



# Embryology /organogenesis/

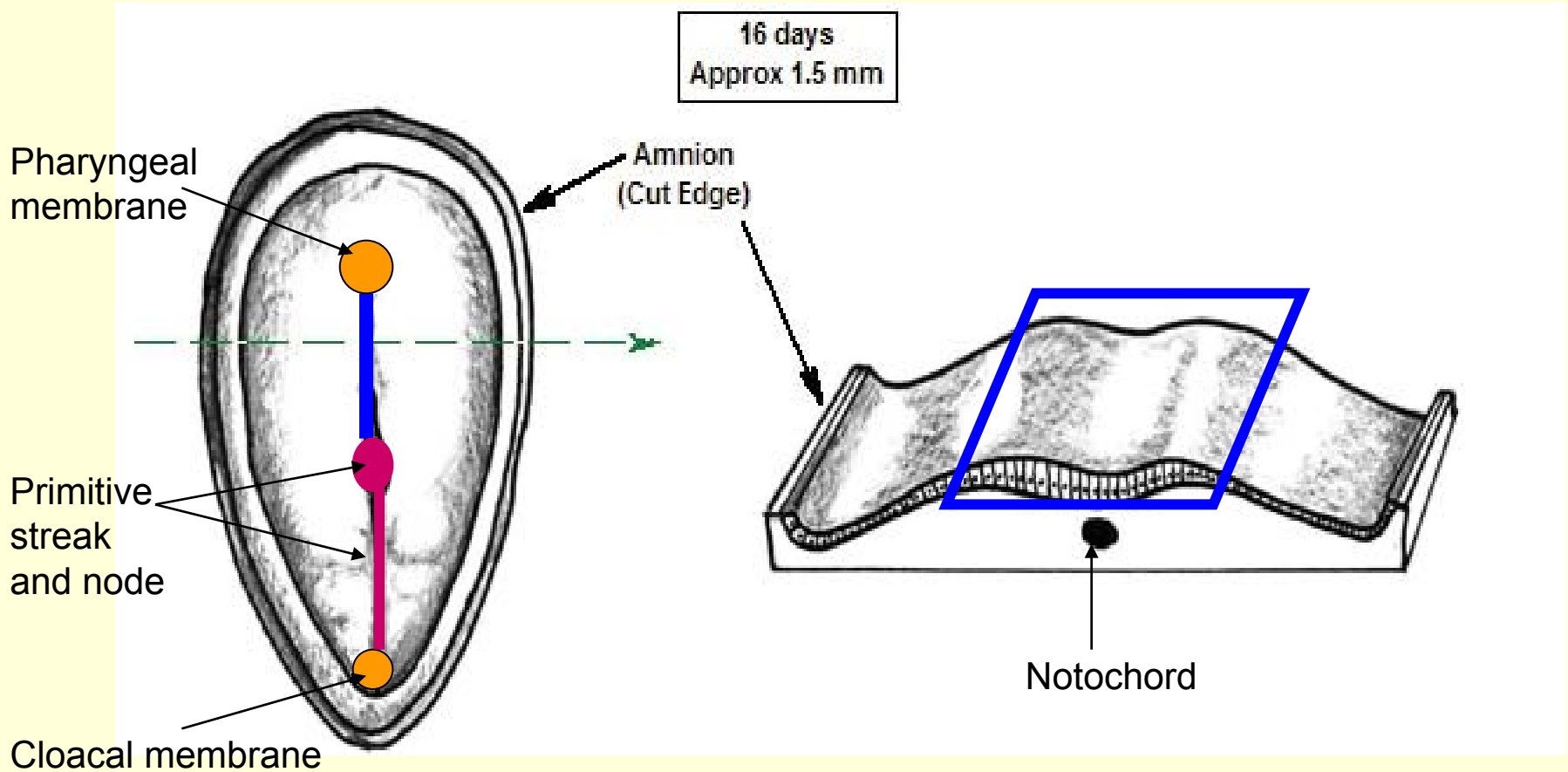
Development and teratology  
of nervous system.

Repetition: nervous tissue.

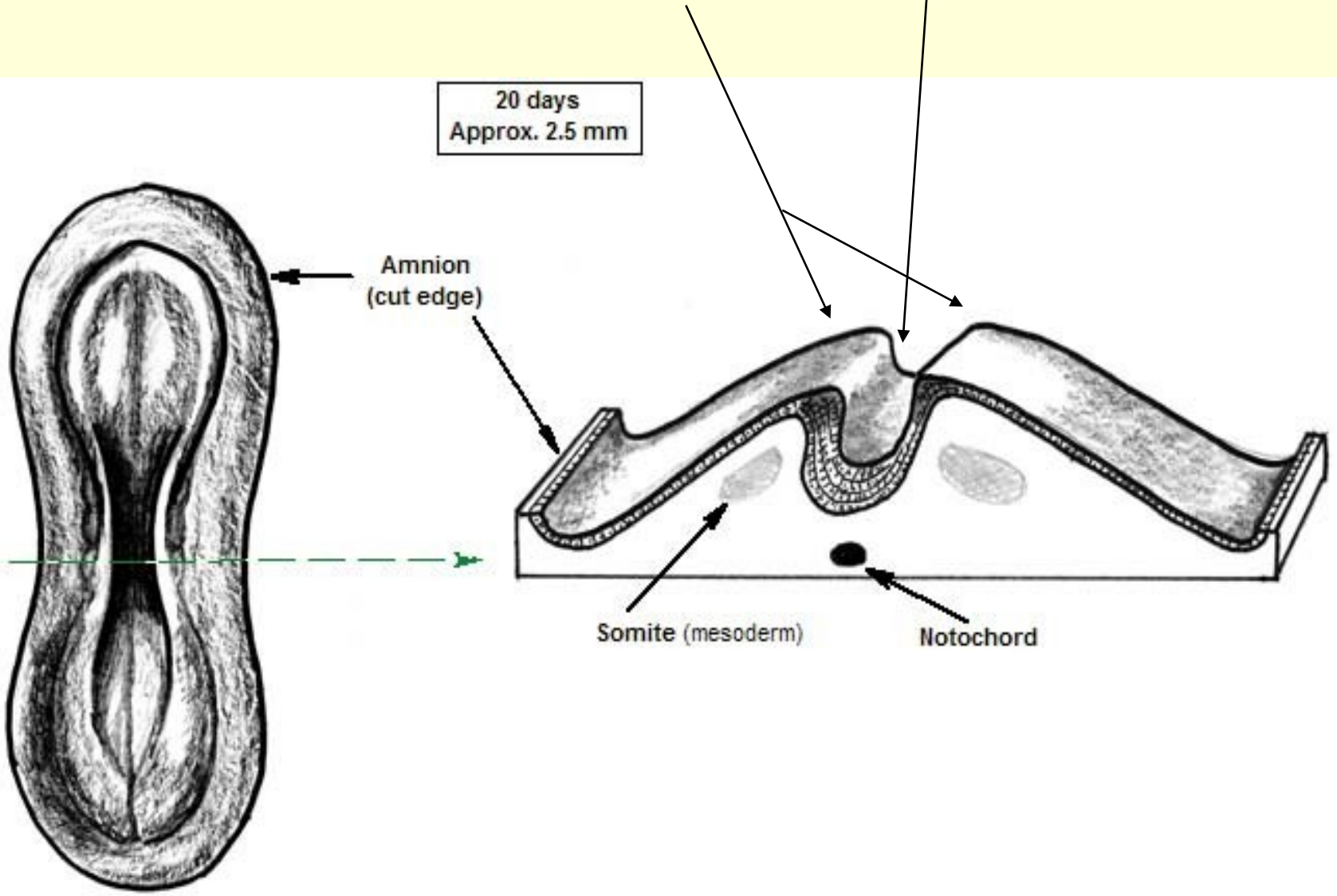
# Special embryology - questions

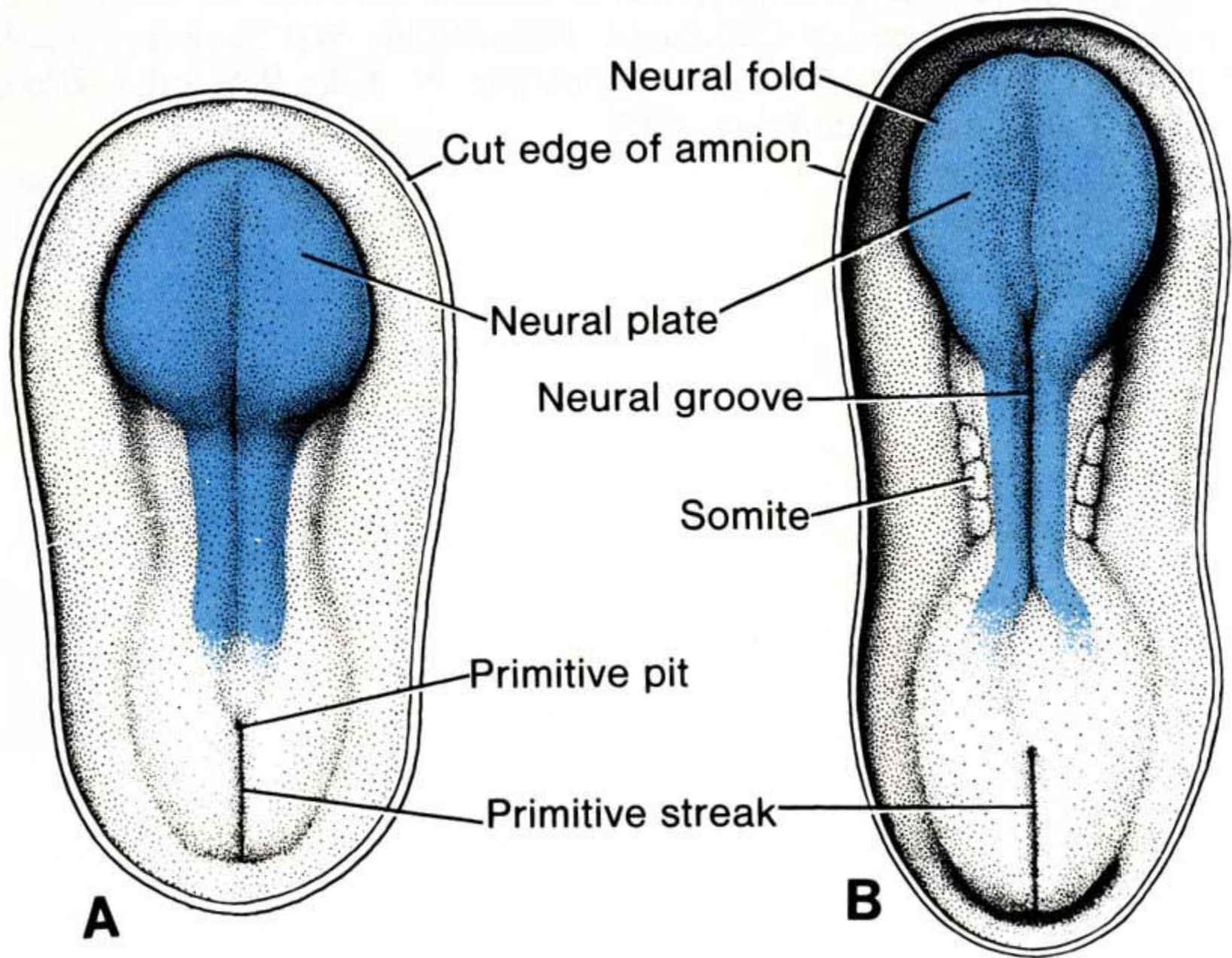
- Development of neural (ganglionic) crest and its differentiation.
- Development of spinal cord.
- Development of the brain – differentiation of secondary brain vesicles; brain chambers.
- Developmental abnormalities of central nerve system.

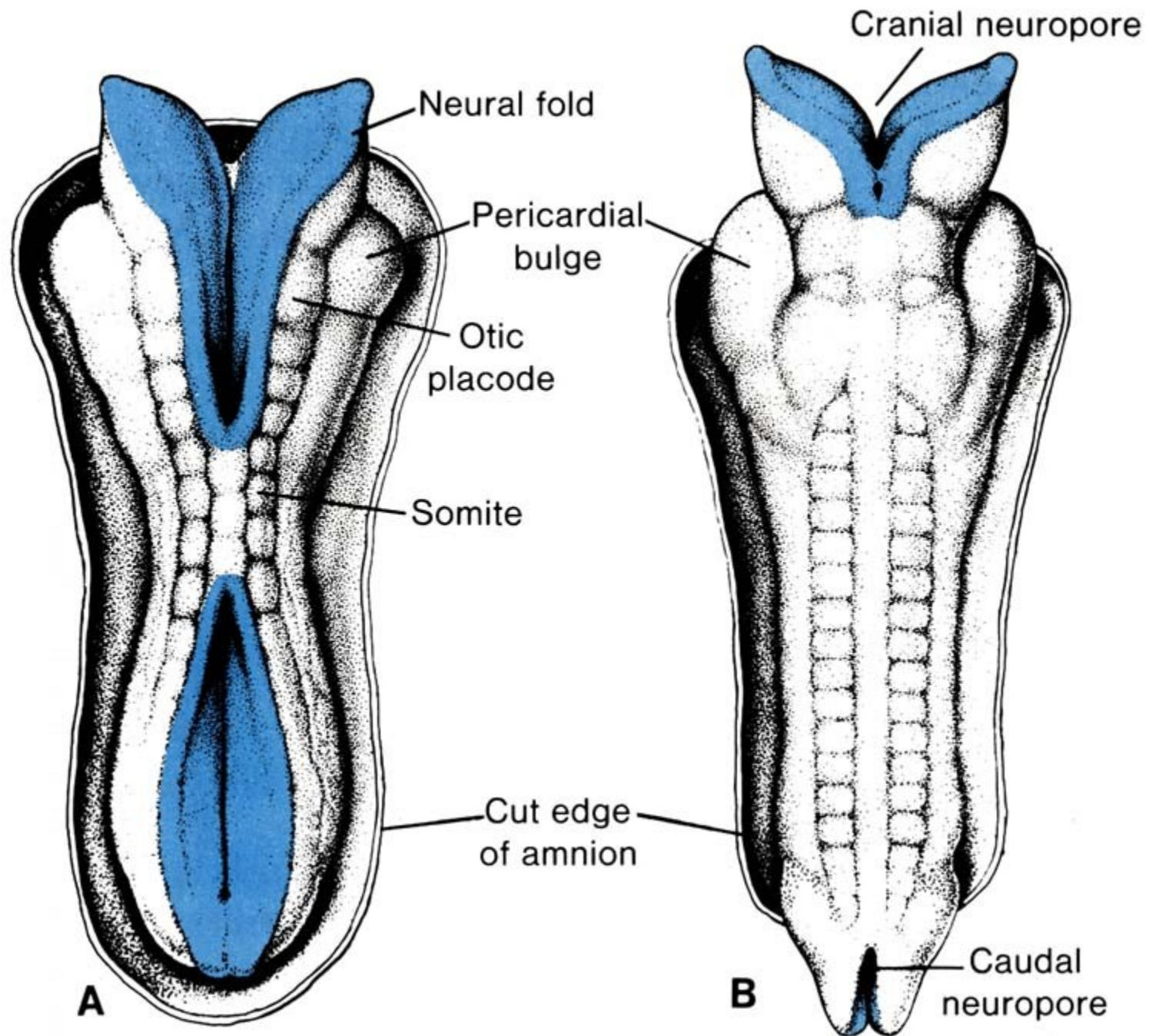
# Neural plate – thickened area of embryonic ectoderm



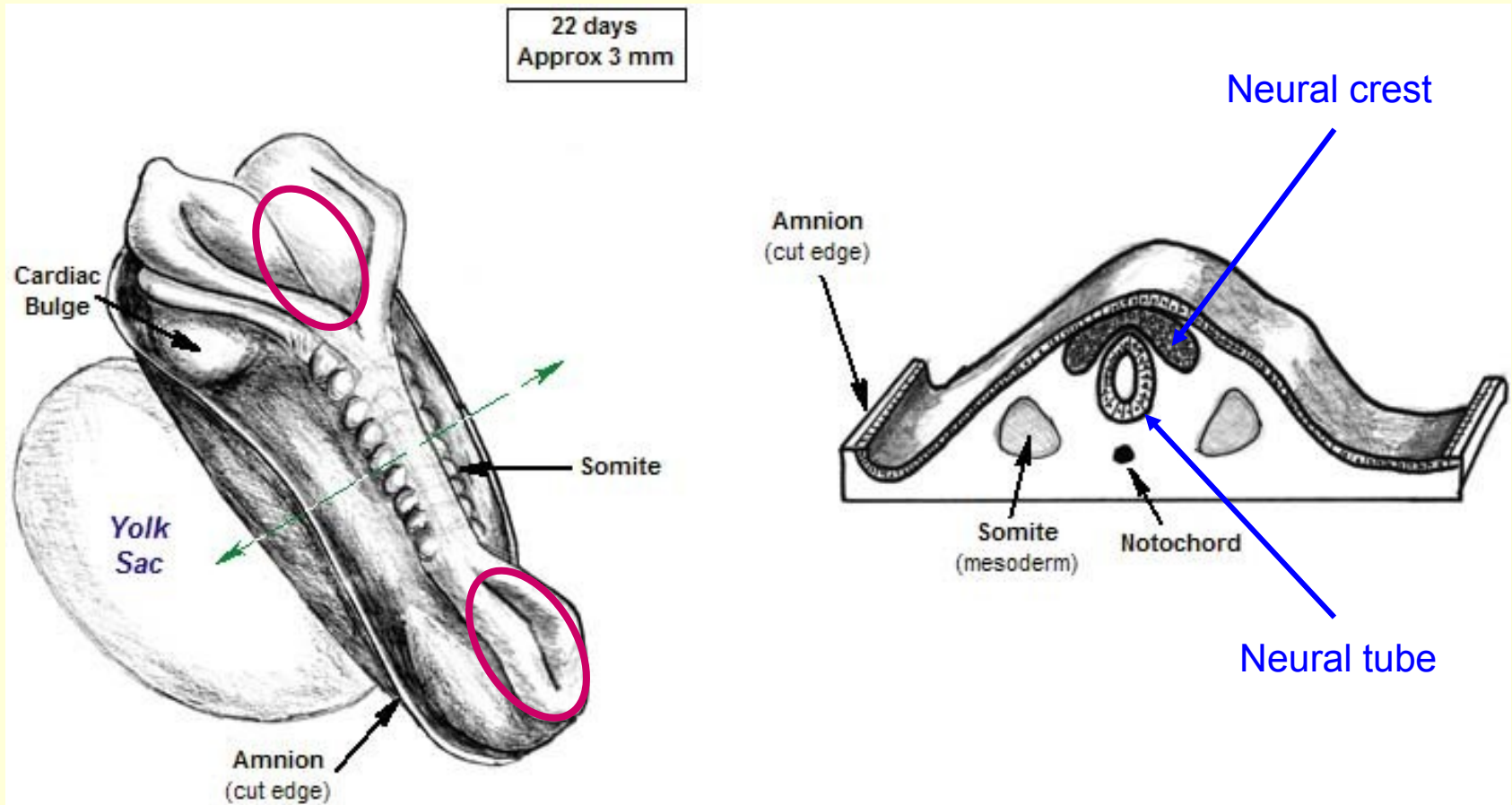
Invagination of neural plate  $\Rightarrow$  neural folds + neural groove







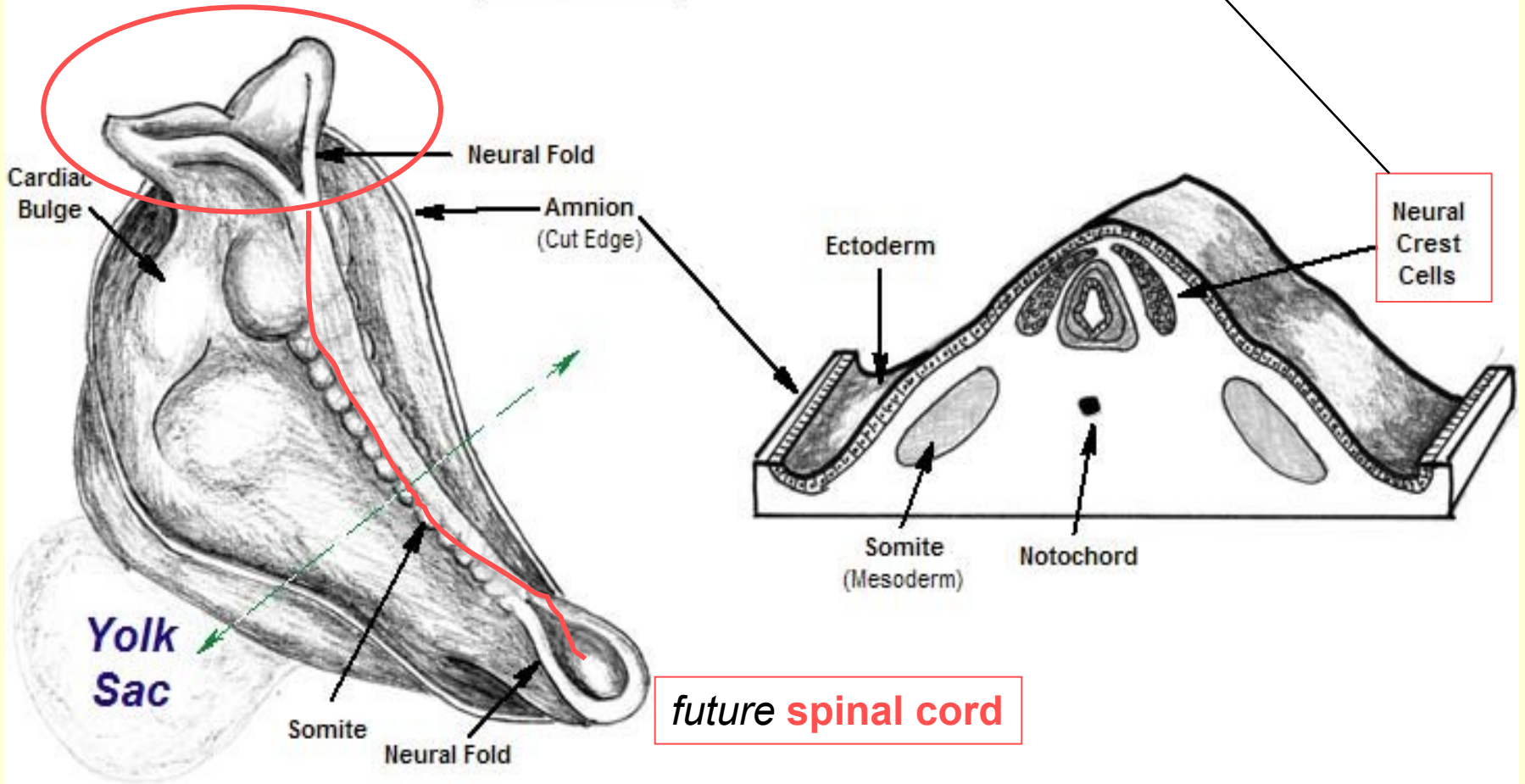
Neural tube and neural crest  
*Neuroporus ant., post.*



**future brain**

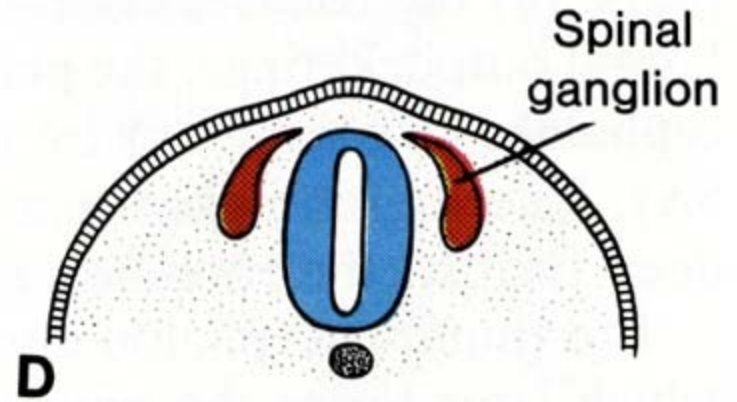
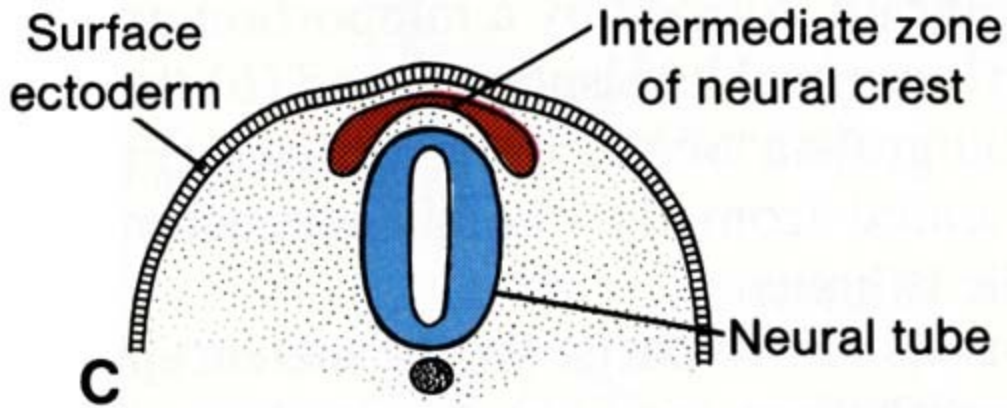
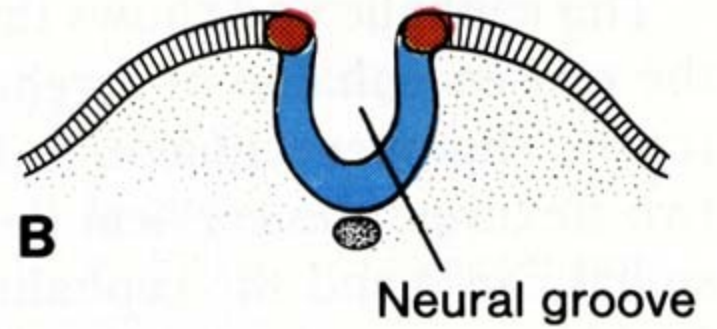
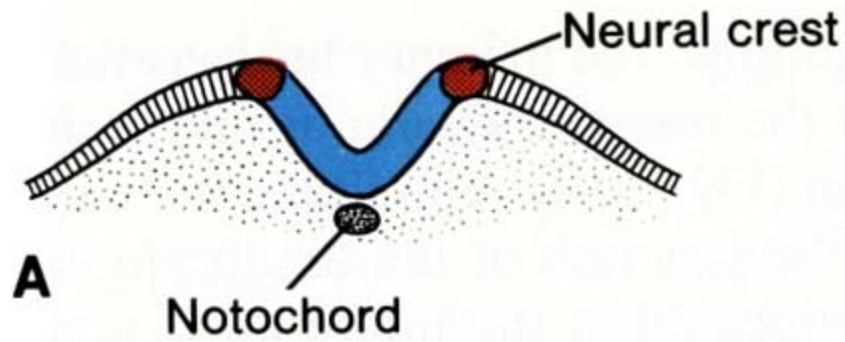
24 days  
Approx 3.5 mm

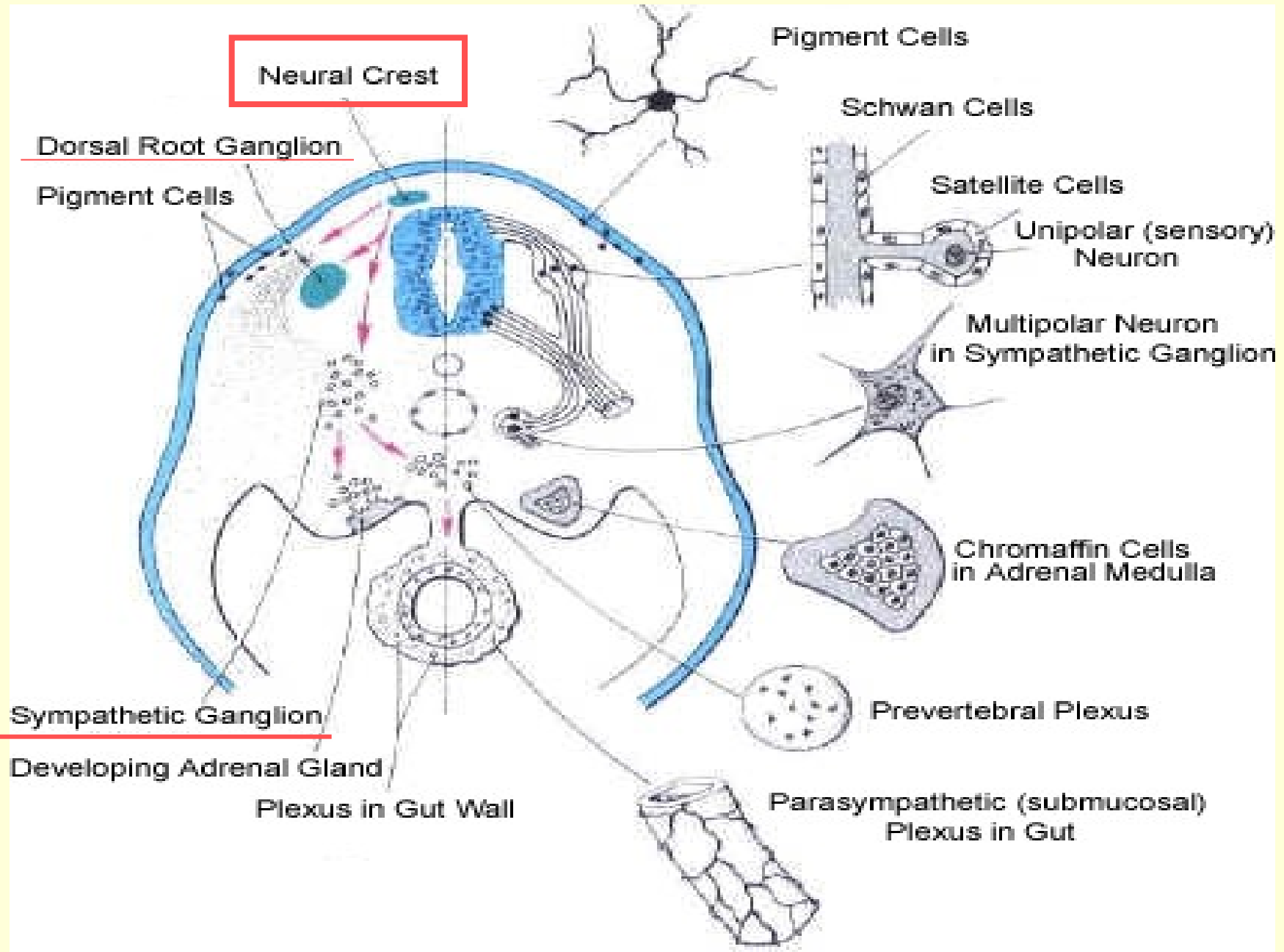
**future spinal and autonomic ganglia**



**future spinal cord**







Neural Crest

Pigment Cells

Schwann Cells

Dorsal Root Ganglion

Pigment Cells

Satellite Cells

Unipolar (sensory) Neuron

Multipolar Neuron in Sympathetic Ganglion

Chromaffin Cells in Adrenal Medulla

Prevertebral Plexus

Sympathetic Ganglion

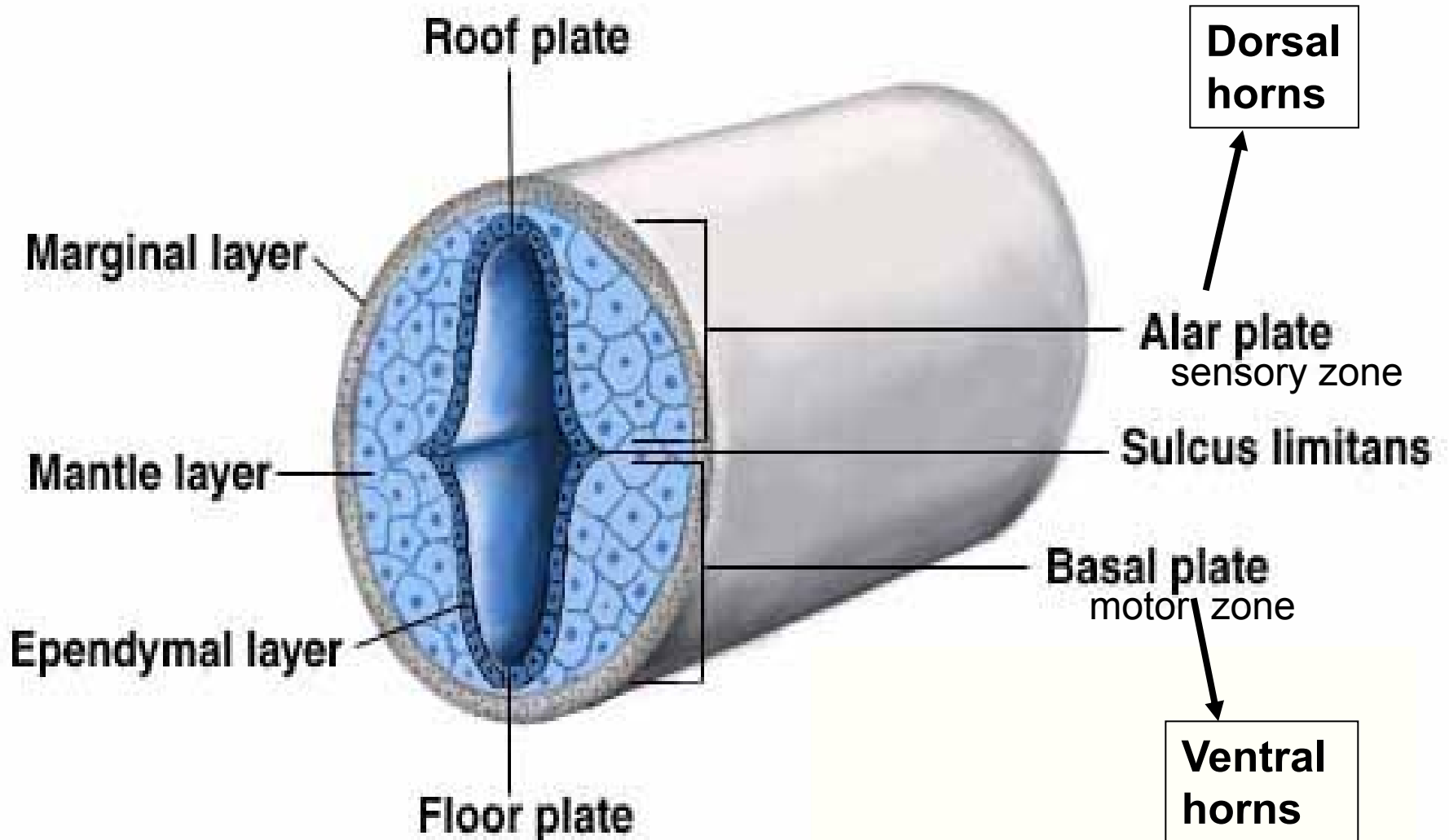
Developing Adrenal Gland

Plexus in Gut Wall

Parasympathetic (submucosal) Plexus in Gut

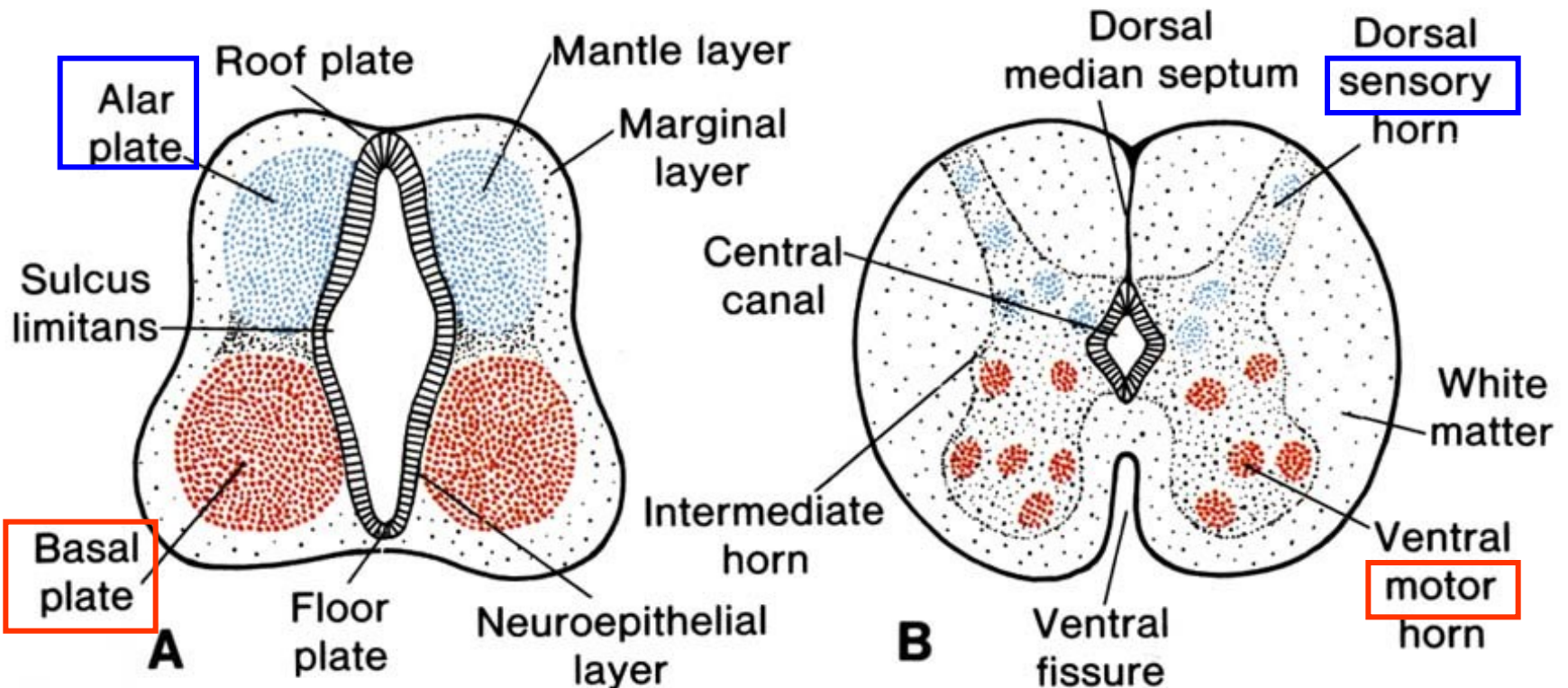


# Spinal cord development



## HISTOGENESIS of SPINAL CORD:

1. Ependymal layer (germinal) – lining of central canal
2. Mantle layer (gray matter) – neuroblasts + spongioblasts give rise to neurons and glial cells
1. Marginal layer (white matter) – without neurons



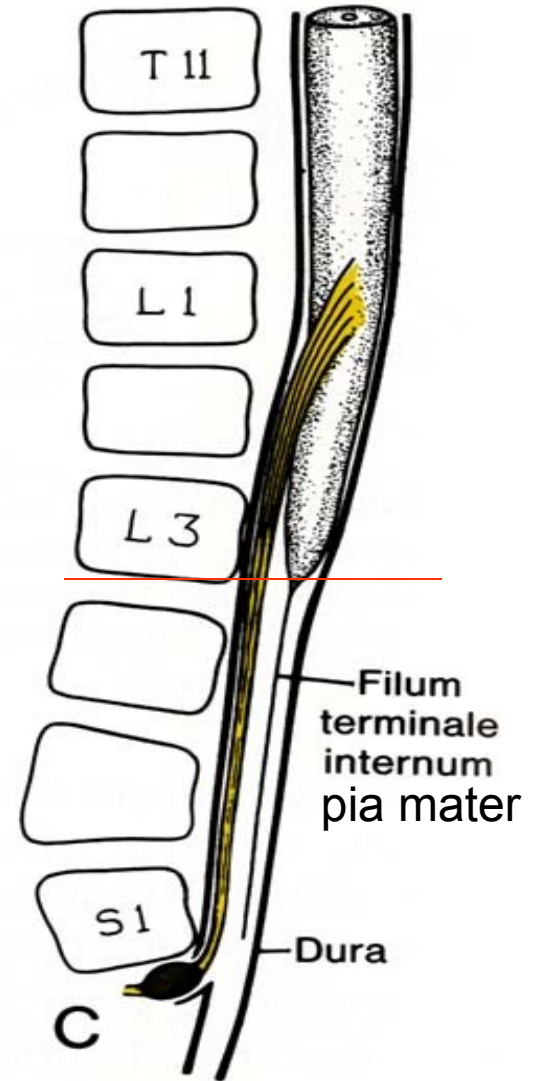
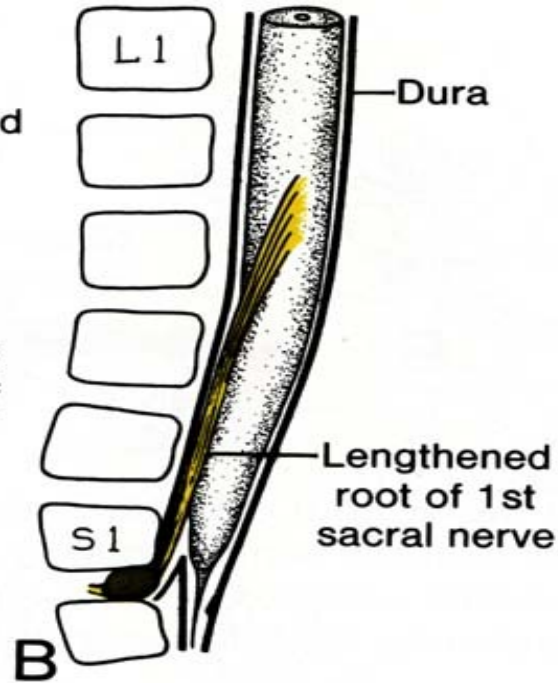
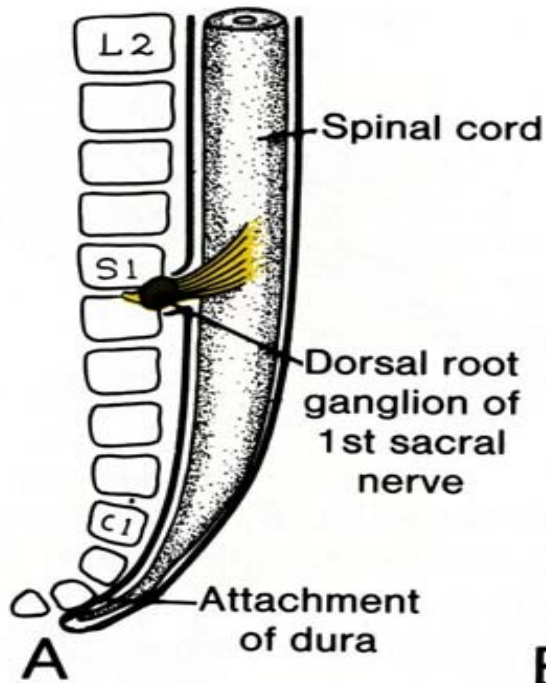


# Positional changes of spinal cord

the end to the 2nd month

new-born child

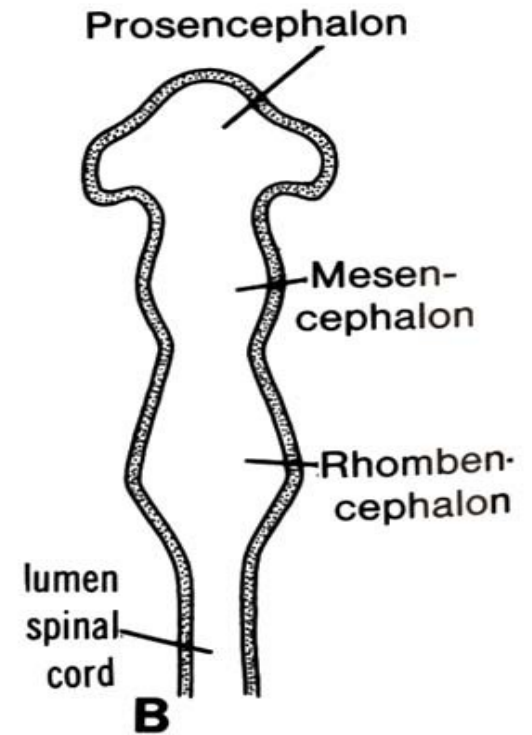
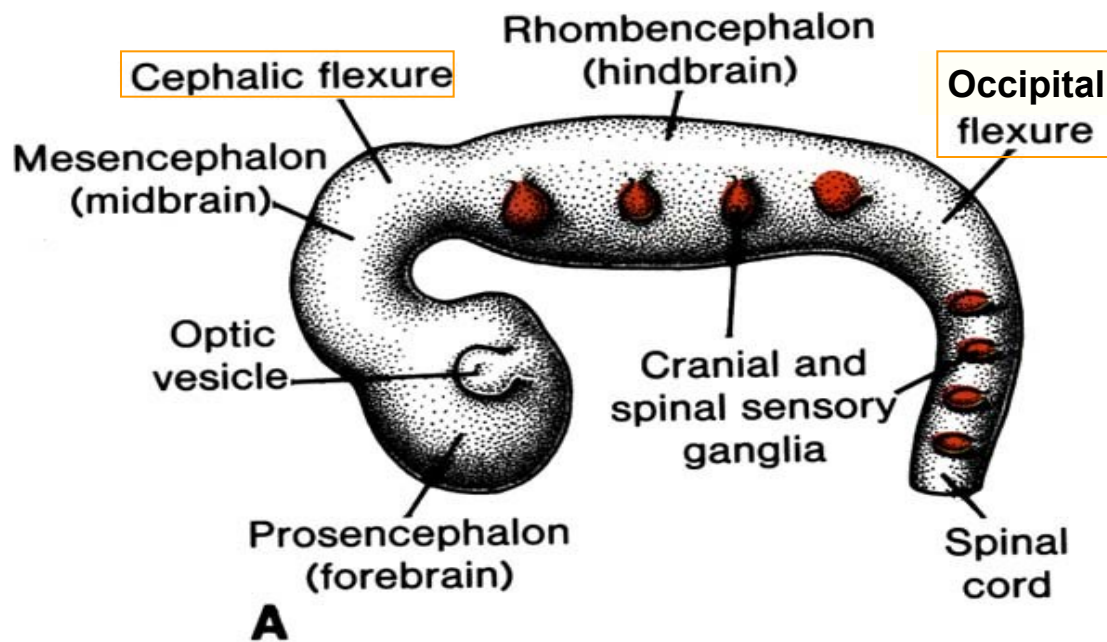
#



Vertebrate canal grows more rapidly than spinal cord and caudal end of spinal cord doesn't extend the entire length of canal in adult; it terminates at L1 in adults # .

# Brain development

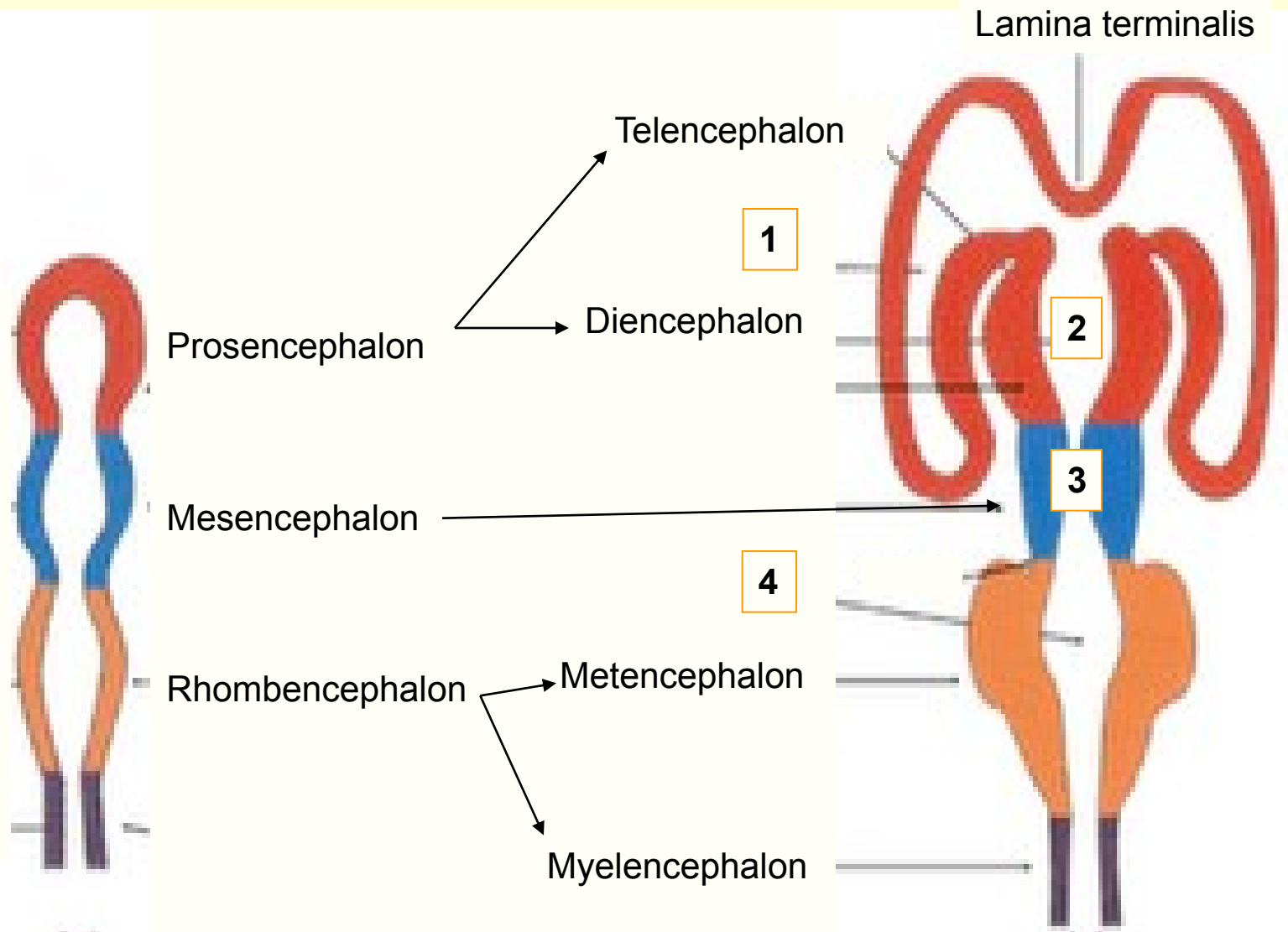
- Brain develops from cranial part of neural tube
- Week 4 – three primary brain vesicles:
  - prosencephalon** (forebrain)
  - mesencephalon** (midbrain)
  - rhombencephalon** (hindbrain)



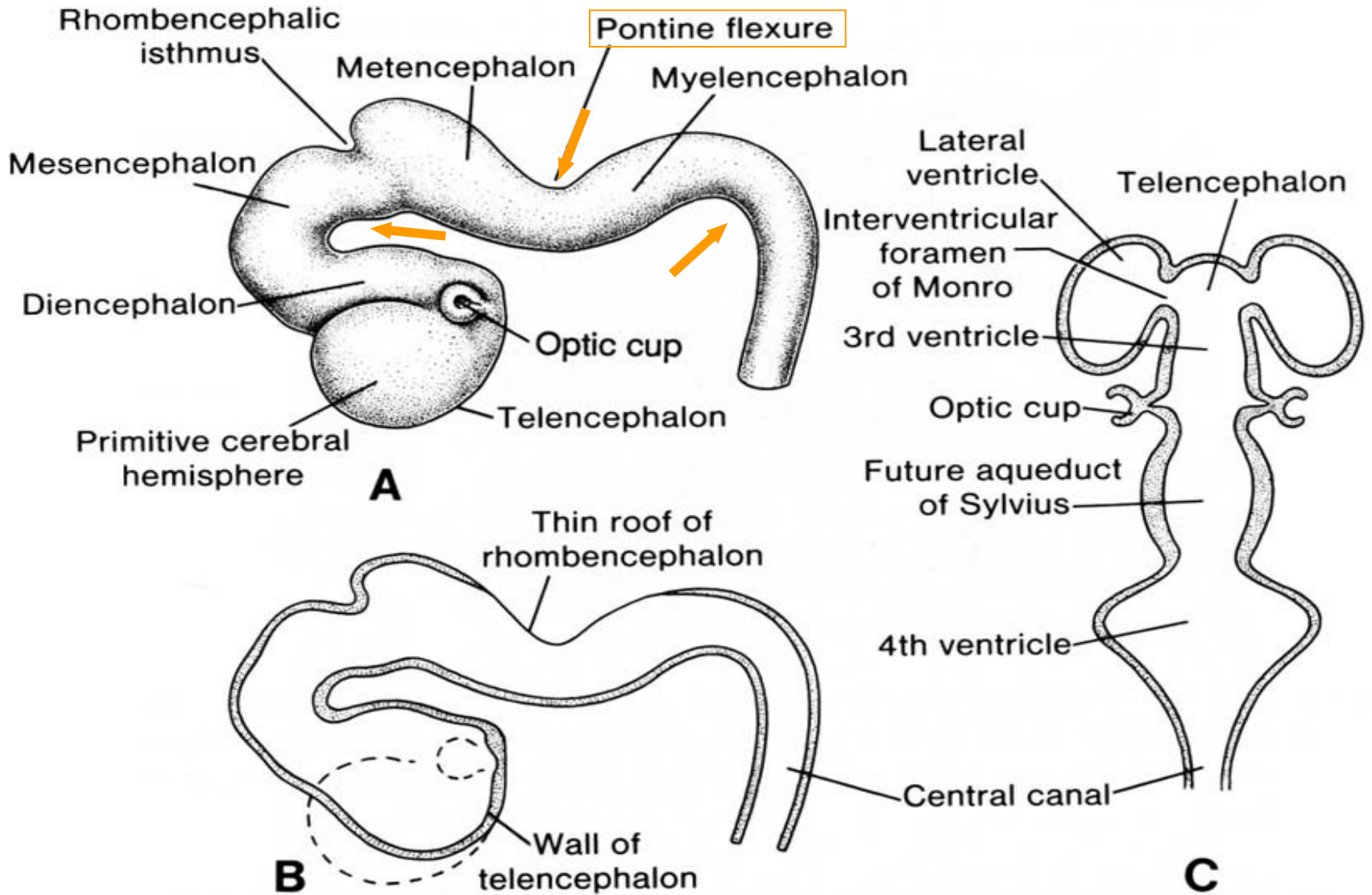


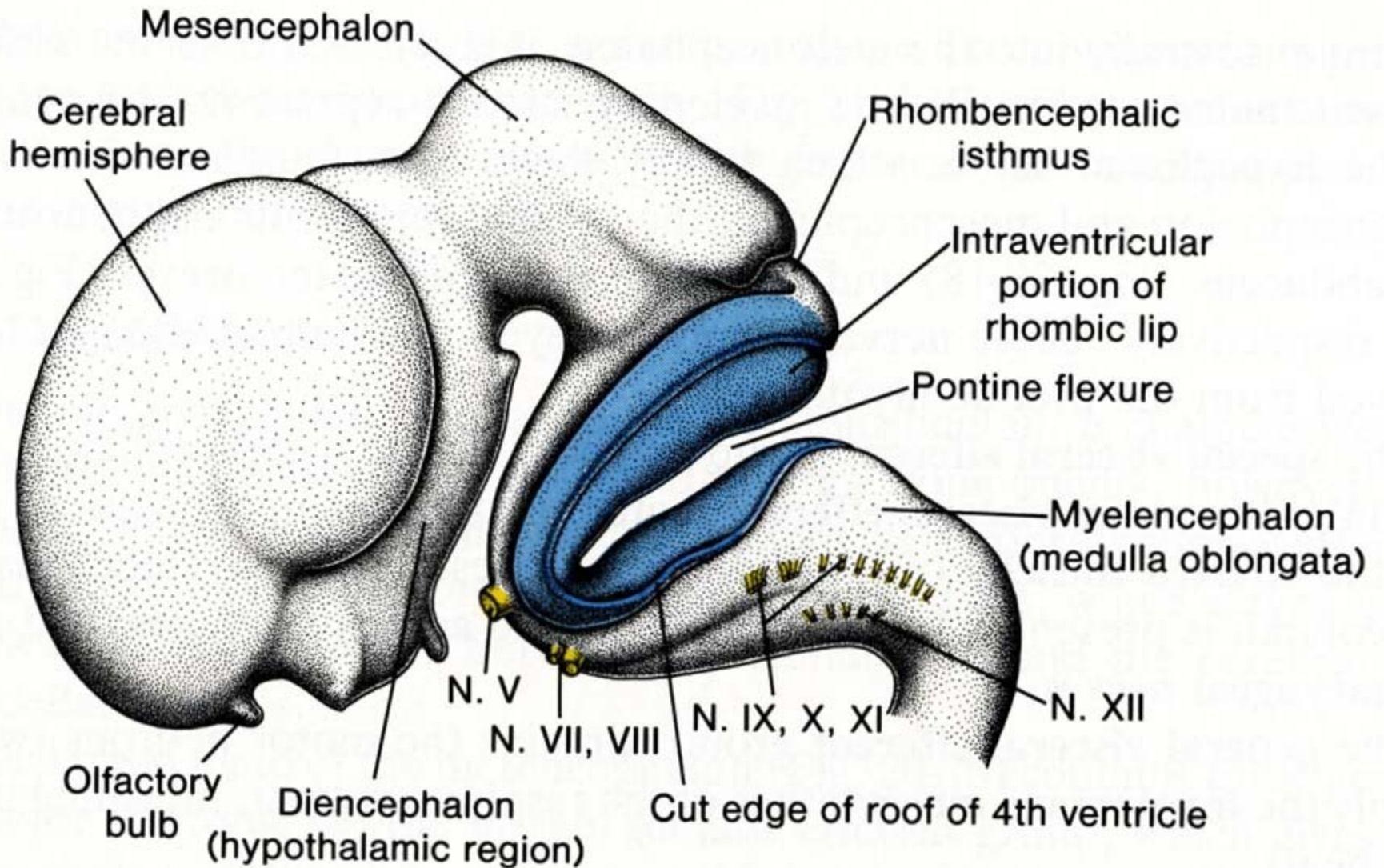
# 5 secondary vesicles:

week 5



1 – ventriculi lat., 2 – ventriculus tertius, 3 – aqueductus cerebri, 4 – ventriculus quartus





# CNS malformations

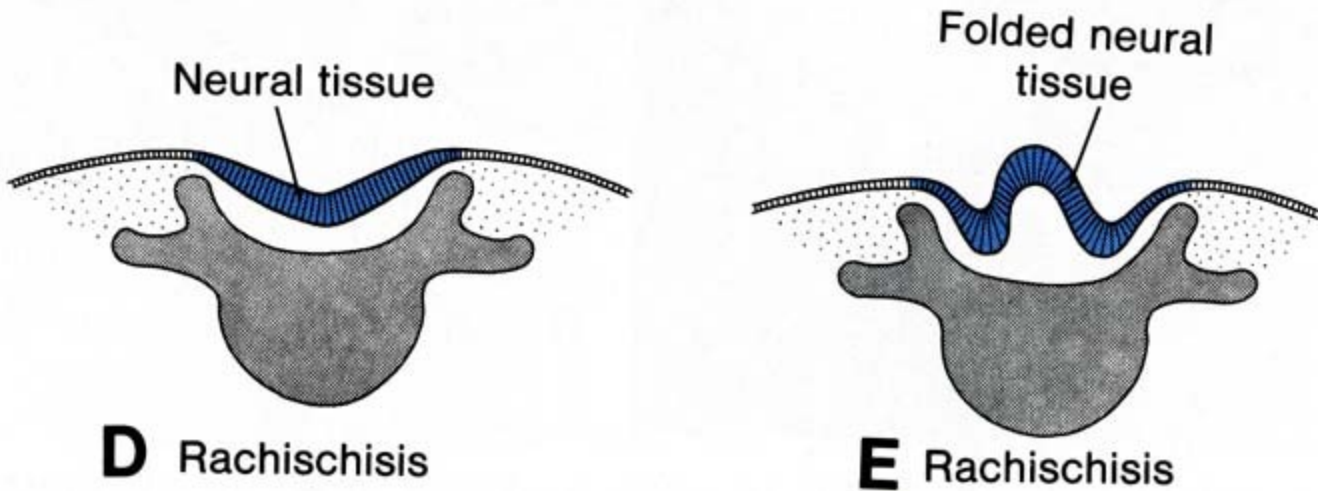
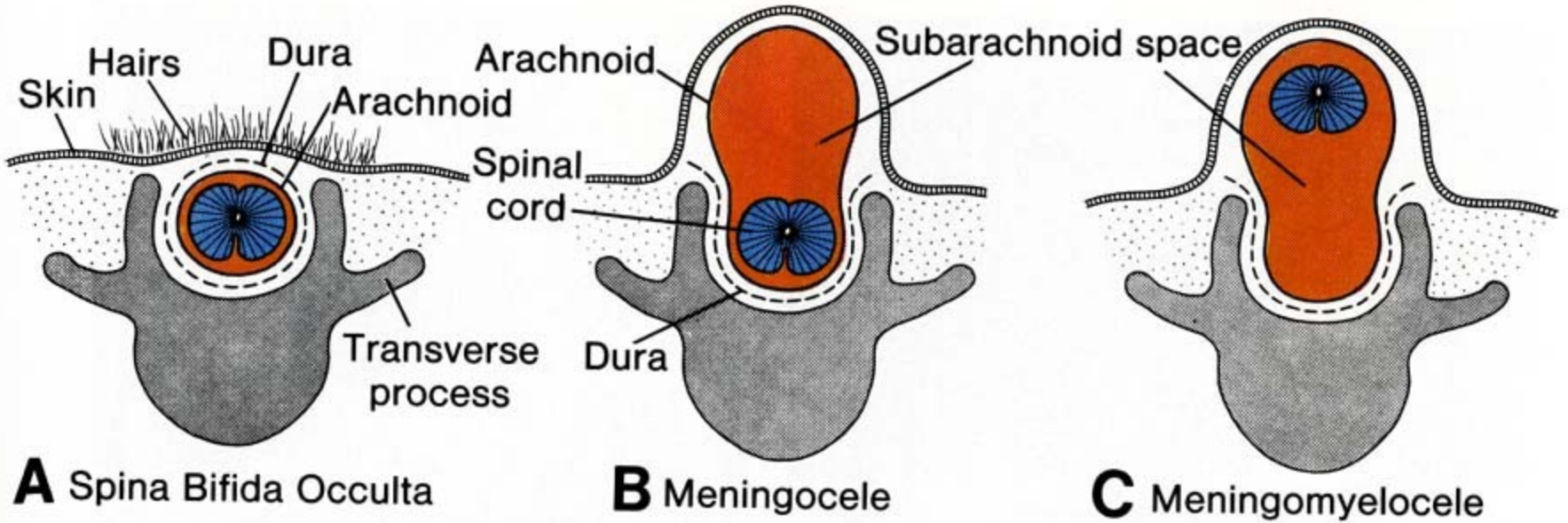
- failure neurulation (absence of notochord inductive influence or teratogen influence on neuroectodermal cells)
- defects of spinal cord
- defects of brain
- difficult malformations of CNS are usually connected with skull or spinal column (vertebral) defects.

# Spinal cord malformations

Defects - clefts of vertebral arches (rarely bodies)

- Meningocele
  - Meningomyelocele
  - Meningohydromyelocele
- } **spina bifida cystica**
- **Myeloschisis** – complete cleft of spinal column in the whole length





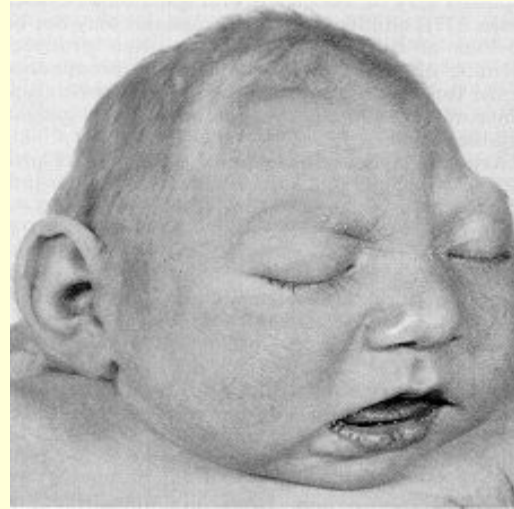
# Brain malformations

- Anencephalia (†) (+ myeloschisis)



# Brain malformations

- Microcephalia



- Hydrocephalus

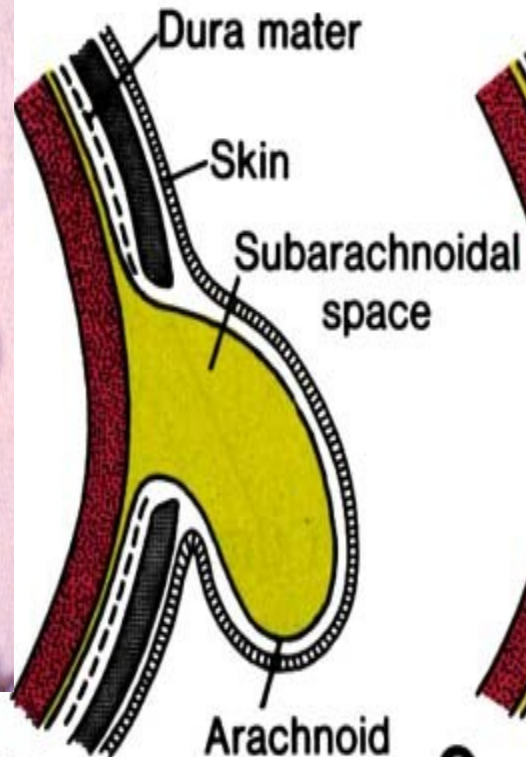




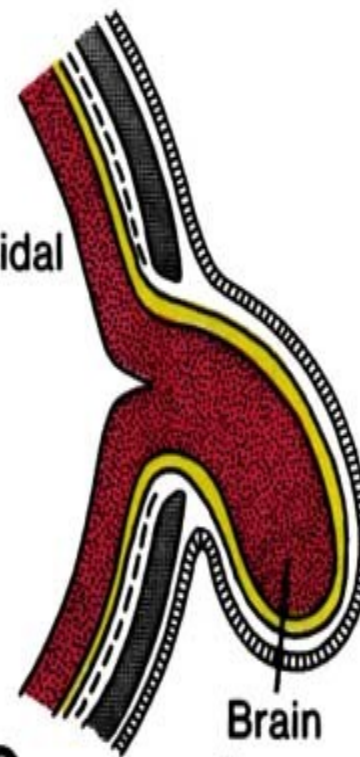
# Brain and meninges hernia(tion)



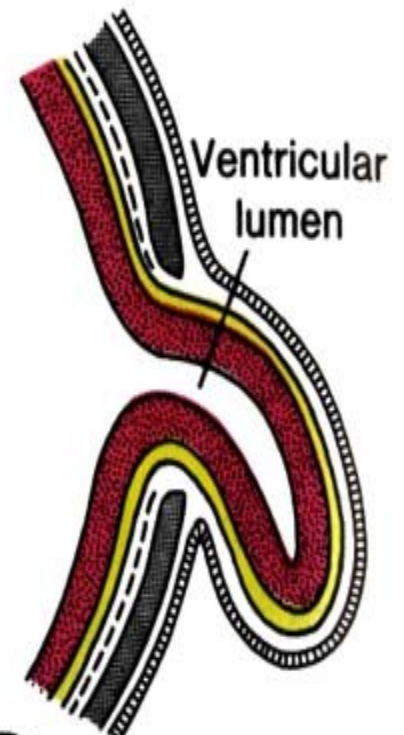
**A**  
Meningoencephalocele



**B**  
Meningocele



**C**  
Meningoencephalocele



**D** Meningohydro-encephalocele



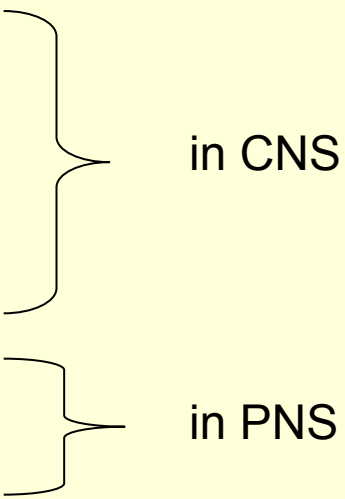
# General histology - questions

- Nerve tissue – definition, structure, function and origin.
- Microscopic structure of nerve cell, types of neurons. The sheaths of nerve processes.
- Synapses – their structure and function. Nerve mediators (neurotransmitters).
- Central and peripheral nerve endings.
- Neuroglia – classification, cytological character and function.

# Terms

- Neuron – perikaryon – axon (= neurite) – dendrite(s)
- Nissl bodies = rough ER
- Axon hillock
- Myeline sheath
- Schwann sheath
- Mesaxon
- Internodium
- Node of Ranvier
- Neuron – classification
- Synapse (presynaptic knobe, synaptic cleft, postsynaptic membrane)
- Neurotransmitters

# Terms

- Neuroglia - classification
  - Oligodendroglia
  - Astrocytes
  - Microglia (of Horteg)
  - Ependyma - tanocytes
  - Schwann cells
  - Satelite cells
- 
- The diagram consists of two vertical curly braces on the right side of the list. The upper brace groups the first four items (Oligodendroglia, Astrocytes, Microglia, and Ependyma - tanocytes) and is labeled 'in CNS'. The lower brace groups the last two items (Schwann cells and Satelite cells) and is labeled 'in PNS'.
- in CNS
- in PNS

# Special histology - questions

- Structure of the brain cortex. Cyto- and myeloarchitecture.
- Structure of the cerebellum. Synapses of the cerebellum.
- Microscopic structure of the spinal cord.
- Microscopic structure of ganglia and peripheral nerves.
- Ependyma, plexus chorioideus and meninges.

# Terms

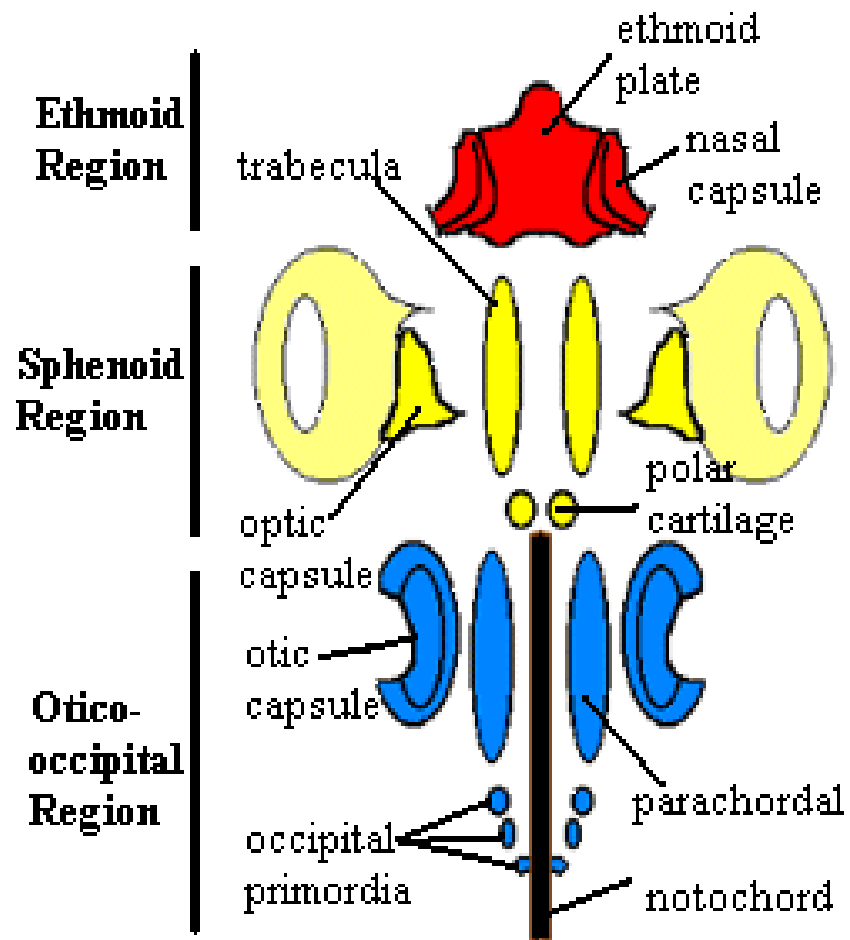
- Brain cortex – 6 layers (lamina)
- Cajal cells, Martinotti cells, granular and pyramidal cells
- Membrana limitans gliae superficialis et profunda (seu perivascularis)
- Brain barrier
- Cerebellum – 3 layers of cortex (stratum)
- Purkinje cells, basket cells, granular cells
- Glomeruli cerebellares
- Mossy and climbing fibers

# Terms

- Dura mater – arachnoidea – pia mater
- Endoneurium – perineurium – epineurium
- Plexus chorioideus

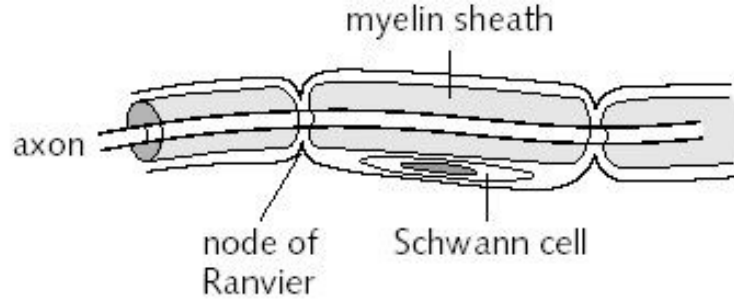




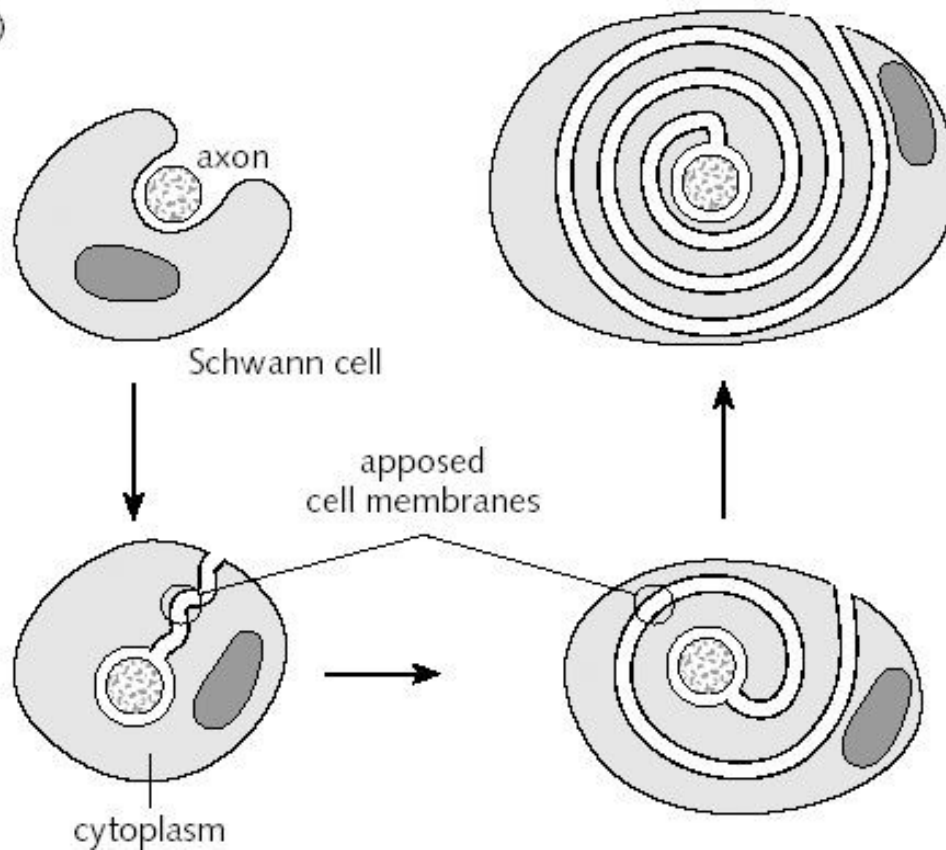


**Figure 3. Schematic view of vertebrate braincase development**

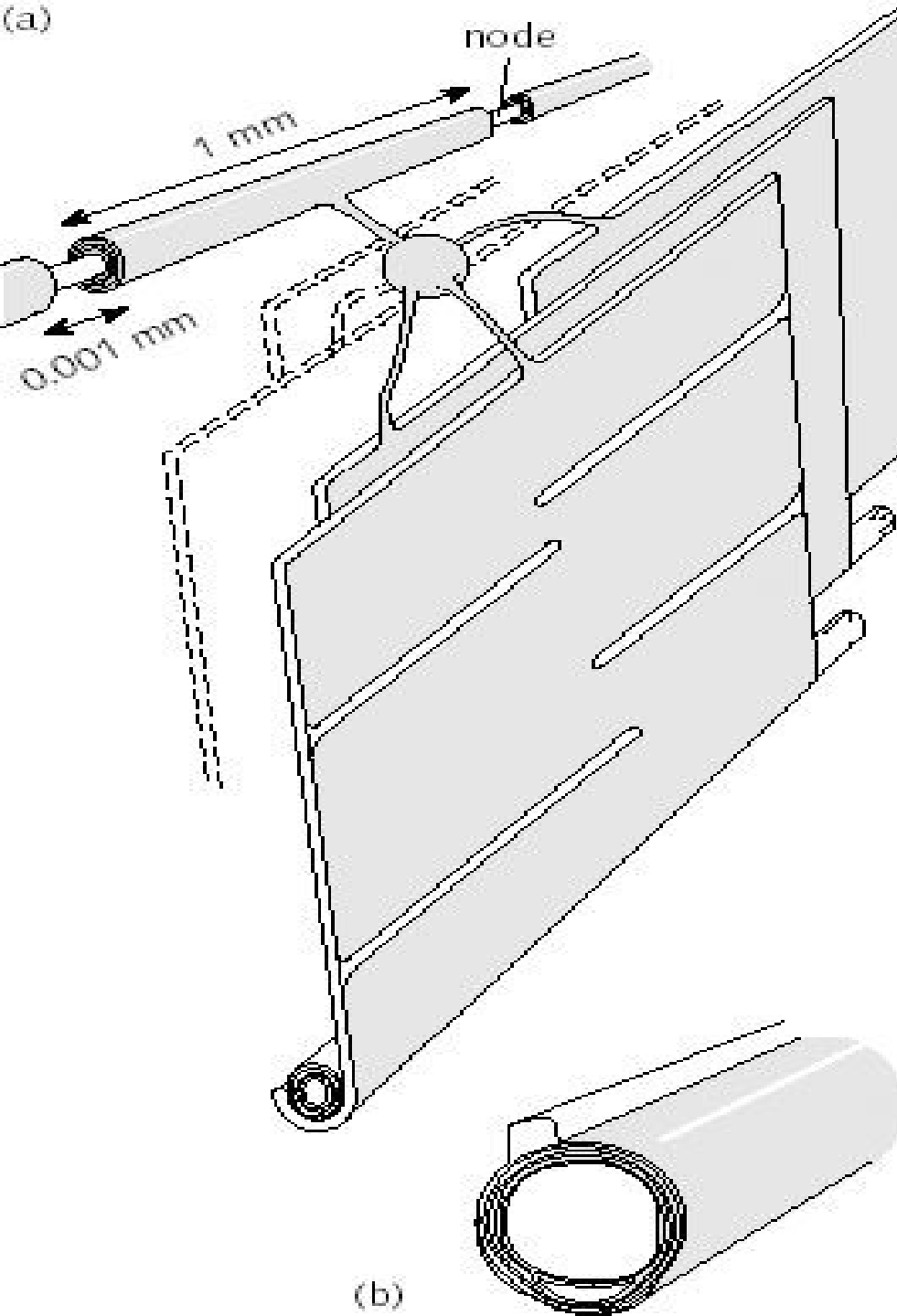
(a)



(b)

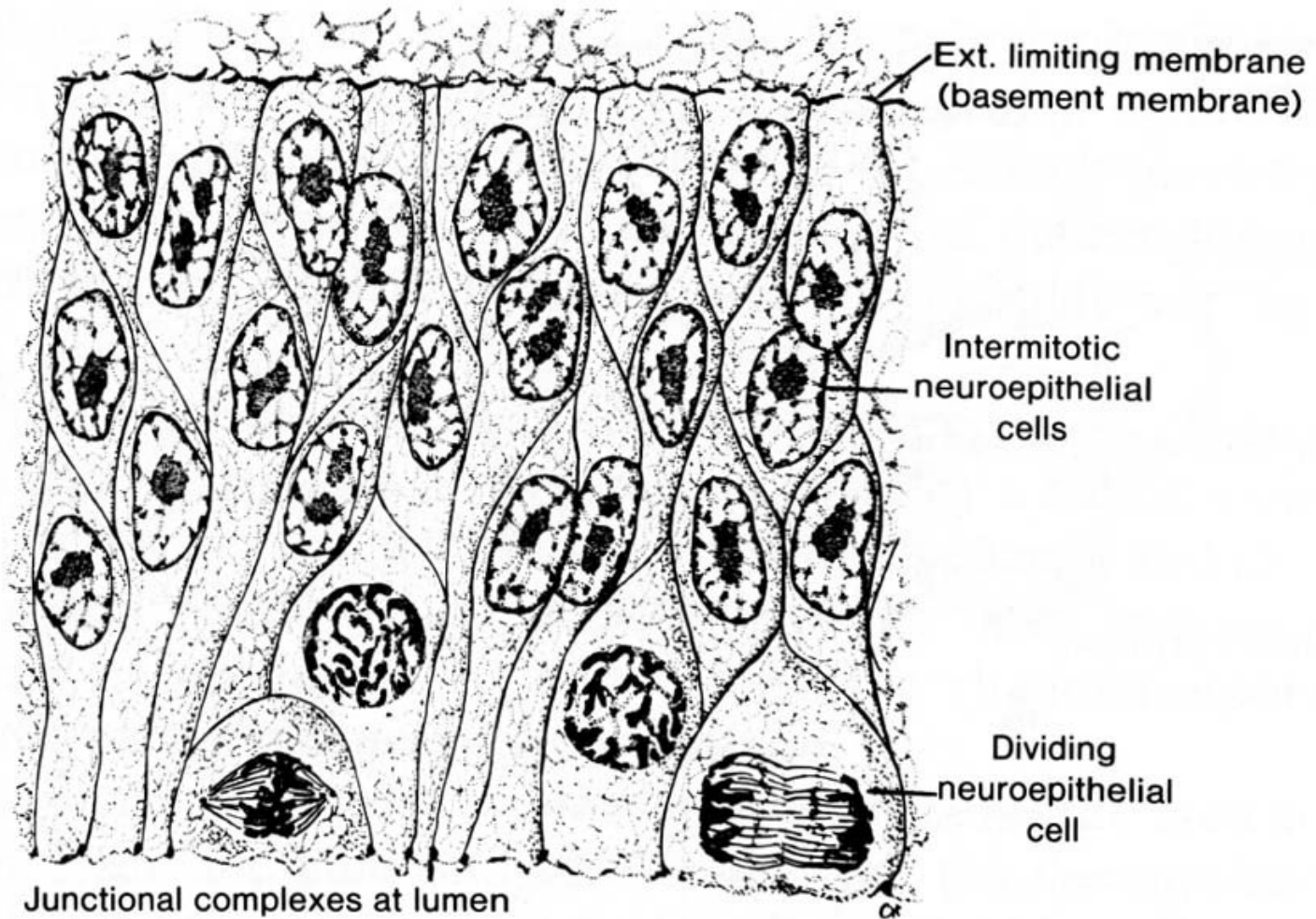


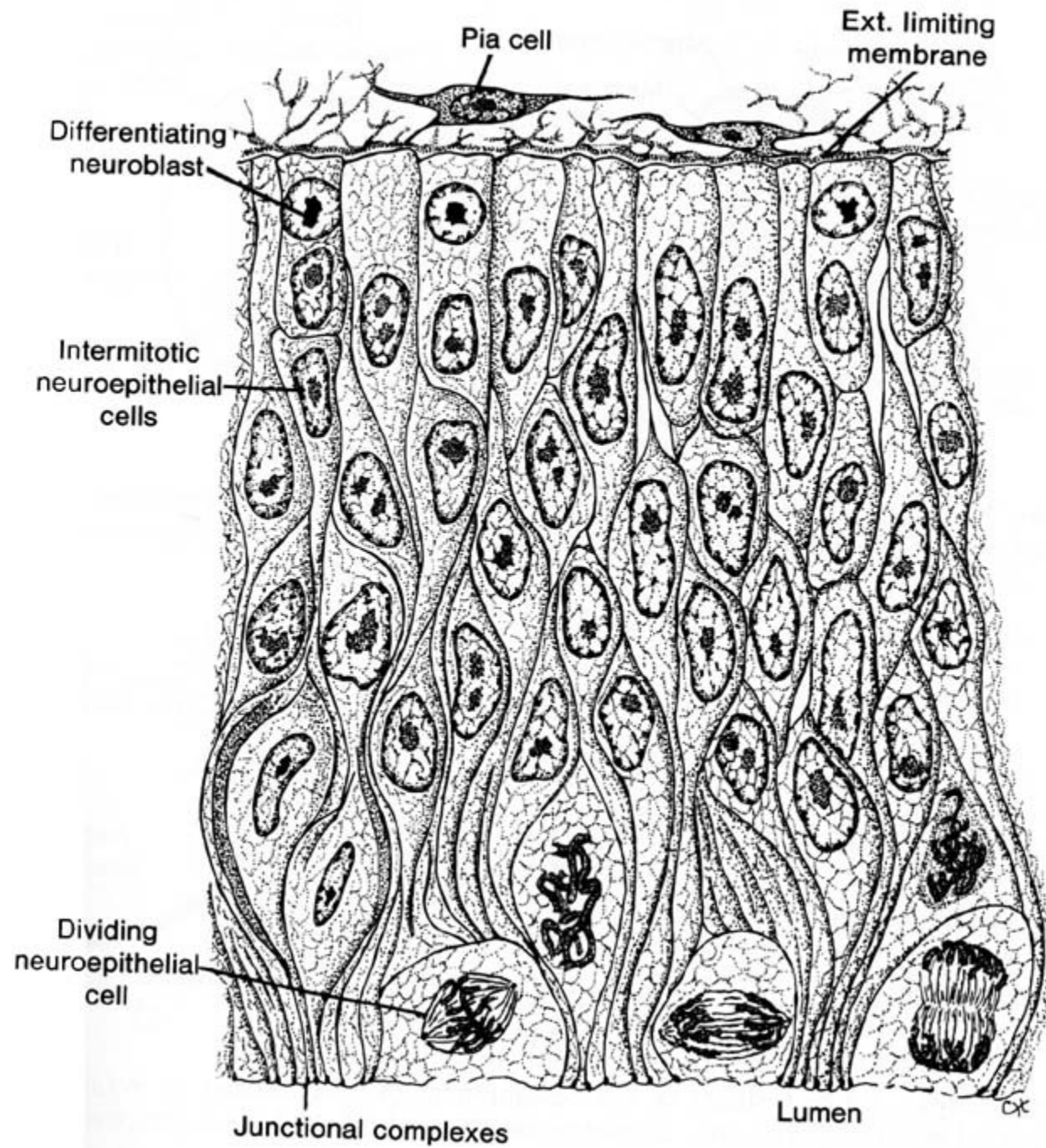
*Fig. 1 (a) A myelinated axon in the peripheral nervous system and (b) its development. Each Schwann cell myelinates a single axon, to which it is directly apposed. During development (anticlockwise) Schwann cells loosely ensheath axons and the myelin sheath grows around the axon to form concentric layers, which become tightly apposed*

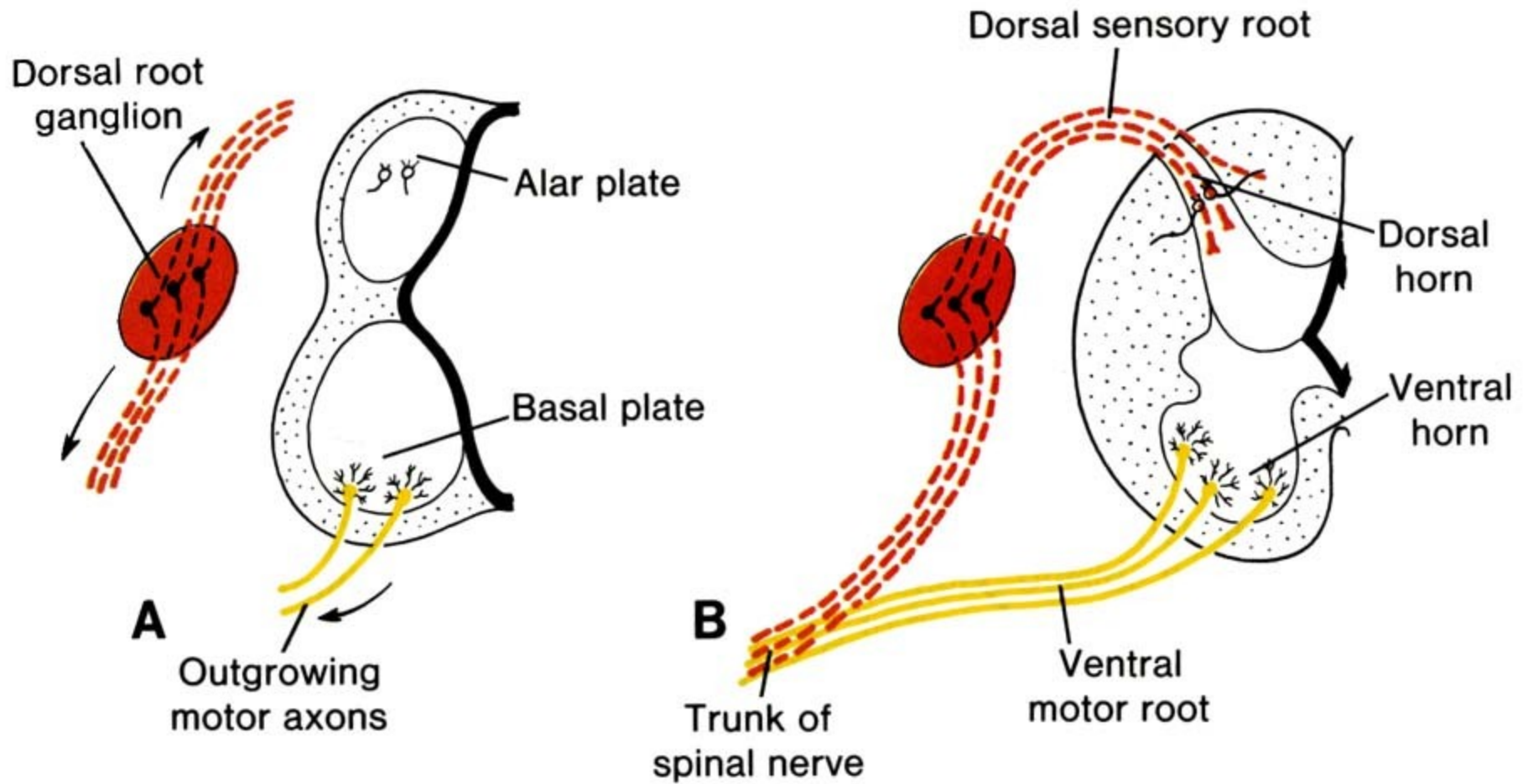


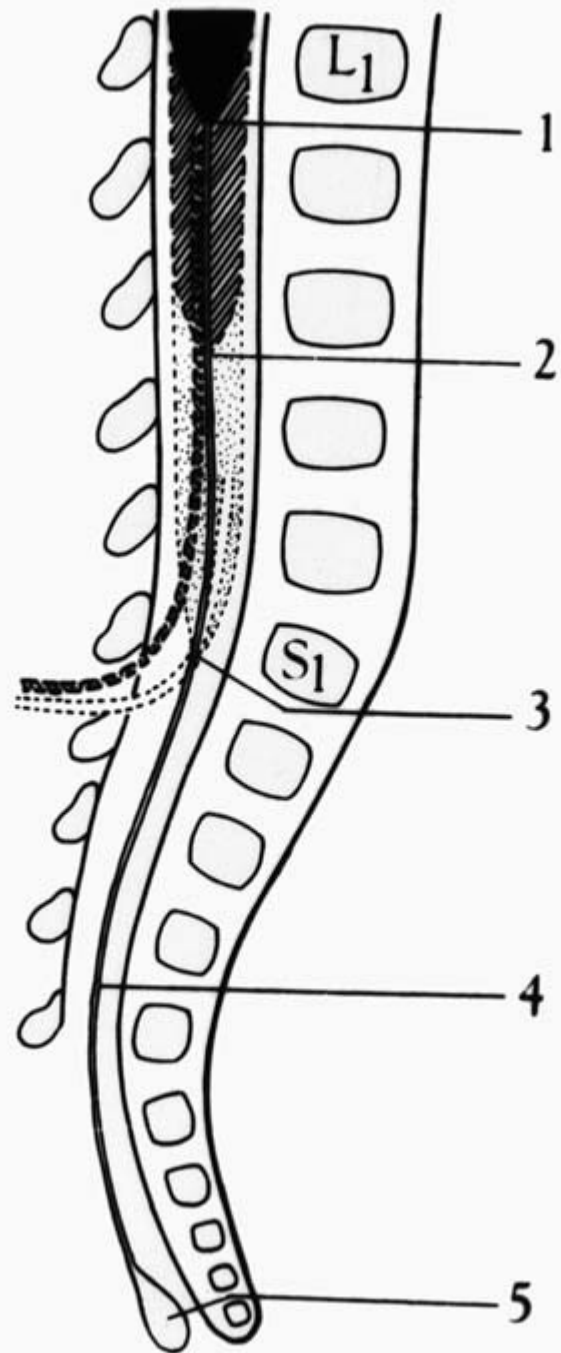
*Fig. 3 Myelination in the central nervous system. A single oligodendrocyte myelinates numerous axons (a) and, in section, concentric layers of myelin are seen to spiral around the axon (b). Myelin sheaths are arranged along axons in segments 1 mm long separated by short nodes, and would appear as large sheets if they were unwrapped from around the axon*

# HISTOGENEZE NERVOVÉ TRUBICE













a



b



c



d

hydrocephalus