

# Differentiation of mesoderm

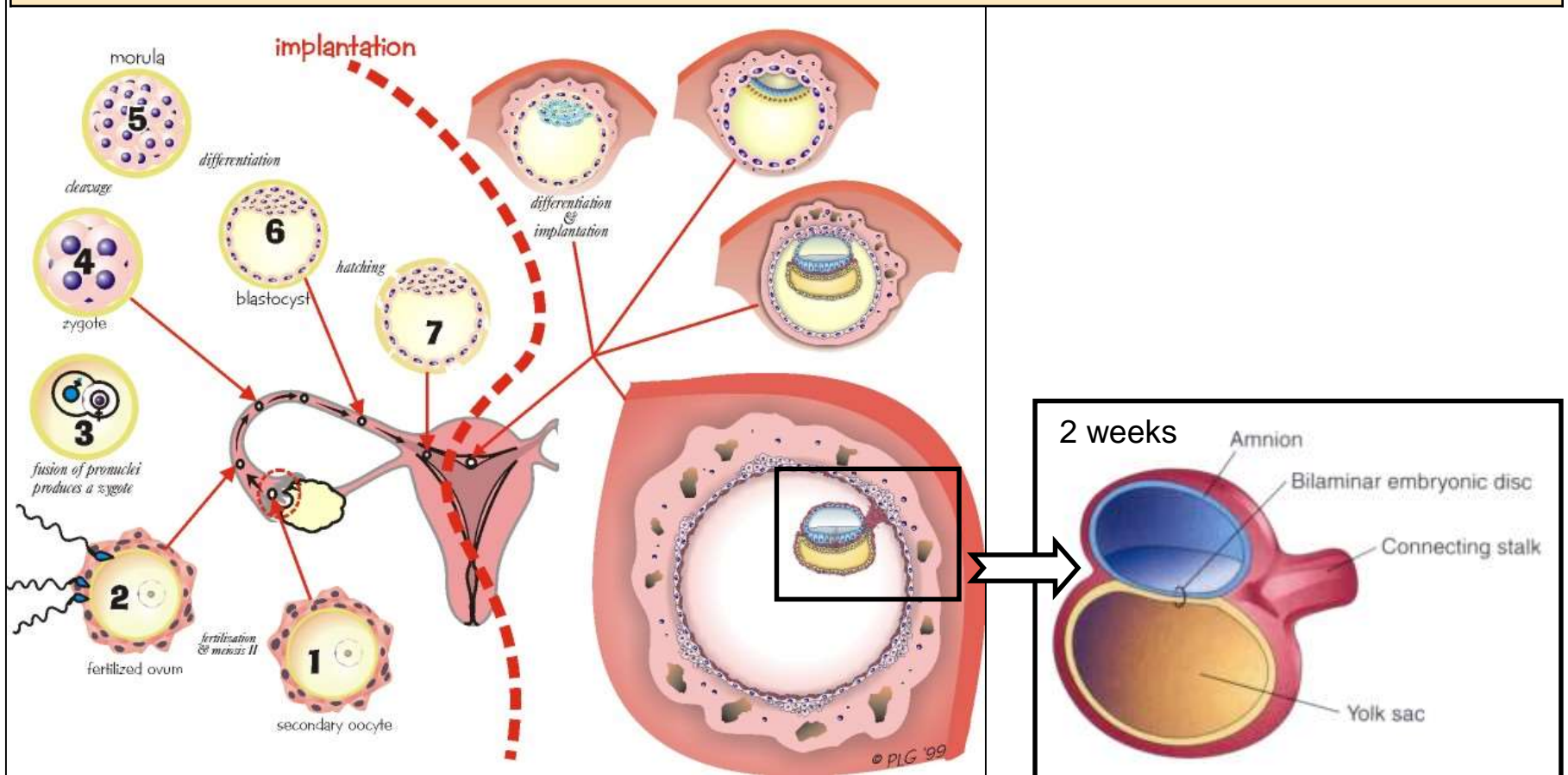
Dr. Bódi Ildikó  
2019.12.04.



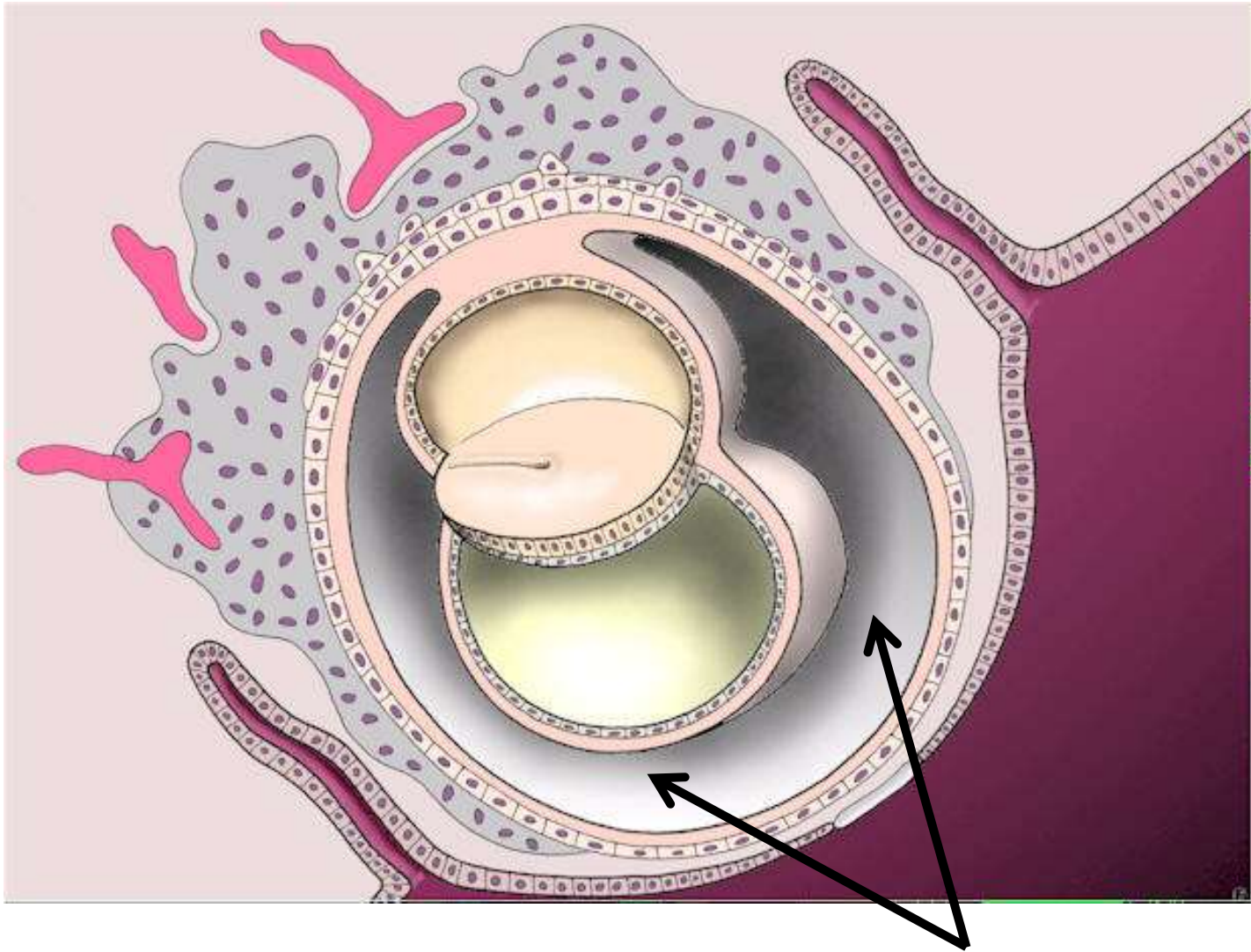
36. Germ cells, fertilization, cleavage (the division of cells in the early embryo)

37. Blastulation, implantation, decidua

38. Development of the embryo shield, ectoderm, endoderm and mesoderm



# The two-layer embryo shield: epiblast and hypoblast



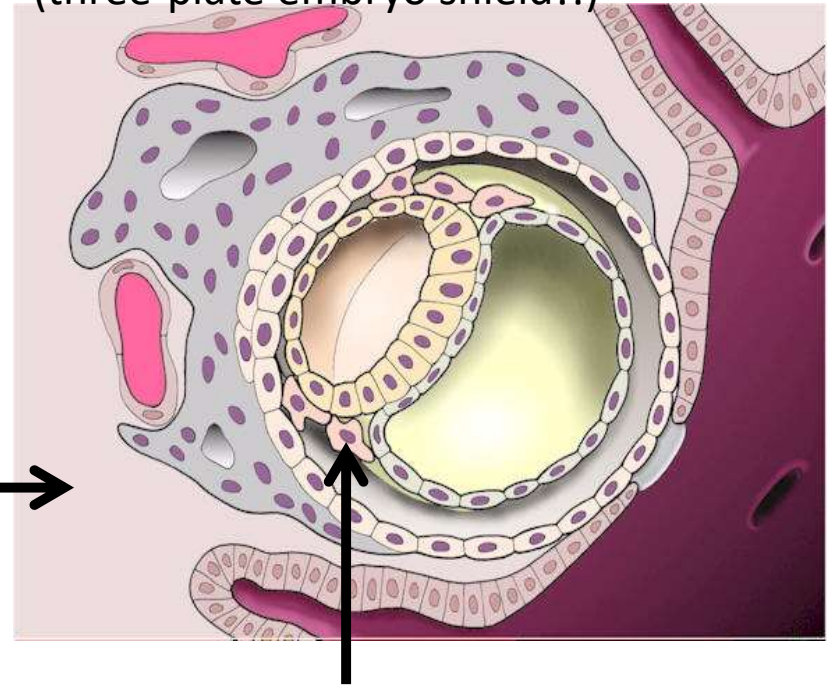
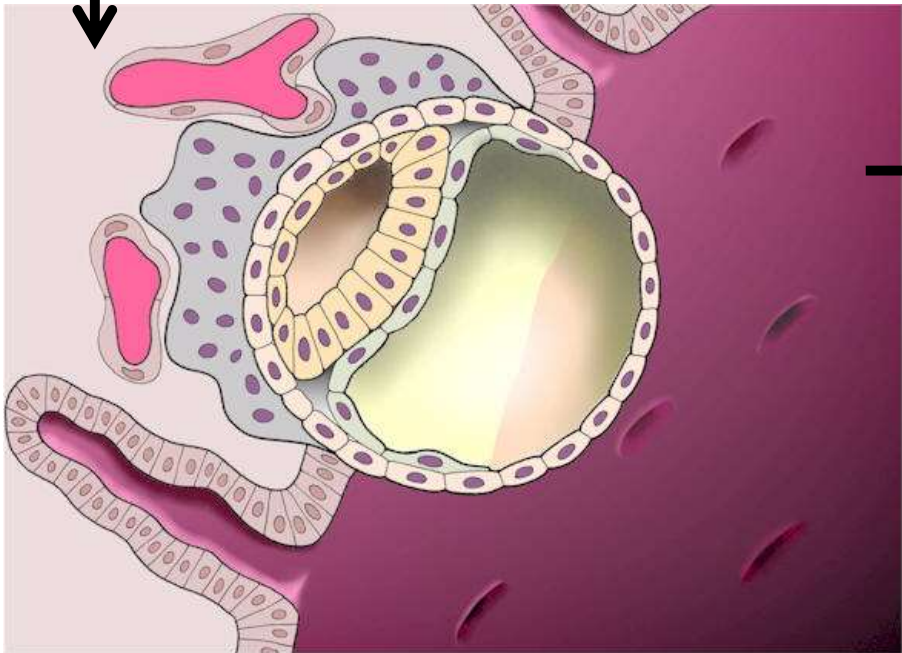
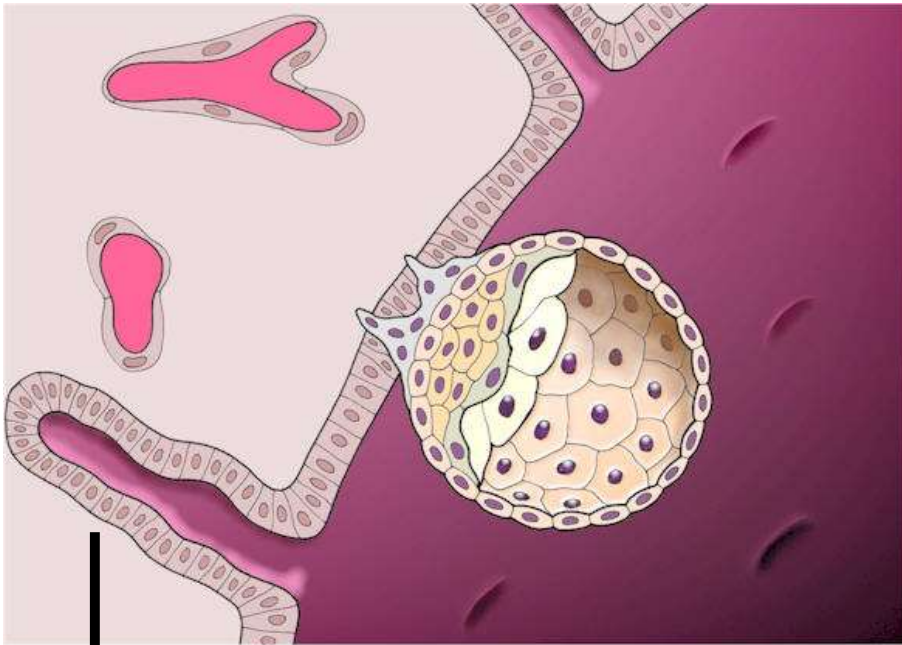
Coelom = embryonic body cavity

Extra-embryonic Coelom



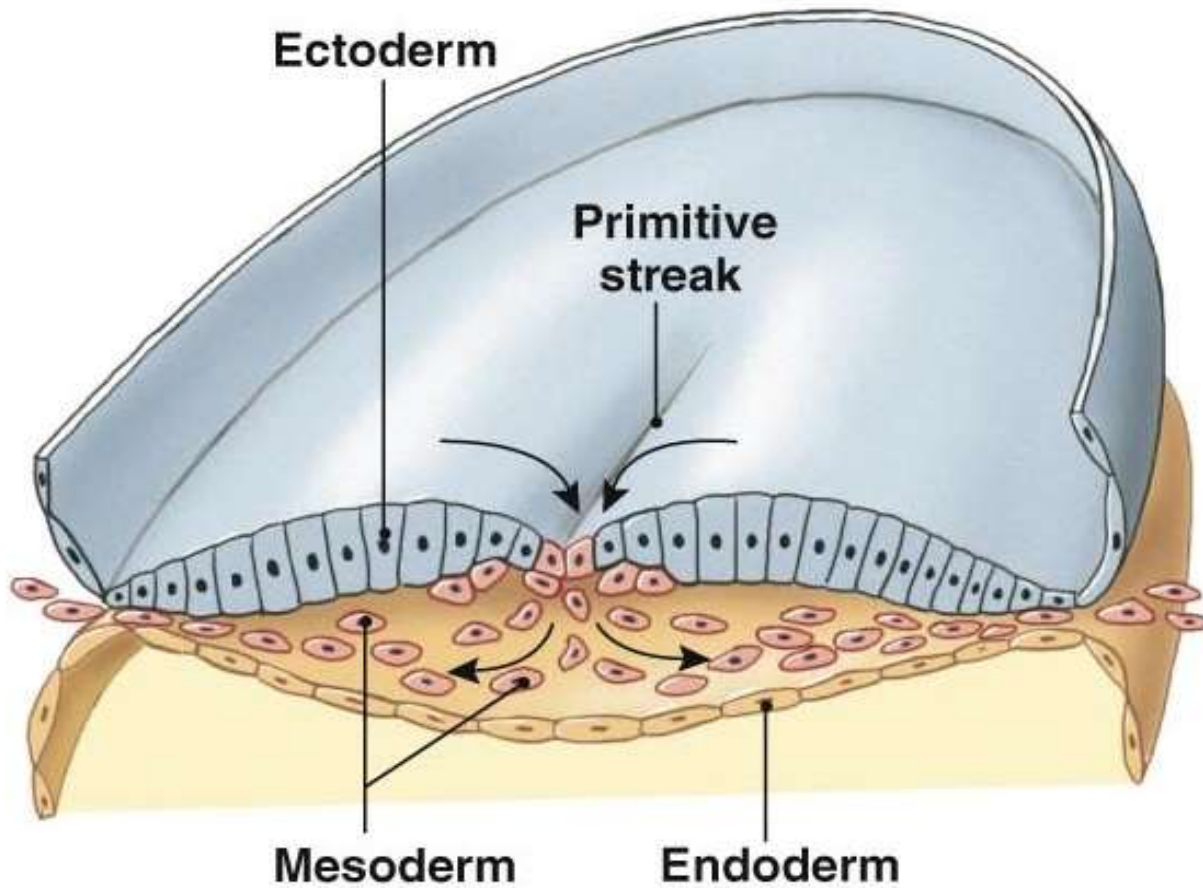
## Implantation and gastrulation

Gastrulation: The blastula continues to develop, eventually forming a structure called the gastrula. (three-plate embryo shield!!)

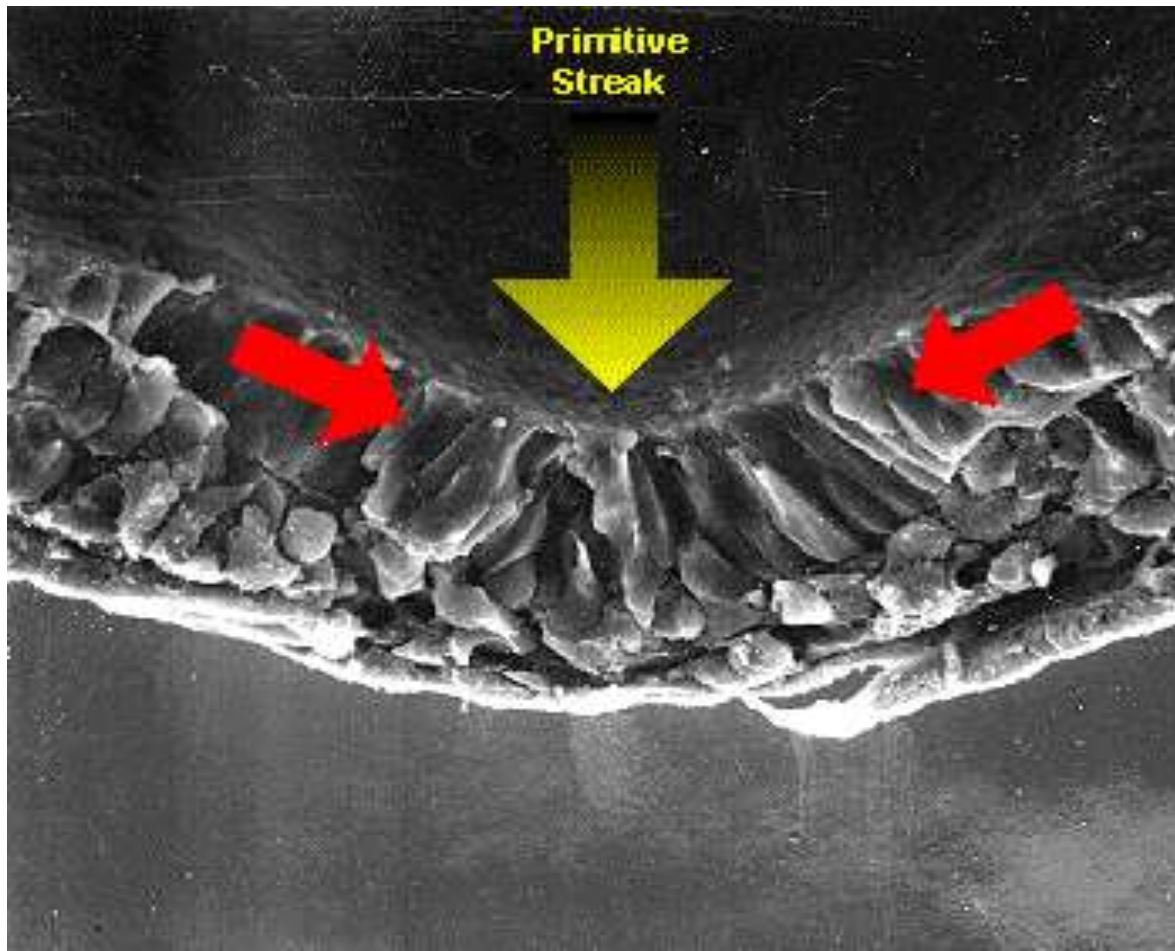


The extraembryonic mesoderm appears

# Gastrulation



# THE DEVELOPMENT OF MESODERMA, DERIVATIVES OF GERM LAYERS (Weeks 3-8 of Development)





# The TRILAMINAR EMBRYO - 3rd week

1. Induction from the hypoblast cells



2. Proliferation of the epiblast cells



3. Caudal forms the primitive streak with primitive node and primitive groove



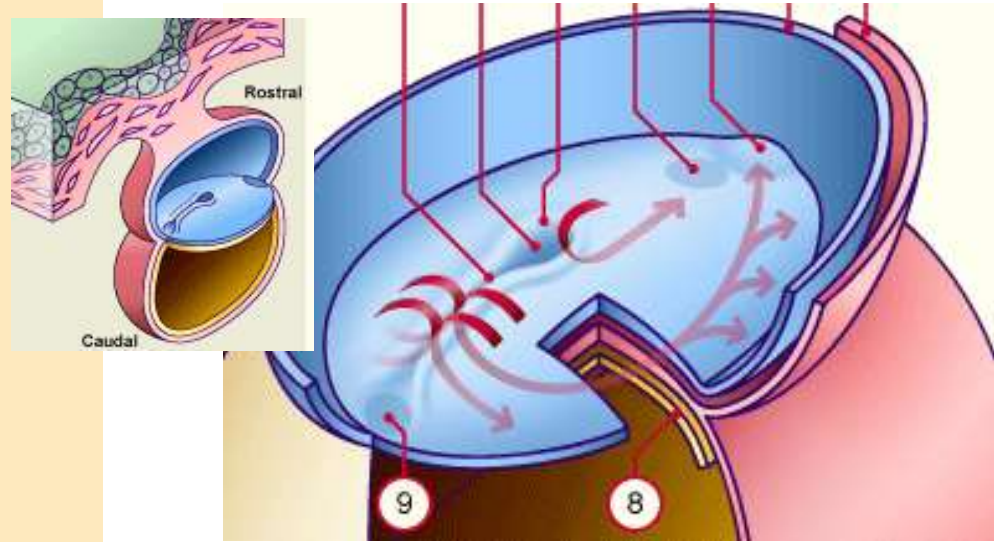
4. The proliferated epiblast cells migrate into the 2 layers



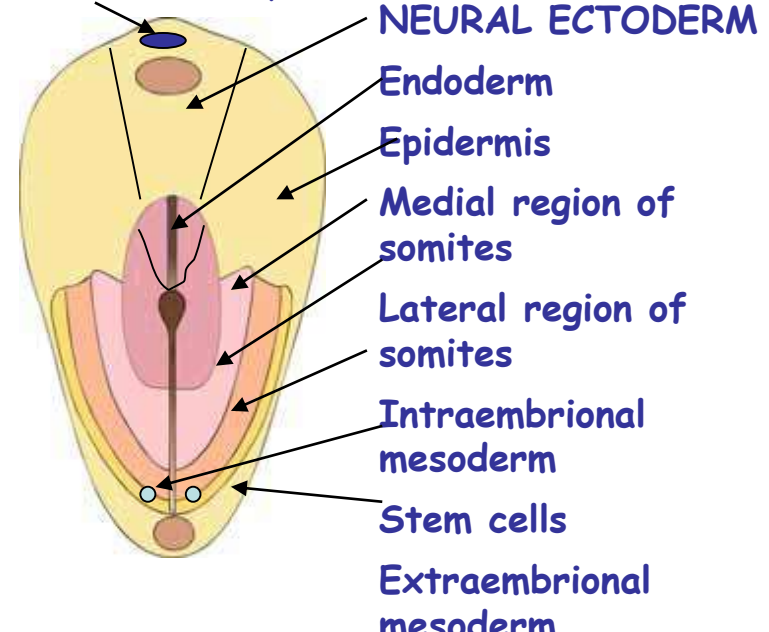
5. **Forming the mesoderm**

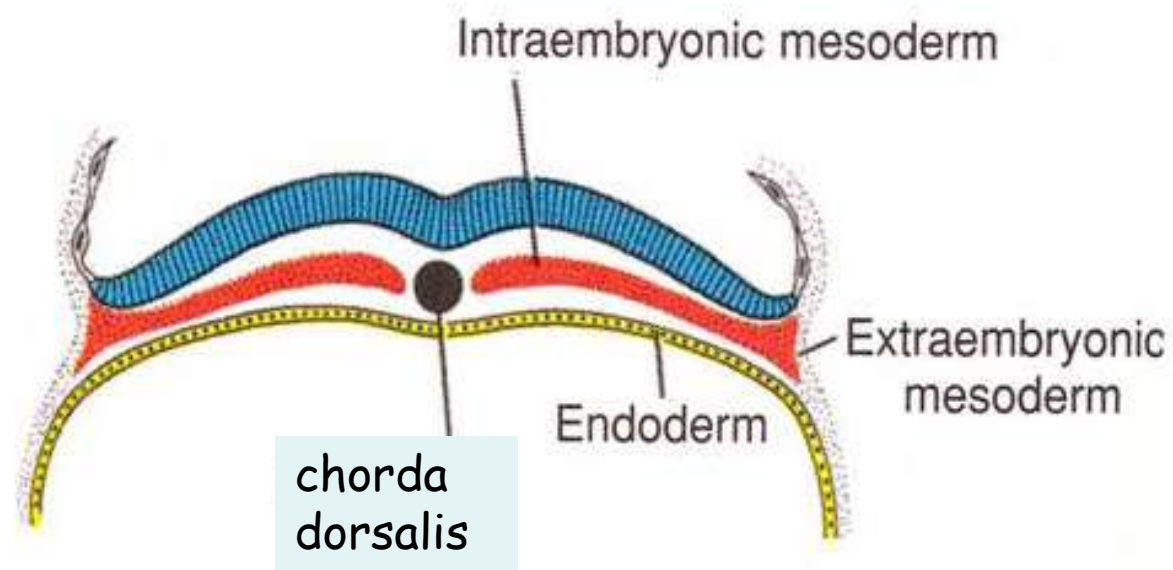
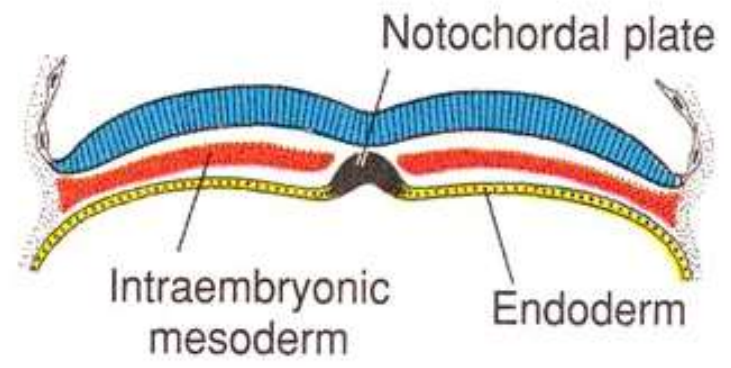
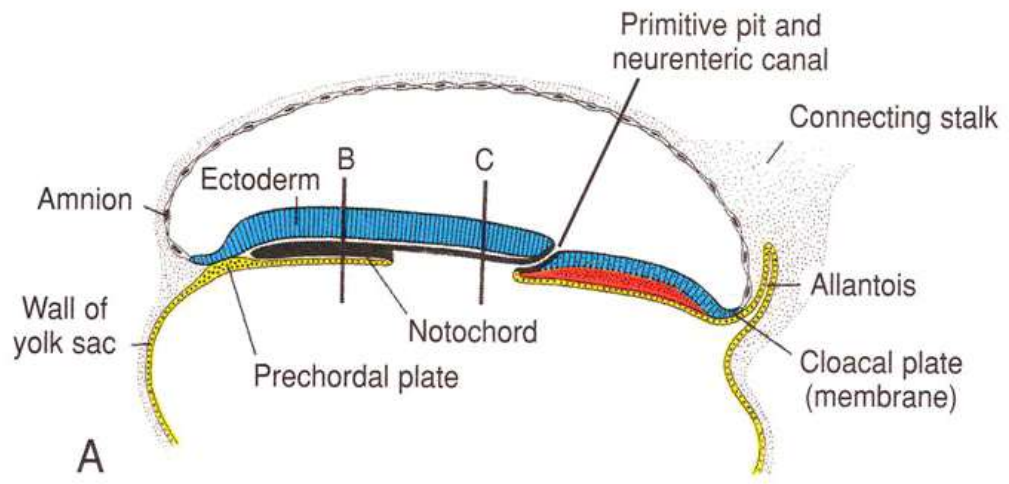
**TRILAMINAR EMBRYO:**

ectoderm, mesoderm, endoderm



Heart field (in deep)







# Parts of Mesoderm

**Paraxialis** mesoderm - somita

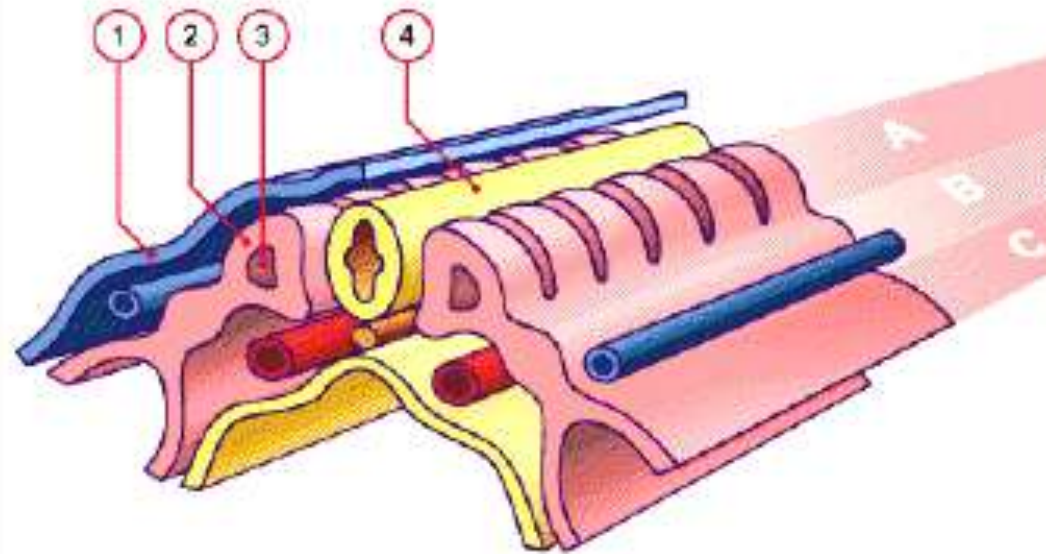
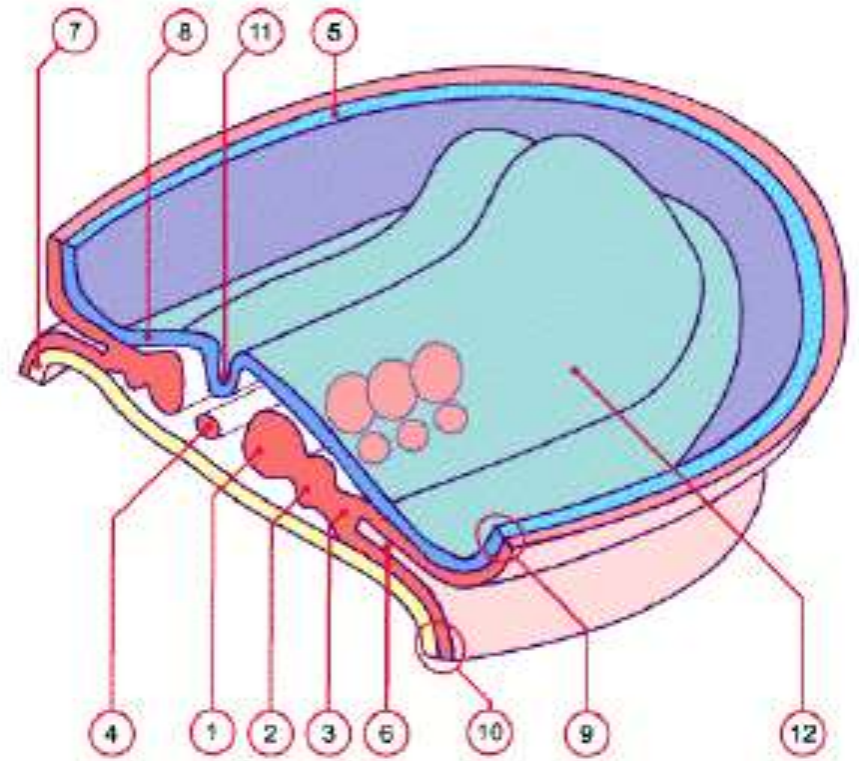
**Intermedier** mesoderm

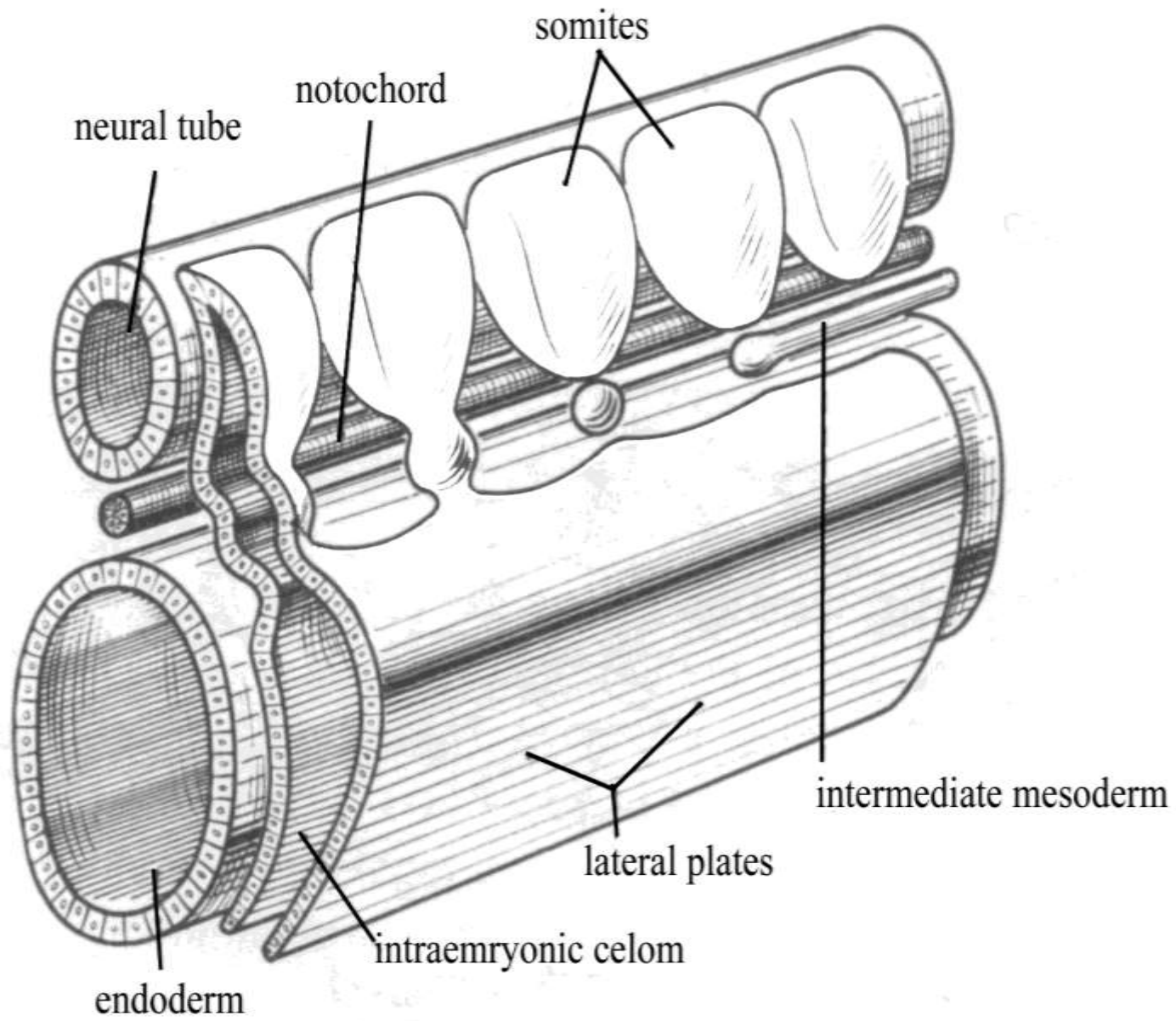
gononephrotom

**Parietalis** mesoderm

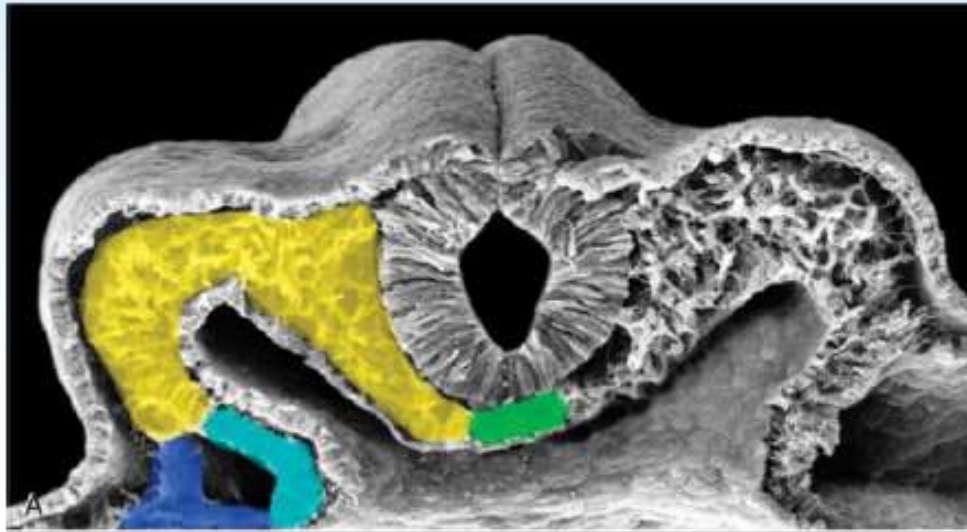
somatopleura

splanchnopleura



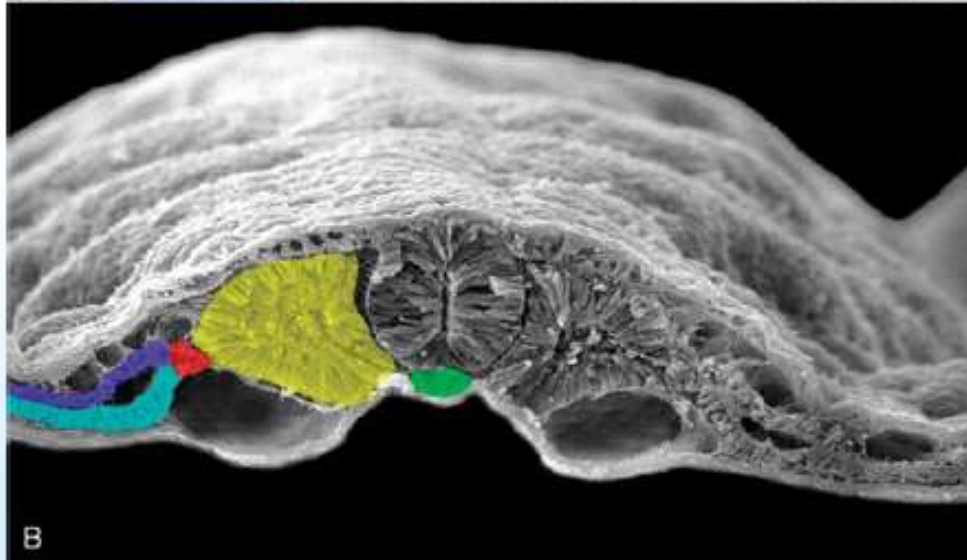


# PARTS OF MESODERM



**AXIAL** - green

**PARAXIAL**-yellow



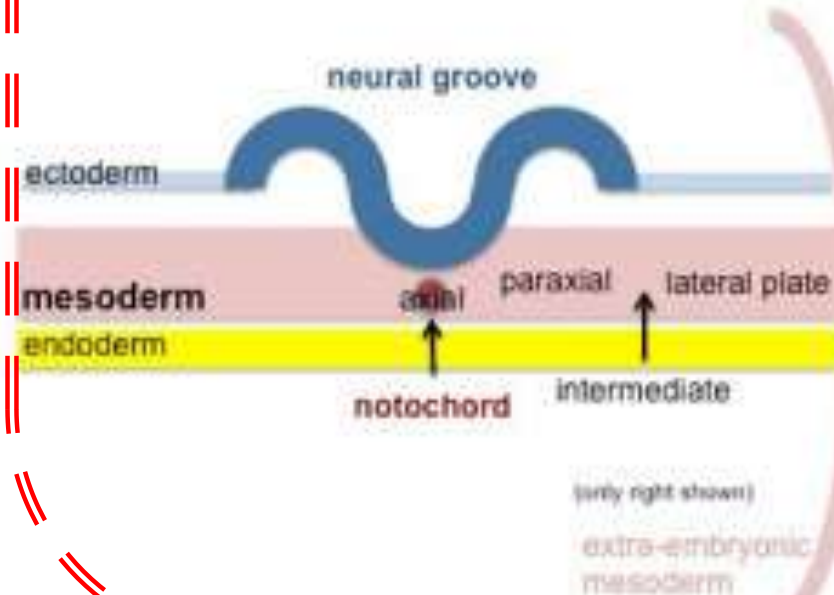
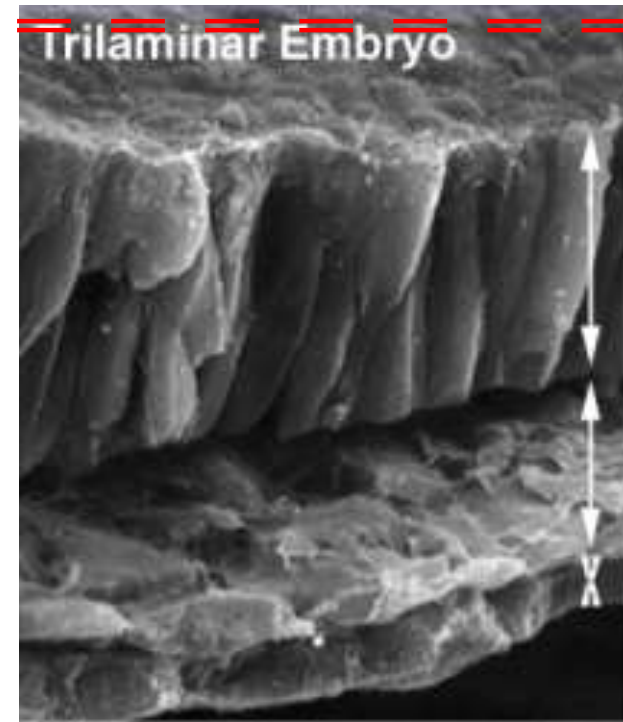
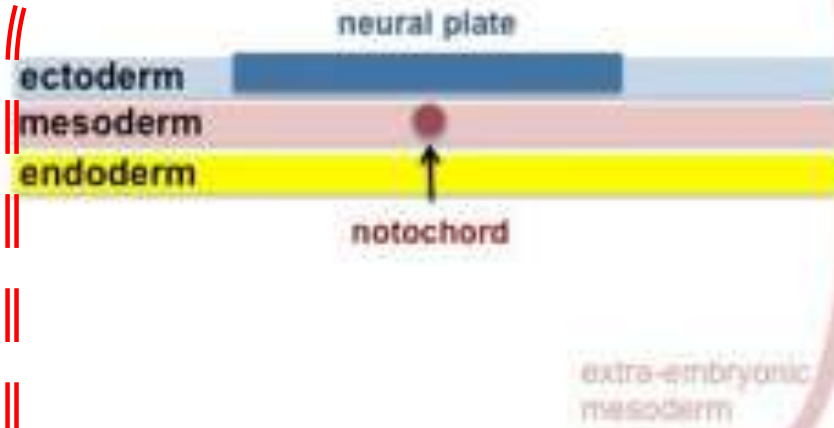
**INTERMEDIER**  
- red

**LATERAL** - blue

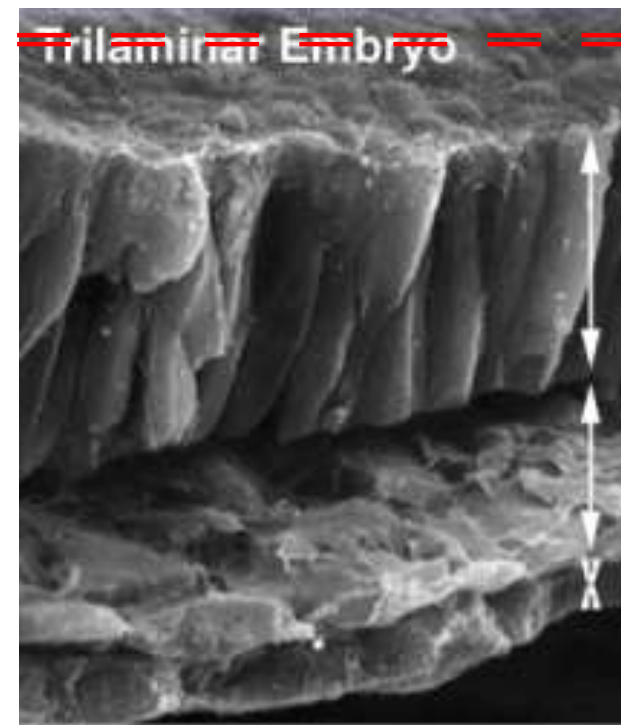
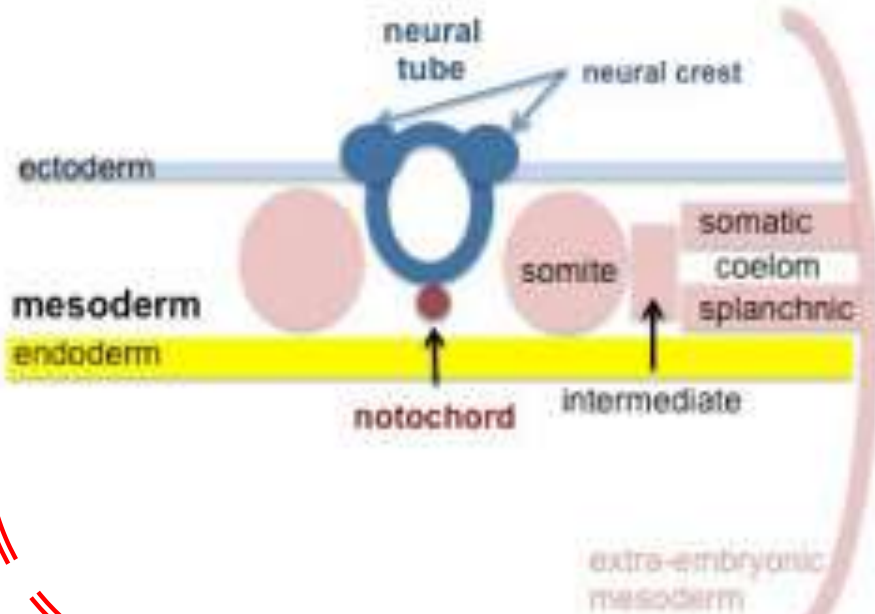
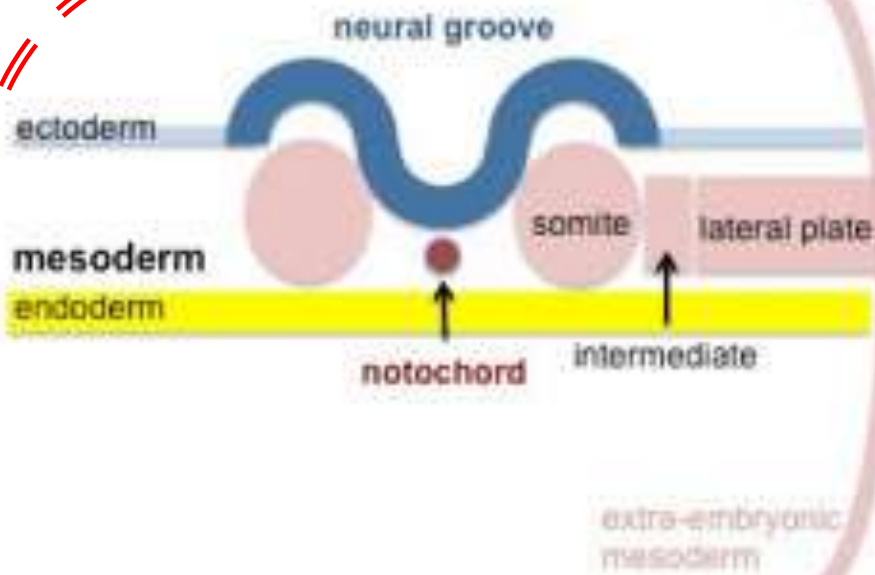


## Trilaminar Embryo

(transverse section)



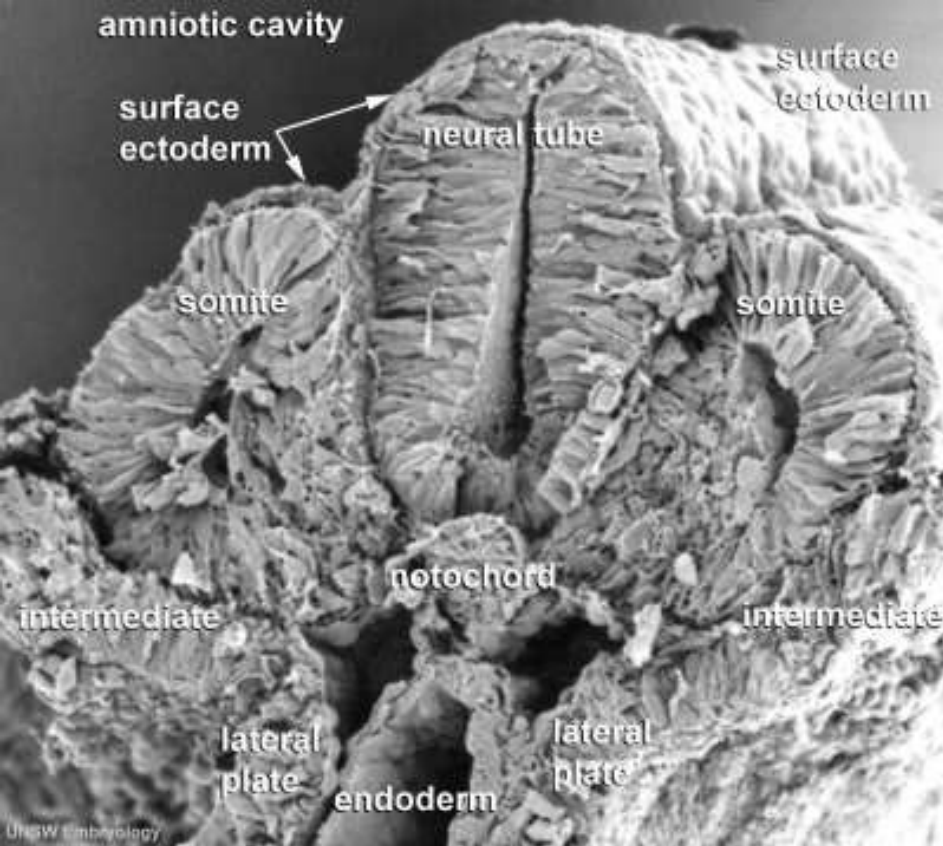
- **Paraxial mesoderm** - somites - musculoskeletal structures
- **Intermediate mesoderm** - urogenital (kidney and genital)
- **Lateral plate mesoderm** - body wall, body cavities, cardiovascular and GIT structures



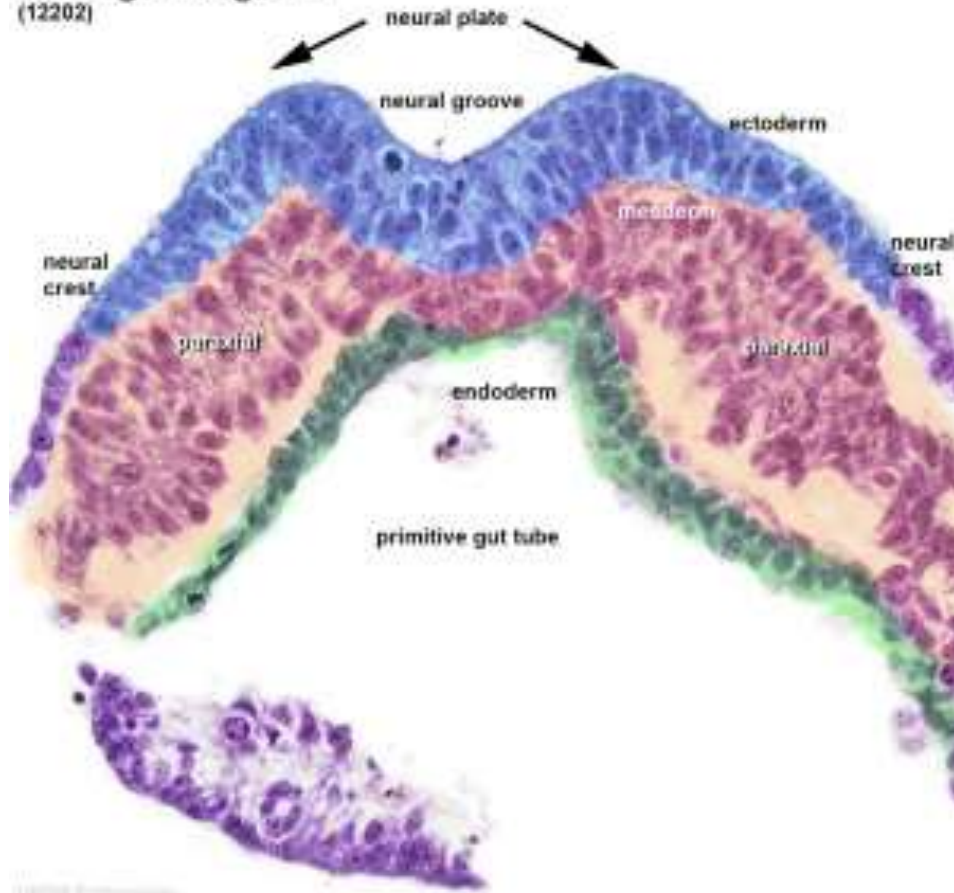
Ectoderm  
Mesoderm  
Endoderm

(Image: K. Sulik)

- **Paraxial mesoderm** - somites - musculoskeletal structures
- **Intermediate mesoderm** - urogenital (kidney and genital)
- **Lateral plate mesoderm** - body wall, body cavities, cardiovascular and GIT structures



**Carnegie Stage 10**  
(12202)



**Week 4** Scanning electron micrograph of a cross-section of a human embryo at week 4 ([stage 11](#)).

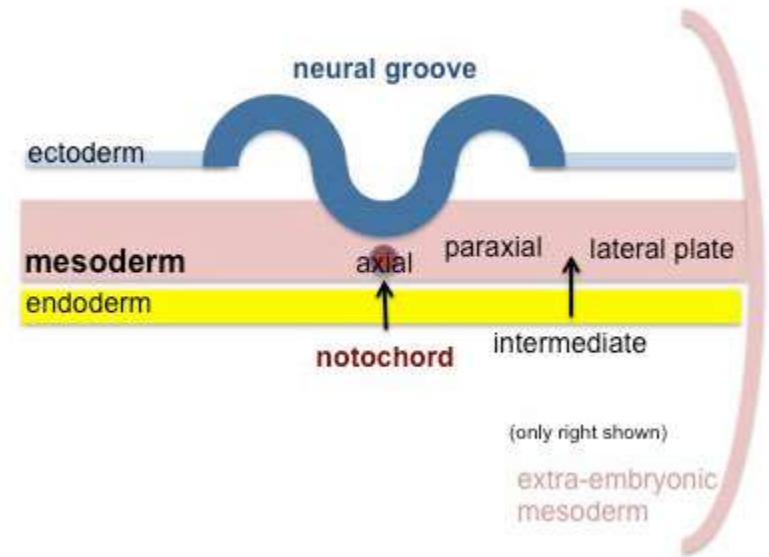
Note the mesoderm structures now present and their relative position and size within the embryo.

Compare the mesoderm structures to those formed by ectoderm (neural tube and epidermis) and endoderm (epithelia of developing gastrointestinal tract).



# Paraxial Mesoderm

- lies adjacent to axial mesoderm (notochord) and forms 2 components:
  - Head - unsegmented paraxial mesoderm
  - Body - segmented paraxial mesoderm
- Generates trunk muscles, skeleton, dermis of skin, blood vessels, connective tissue



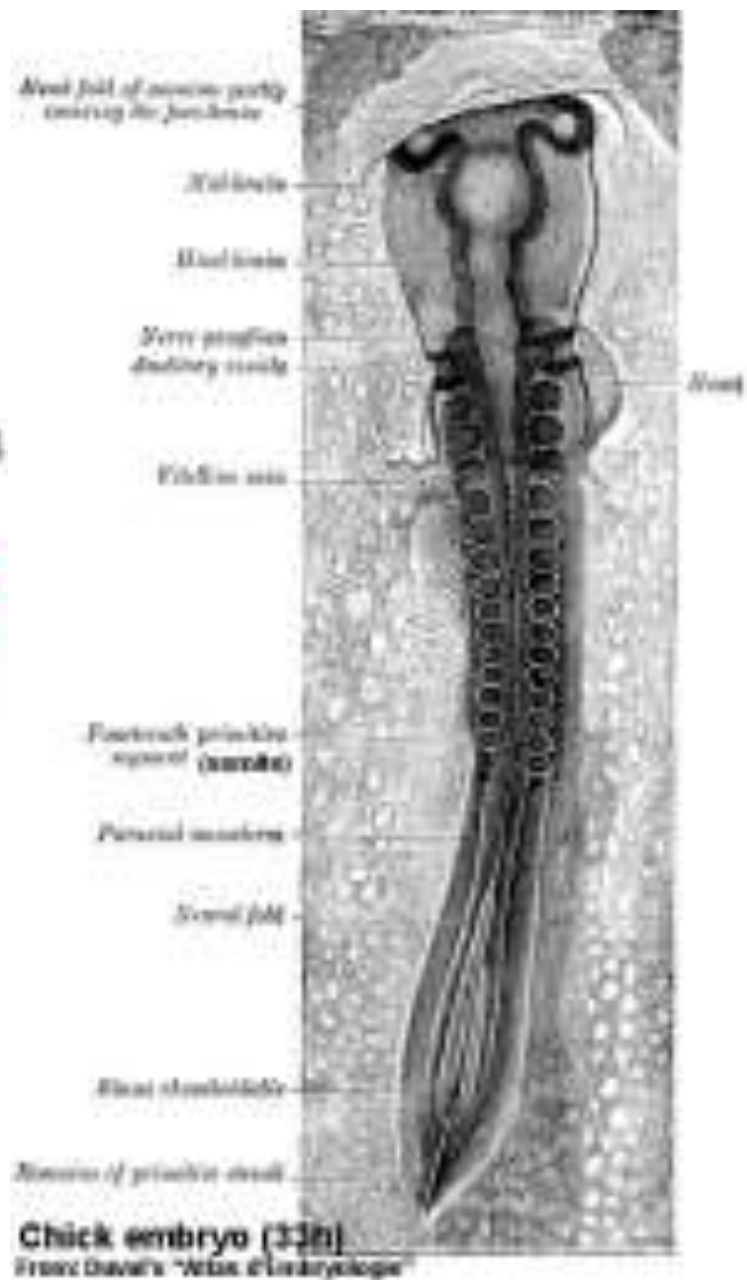
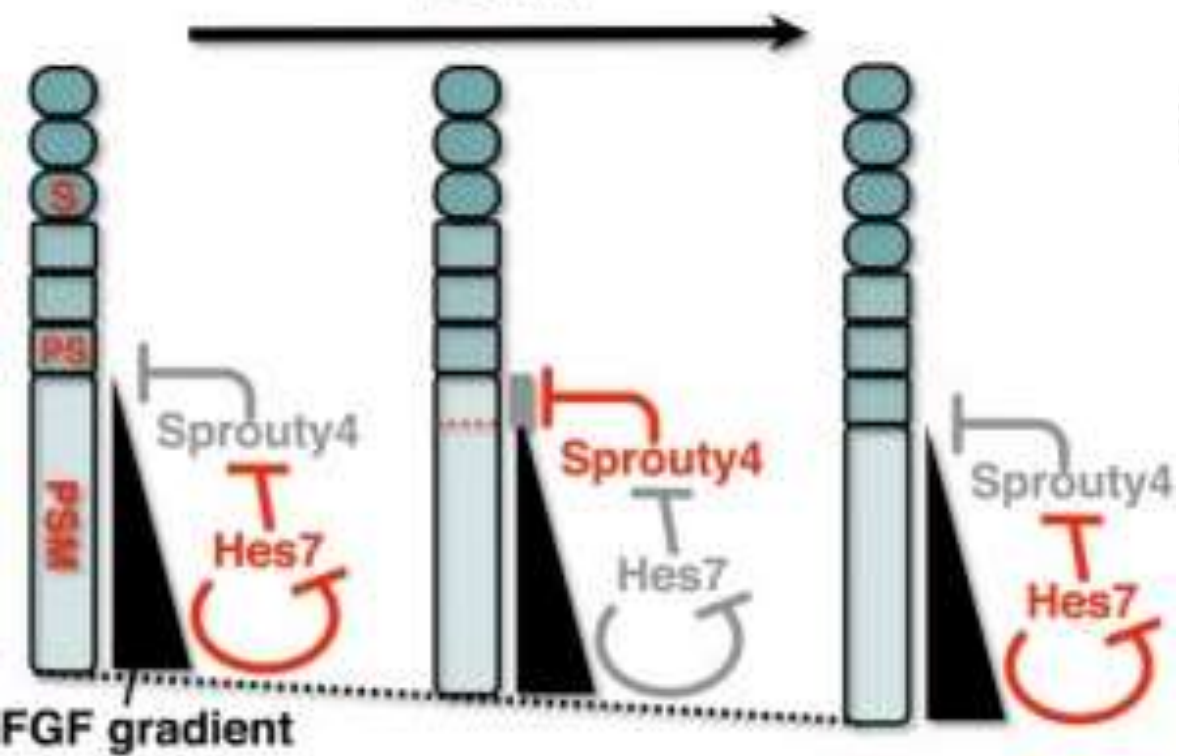
## Segmented Paraxial Mesoderm

- segments called **somites** - transient embryonic structures.
- first pair of somites (day 20)
- segmentation imposes a pattern on nerves, vasculature, vertebra....
- somites appear in ordered sequence cranial to caudal
- appearance so regular used to stage the embryo (Hamburger & Hamilton 1951- chicken)
  - thought to be generated by a "clock" (1 pair every 90 minutes)
  - neural tube begins to close at 4th somite level, 44 pairs of somites

# Development of the somites

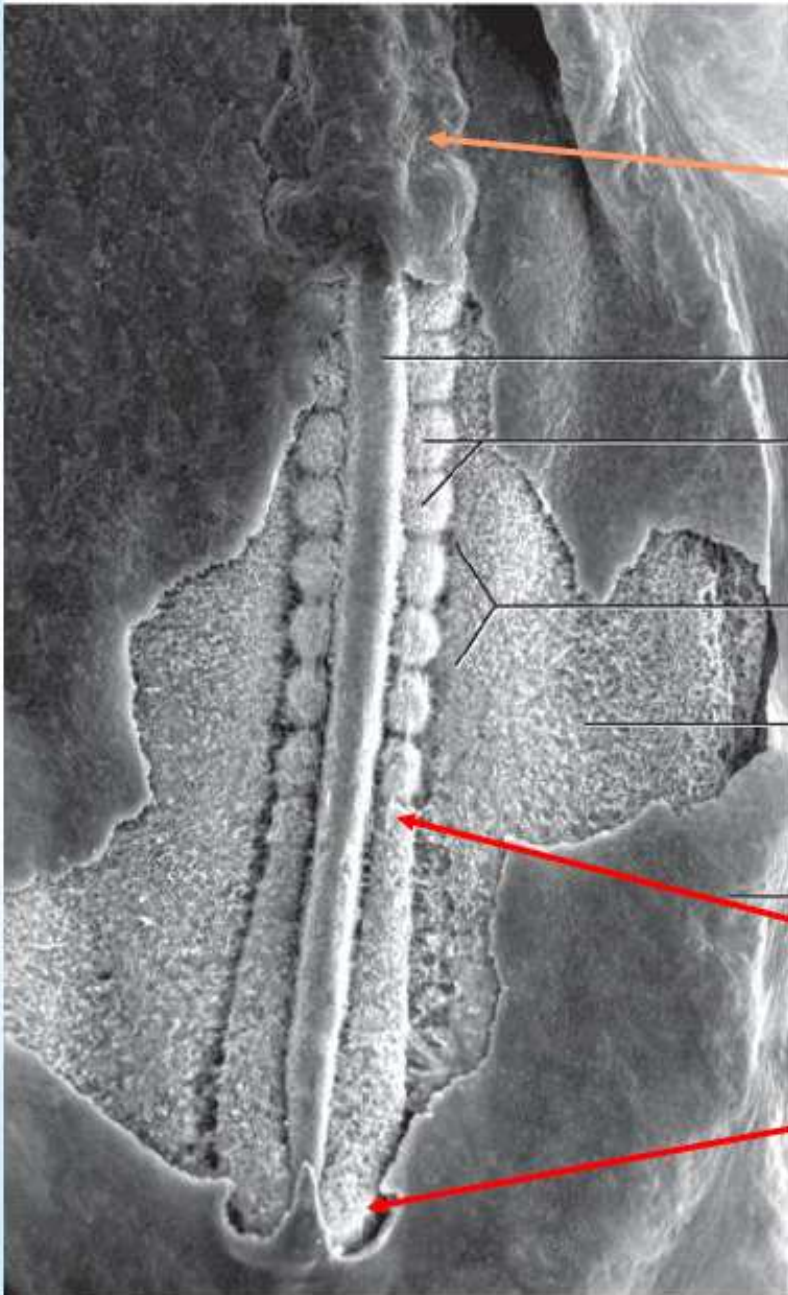
- In the beginning of the 3rd week
- The first appears CRANIAL and developing caudal (3 paar/day)
- 4 OCC, 7 CERV, 12 THOR, 5 LUMB, 5 SACR, 8-10 COCC
- Neuromers

120 min





Cranial



## SOMITOMER

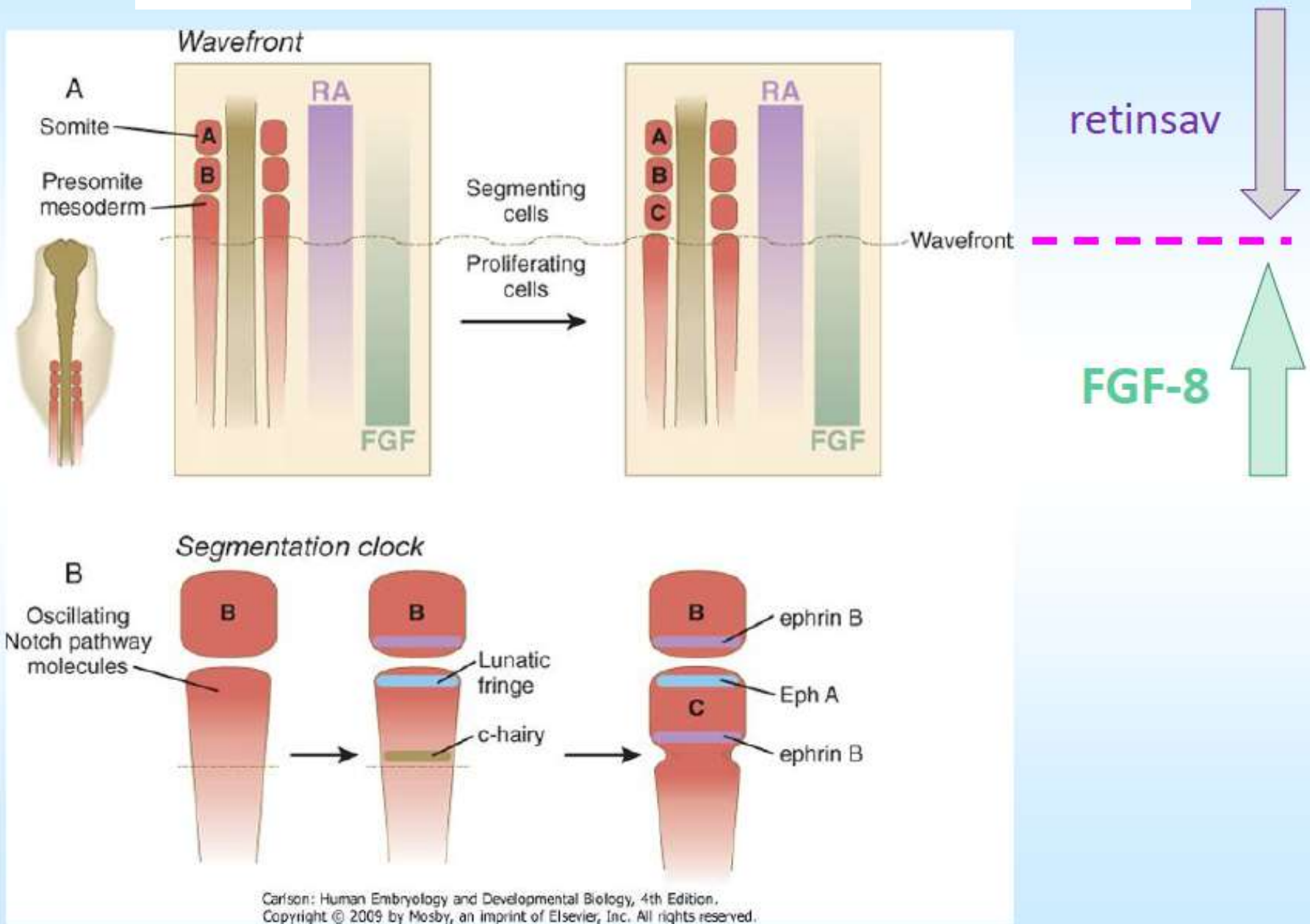
They will not segment

Cranio-caudal segmentation

Caudal

Not yet segmented

# REGULATION OF SEGMENTATION



- Different segmental level somites have to generate different segmental body structures?
- somite has to form different tissues?
- Somite Differentiation
- Compartmentalization accompanied by altered patterns of expression of Pax genes within the somite
- rostro-caudal axis appears regulated by Pax/Hox expression, family of DNA binding transcription factors

Somite initially forms 2 main components

- ventromedial- **sclerotome** forms vertebral body and intervertebral disc
- dorsolateral - **dermomyotome** forms dermis and skeletal muscle



# A somiták (őscsigolyák) differenciációja

A 4. héten a somiták szerkezete fellazul, ventromedialis részükből a sejtek a chorda dorsalis és a velőcső köré vándorolnak.

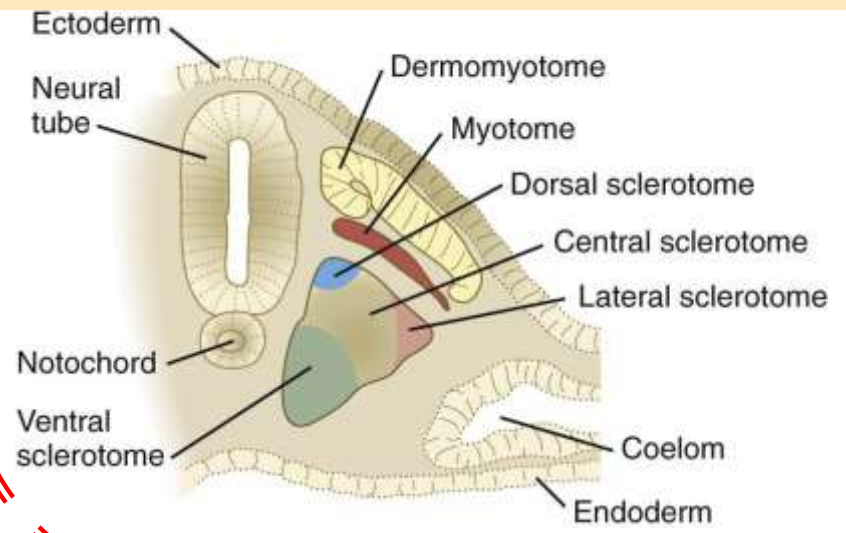
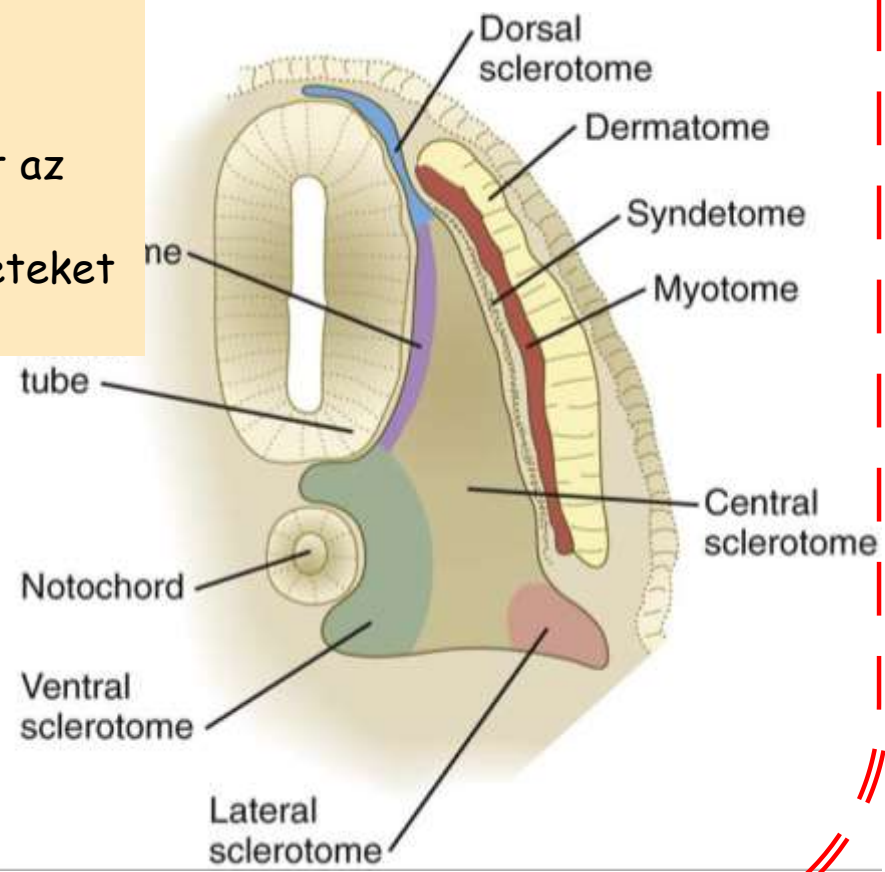
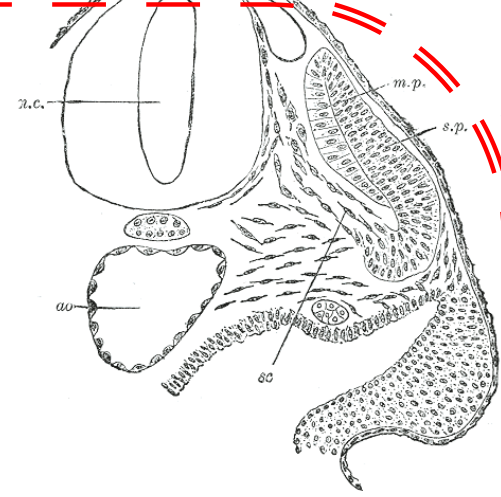
sclerotom . gerinc

a maradékból lesz a dermatomyotom

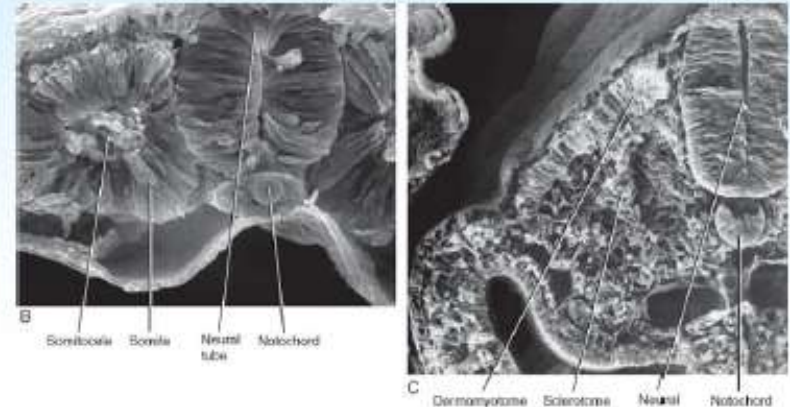
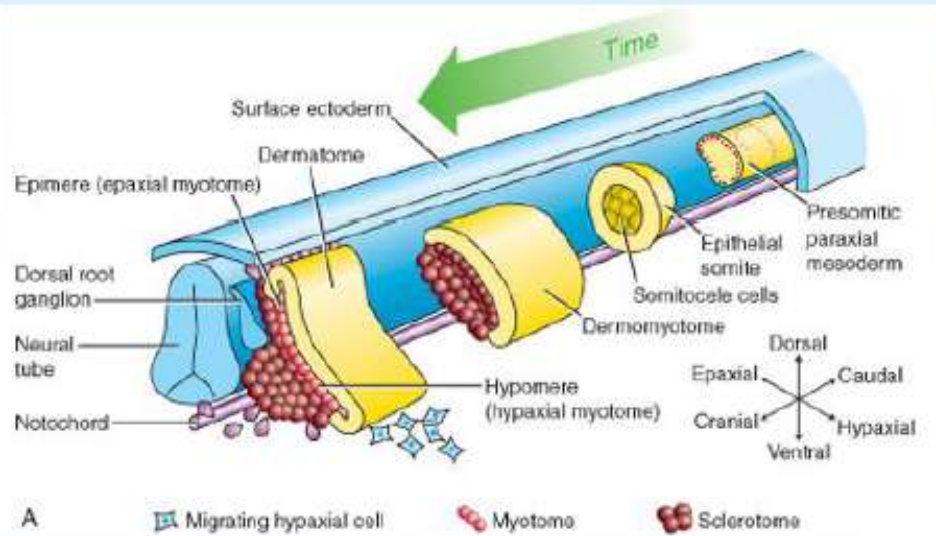
myotom (izomszegmentum) és a

dermatom, amely elvesztve hámjellegét az

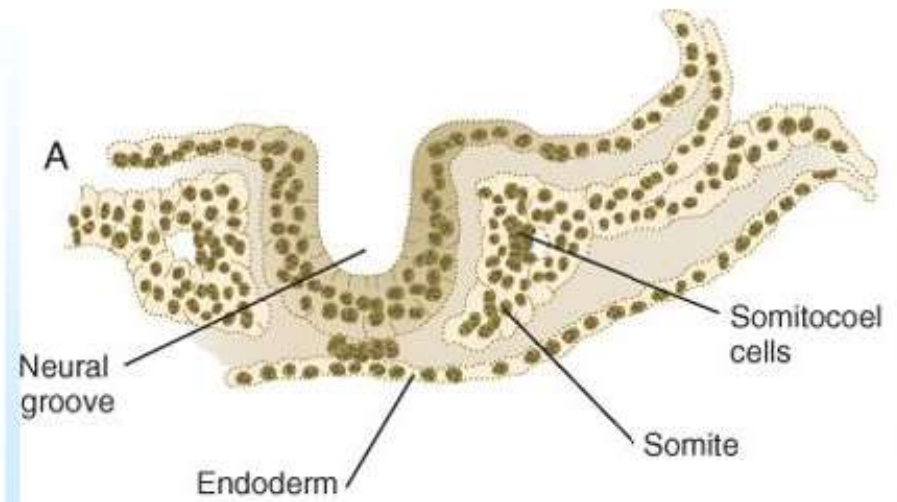
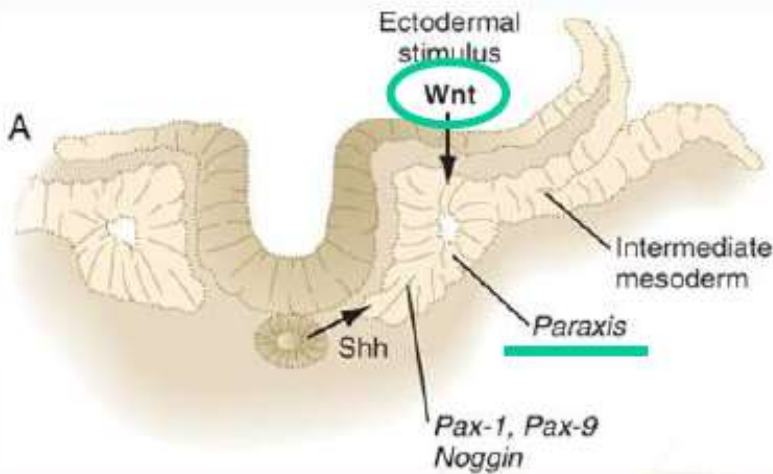
ektoderma alá áramlik - dermist és subcutan szöveteket képezi.



# DIFFERENTIATION OF THE SOMITES



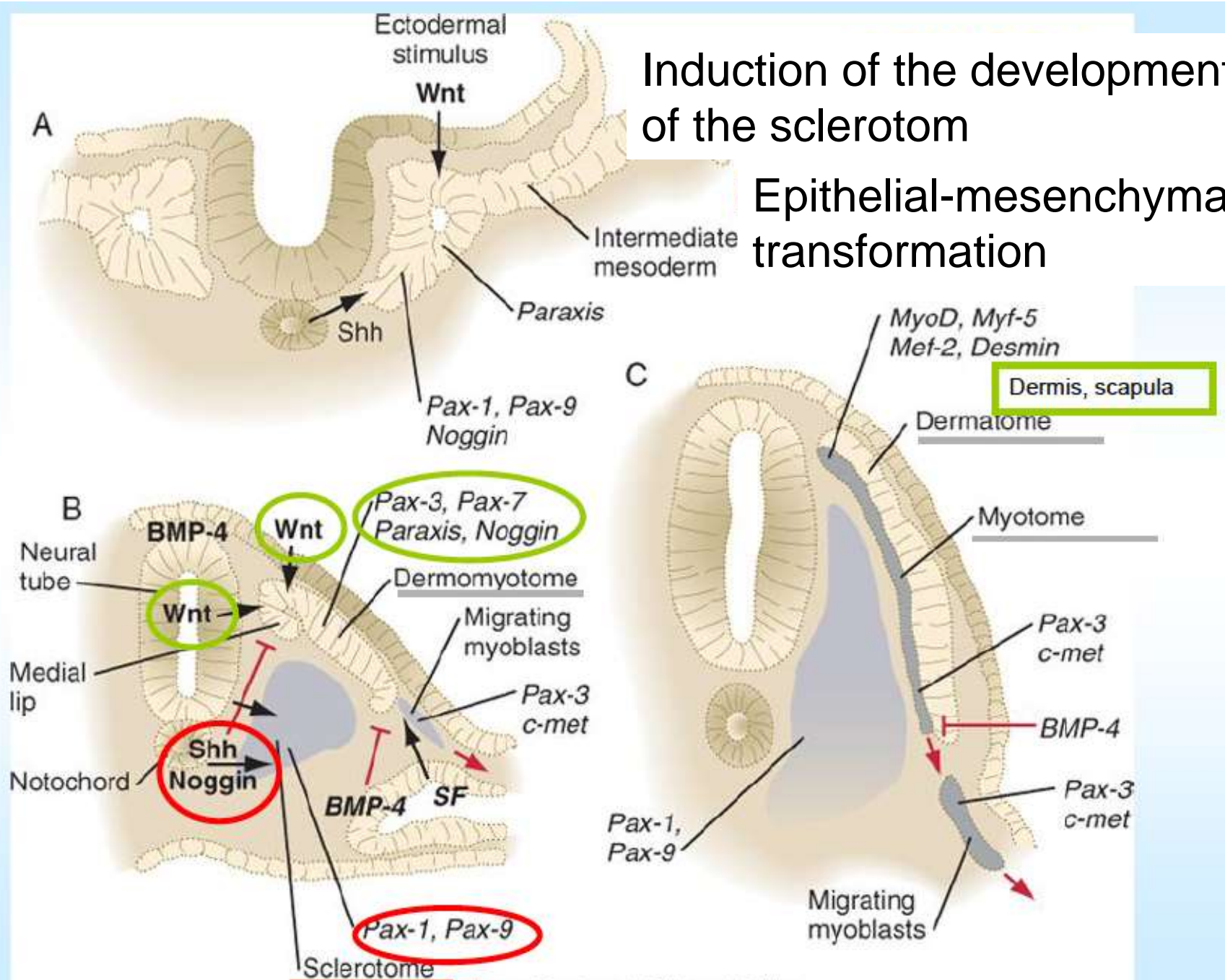
Schoenwolf et al: Larsen's Human Embryology, 4th Edition. Copyright © 2009 by Churchill Livingstone, an imprint of Elsevier, Inc. All rights reserved.



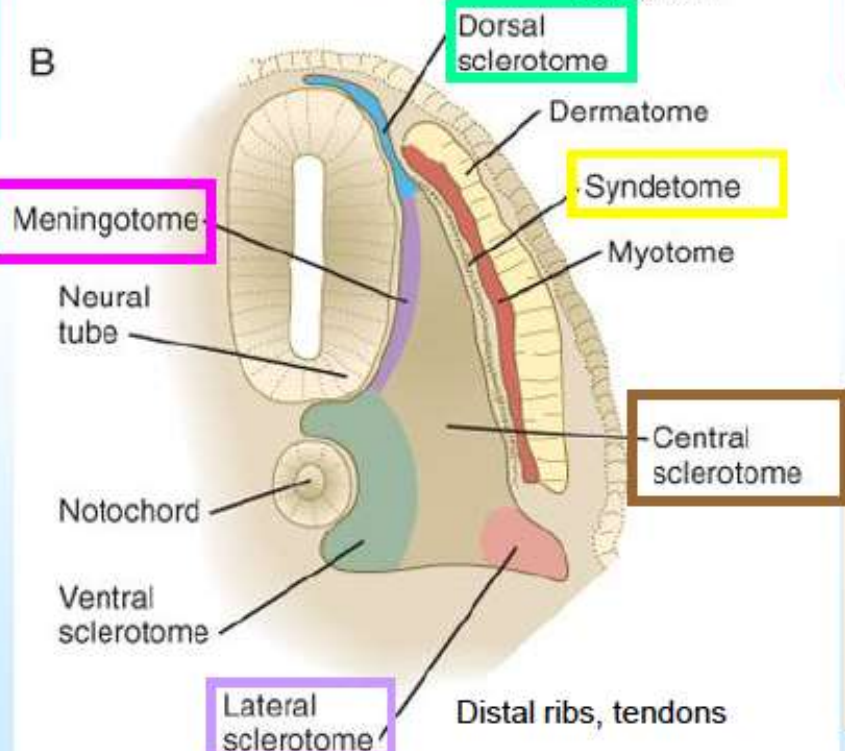
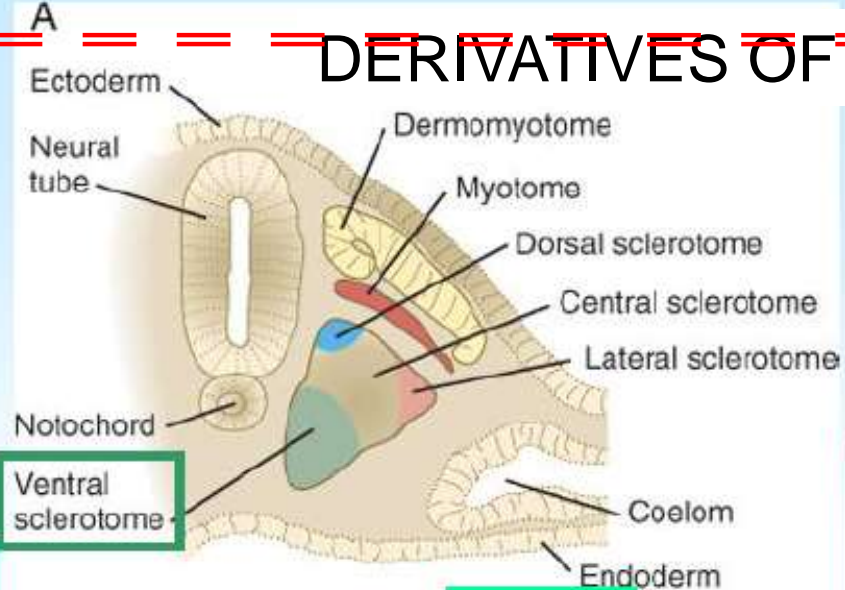


# Induction of the development of the sclerotome

## Epithelial-mesenchymal transformation



# DERIVATIVES OF THE SCLEROTOME



Vertebrae and discs

Arcus and proc.spinosus

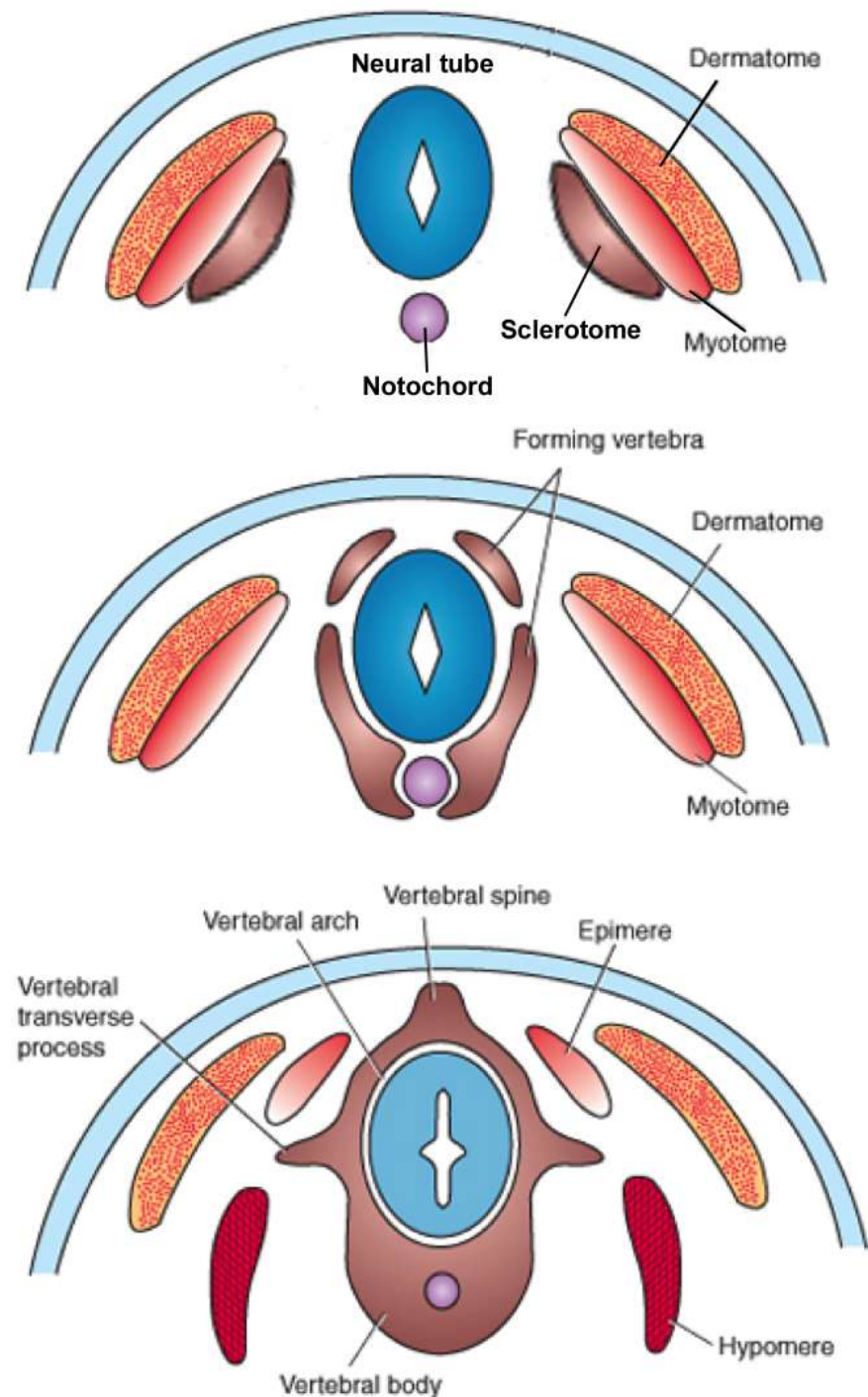
Meninges and their vessels

Meningotome

Tendo of the back muscles

Processus transversus, Proximal part of the ribs

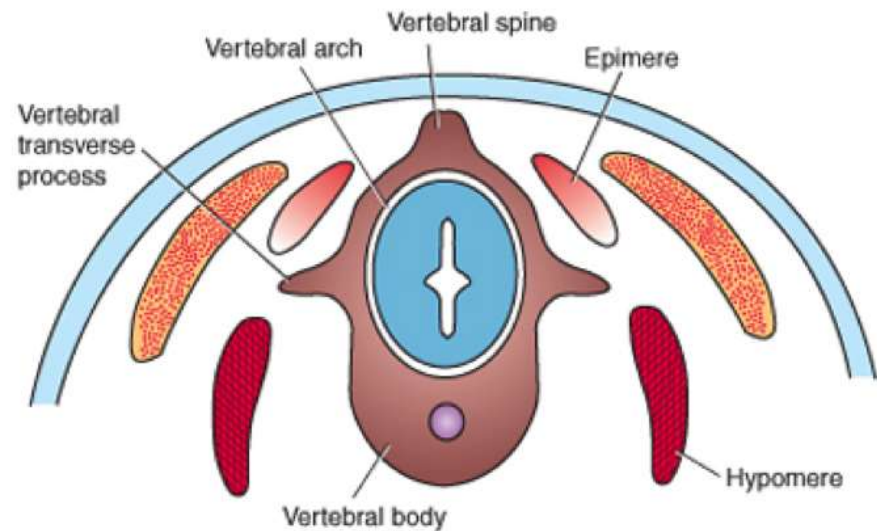
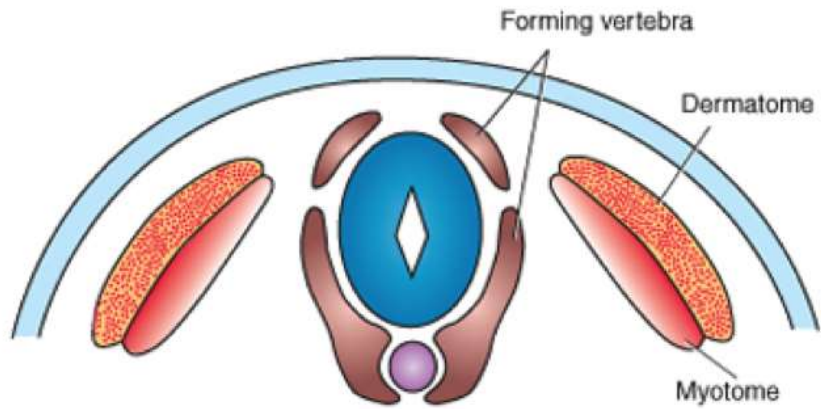
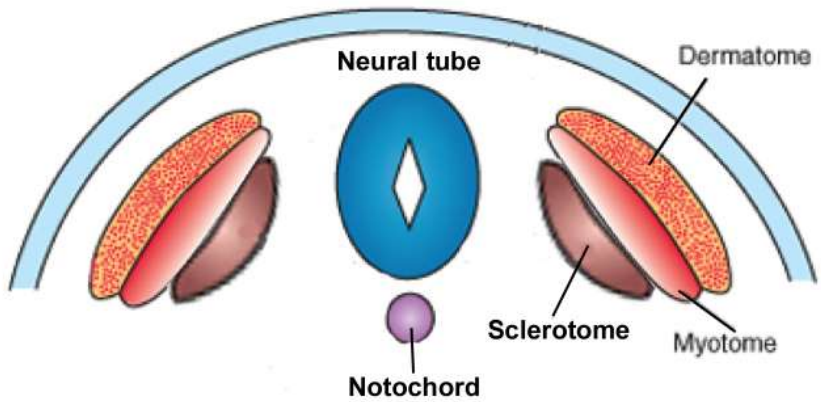




Within the Somites, three layers are separated: outside the dermatom, inside the myotome, and inside the sclerotom.

The cells of the sclerotom migrate towards medial and surrounding the chorda dorsalis and the neural tube, forming primitive vertebrae, but also the ribs and the sternum.

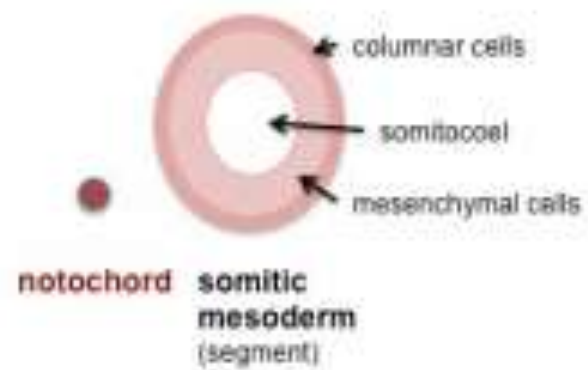
they also form the intervertebral discs and the ligaments of the spinal column.

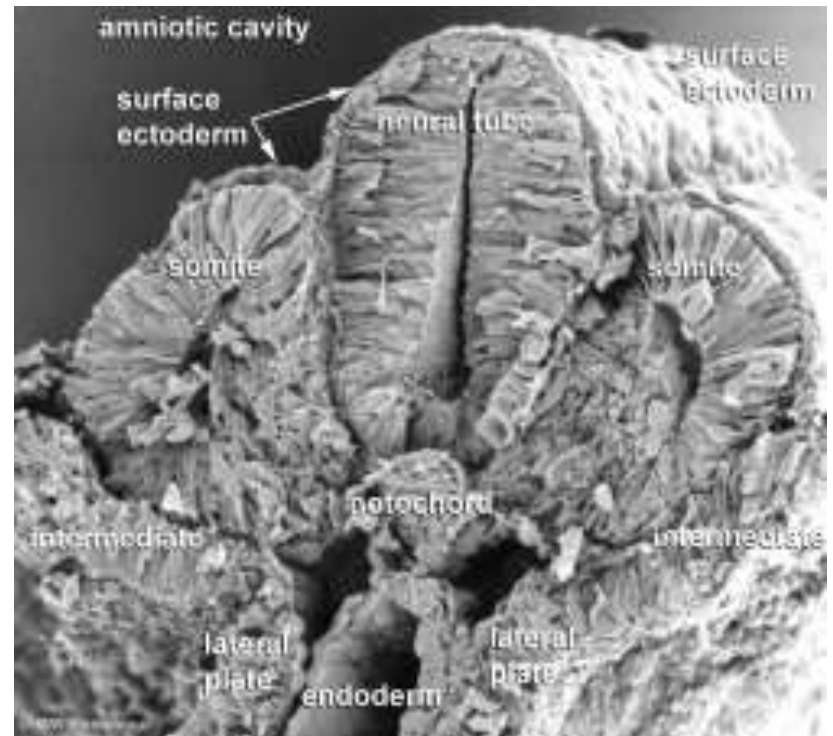
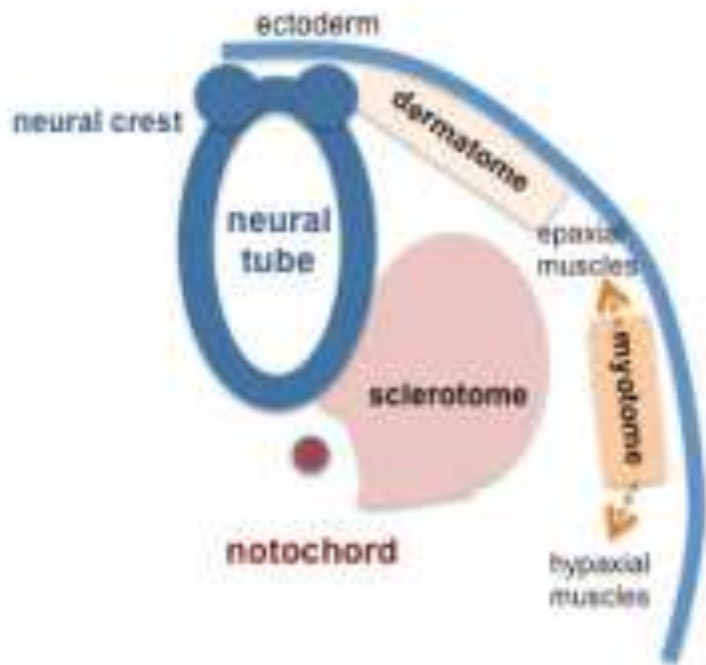


Myotomes divide.

Dorsally located epimers provide deep back muscles and sub-occipital muscles, ventral hypomeres will be the anterolateral muscle groups of the torso: neck muscles, chest muscles, abdominal muscles, limb muscles, eye and tongue muscles.

Dermatomes (or cuticles) give the connective tissue of the skin above the spine

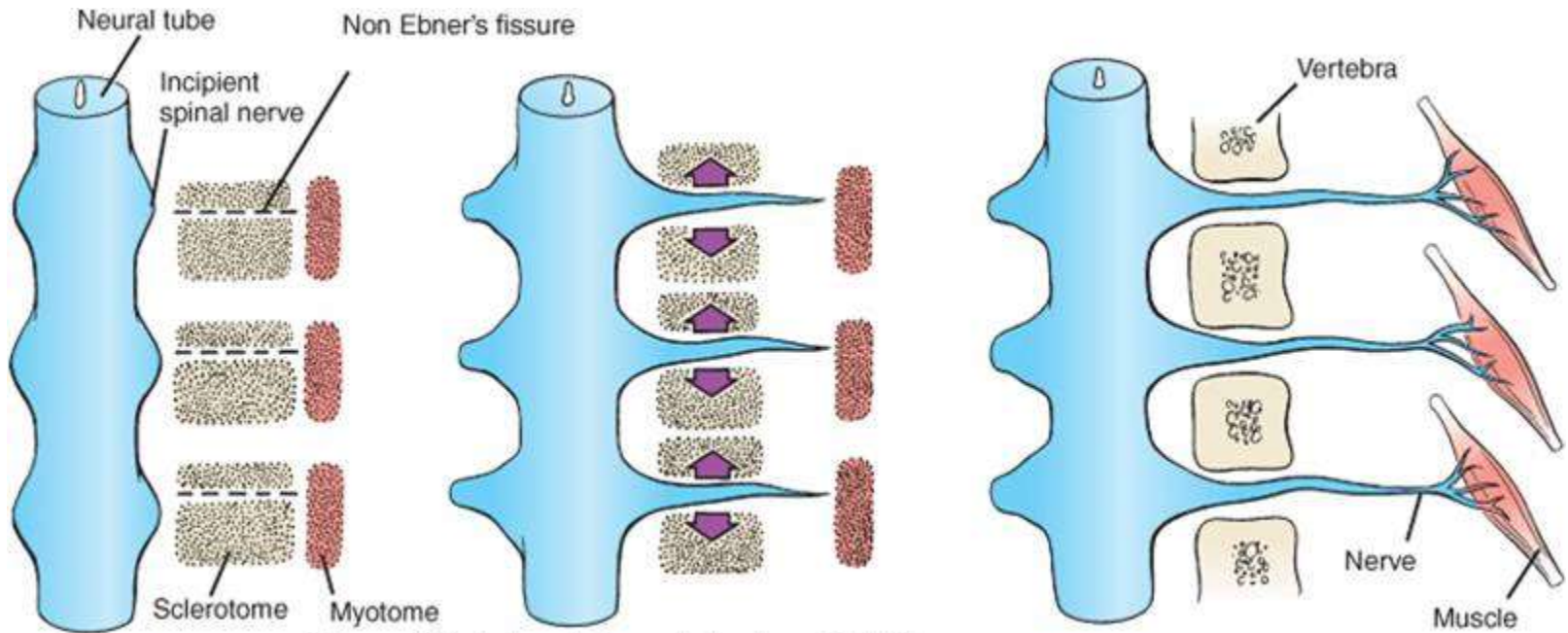
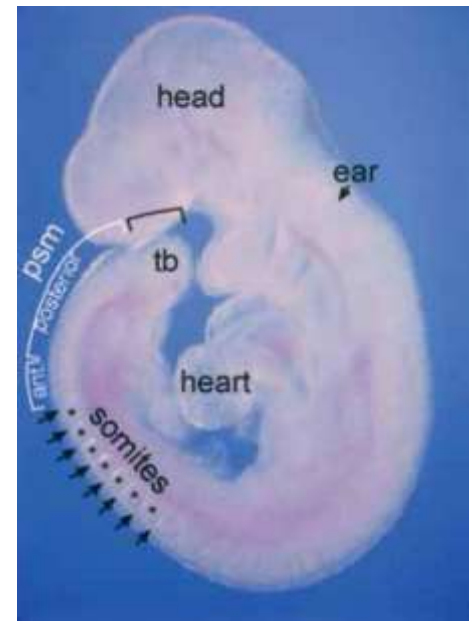




- ball forms through epithelialization and interactions (cell-cell, cell-extracellular matrix, ECM) fibronectin, laminin
- has 2 populations of cells - peripheral columnar and central mesenchymal
- early somite has cavity- somitocoel, cavity is lost during growth
- somite enclosed by ECM connected to nearby tissues



# Somites rearrangement, vertebrae formation

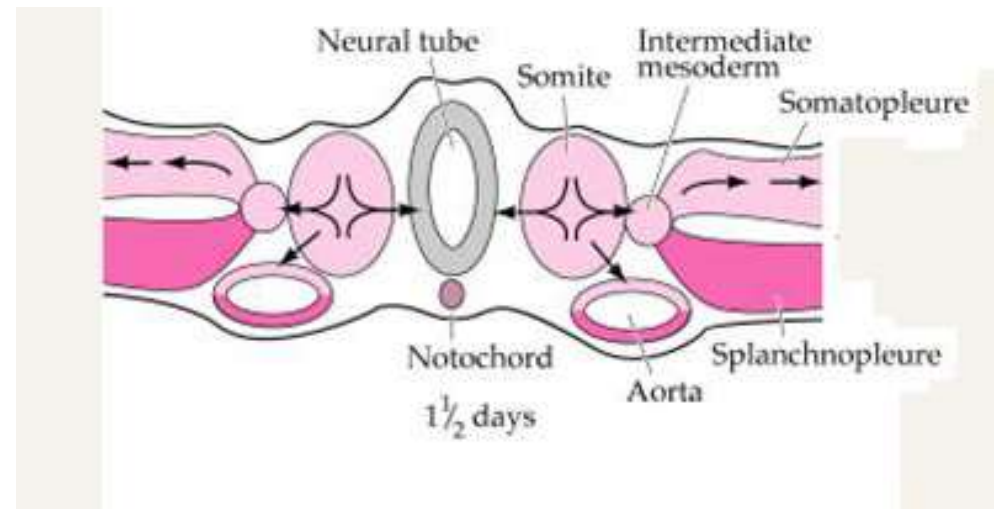
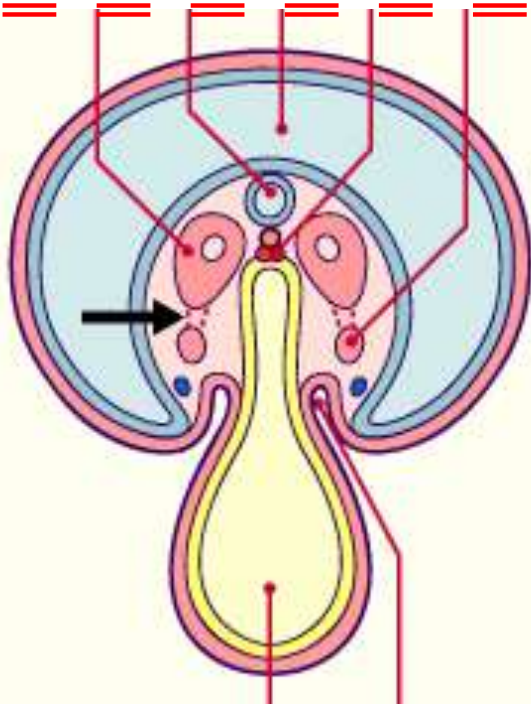


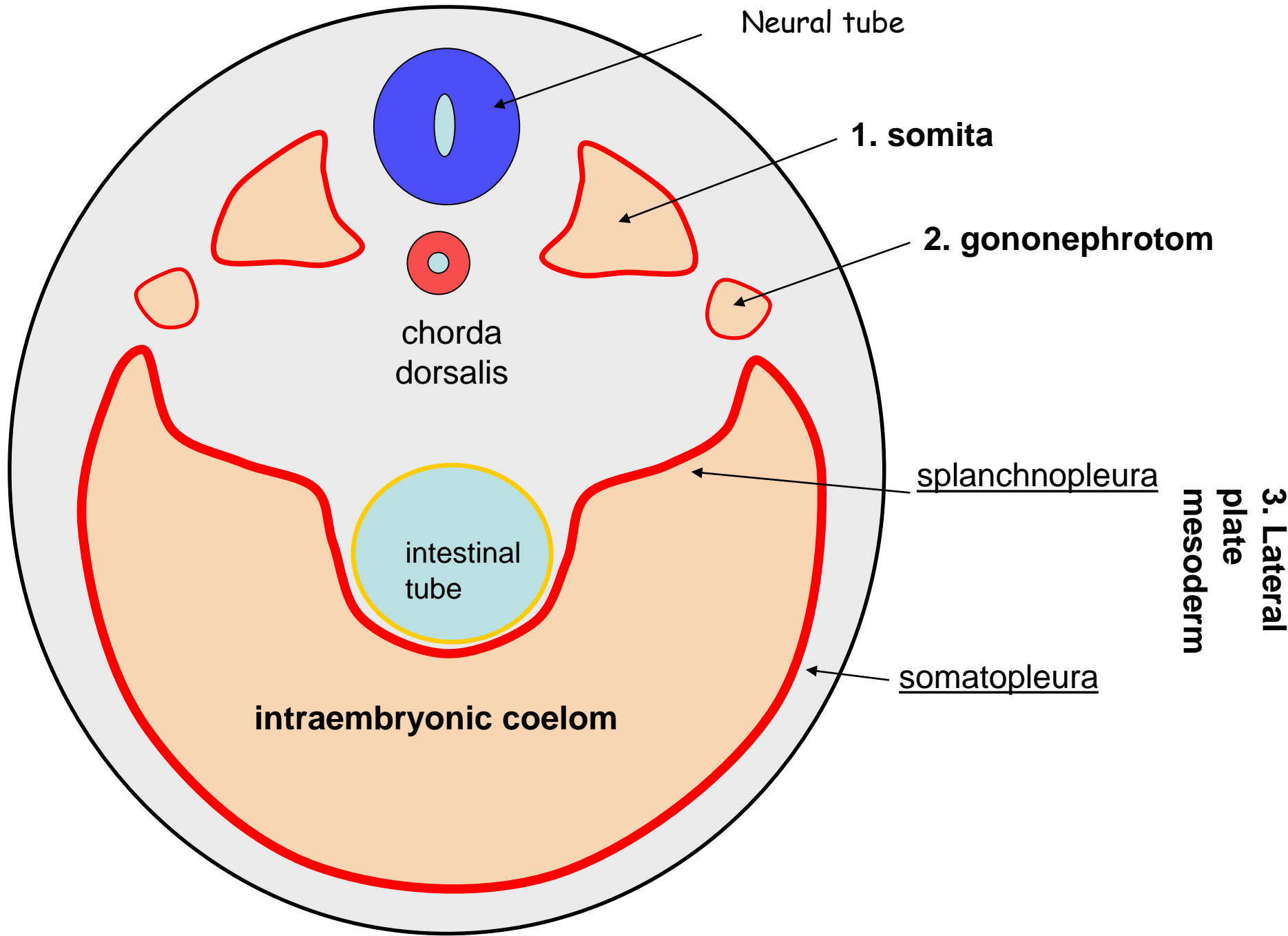
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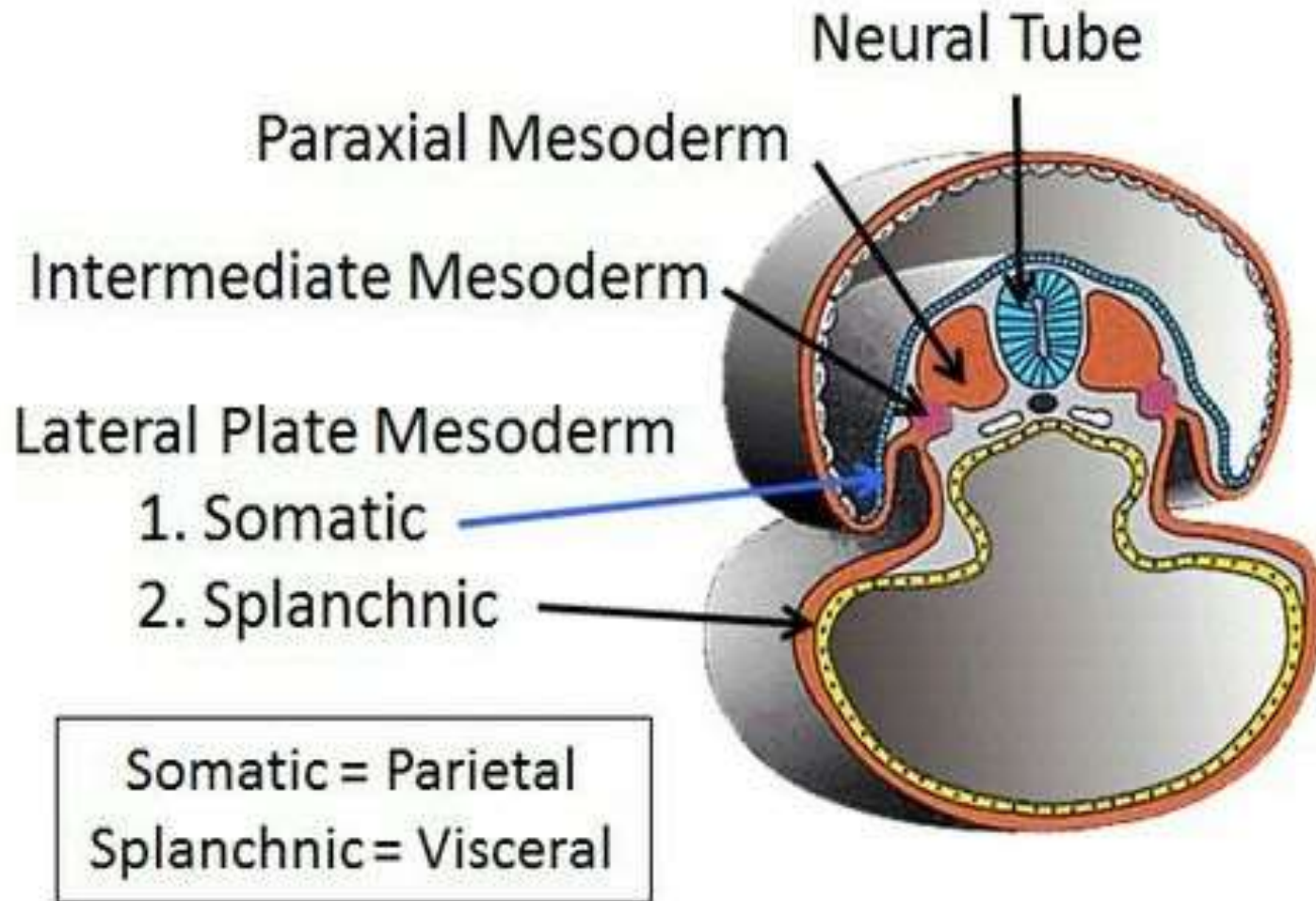
# Derivatives of INTERMEDIER MESODERM

The intermediate mesoderm or gononephrotom is the kidneys and developing gonads create it.

It is segmented down the neck and upper dorsal region to form a coherent nephrogenic bundle.



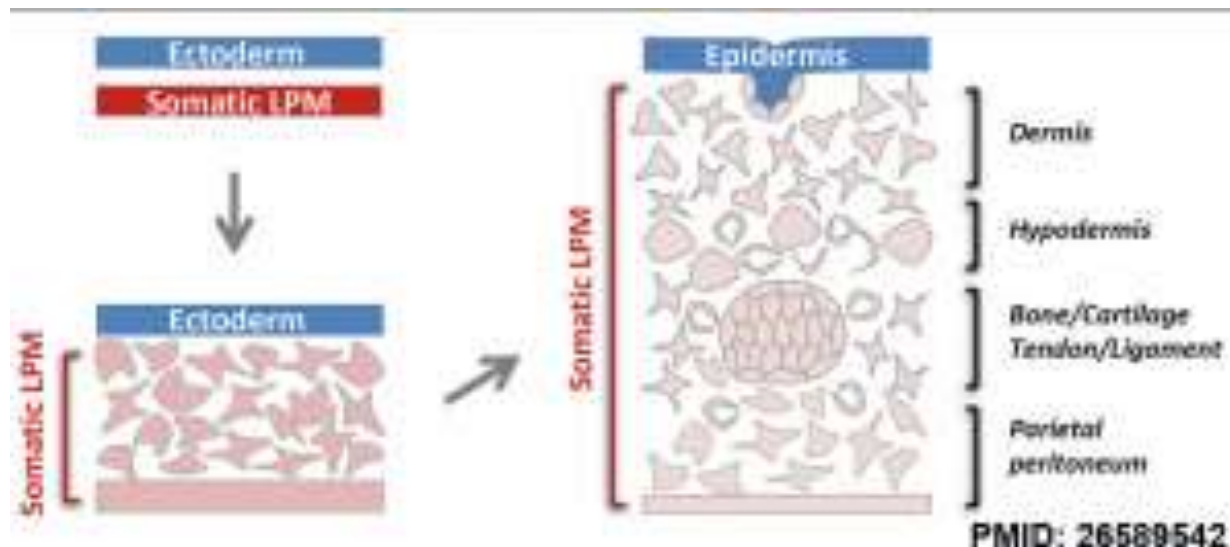






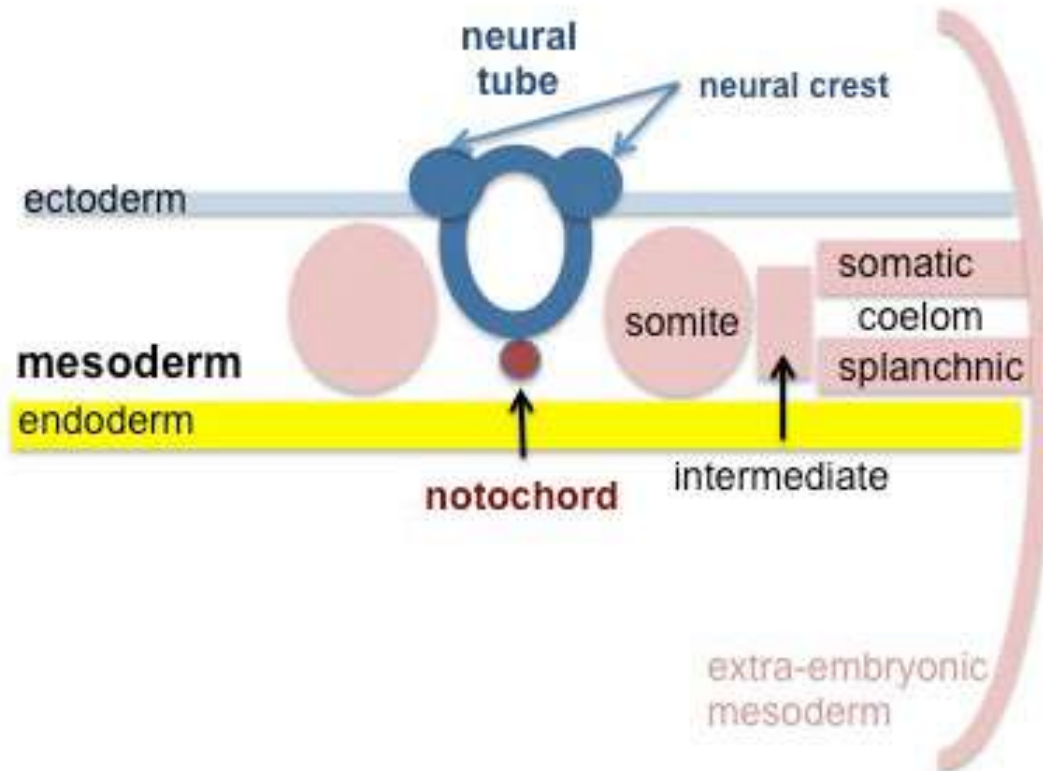
# Somatic Mesoderm

- The intraembryonic coelom divides the lateral plate into 2 portions closest to ectoderm
- body wall osteogenic, chondrogenic and fibrogenic
- except ribs and scapula

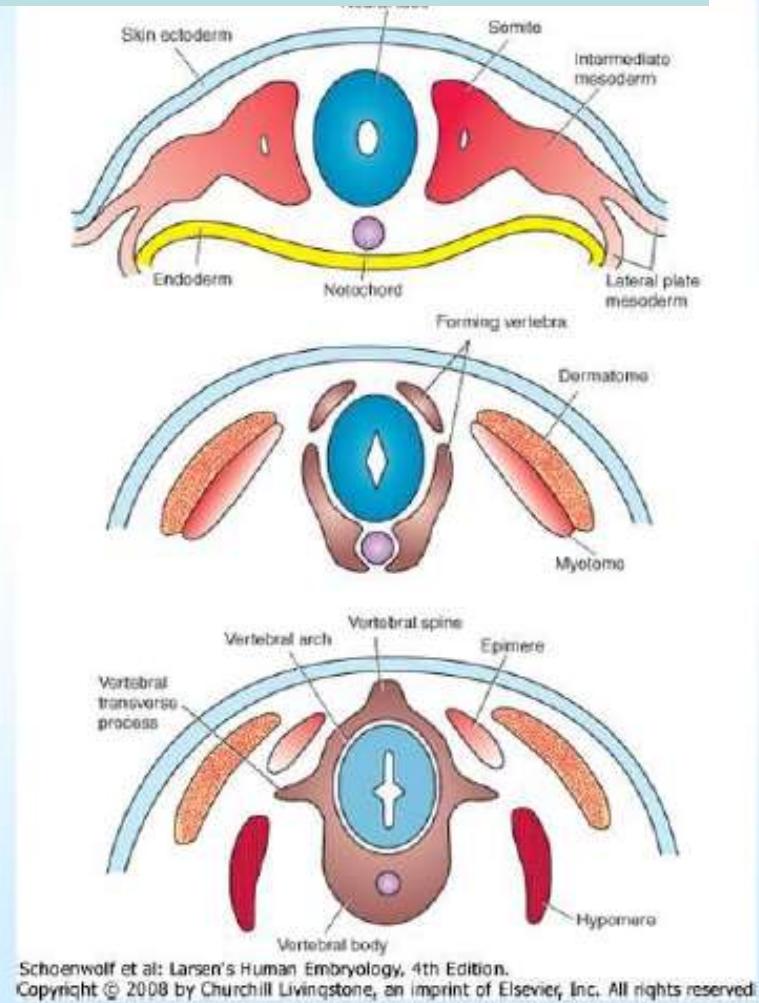
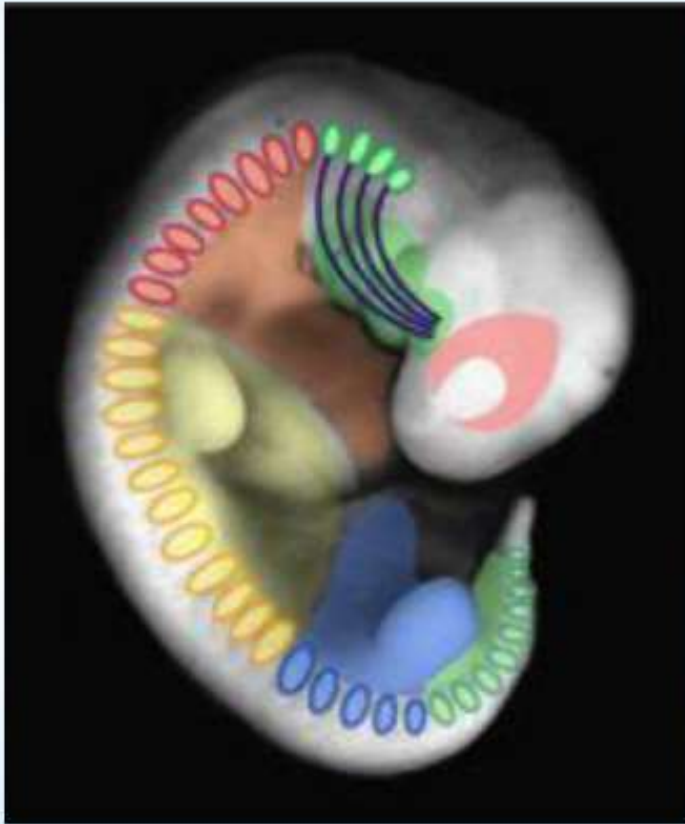


# Splanchnic Mesoderm

- lies closest to endoderm
- prechordal splanchnic mesoderm - cardiac mesoderm
- splanchnic mesoderm - smooth muscle of gastrointestinal tract (GIT) and blood vessels



# Development of limb muscle and skeletal muscle

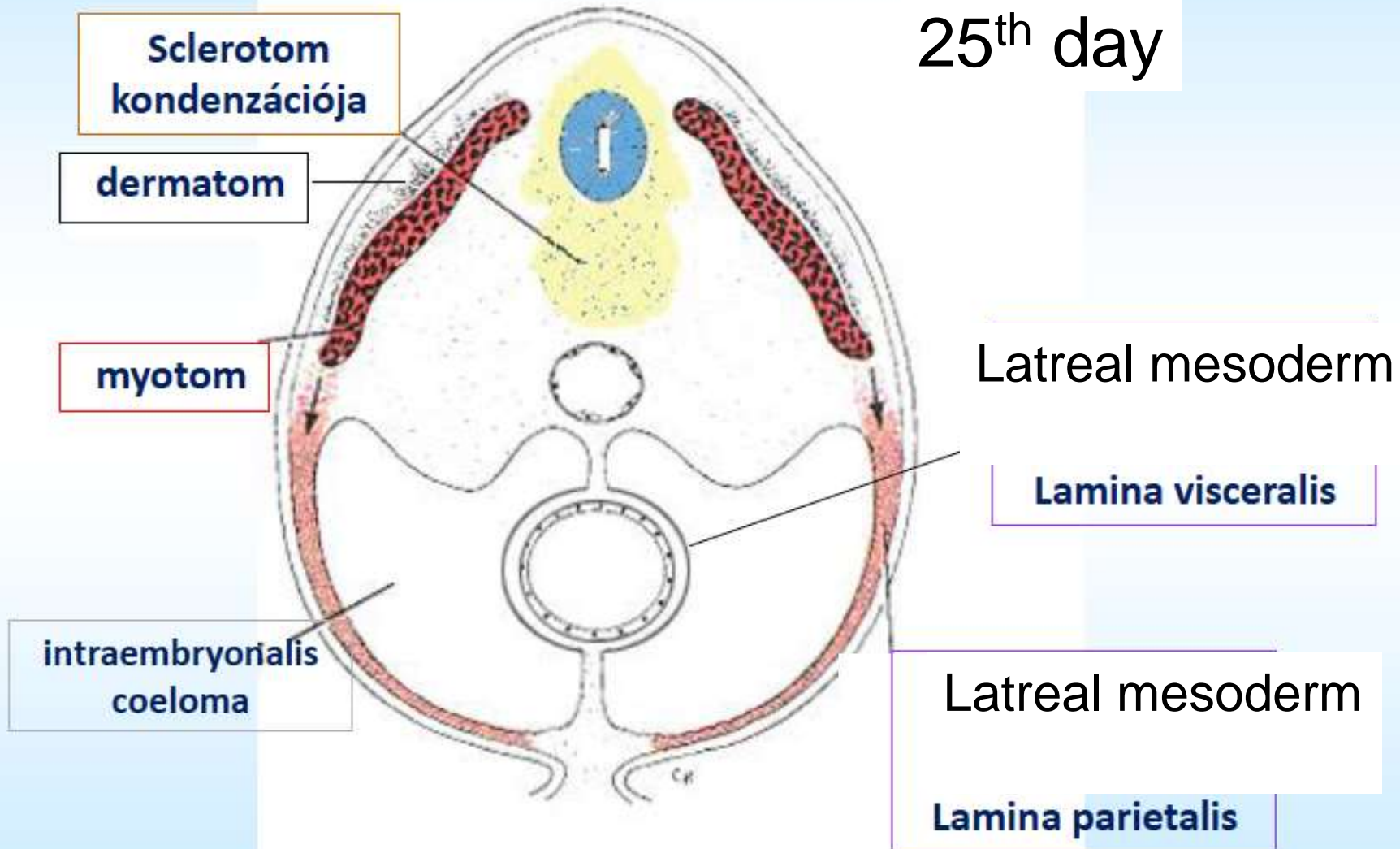


The skeletal muscles are derived from the myotome.

The smooth muscle and the heart muscle are developed from the visceral part of the lateral mesoderm

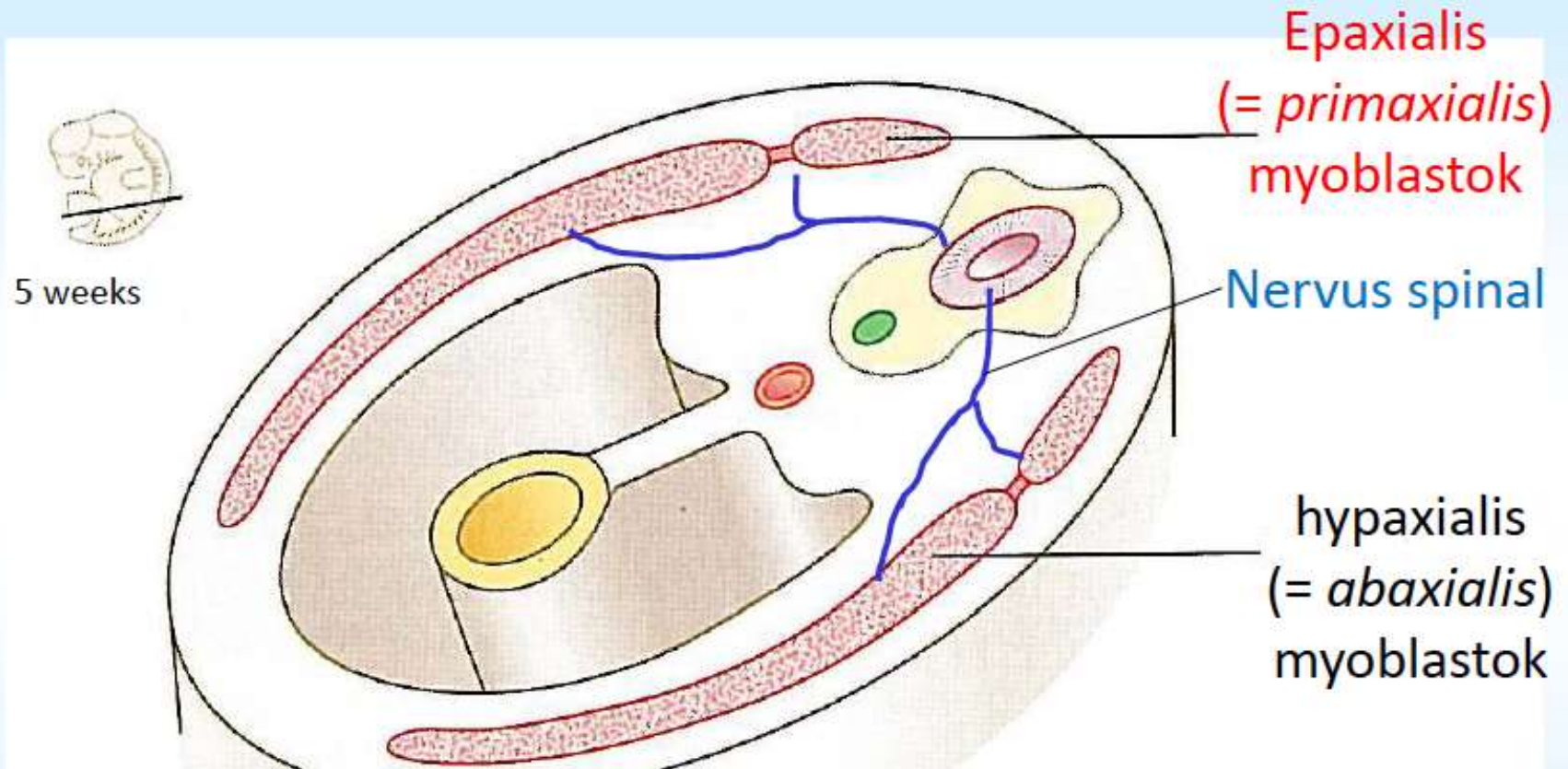
# Skeletal muscle

25<sup>th</sup> day





# Development of skeletal muscle



## Definition of **primaxial** and **abaxial**

**Primaxial:** which is within of the border

**Abaxial:** structures, which migrates toward of the lateral border

# Development of skeletal muscle

Hypaxial muscles

Extensor muscles of the limb

Flexor muscles of the limb

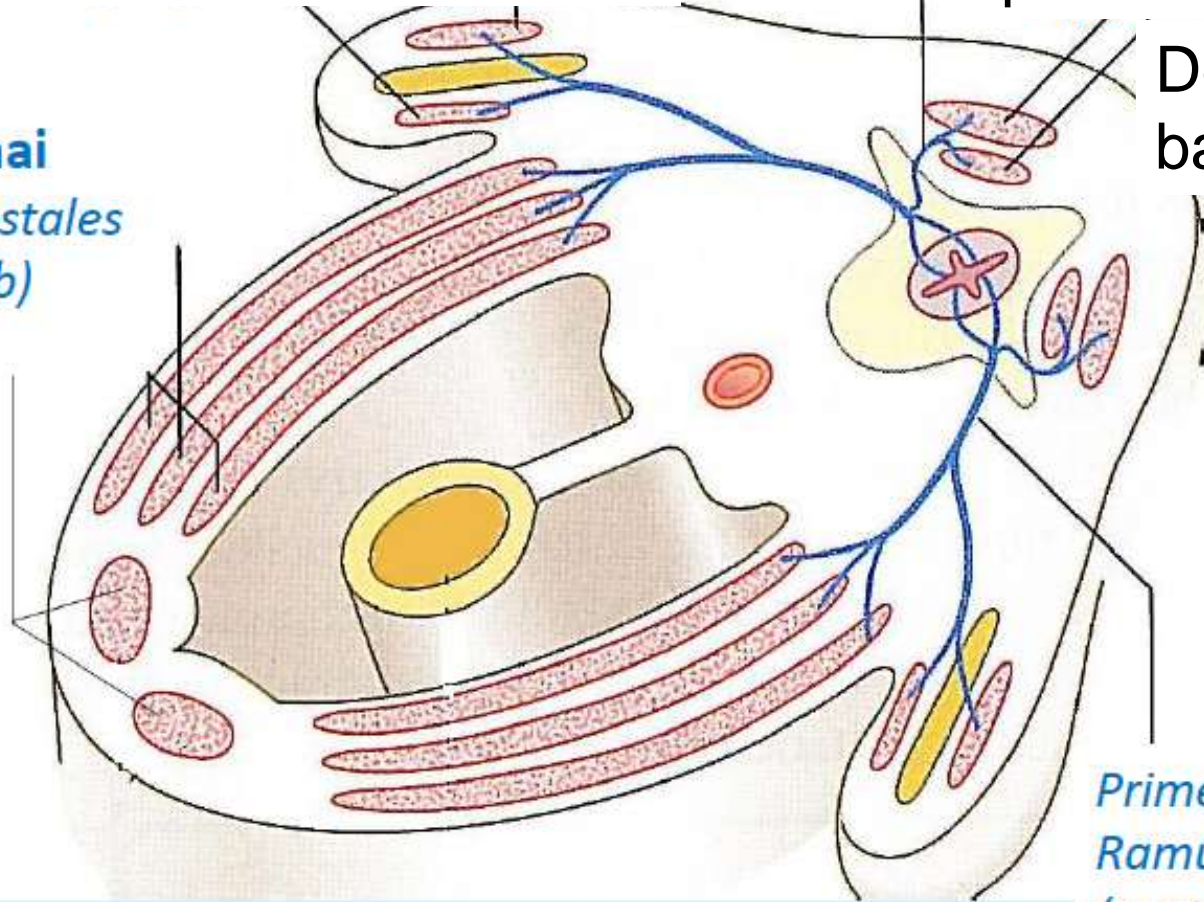
Primer

Ramus dorsalis (n. spin.)

Epaxial muscles

Deep back muscle

Törzsfal izmai  
(mm. intercostales  
hasizmok, stb)



Primer

Ramus ventralis  
(n. spin.)





**Mesoderma**

Axialis	Chorda dorsalis	<ul style="list-style-type: none"><li>• Nucleus pulposus (discus intervertebralisban)</li><li>• Lig. apicis dentis</li></ul>
Paraxialis	Sklerotom	<ul style="list-style-type: none"><li>• Vertebrae, ribs</li><li>• Anulus fibrosus (discus intervertebralisban)</li></ul>
	Dermatom	<ul style="list-style-type: none"><li>• Connective tissue of the dermis and hypodermis of the back</li></ul>
	Myotom	<ul style="list-style-type: none"><li>• Skeletal muscles:<ul style="list-style-type: none"><li>Deep back muscles (m.erector spinae) (Epimer)</li><li>Neck muscles (Hypomer)</li><li>Muscles of the lateral and ventral trunk (Hypomer)</li><li>Muscles of the limbs (Hypomer)</li><li>Diaphragm (from the C4 myotom)</li><li>Muscles of the tongue</li><li>External muscles of the eye</li></ul></li></ul>
Intermedier		<ul style="list-style-type: none"><li>• Kidneys and gonads (se)</li></ul>



Oldallemezek

Visceral part  
of the  
Splanchnopl.

- Heart, vessels and blood cells
  - Suprarenal gland
- Visceral part of the serous membranes  
(pericard, pleura, peritoneum)

Digestive and respiratory systems: connective  
tissue, cartilage, vessels and smooth muscles

Parietal part  
of the  
Splanchnopl.

Cortex of the suprarenal gland  
Parietal part of the Pericard, pleura and peritoneum  
Lims: cartilage, bones, connective tissue

intra-  
embryonalis  
coeloma

Cavities of the serous membranes: Cavum pericardii,  
Cavum pleurae and Cavum peritonei

Thank you for your attention!

