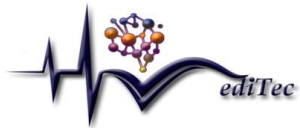




Co-funded by the
Erasmus+ Programme
of the European Union



Training for students
1.-15.9.2019 Košice, Slovakia

EMBRYOLOGY

Prof. MUDr. Eva Mechírová, CSc.

Developmental processes

- ✓ **proliferation** - mitotic division
- ✓ **differentiation** – specialization of cells
- ✓ **migration** – genetically regulated
- ✓ **induction** – interaction between the cells
- ✓ **growth** - heredity and environment
- ✓ **morfogenetic death** of the cells- apoptosis

Apoptosis - is a genetically regulated process of cell death, in the process of normal cell growing and differentiation

- is characterized by condensation of chromatin and fragmentation of DNA
- the cell is phagocytosed without inflammatory reaction

Ontogenetic development – prenatal period:

1. Embryonic period - (1. – 8. week of development)

a/ blastogenesis: 1. – 2. week of development

- zygote - 1. day
- morula - 3. – 4. day
- blastocyst - 5. – 7. day
- embryonic disc - 8. – 14. day

b/ early organogenesis: 3. – 8. week

embryo



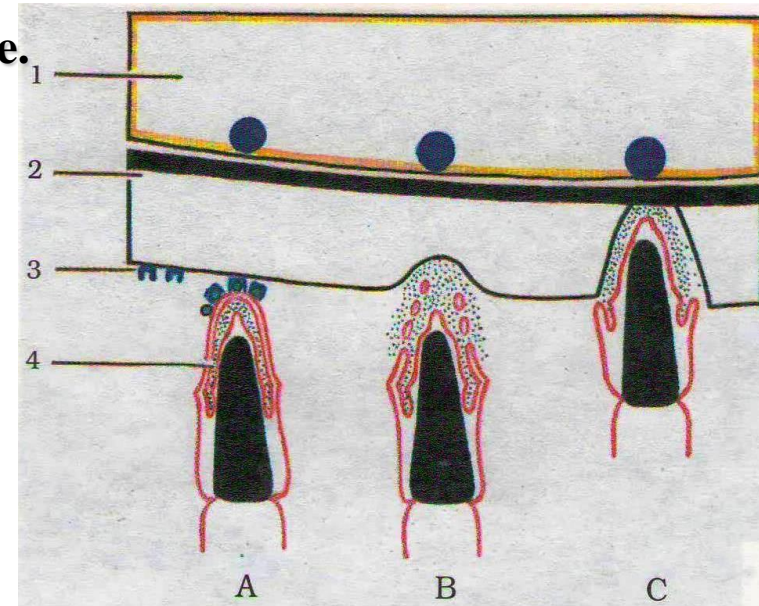
2. Fetal period - 9. – 40. week - organogenesis and histogenesis

fetus

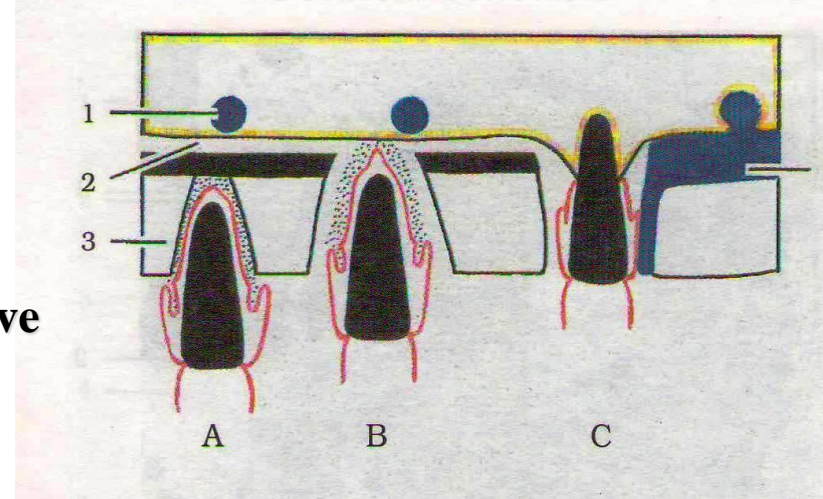
FERTILIZATION

1. **Capacitation**-glycoproteins removed from the surface of sperm cell membrane and proteins from acrosome.
2. The sperm acrosome releases **hyaluronidase** and passes through corona radiata – **acrosome reaction**.
3. Acrosome releases **acrosin** and penetrate zona pellucida – **end of acrosome reaction**.
4. The sperm contacts oolema.
5. Secondary oocyte stops the entry of more sperms- **cortical reaction** – completes second meiotic division and gives rise to female pronucleus.
6. The sperm enters the oocyte, head forms male pronucleus and the tail degenerates.
7. Male and female pronucleus fuse together and give rise to a new diploid cell **ZYGOTE**, primordium of a new human being with 46 chromosomes.

Acrosome reaction



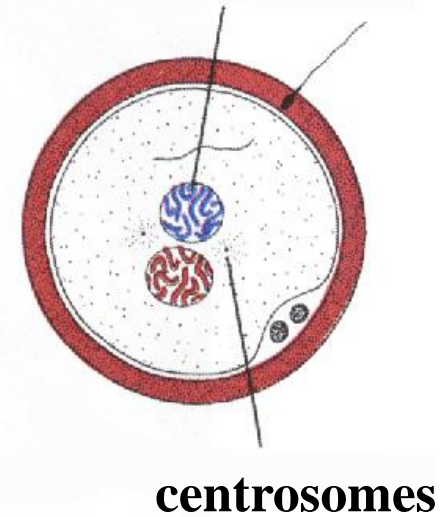
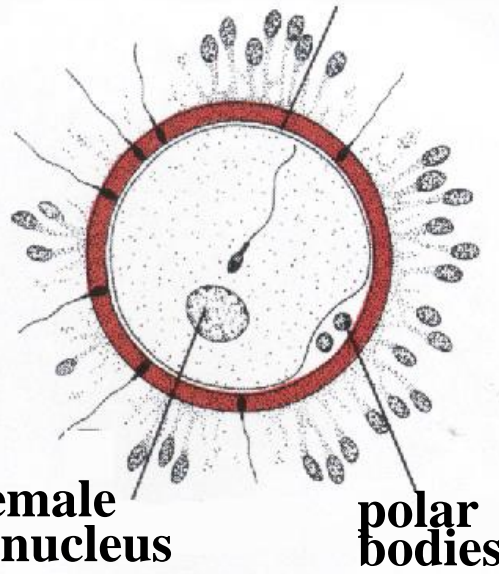
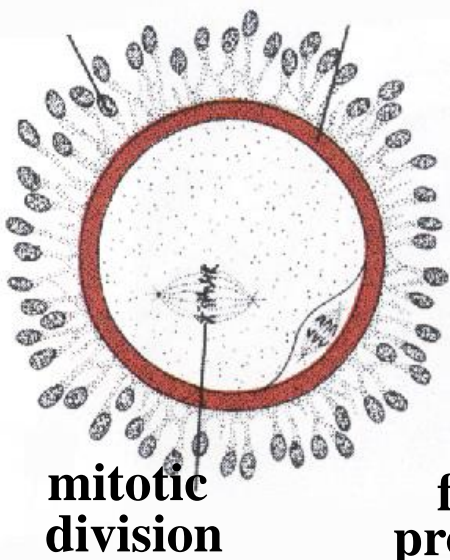
Cortical reaction



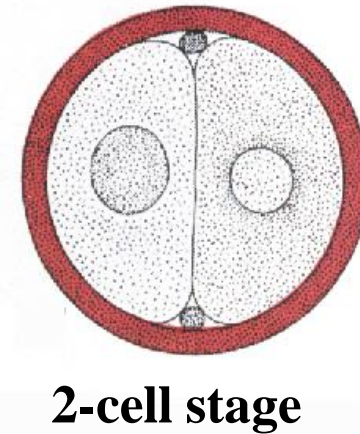
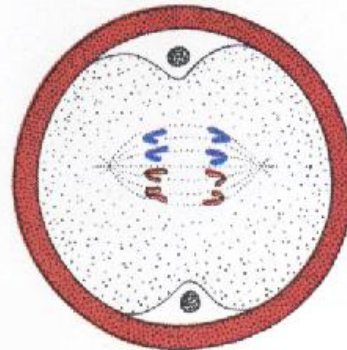
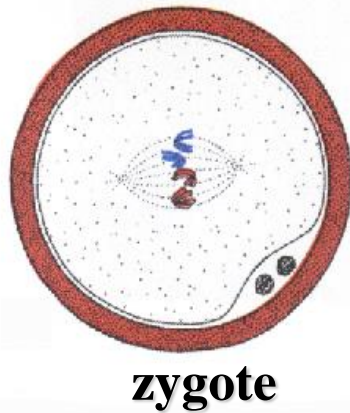
corona radiata

zona pellucida

male pronucleus



1.-2. day

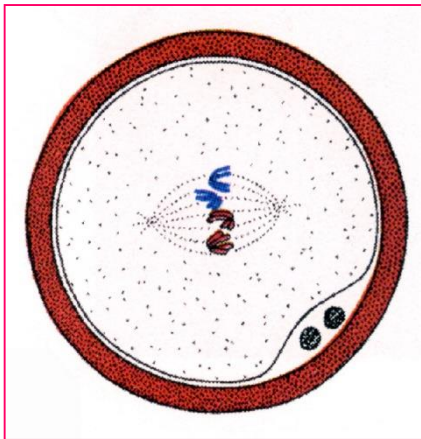


Zygote, surrounded by zona pellucida, start the cleavage 30 hours after fertilization

Cleavage - mitotic division of zygote - blastomeres

- **First division 30 hours after fertilization in the uterine tube – 2 blastomeres**
- **Blastomeres in next divisions are step by step smaller (half size)**

Zygote



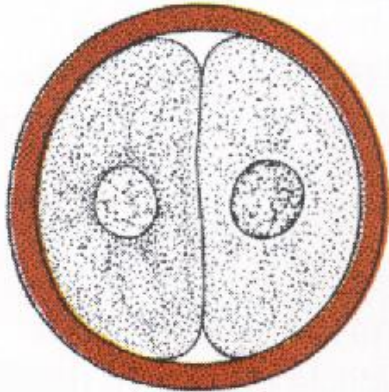
2-cell stage



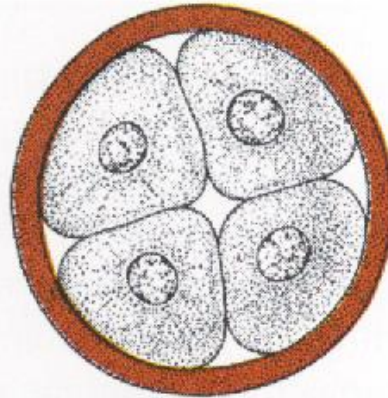
4-cell stage



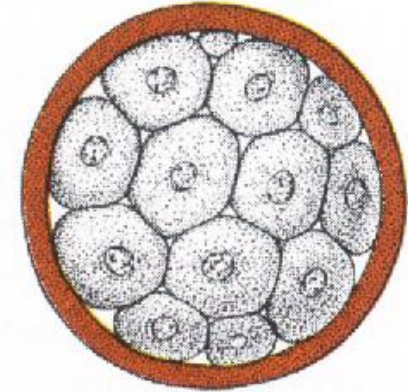
**2-cell stage
(blastomeres)**



4-cell stage



**morula
(16 and more blastomeres)**

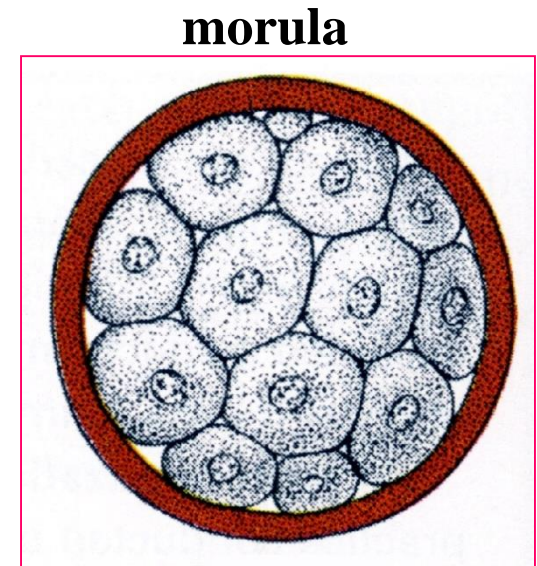


Cleavage — in the uterine tube

3. day

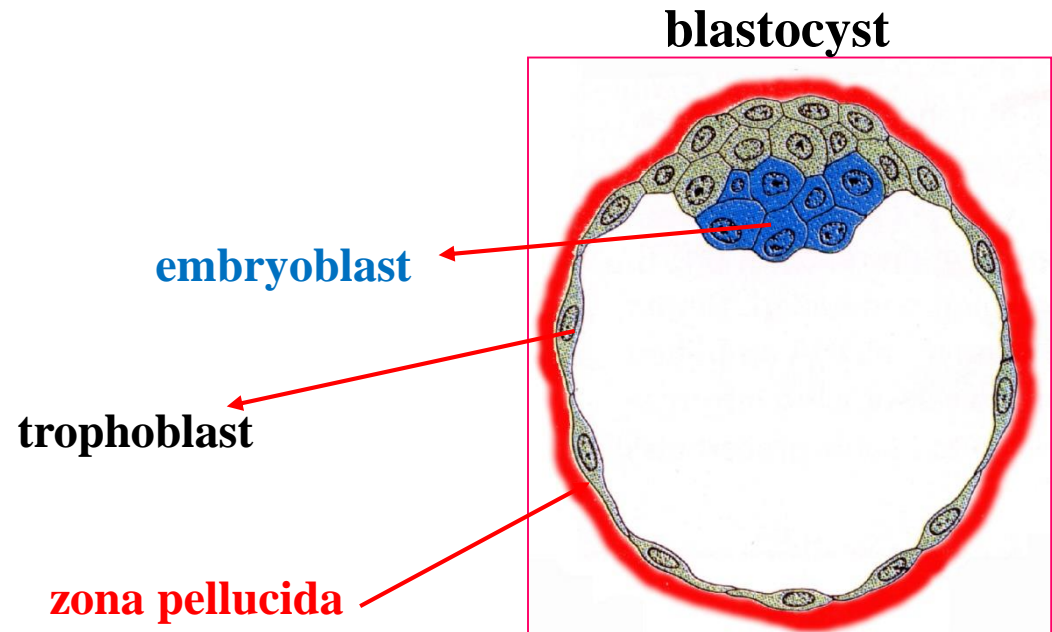
Morula

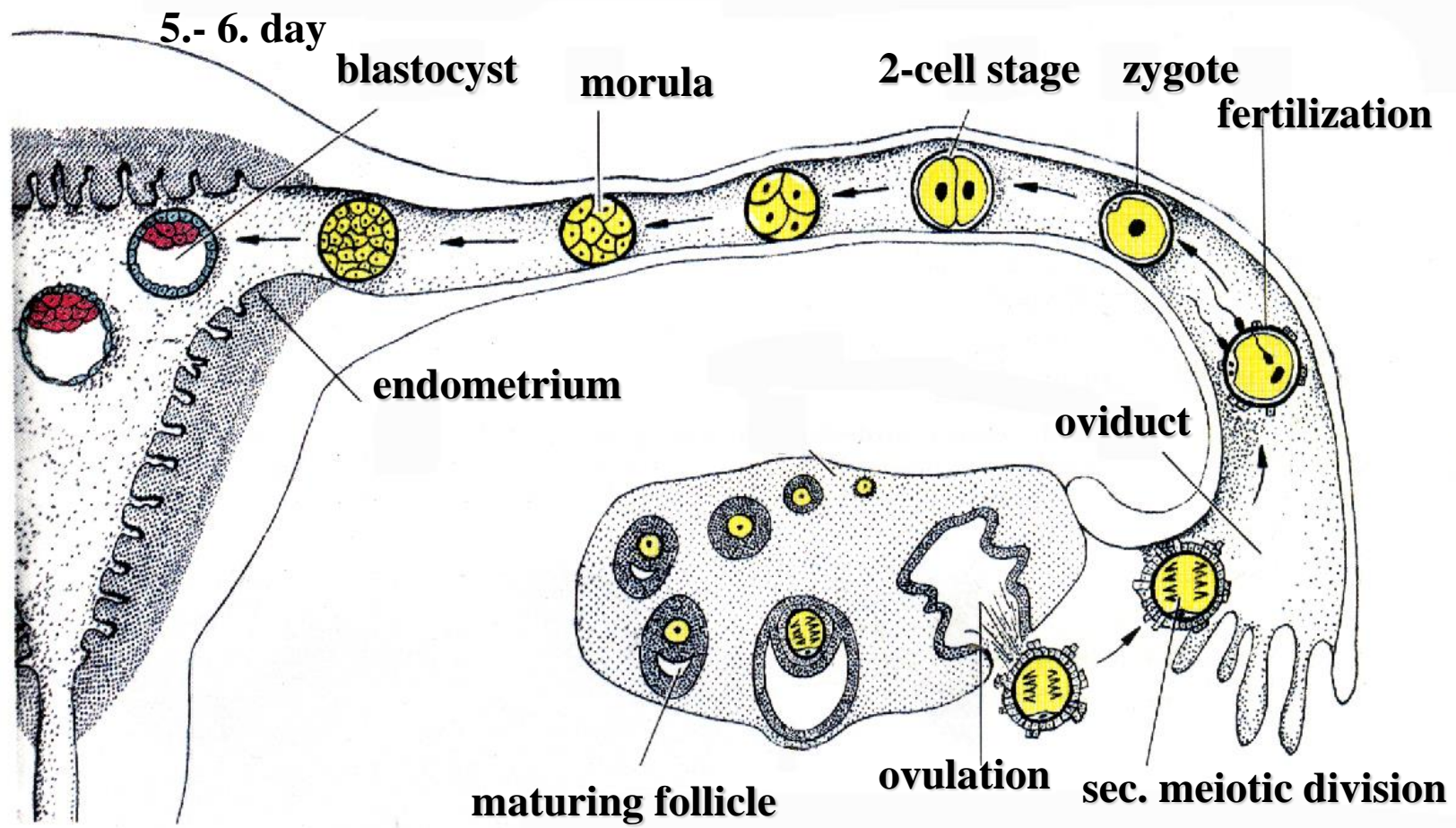
- 16 blastomeres
- zona pellucida on the surface protects against embedding
- morula passes down the uterine tube 75-80 h
- in the uterus the cells of morula rapidly divide, between them the cavity occurs and the blastocyst give rise



Blastocyst

- 60 cell stage
- ball-like structure with a cavity
- outer cell lining– **trophoblast**
- inner cell mass – **embryoblast**
- zona pellucida



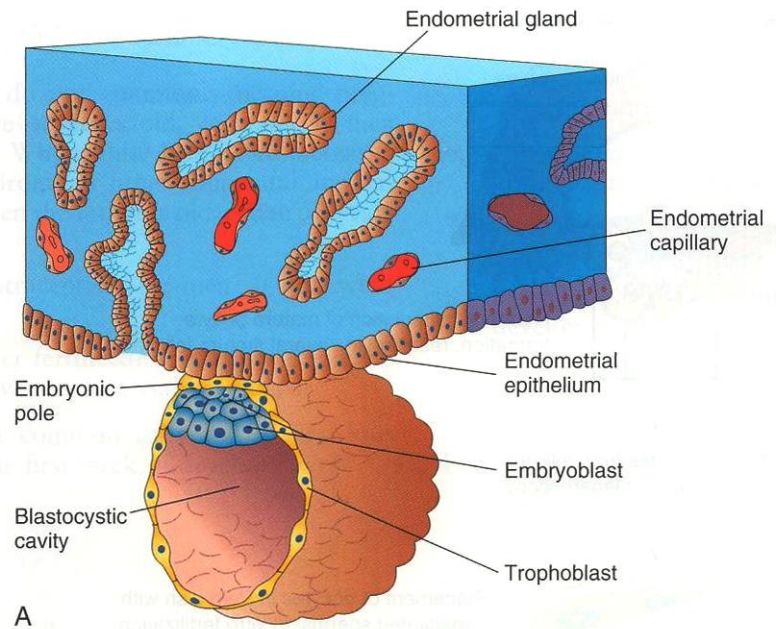


Cleavage and passage of fertilized oocyte through the uterine tube

Implantation

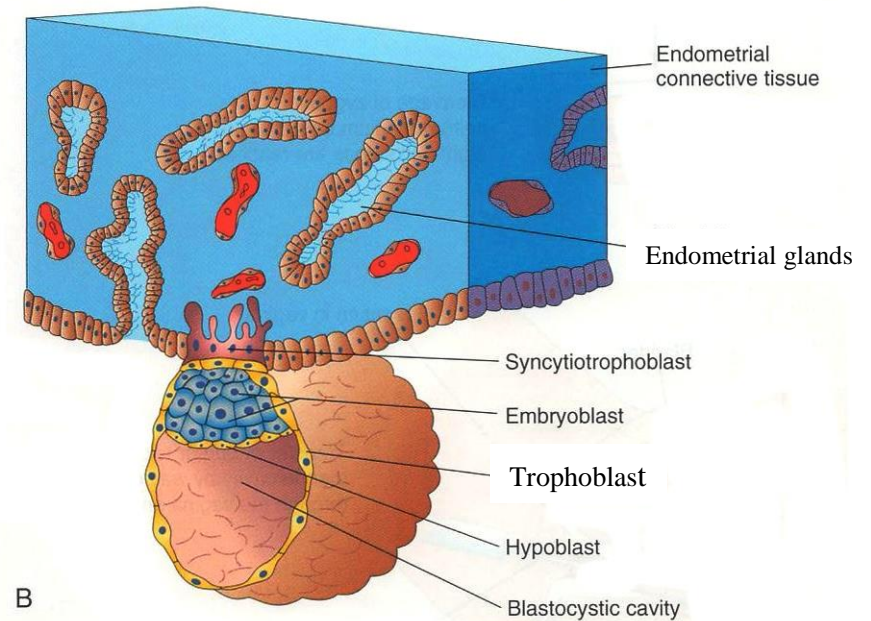
6. day

Attachment of blastocyst to the endometrial epithelium – embryonic pole.



7. day

Trophoblast has penetrated the epithelium and has started to invade the connective tissue of endometrium.

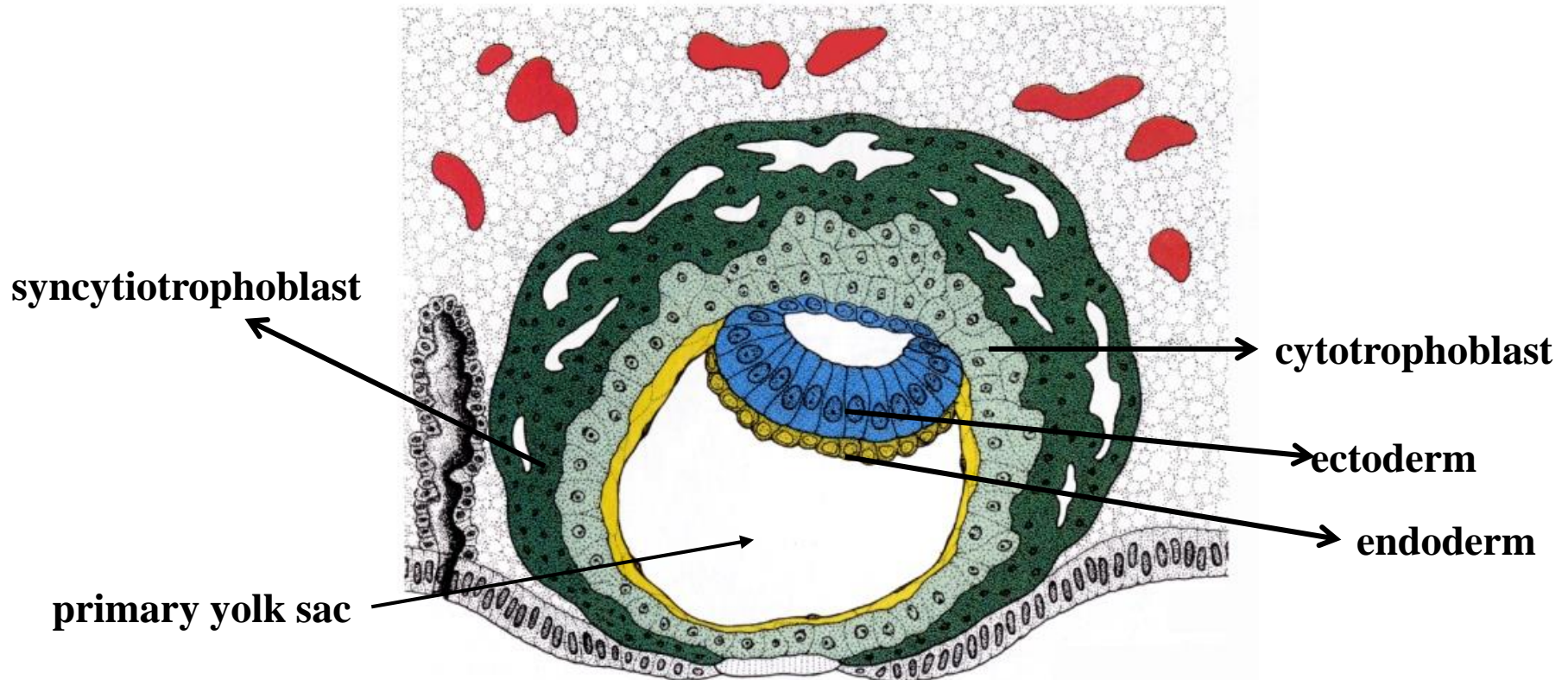


8. day

Trophoblast has divide into syncytiotrophoblast and cytotrophoblast

Embryoblast has divide into ectoderm (**epiblast**) and endoderm (**hypoblast**)

-2 embryonic germ layers – **embryonic disc**

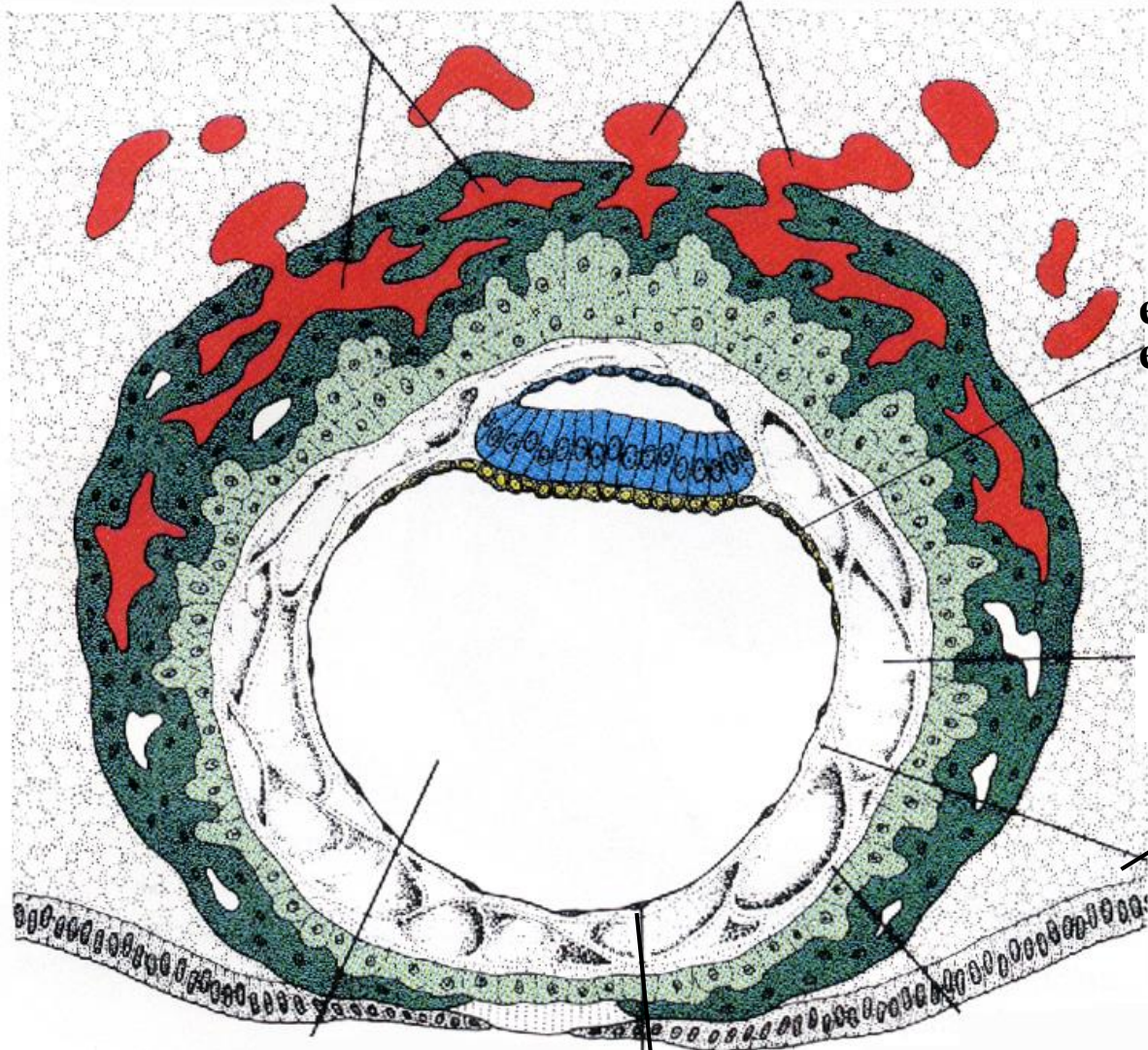


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lacunae

blood capillaries

10.day



extraembryonic endoderm

extraembryonic mesoderm

yolk sac or umbilical vesicle

extraembryonic endoderm

13.day

Primary yolk sac decreases in size. Formation of primary chorionic villi. Extraembryonic mesoderm is split into splanchnic and somatic.

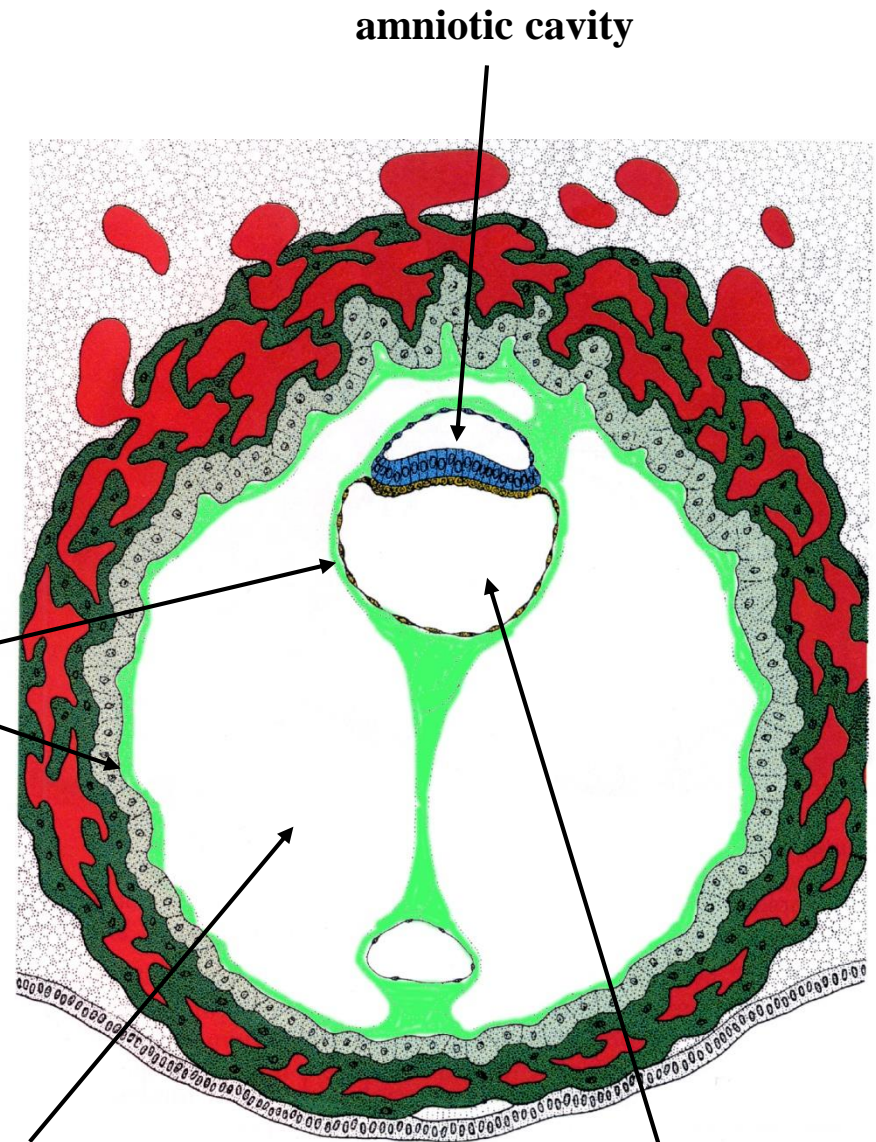
splited extraembryonic mesoderm

14.day

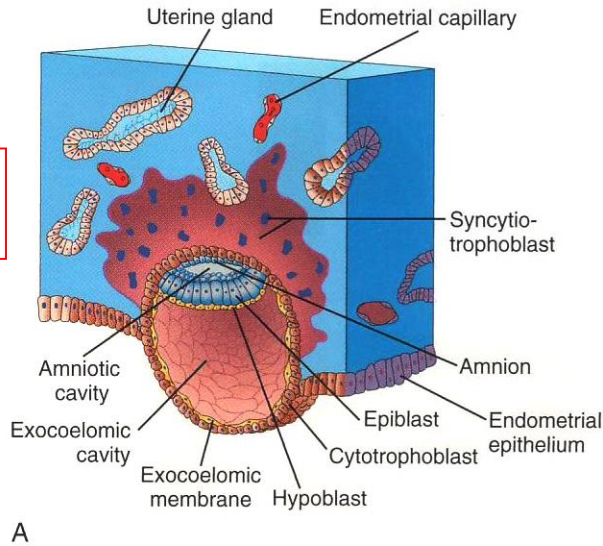
Formation of secondary yolk sac - secondary umbilical vesicle.

extraembryonic coelom

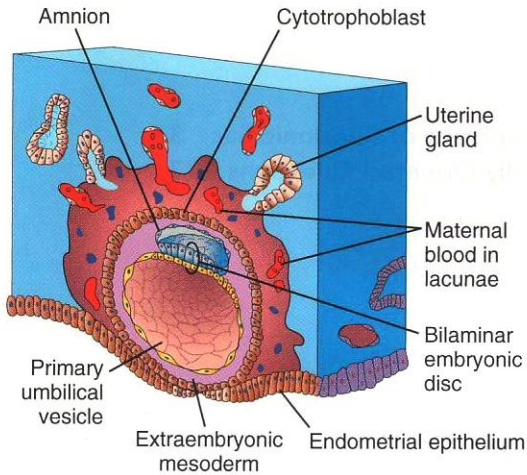
secondary yolk sac



8. day

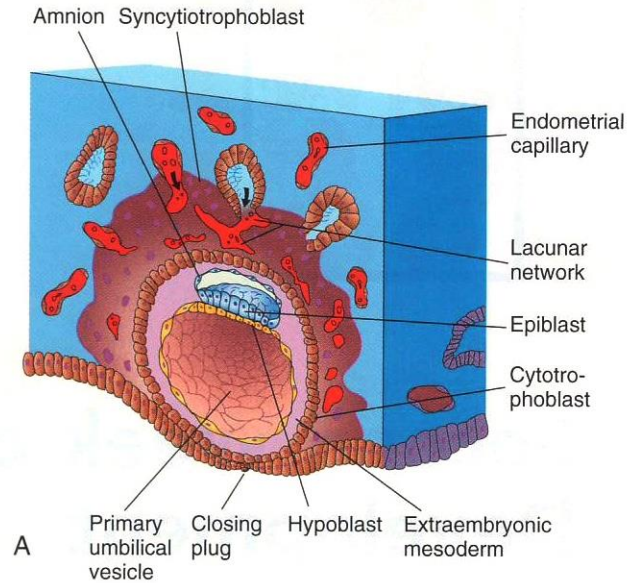


9. day

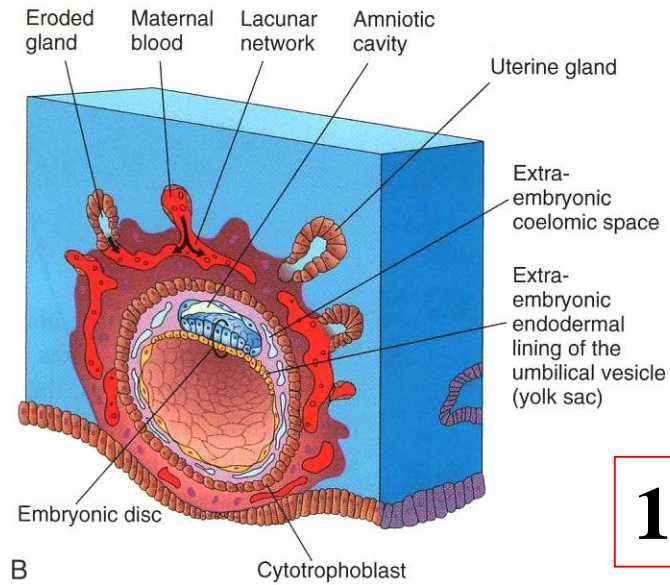


Summary

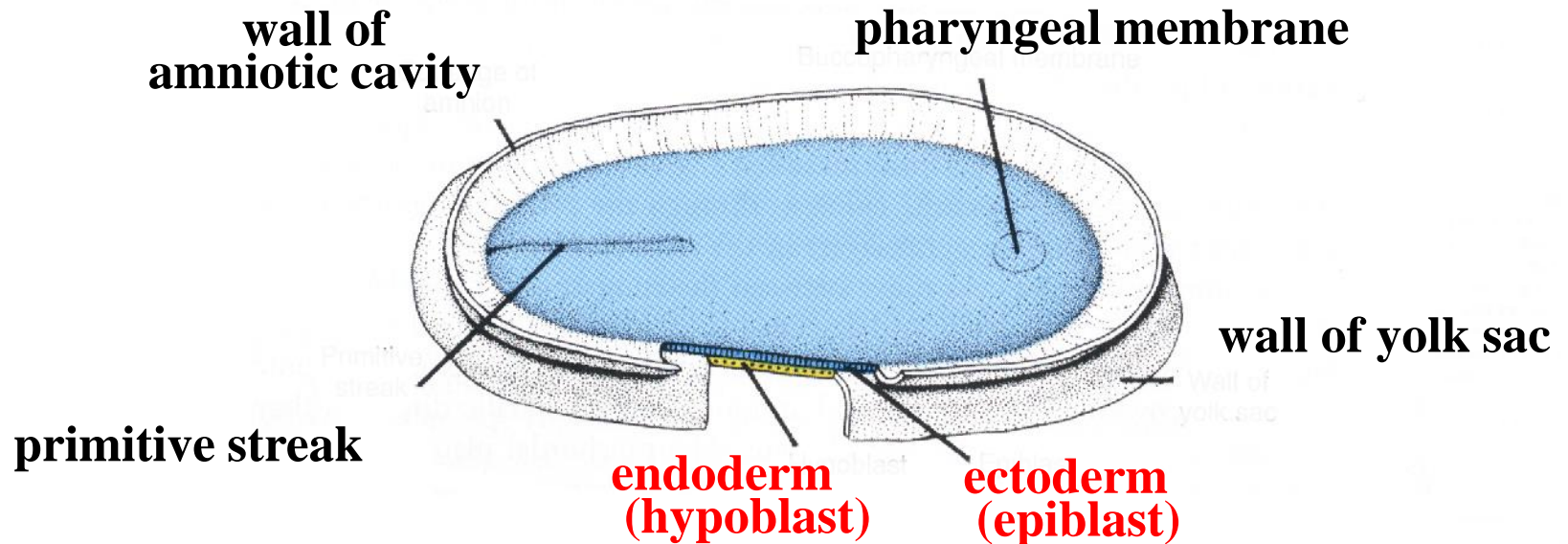
10. day



12. day



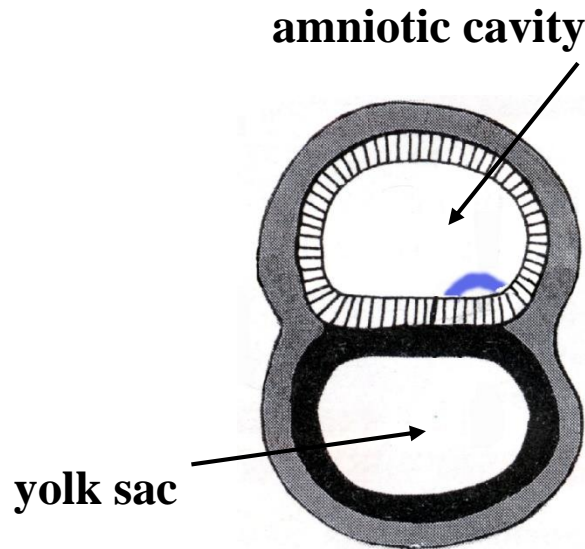
Two layered embryonic disc — end of 2nd week



2 germ layers: ectoderm
endoderm

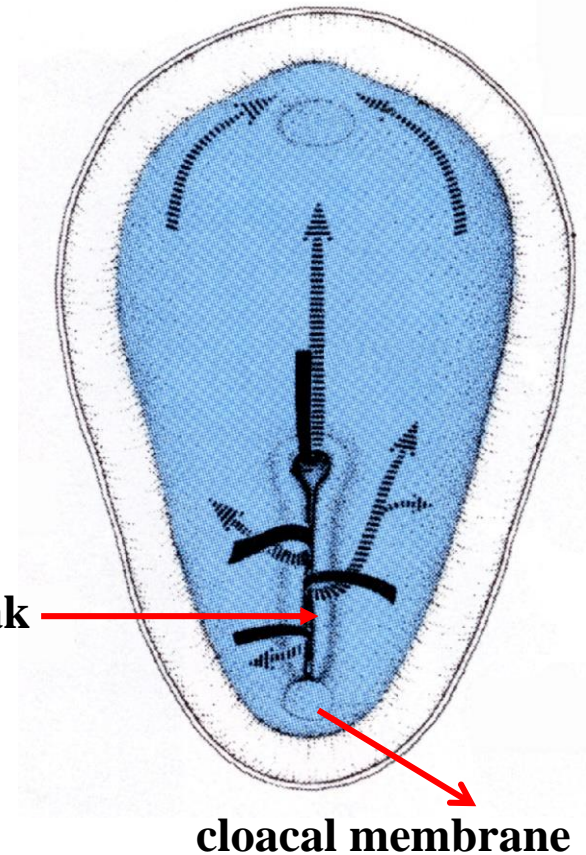
Development of intraembryonic mesoderm

- beginning of 3. week - future caudal part (cloacal membrane) of two-layered embryonic disc
- by proliferation of ectodermal (epiblast) cells primitive streak develops
- primitive streak grows cranially in the midline of the bilaminar embryonic disc

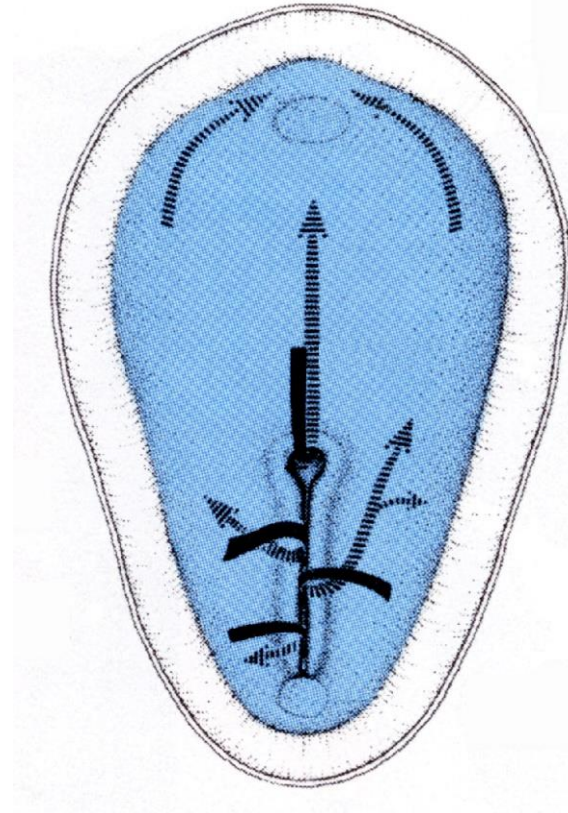


16. day

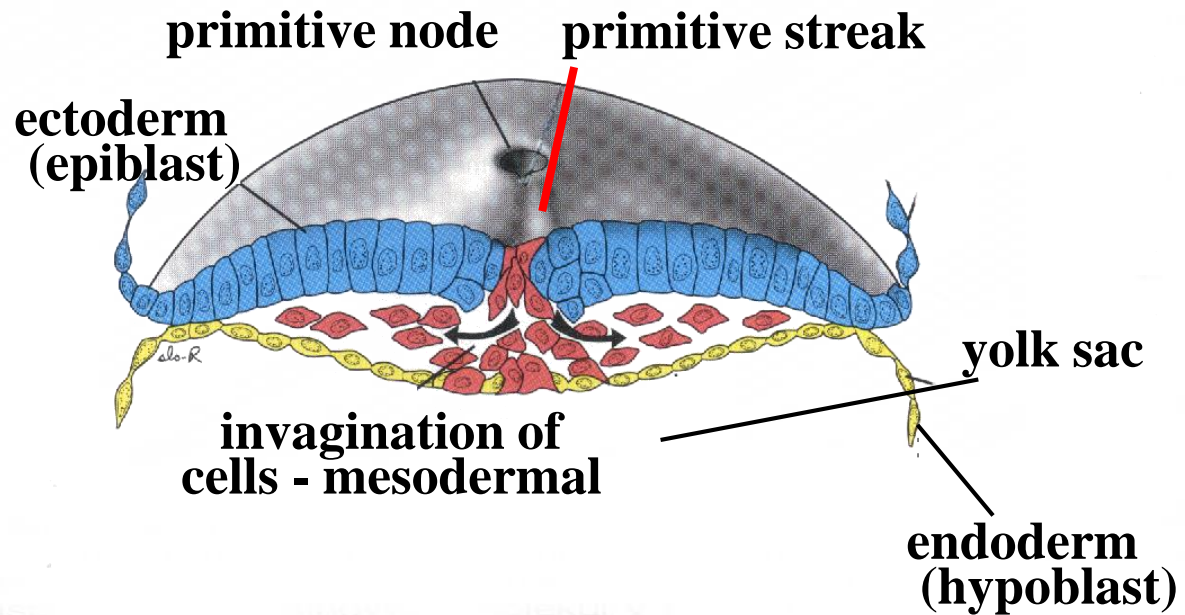
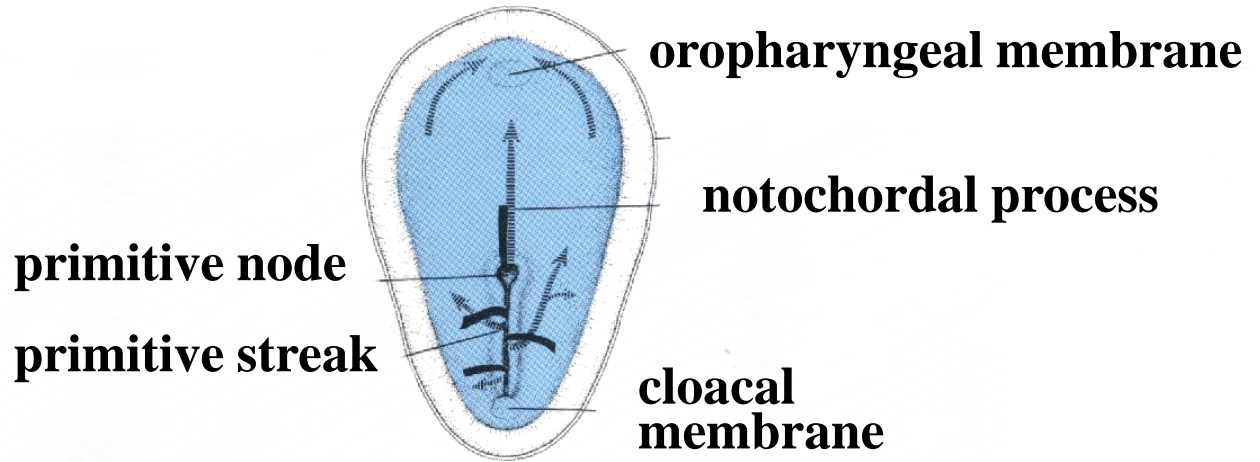
primitive streak

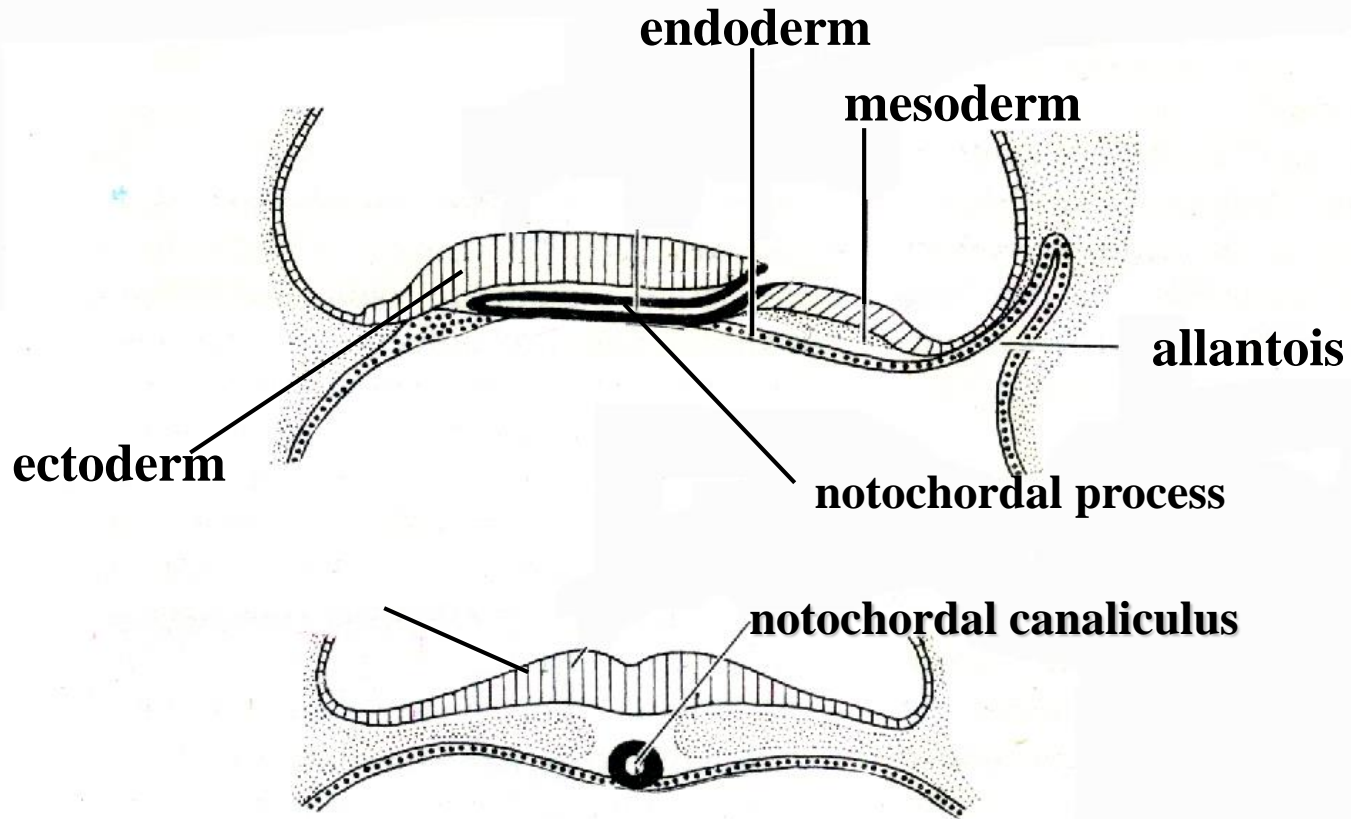


- primitive streak elongates, its cranial end proliferates to form the primitive node
- in the primitive streak develops a narrow primitive groove that ends in a primitive pit
- influence of **embryonic growth factors** – ectodermal cells proliferate and migrate through the primitive groove between ecto and endoderm, spread cranially and laterally and give rise to **embryonic mesoderm - third germ layer**



16. day





Development of the notochordal process and notochord

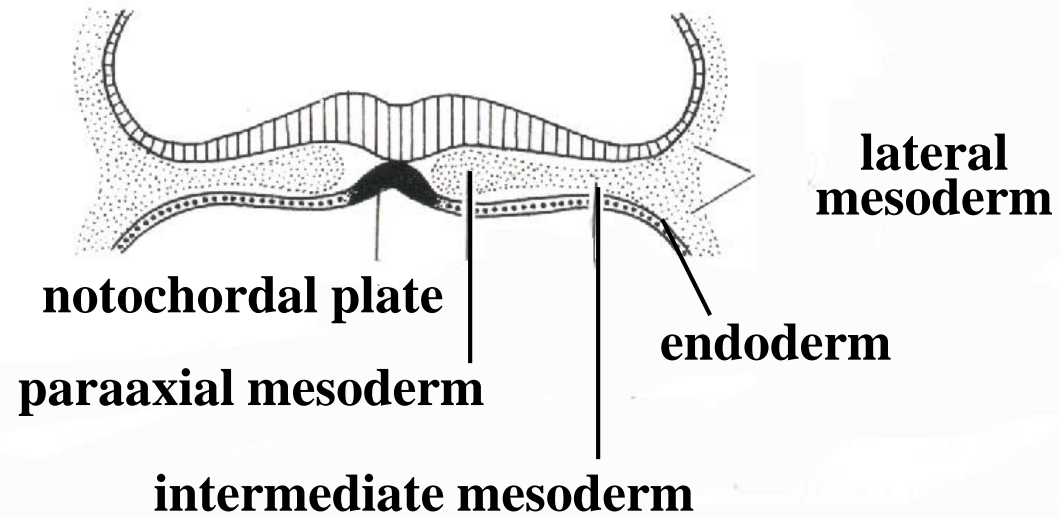
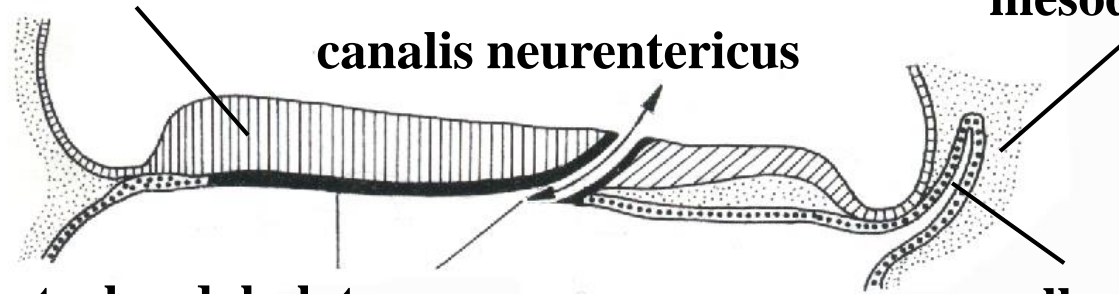
ectoderm

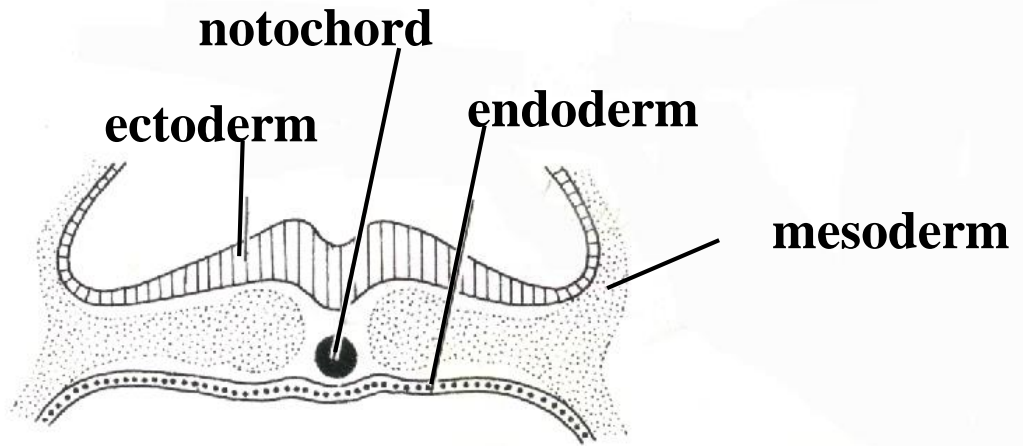
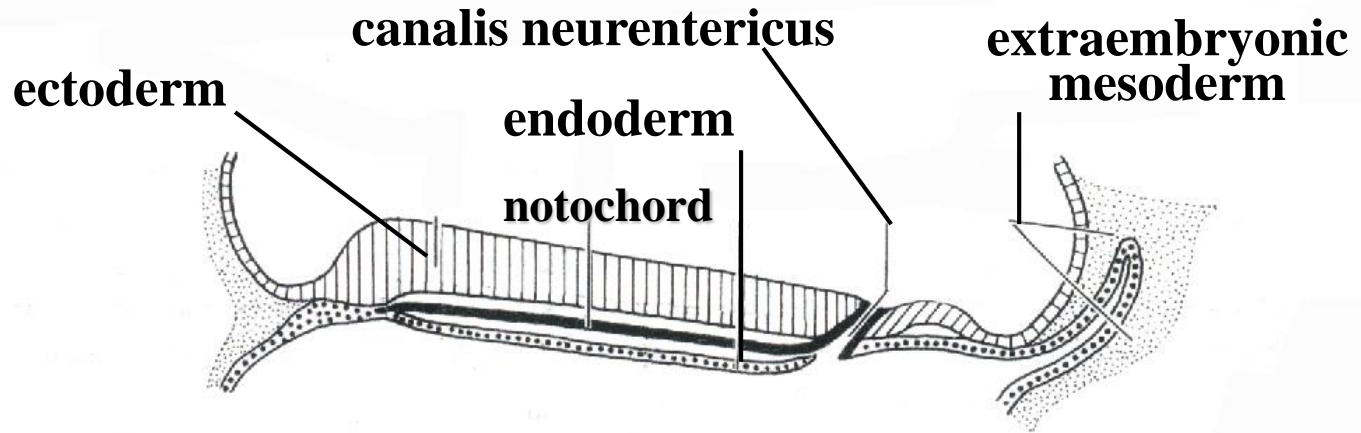
**extraembryonic
mesoderm**

canalis neurentericus

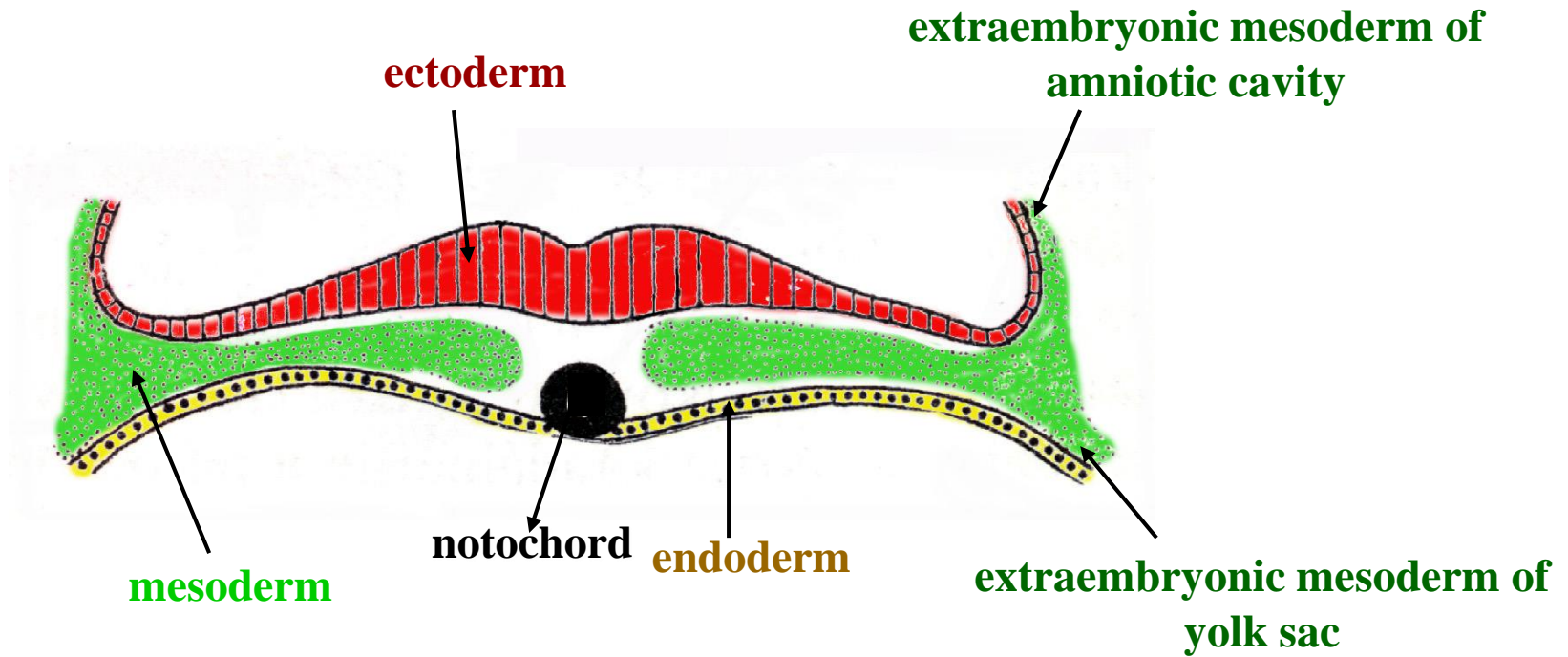
notochordal plate

allantois





Differentiation of **intraembryonic mesoderm**: paraxial
intermediate
lateral
cardiogenic



3rd week

Differentiation of intraembryonic mesoderm

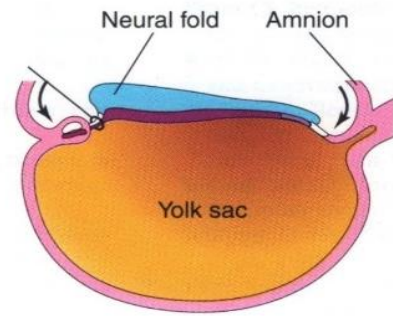
Paraxial mesoderm gives rise to somites (40-42) and these are divided into 3 parts:

1. Sclerotome – axial skeleton
2. Myotome – striated skeletal muscles
3. Dermatome – dermis of cutis

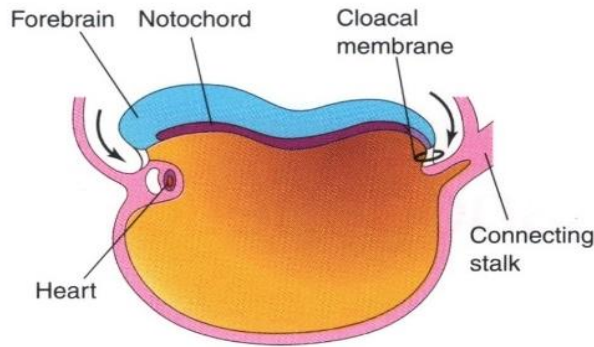
Intermediate mesoderm gives rise to male and female genital and urinary system.

Lateral mesoderm is split into somatopleura and splanchnopleura.

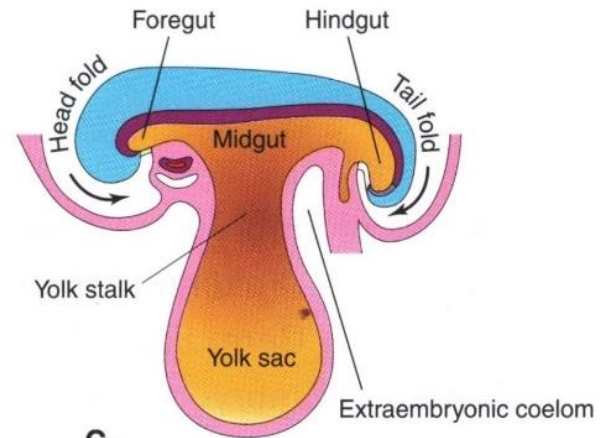
Cardiogenic area mesoderm is situated in front of pharyngeal membrane



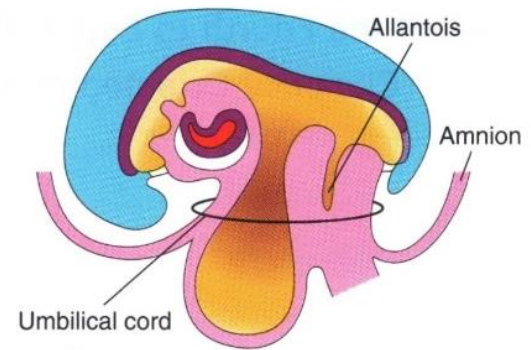
A₂



B₂



C₂



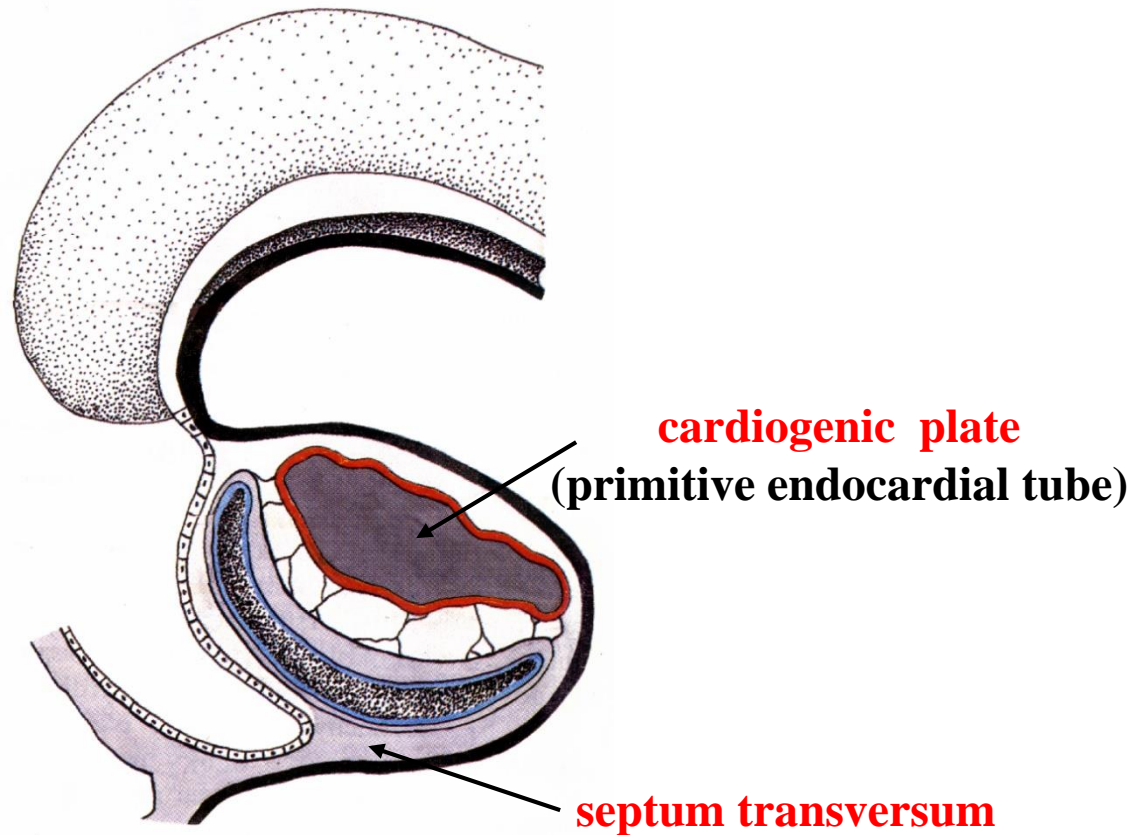
D₂

Folding of the embryo

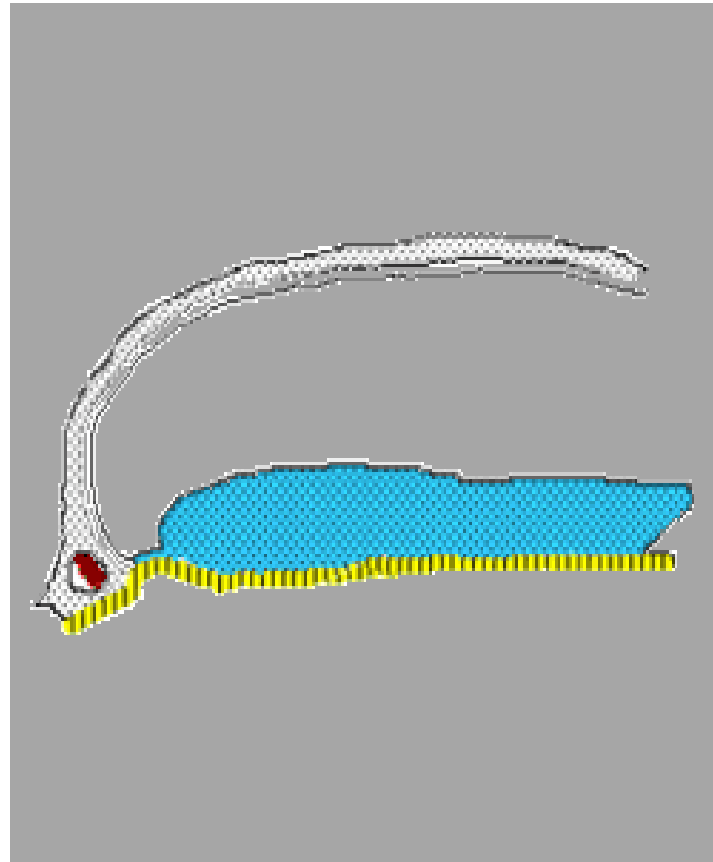
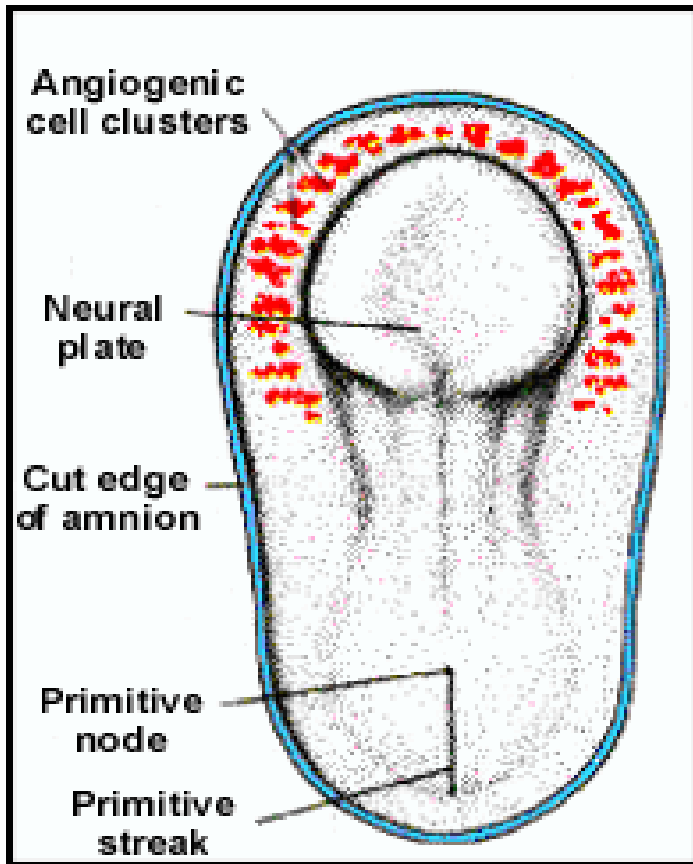
Development of mesoderm in front of oropharyngeal membrane

cardiogenic plate

- intraembryonic mesoderm at the cranial part of embryonic disc, in front of pharyngeal membrane is the developing **mesoderm of septum transversum and mesoderm of cardiogenic area**
- after folding of the embryo are situated in the thoracal and abdominal part



Mesoderm of cardiogenic area



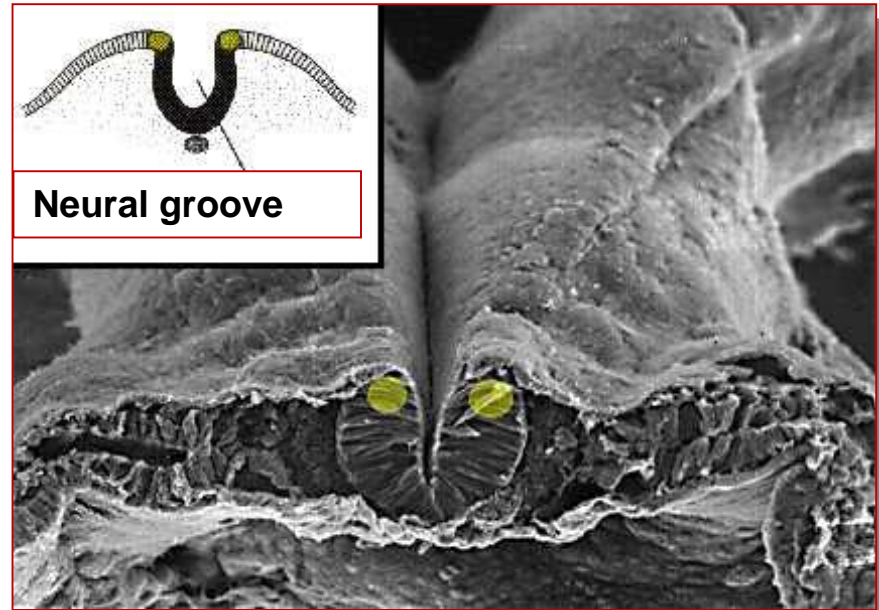
DEVELOPMENT OF THE NERVOUS SYSTEM

Neurulation

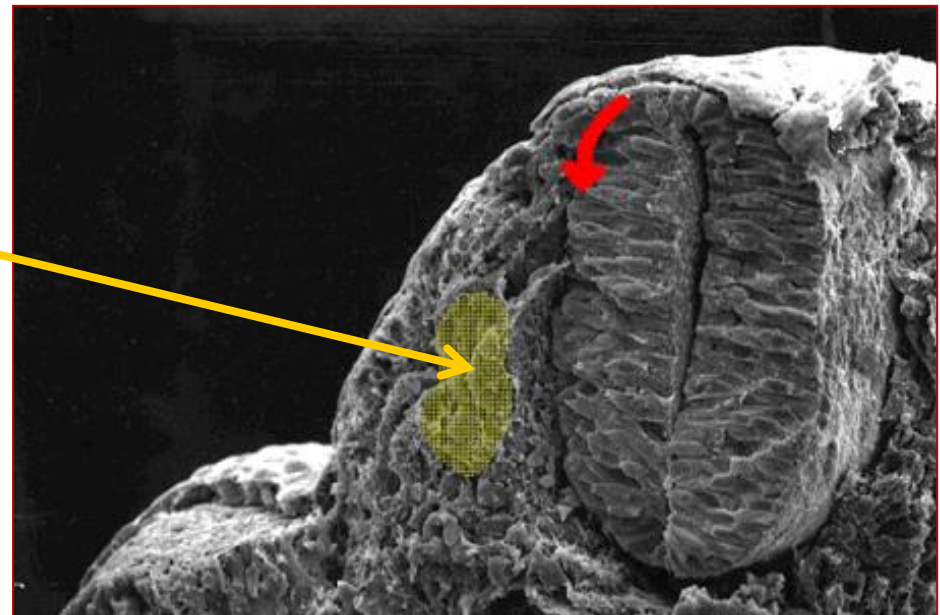
Development of the nervous system

Ectoderm – neuroectoderm – in the midline, between the primitive node and oropharyngeal membrane proliferate.

Give rise to neural tube and neural crest

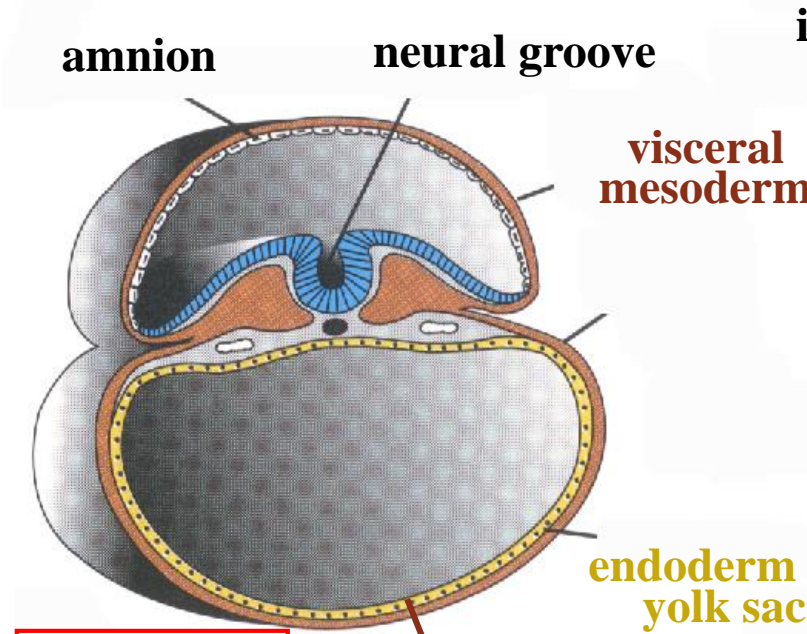
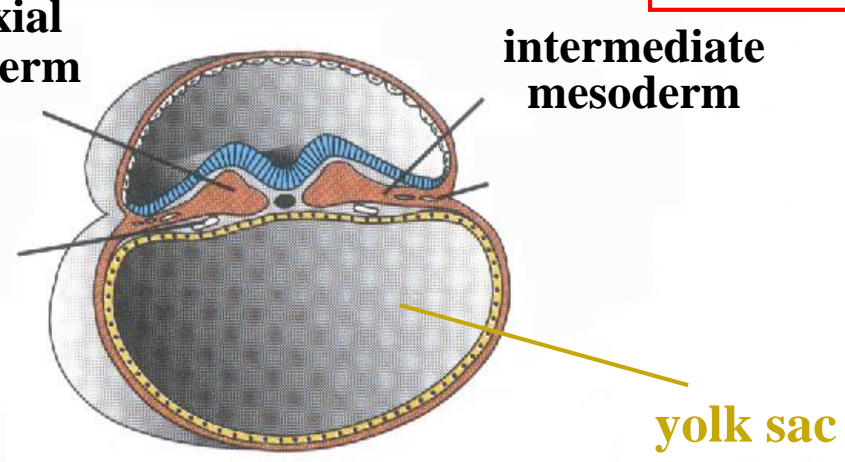
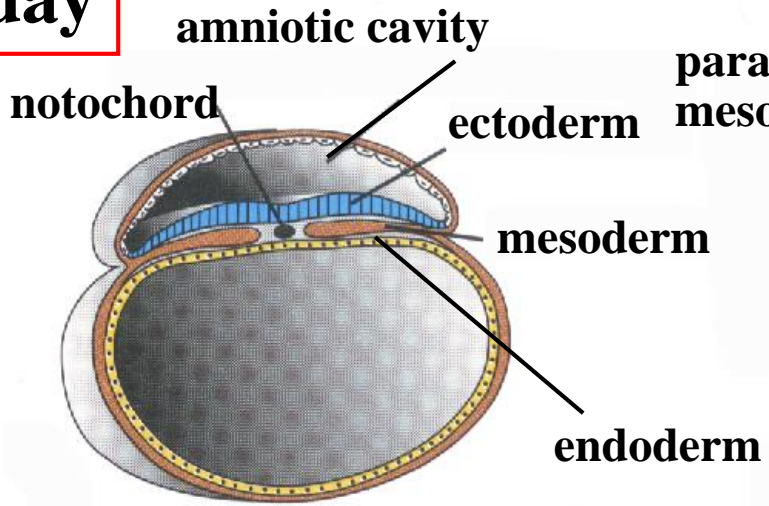


Neural crest

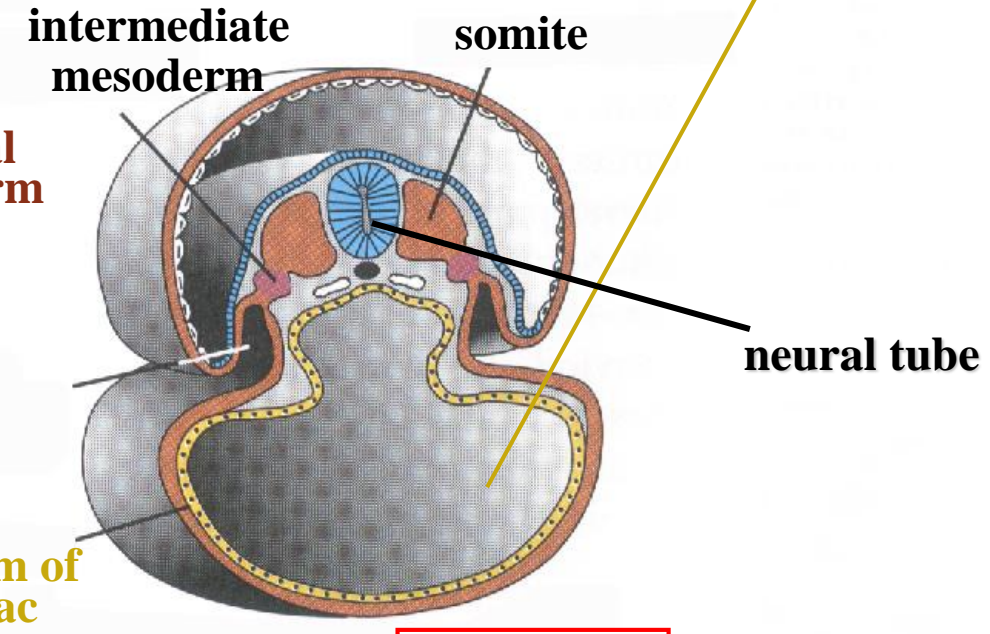


17. day

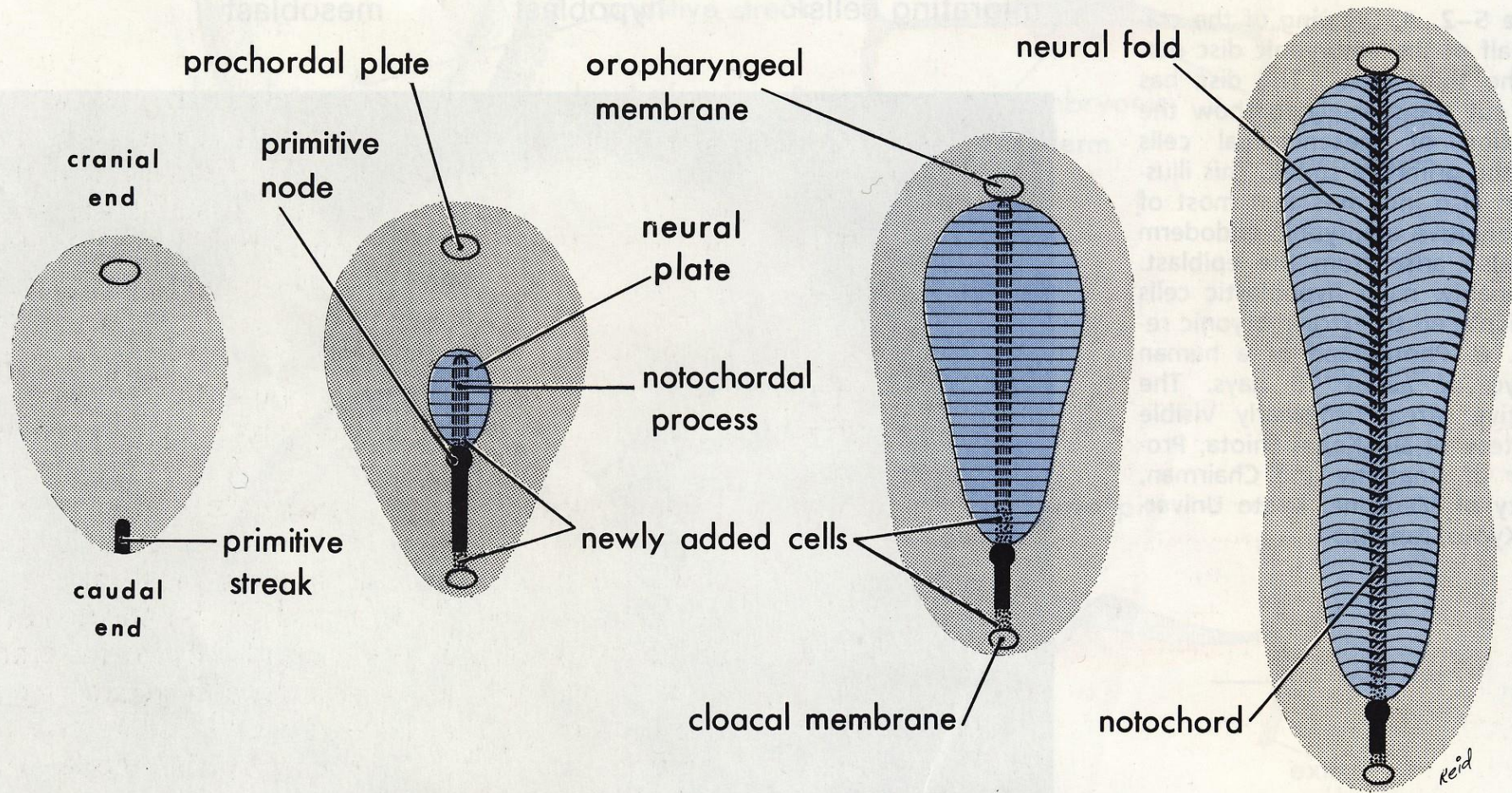
19. day



20. day



21. day



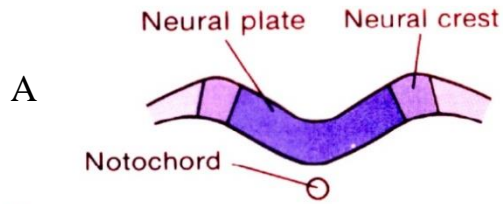
A. day 15

B. day 17

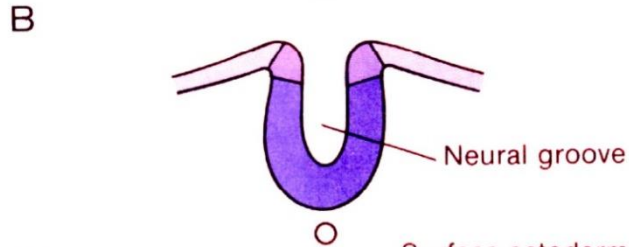
C. day 18

D. day 21

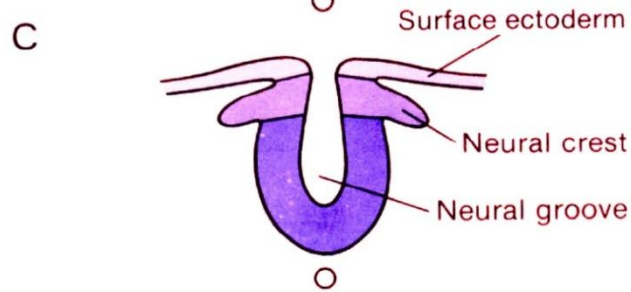
Reid



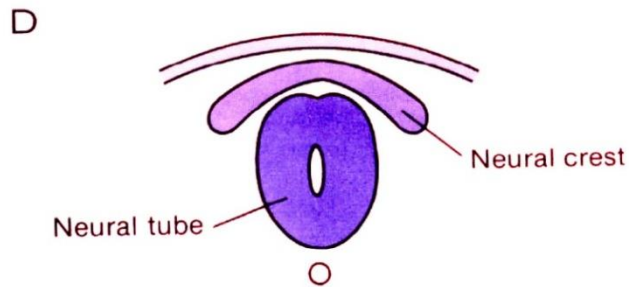
1. Neural plate



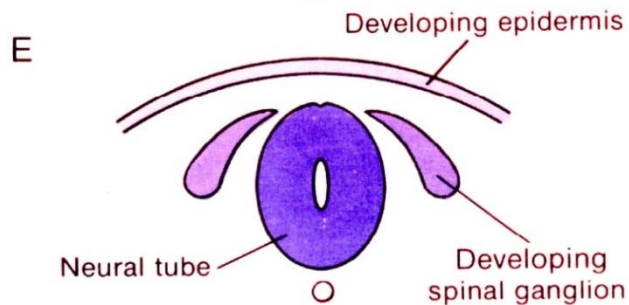
2. Neural groove



3. Neural crest



4. Neural tube



5. Separation of neural crest

6. Developing of epidermis

Neural crest gives rise to:

Cranial and spinal ganglia

Schwann cells

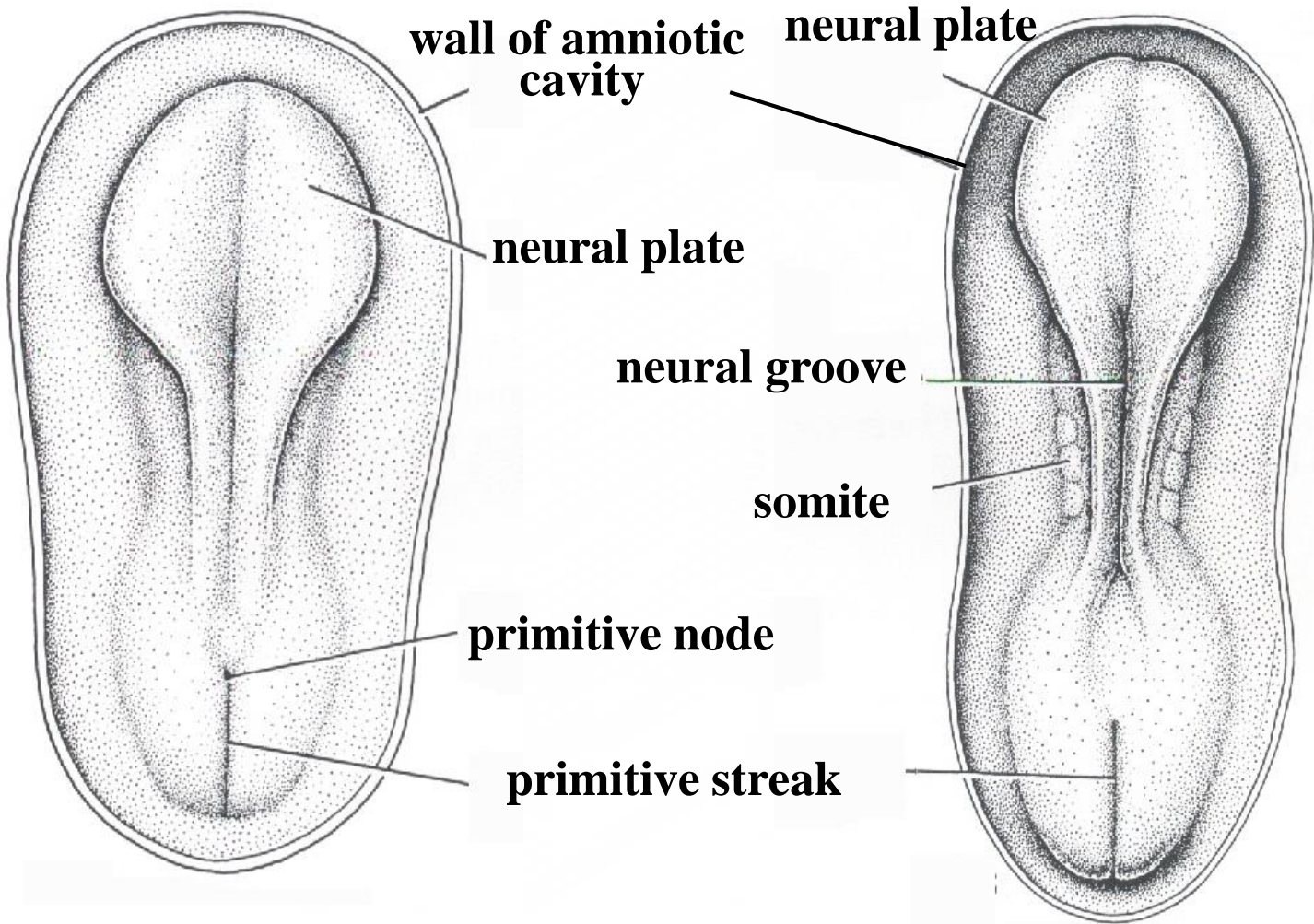
Satelite cells

Cells of pia mater and arachnoid

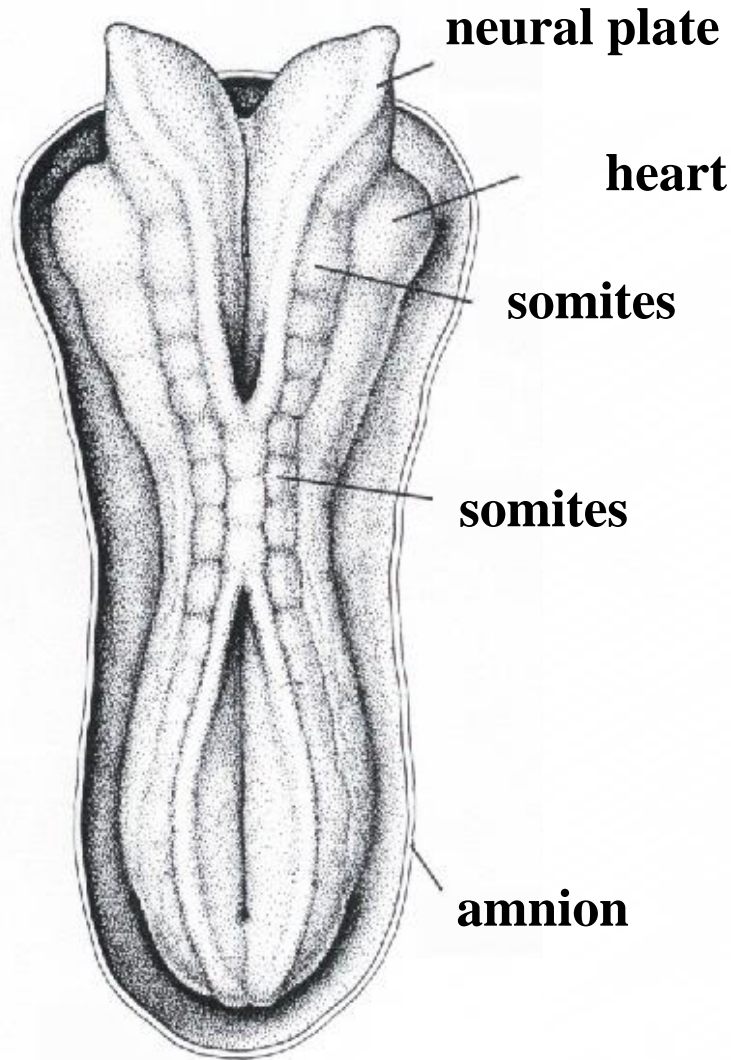
Melanocytes

Odontoblasts

Chromafin cells

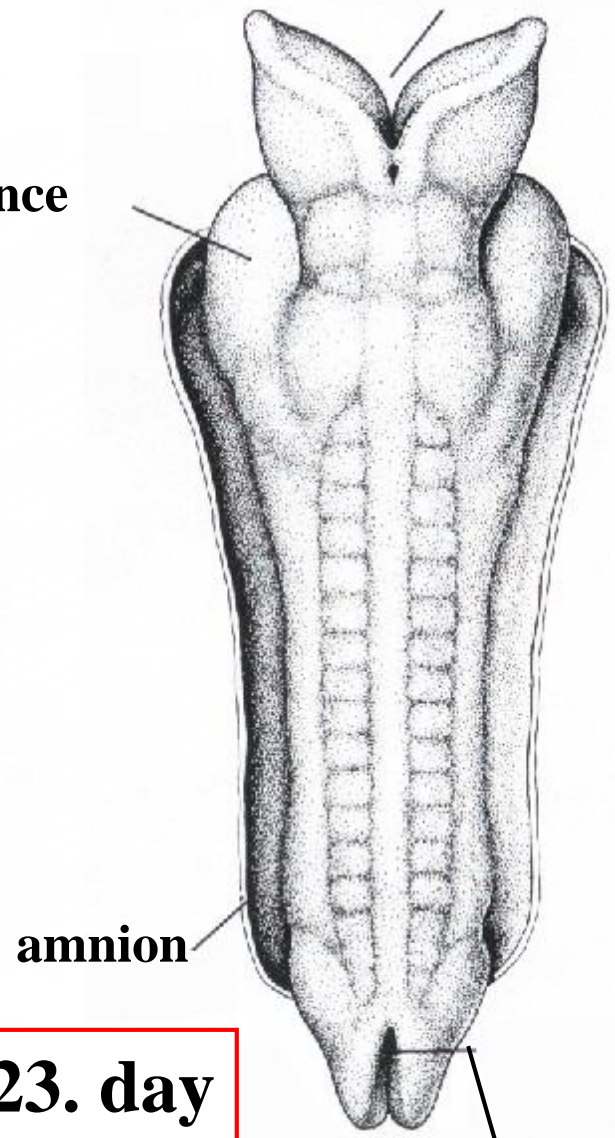


19. day



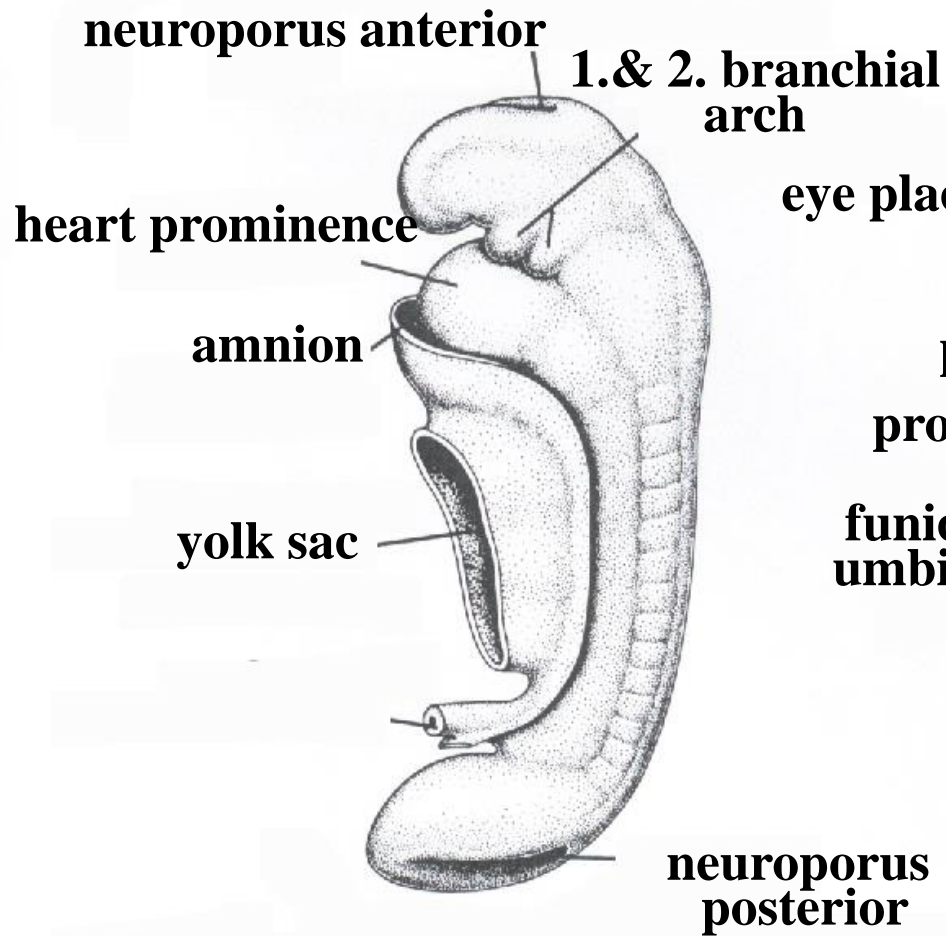
22. day

neuroporus anterior

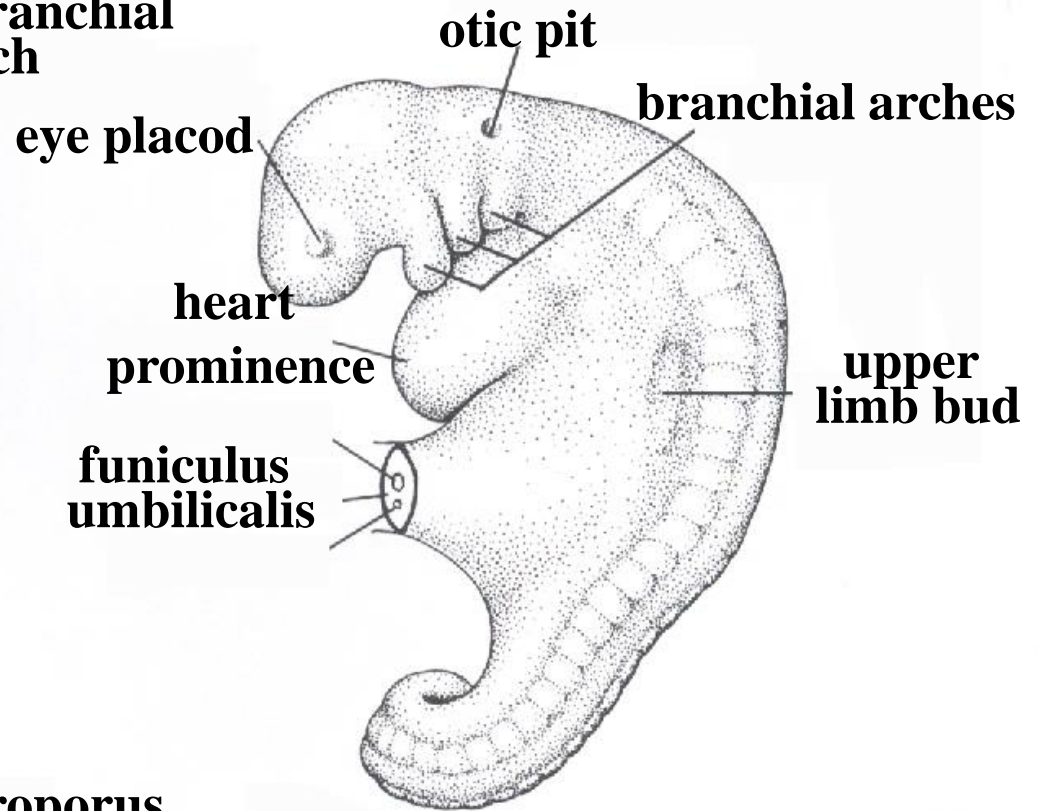


23. day

neuroporus posterior



25. day

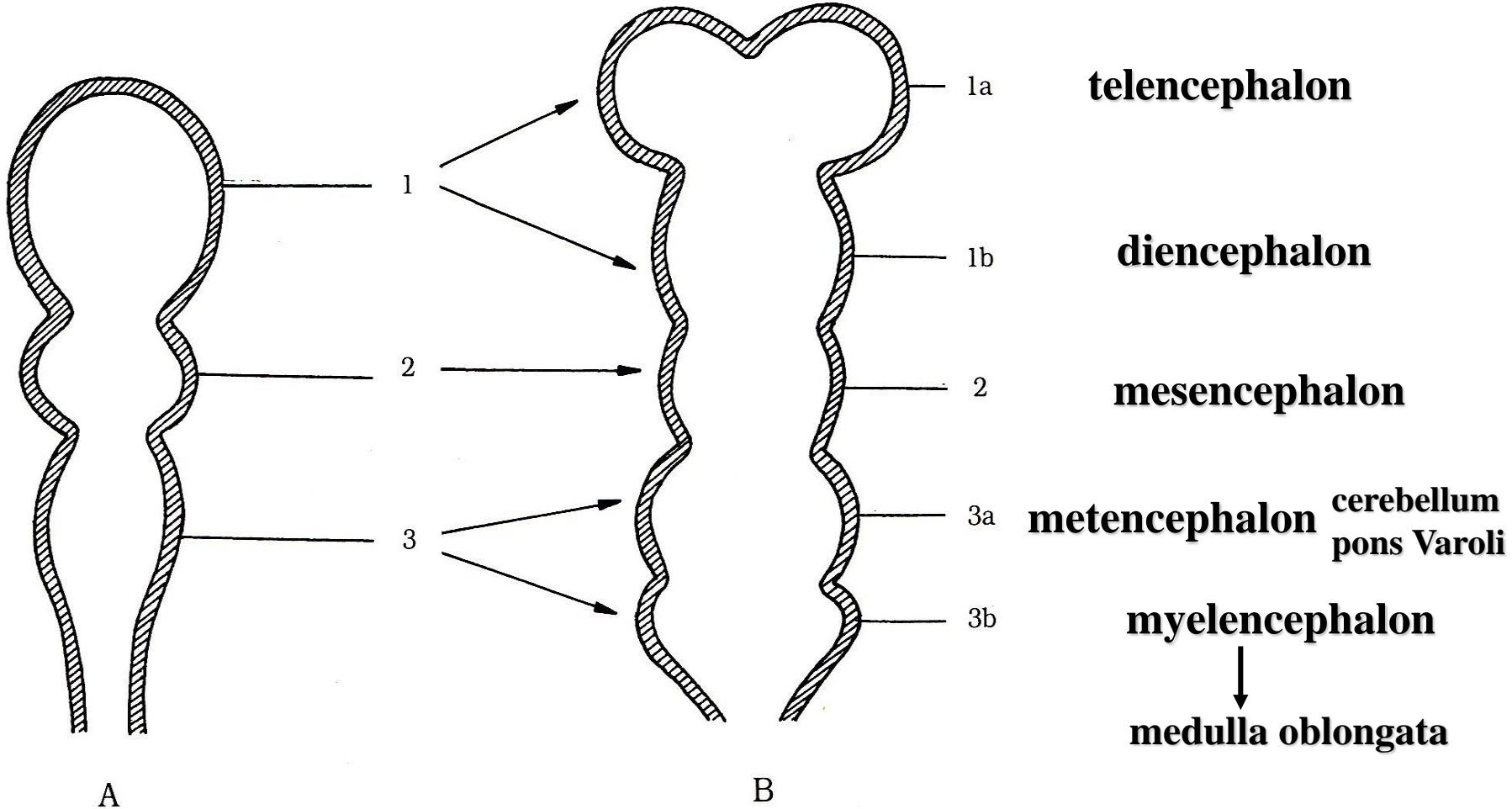


28. day

Brain vesicles

Development of the brain

1. Prosencephalon
2. Mesencephalon
3. Rhombencephalon

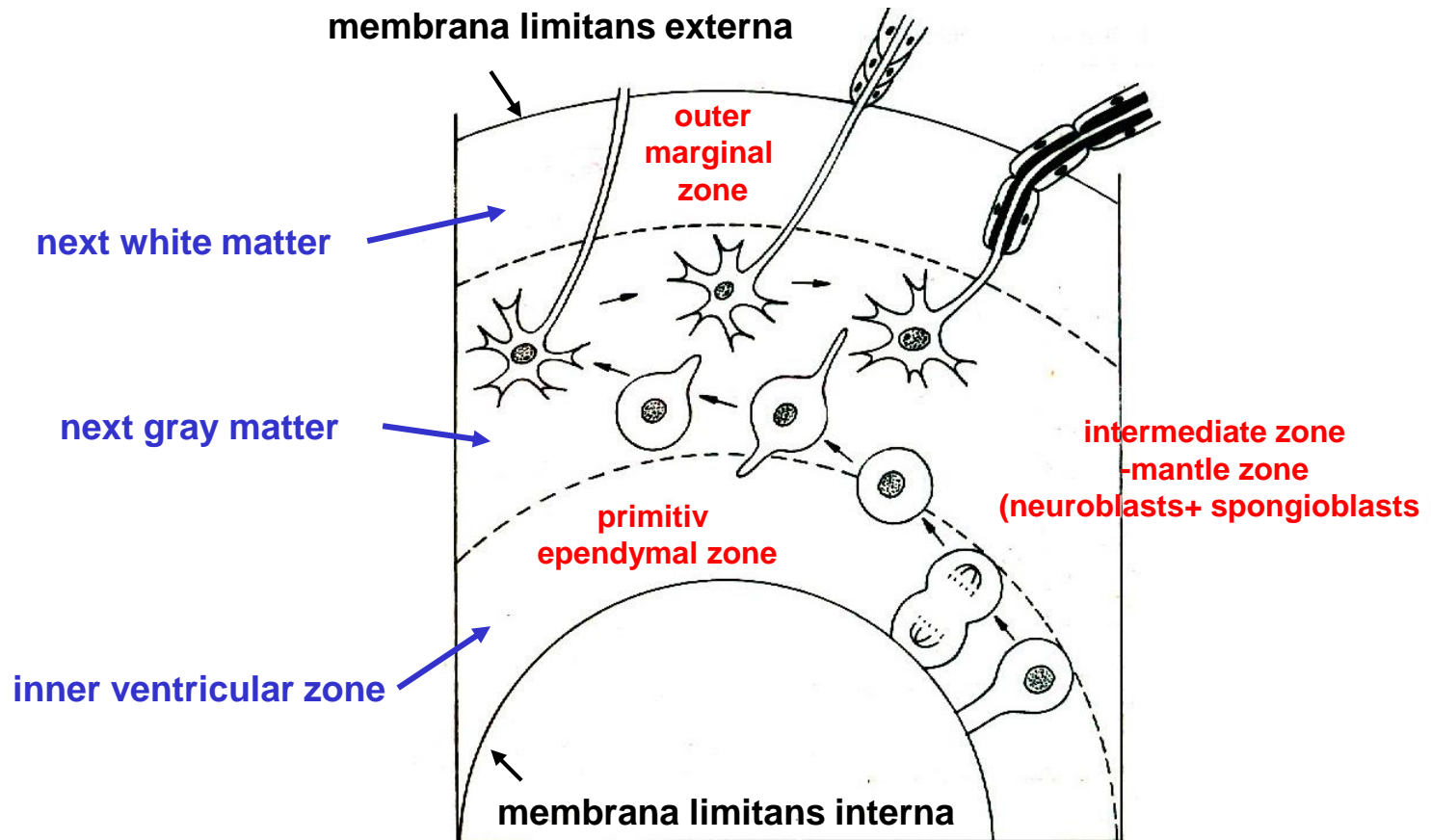


Development of spinal cord

Spinal cord – histogenesis => neuroepithelium

1. Inner ventricular zone – ependymal
2. Middle – intermediate zone – mantle zone matter xt gray matter
3. Outer – marginal zone => next white matter

Neuroepithelium



Neuroepithelium

