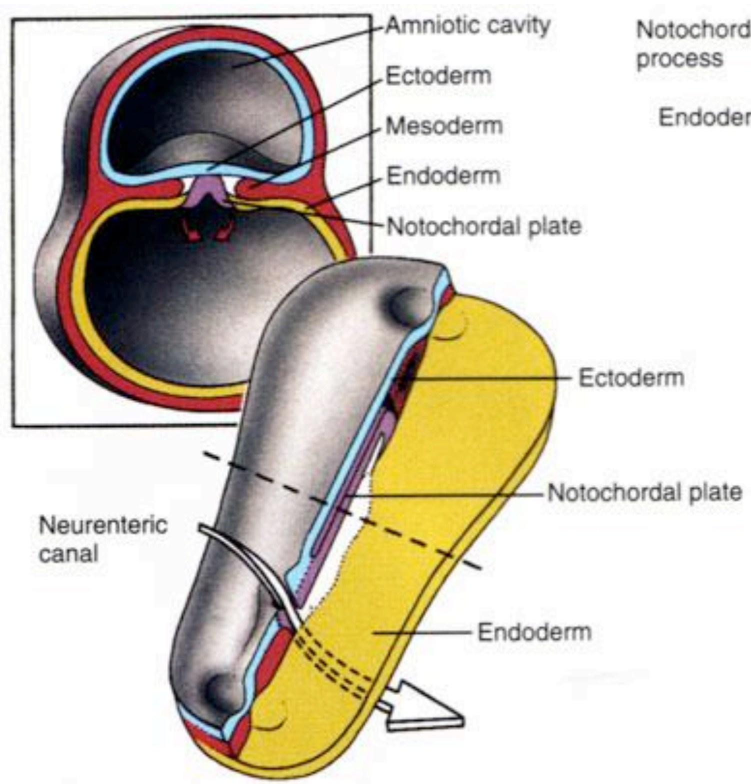
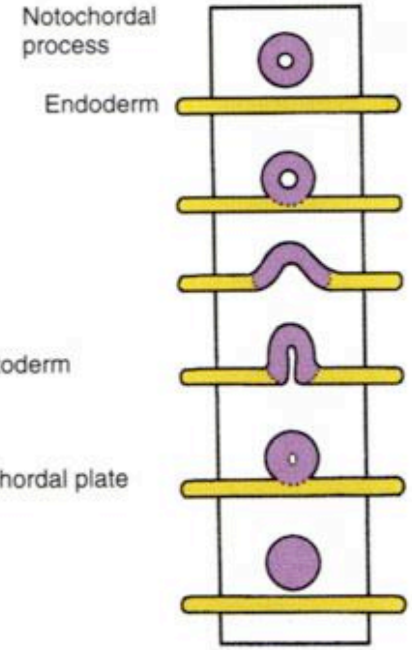
1: Notochord





Hollow

Notochordal plate

Solid

Axial mesoderm

Transient

Development: notochordal process

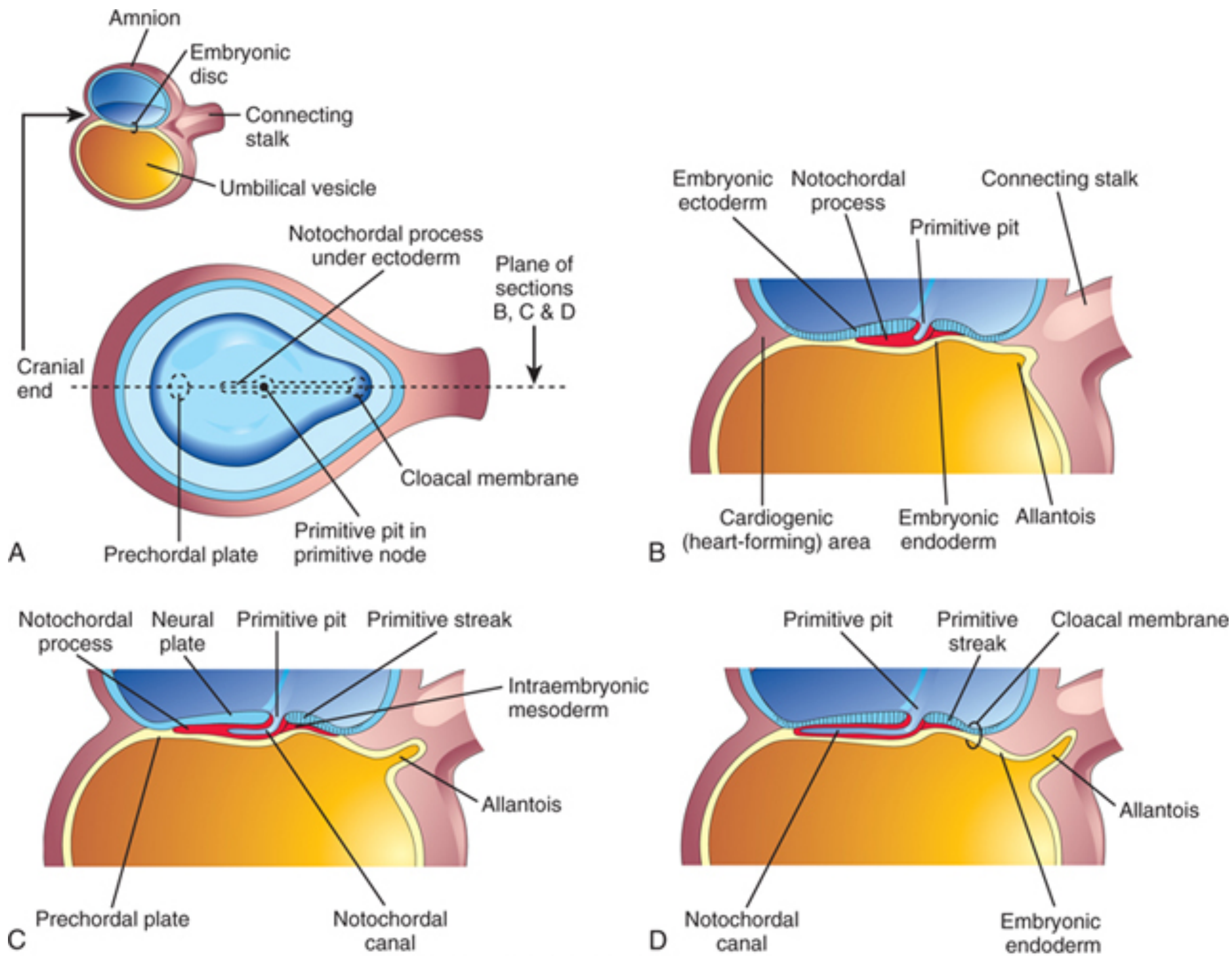
Prechordal plate

Neurenteric canal

Crucial signalling center

Mechanical role in embryonic folding

1: Notochord



Moore et al: Before We Are Born, 8e

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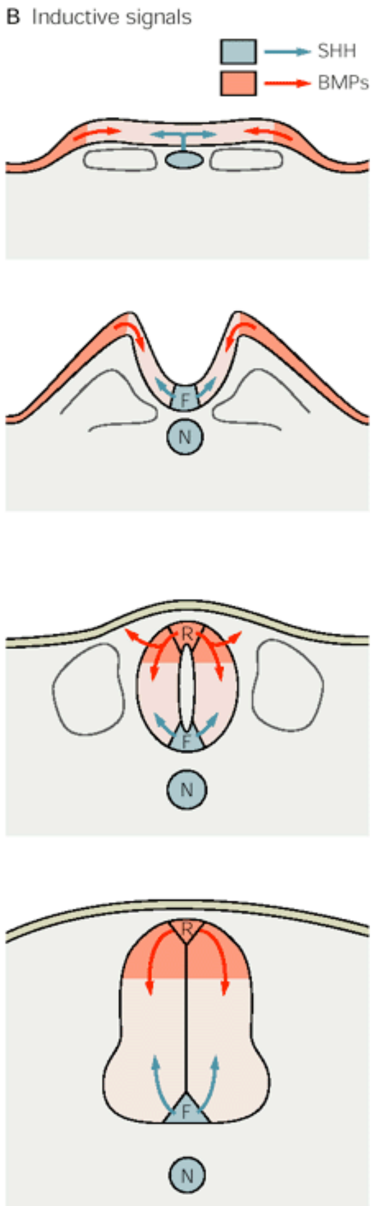
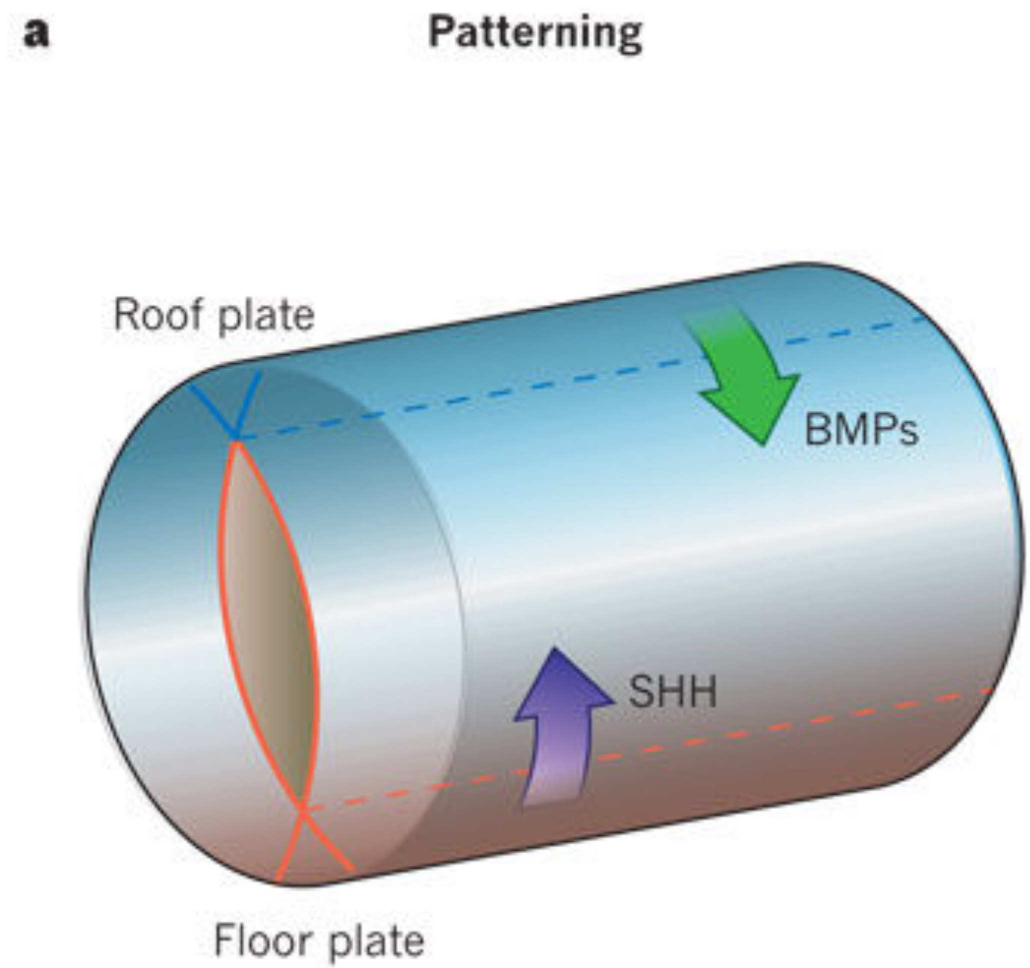
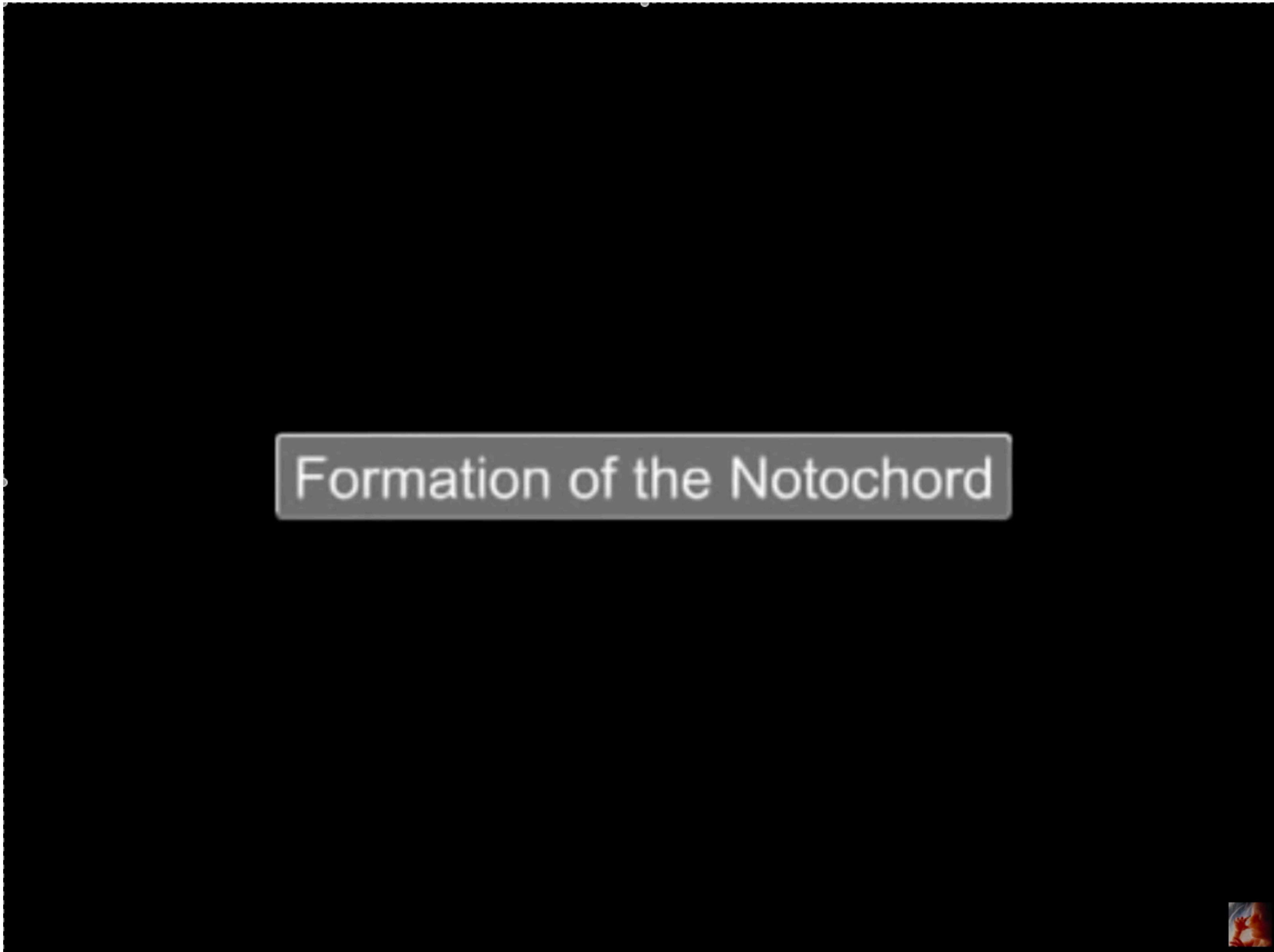
Notochord secretes SHH to establish DV axis of Spinal Cord





1: Notochord



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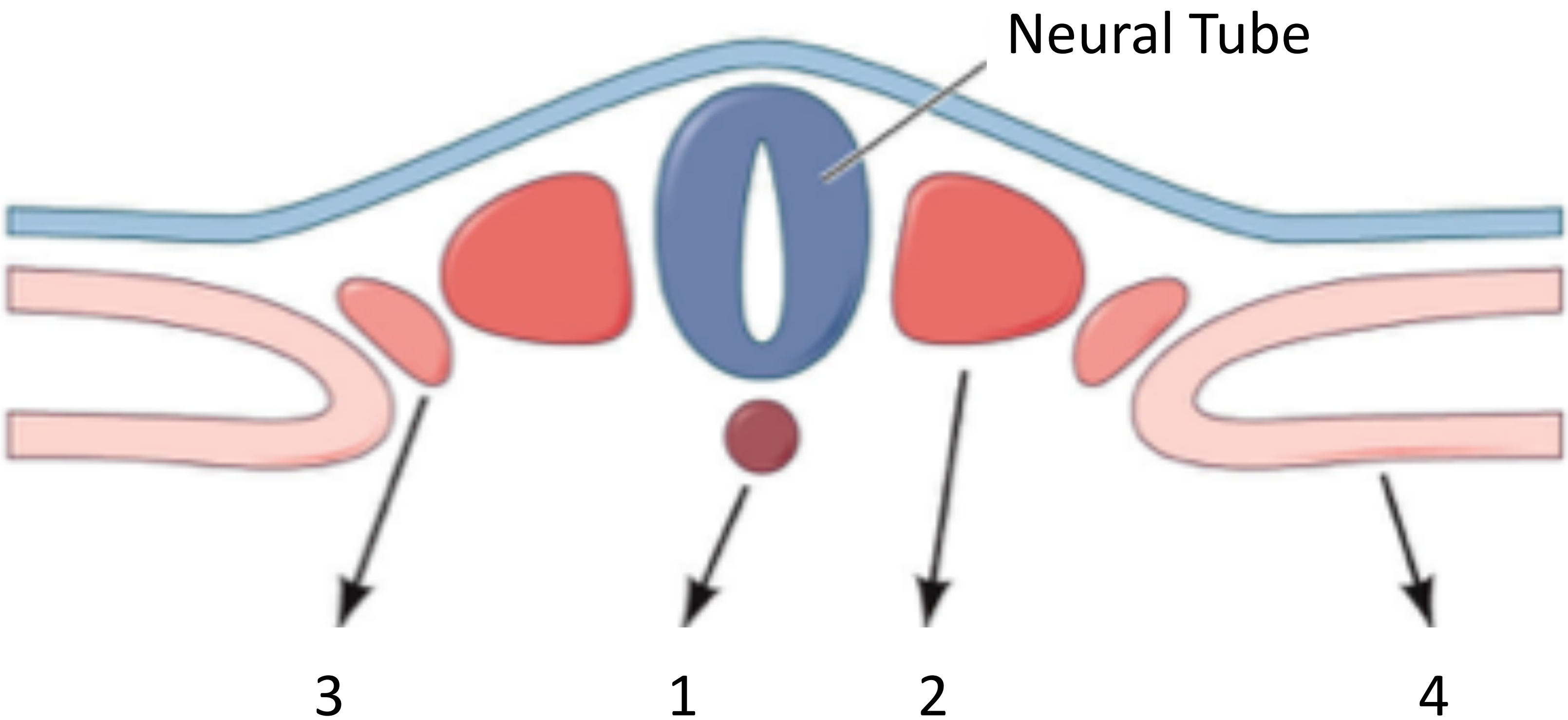

1: notochord
2: paraxial mesoderm
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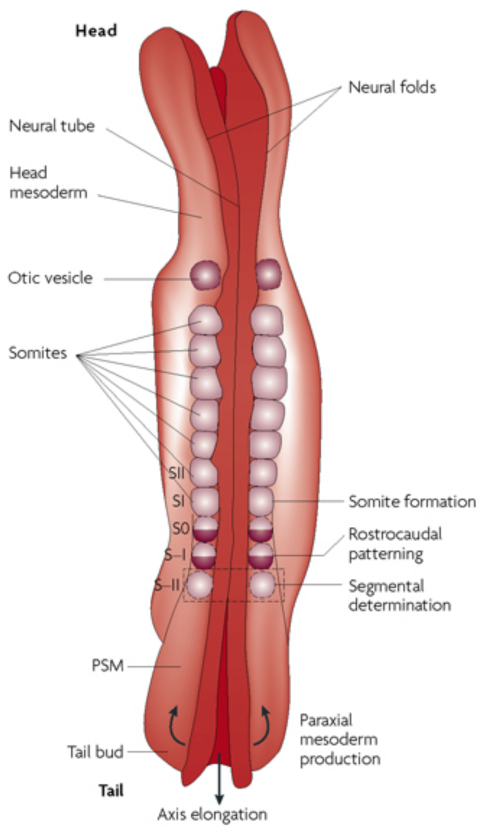
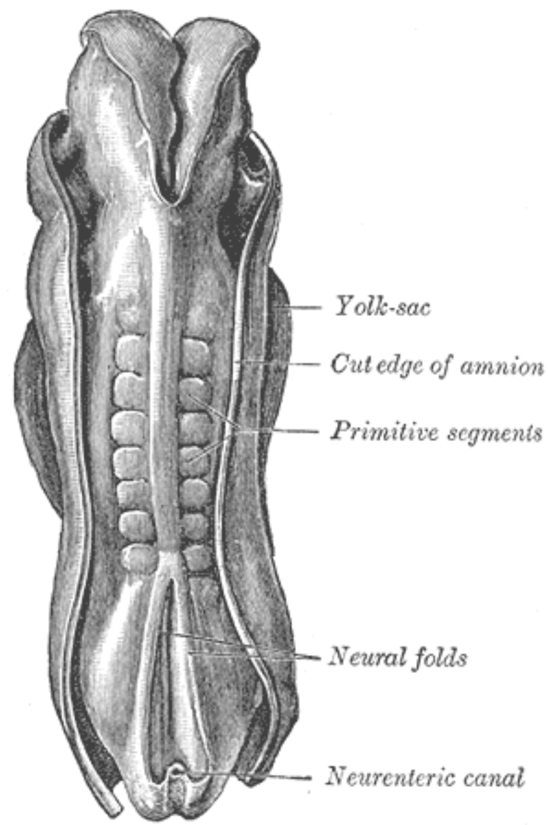
2: Paraxial Mesoderm

Cranial: Unsegmented paraxial mesoderm: head mesenchyme

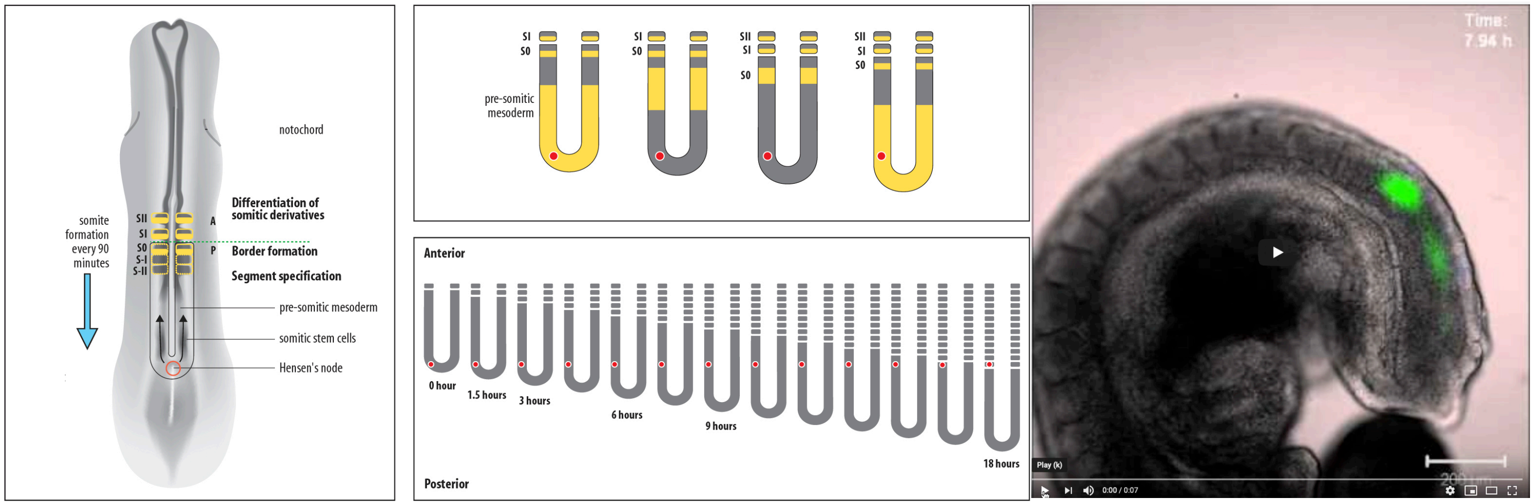
Trunk: Segmented paraxial mesoderm: somites

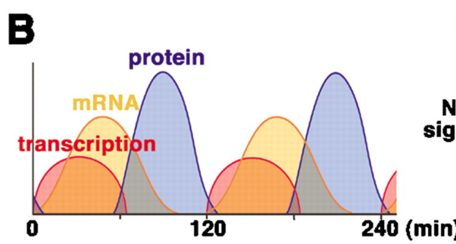


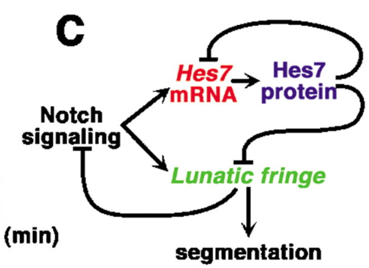


2: Paraxial Mesoderm

Somitogenesis







Block-like bilateral condensations of the paraxial mesoderm

Form every 5-6 hours in a cranial to caudal direction (day 20 to day 30)

'Segmentation clock' depends on *Hes7* transcription/translation

44 max are formed, 33 remain

Somites give rise to axial skeleton and musculature, dermis of the trunk

2: Paraxial Mesoderm

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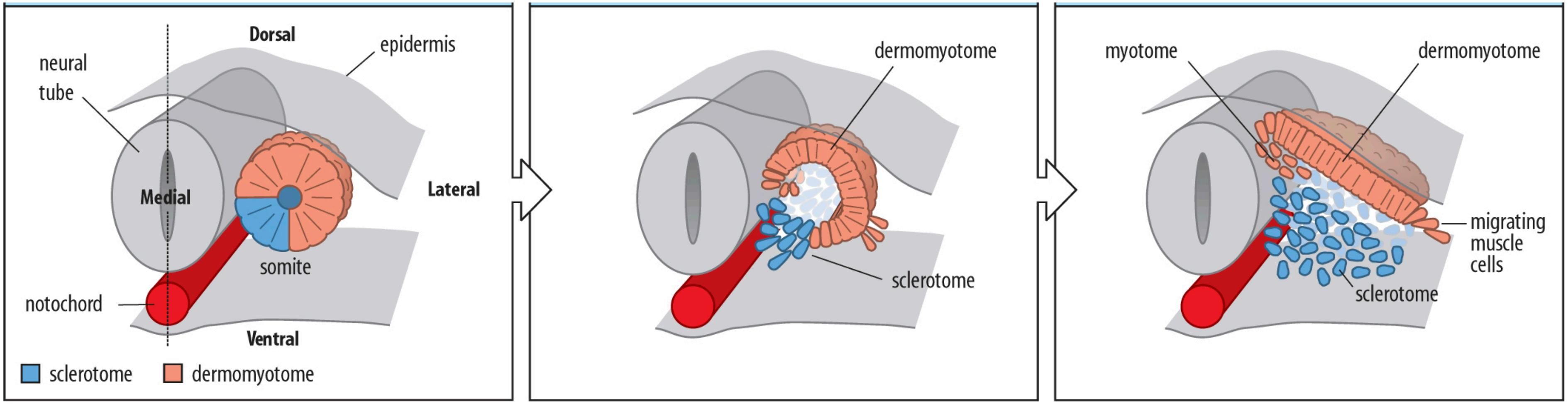
Somite Development



Somites develop into:

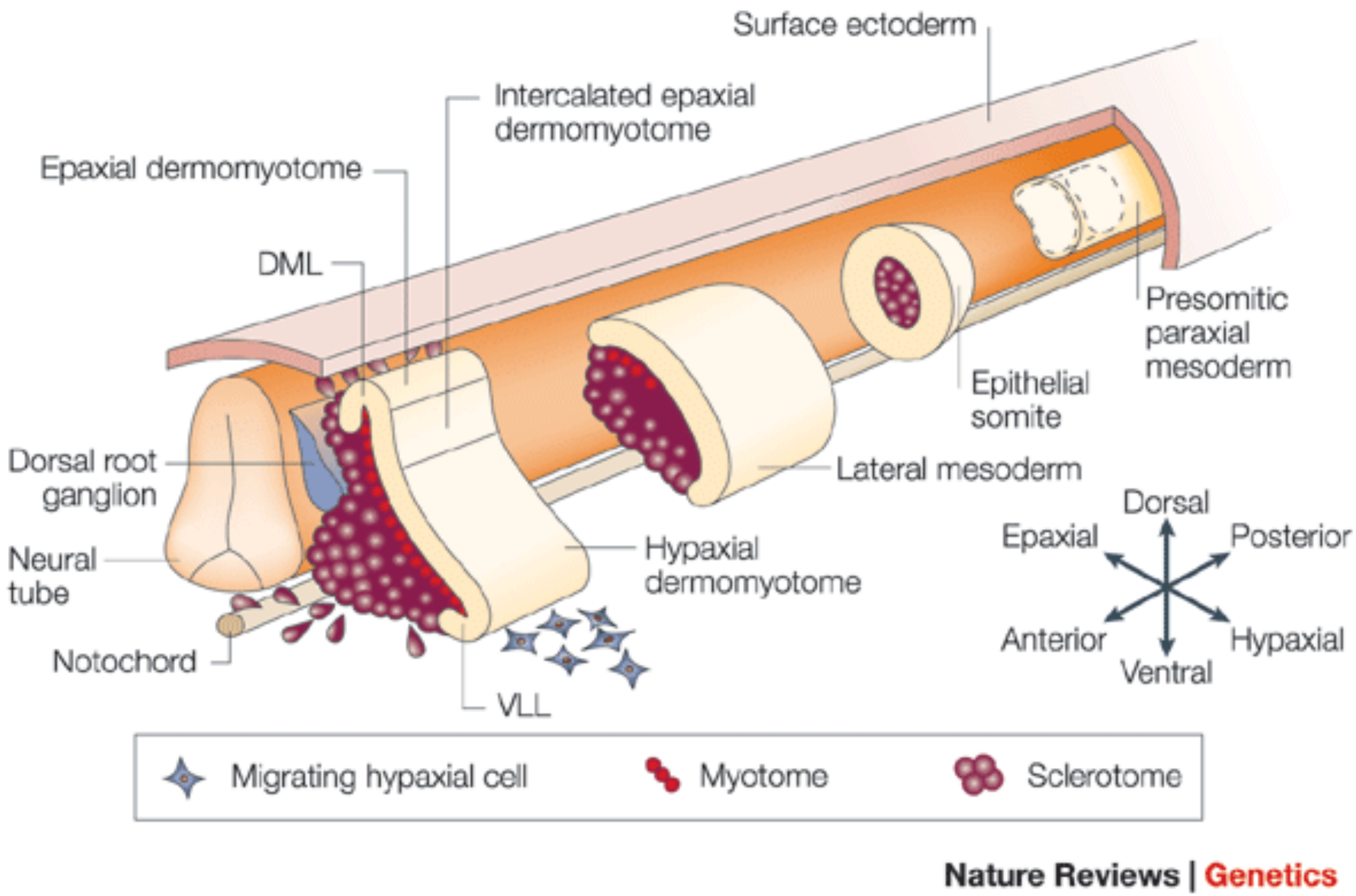
- Sclerotome: mesenchymal cells (ribs, vertebral body and intervertebral disk)
- Dermomyotome: columnar epithelium

Dermomyotome develops into:

- Dermatome: dermis of the trunk
- Myotome: trunk musculature

2: Paraxial Mesoderm

Somite Development



2: Paraxial Mesoderm

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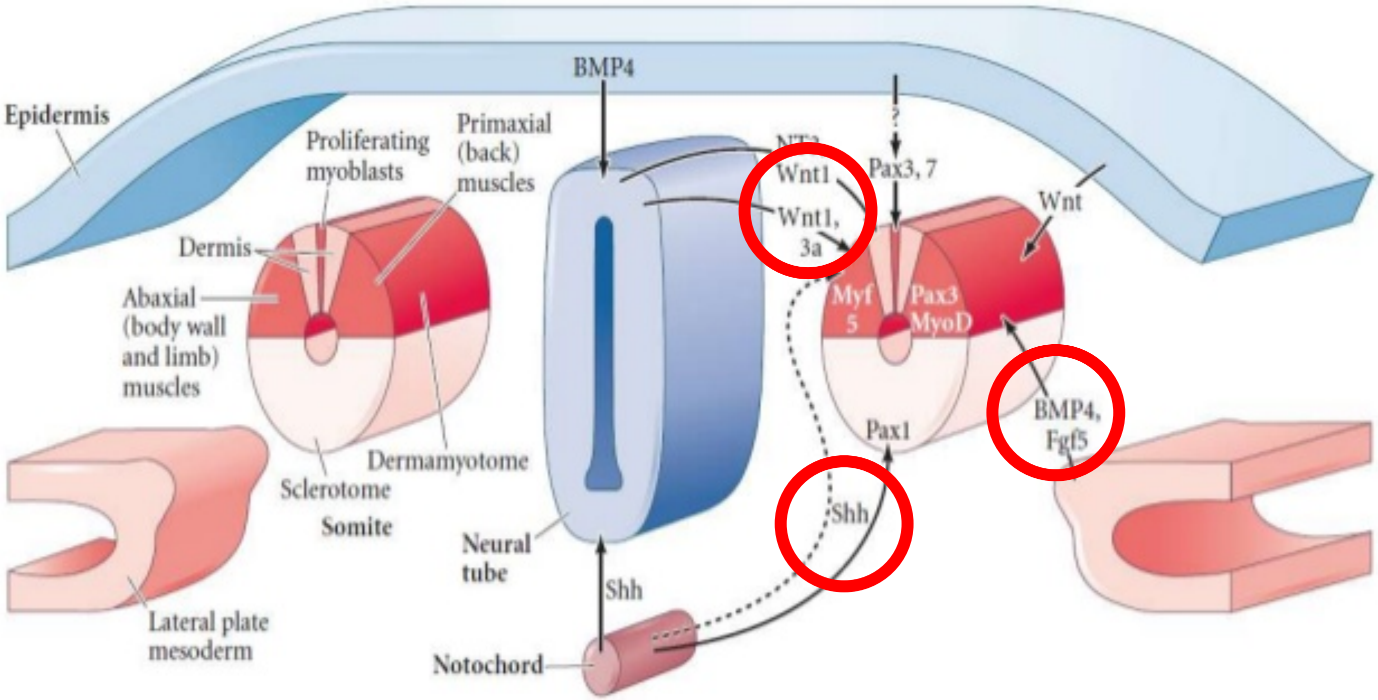
Somite patterning: DV and ML axes



Sonic hedgehog (Shh) (notochord and floor plate): ventral side somites.
BMP-4: lateral side somites.
Wnt family proteins (roof plate): dorsal side somites.

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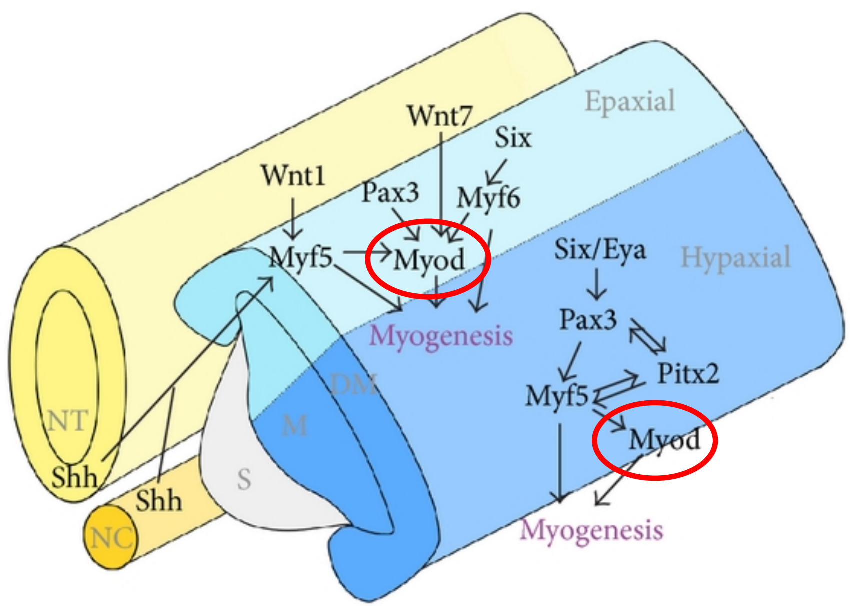
2: Paraxial Mesoderm

Myotome Development



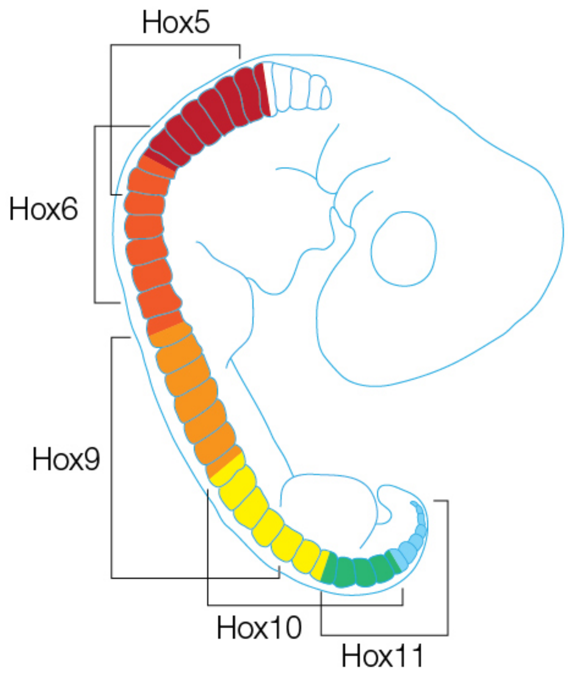
(a)

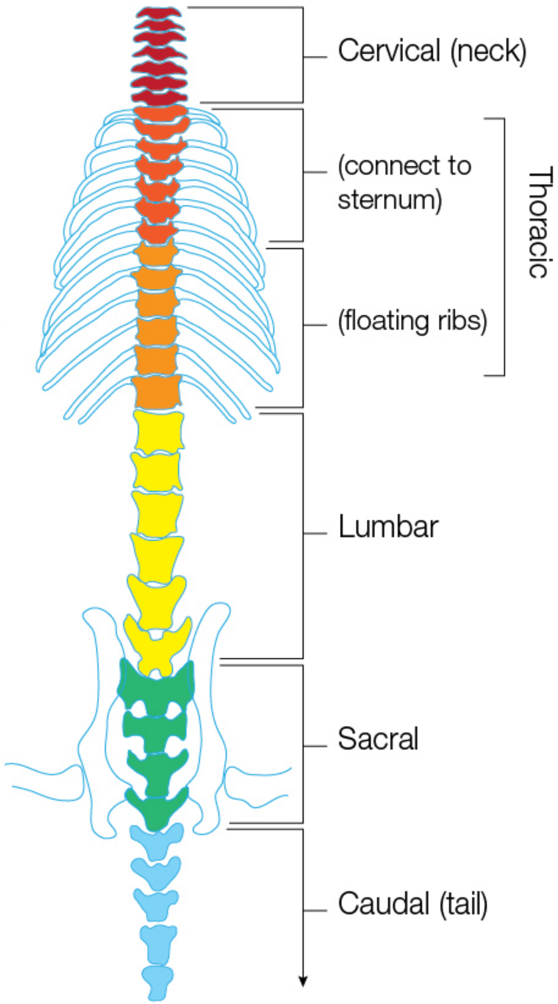
Epaxial myotome: epimere: erector spinae (muscles of the deep back)
Hypaxial myotome: hypomere: 3 primary muscle layers (body wall, limbs)
MyoD initiates myogenesis

2: Paraxial Mesoderm

AP patterning

AP level/*Hox* code defines nature of Somite Derivatives





7: cervical region

12: thoracic region

5: lumbar region

5: sacral region

4: caudal region (tail)

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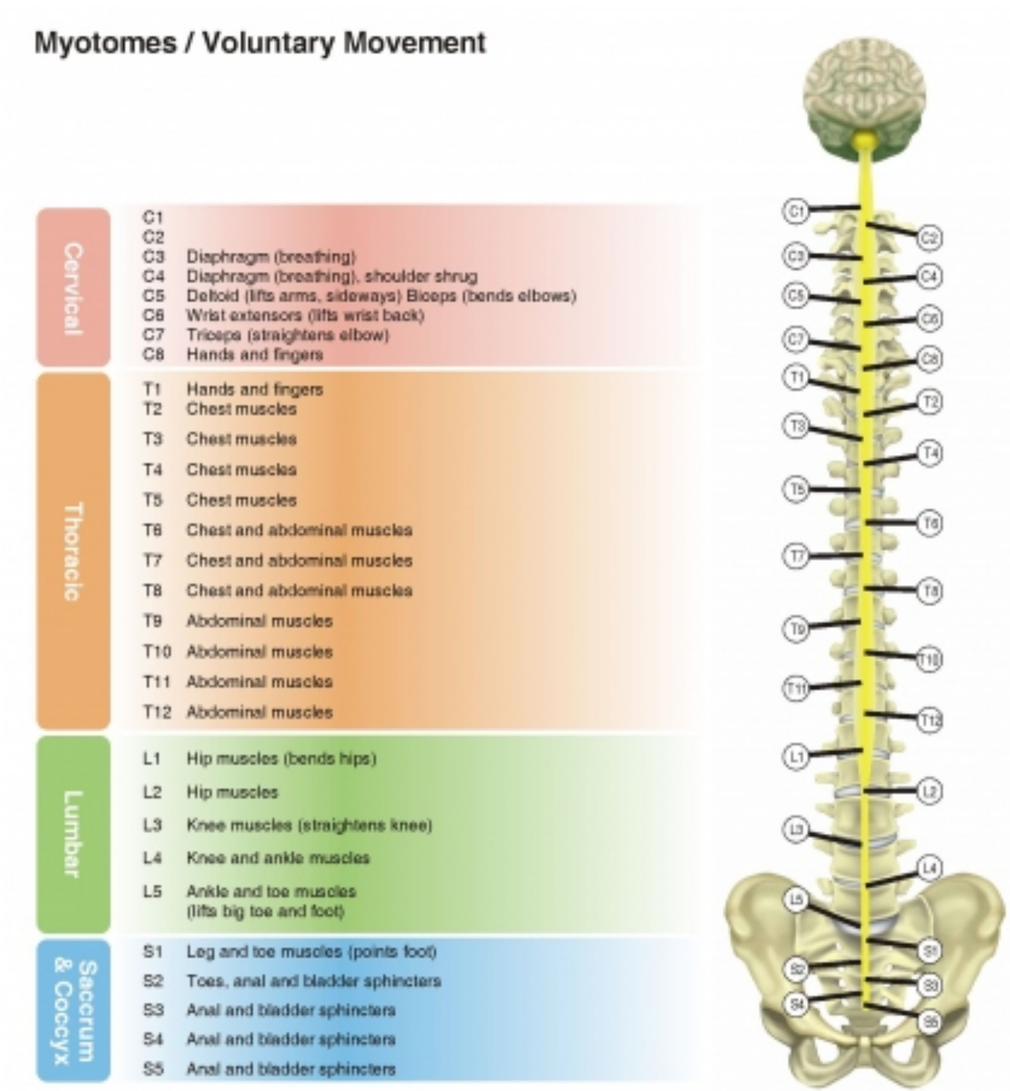
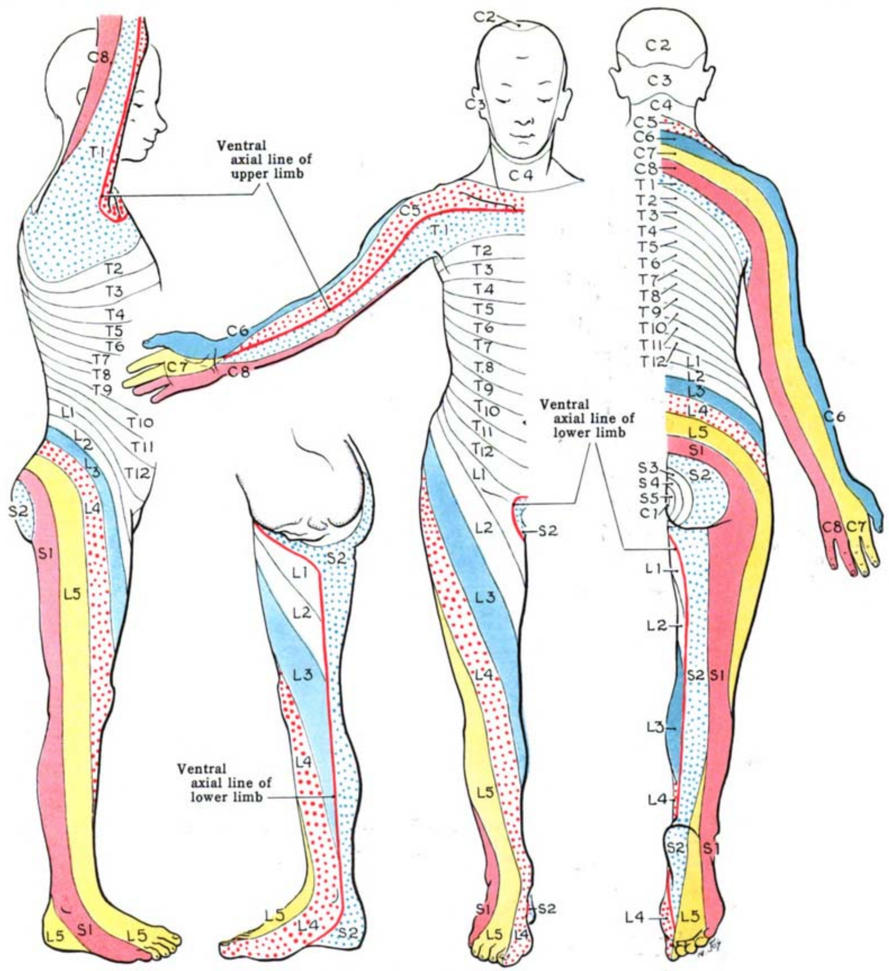
2: Paraxial Mesoderm

Myotome Development



2: Paraxial Mesoderm

Dermatome Development



Embryonic dermatomes will form the dermis

Postnatal dermatome is a strip of skin innervated by a single spinal nerve

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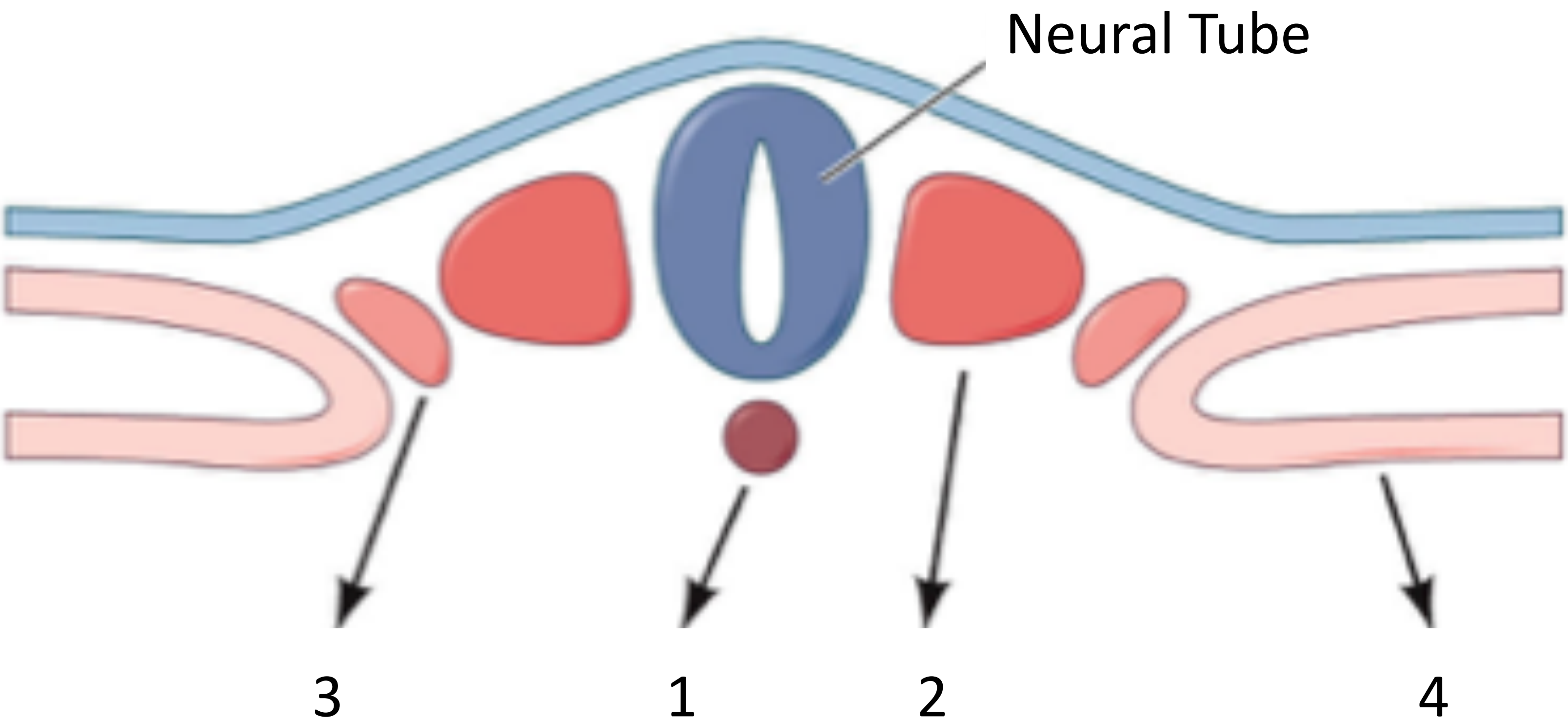


1: notochord

2: paraxial mesoderm

3: intermediate mesoderm

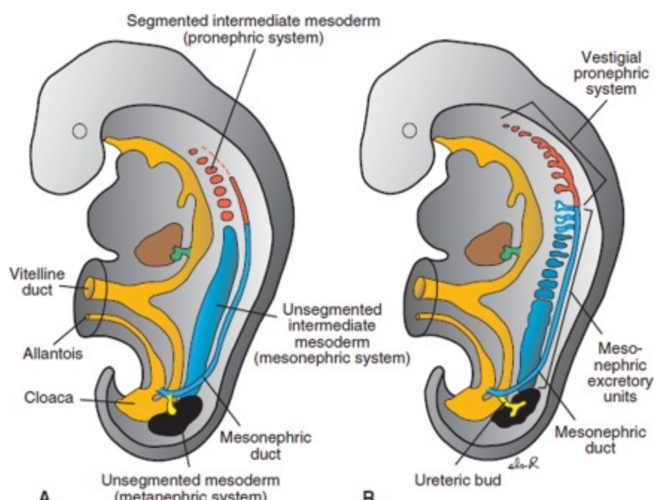
4: lateral plate mesoderm

3: Intermediate Mesoderm

Segmented and unsegmented intermediate mesoderm
Gives rise to urinary system and parts of the genital system

3 nephric systems:

- Pronephros:
  - from segmented intermediate mesoderm
  - regresses
- Mesonephros:
  - embryonic kidney
  - reproductive system
  - collecting duct and tubules of the kidney
- Metanephros:
  - Adult kidney (capsule, glomeruli and nephron tubules)



Pronephros

Mesonephros

Metanephros

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3: Intermediate Mesoderm

<u>Reproductive system develops from:</u>

Mesonephros

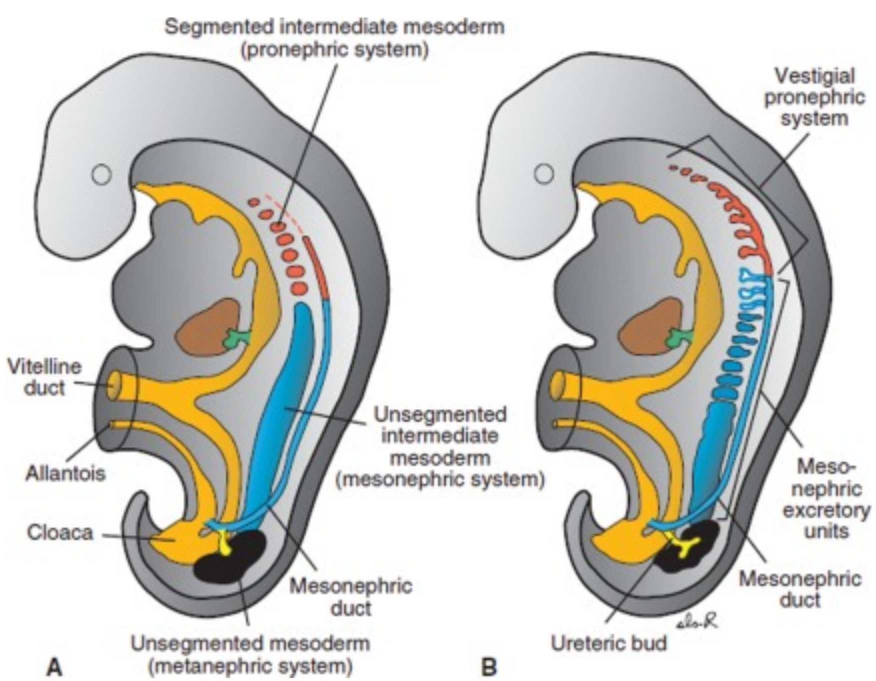
Mesonephric duct

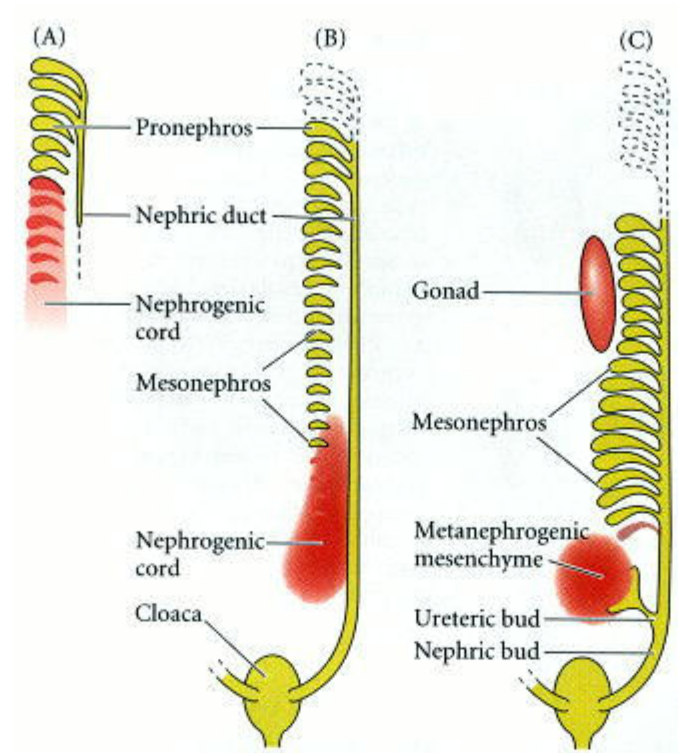
Paramesonephric duct

Urogenital sinus

Mesonephric tubules

(Ureteric bud)



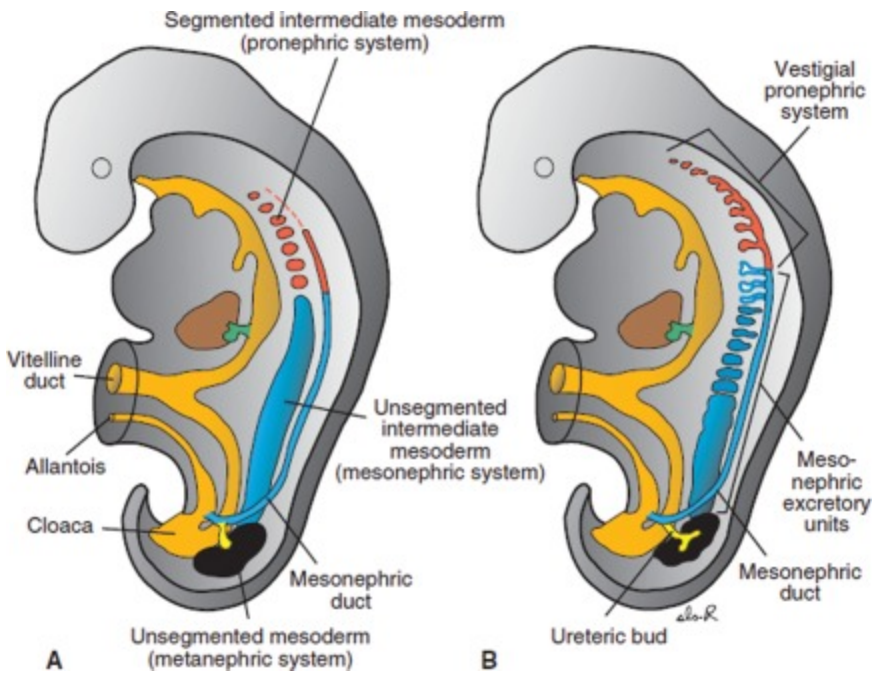


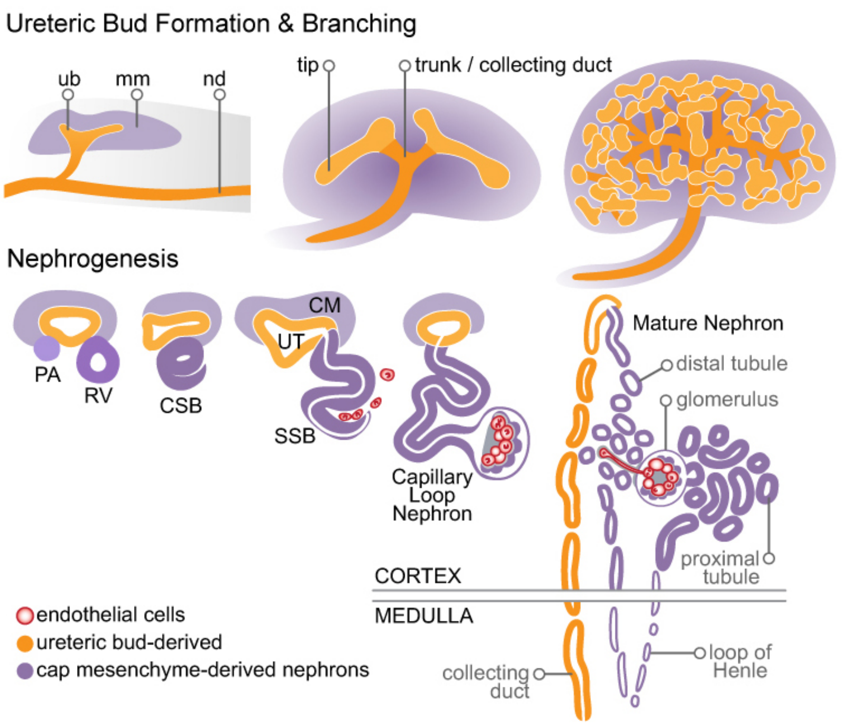
3: Intermediate Mesoderm

Kidney development:

Ureteric bud (of mesonephros) gives rise to ureter, pelvis, collecting duct

Metanephrogenic mesenchyme gives rise to capsule, glomeruli and nephron tubules

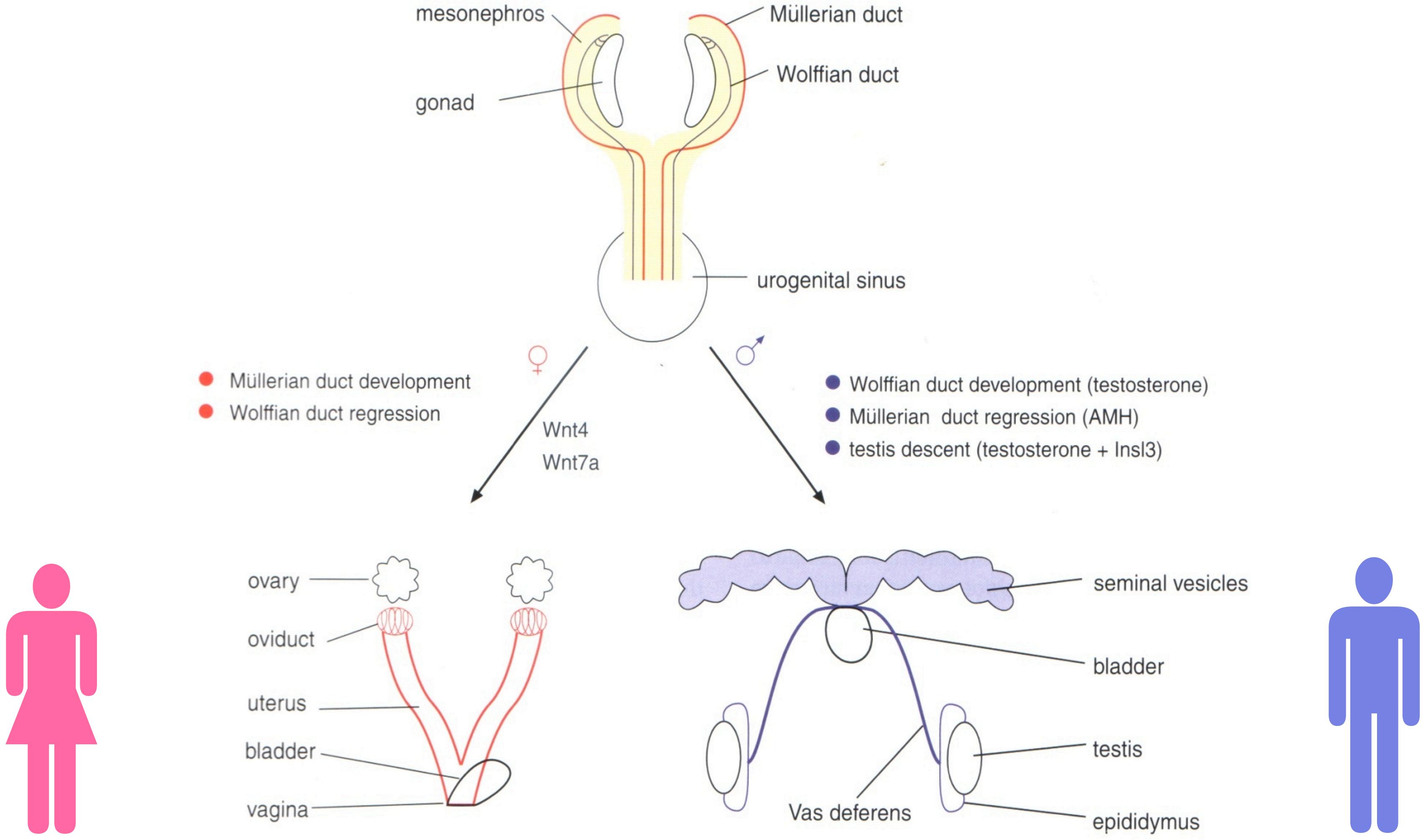




Gonad development

Gonad Development

Bipotential organs



(From: Mouse development, Ch. Sex Determination and differentiation, Swain and Lovell-Badge)

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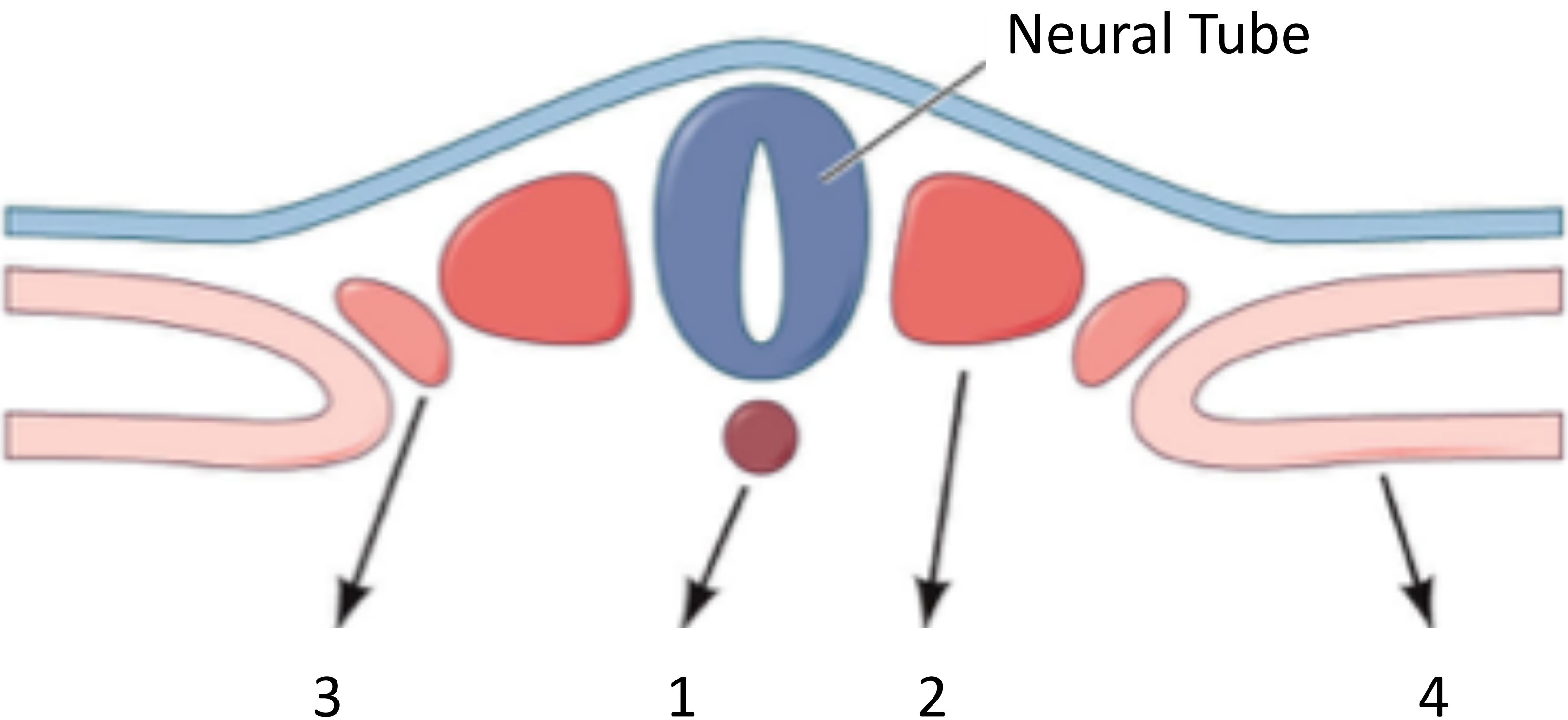

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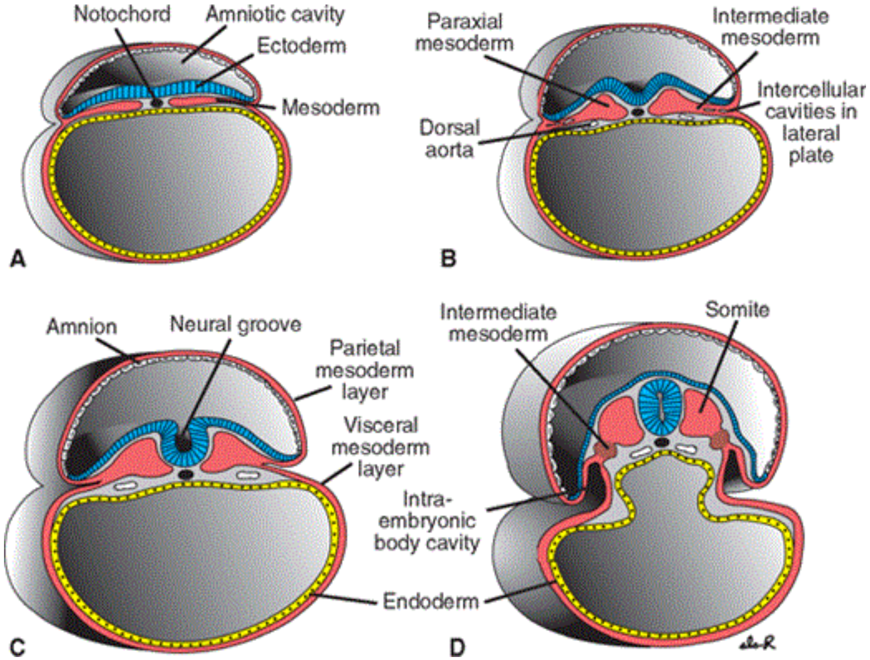
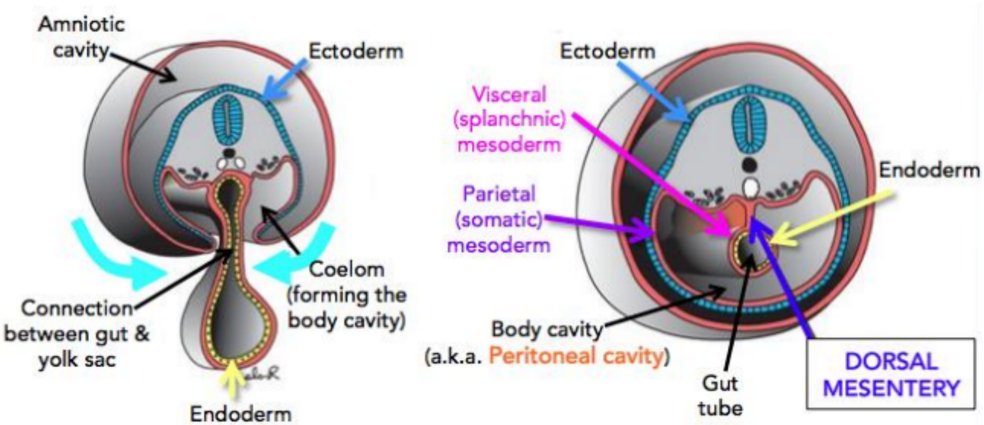
4: Lateral Plate Mesoderm





Lateral plate mesoderm develops into:

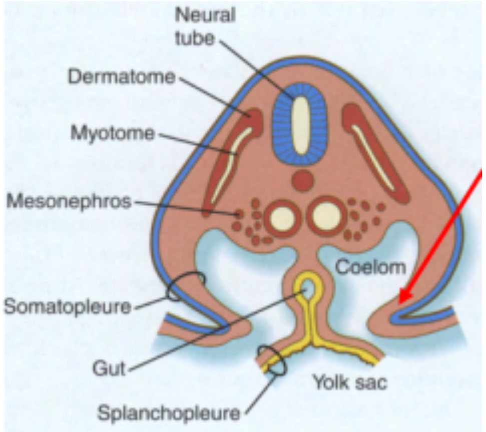
- Splanchnic/visceral mesoderm
- Somatic/parietal mesoderm

Intraembryonic coelom: 3 cavities:

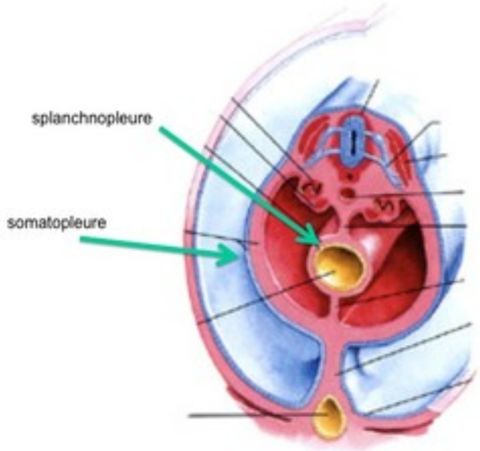
- Pericard
- Pleural
- Peritoneum

4: Lateral Plate Mesoderm

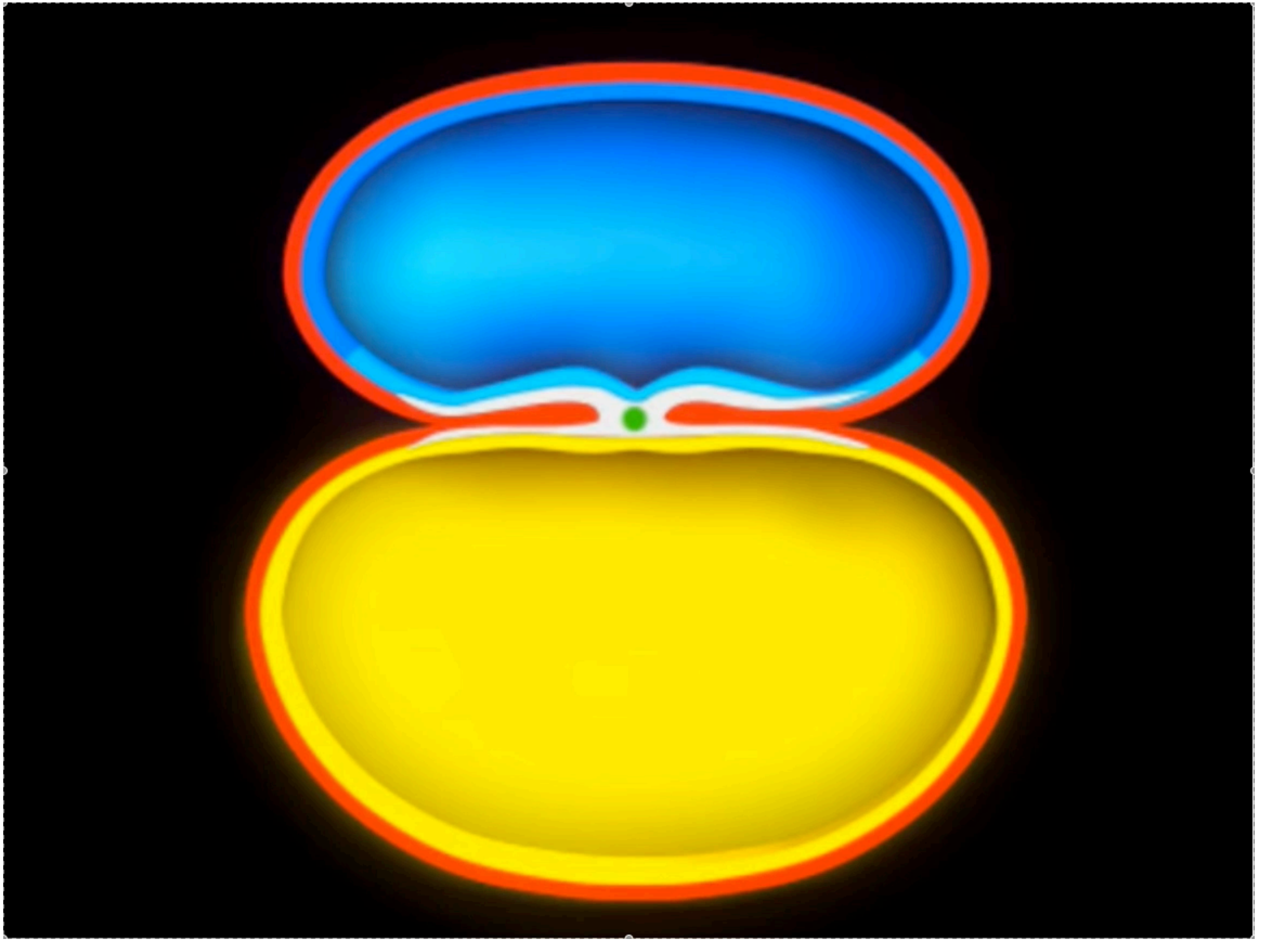
Somatic/parietal mesoderm: **somatopleure**
- Closest to ectoderm
- Gives rise to:
  - Connective tissue and lining of the body wall
  - Bones, ligaments and dermis of the limbs



Splanchnic/visceral mesoderm: **splanchnopleure**
- Closest to endoderm
- Gives rise to:
  - Cardiac mesoderm (prechordal splanchnic mesoderm)
  - Blood vessels
  - Smooth muscles of the gut



4: Lateral Plate Mesoderm



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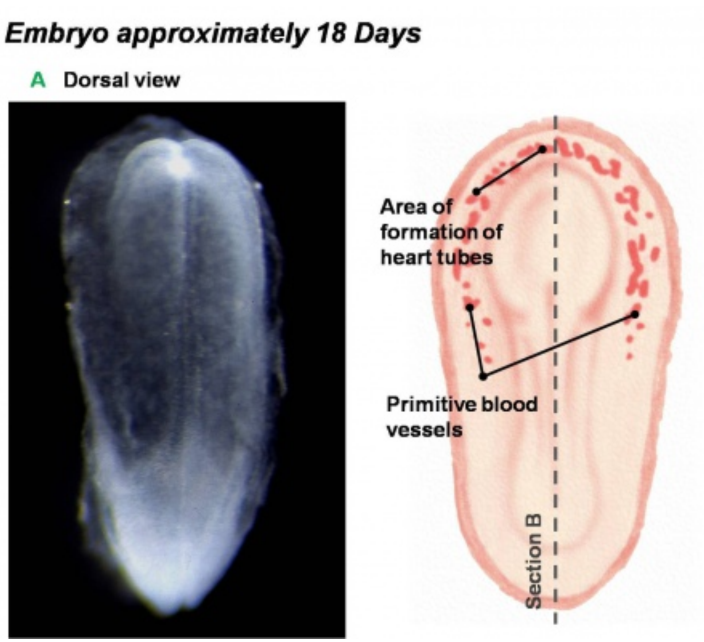
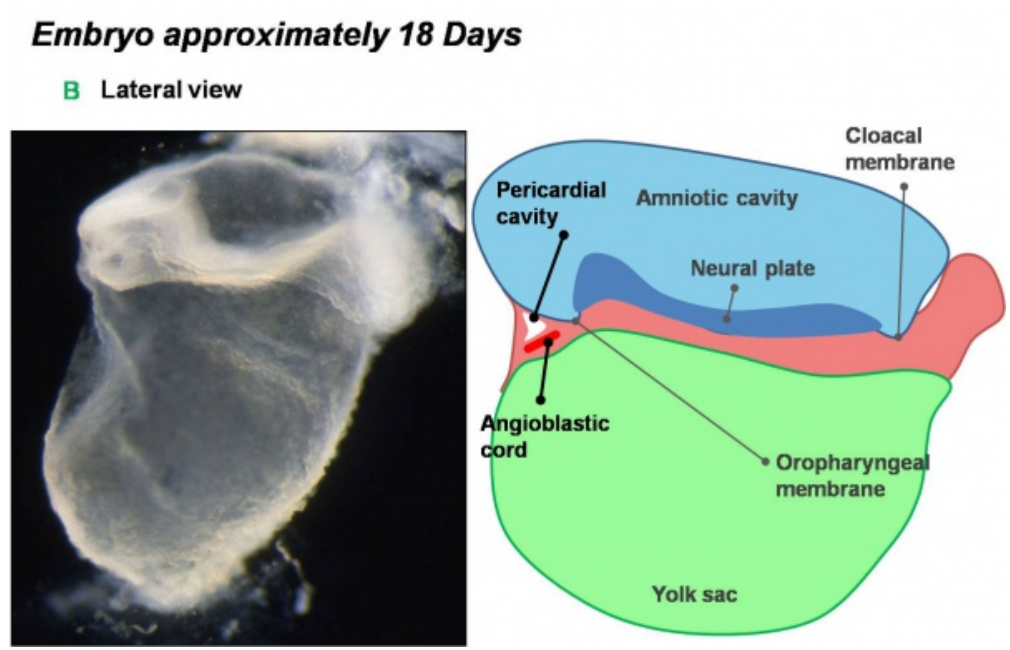
Early Heart Development

Develops from anterior splanchnopleure
Cardiogenic region
Bilateral fields that fuse cranially
Angioblastic cord canalization
Endocardial heart tube fusion due to folding





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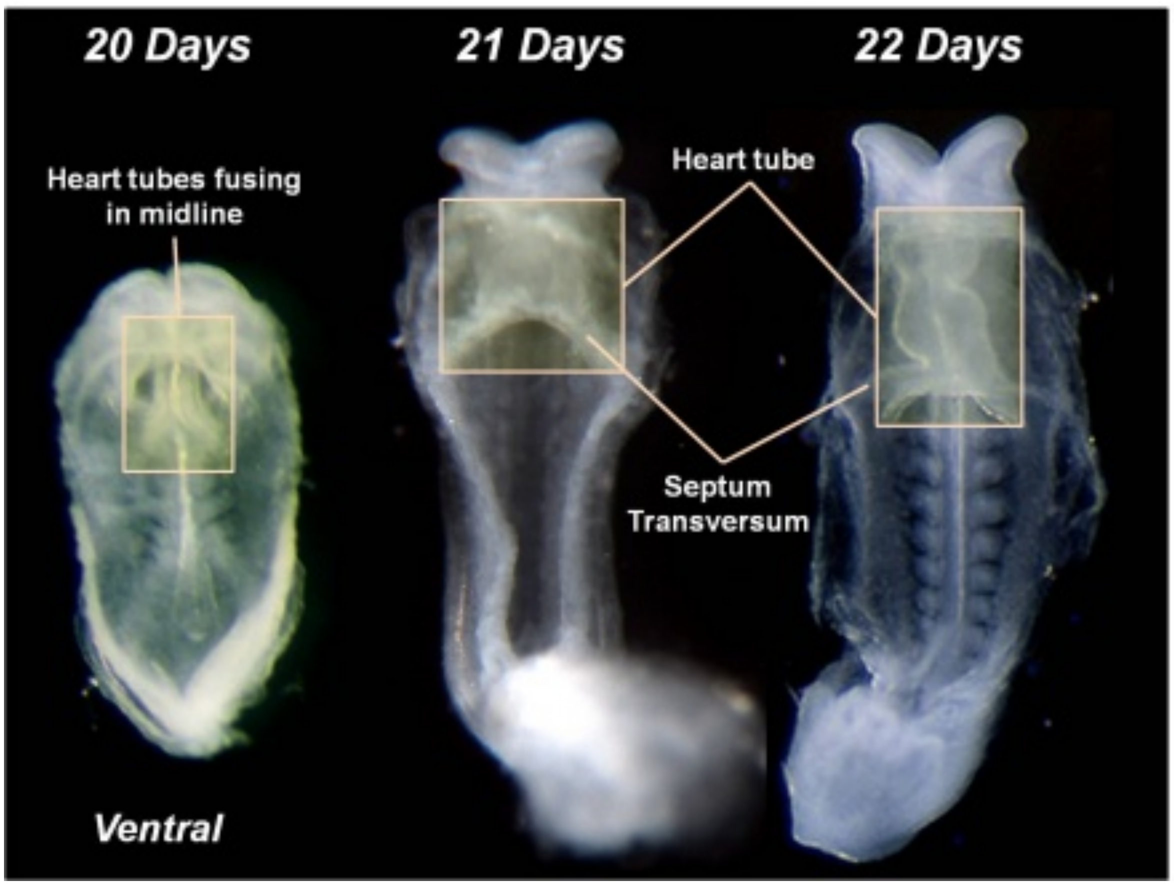
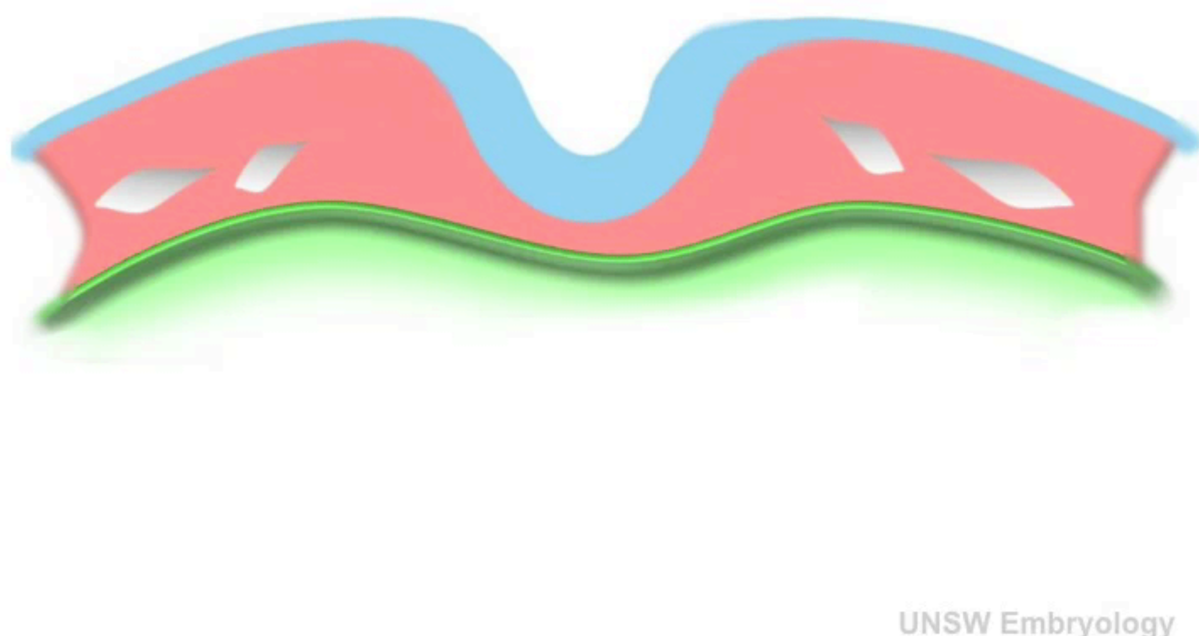


Early Heart Development

- Develops from anterior splanchnopleure
- Cardiogenic region
- Bilateral fields that fuse cranially
- Angioblastic cord canalization
- Endocardial heart tube fusion due to folding

Folding and Fusion of the Heart Tubes



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