

Chapter 7: Neurulation and organogenesis

1- Neurulation

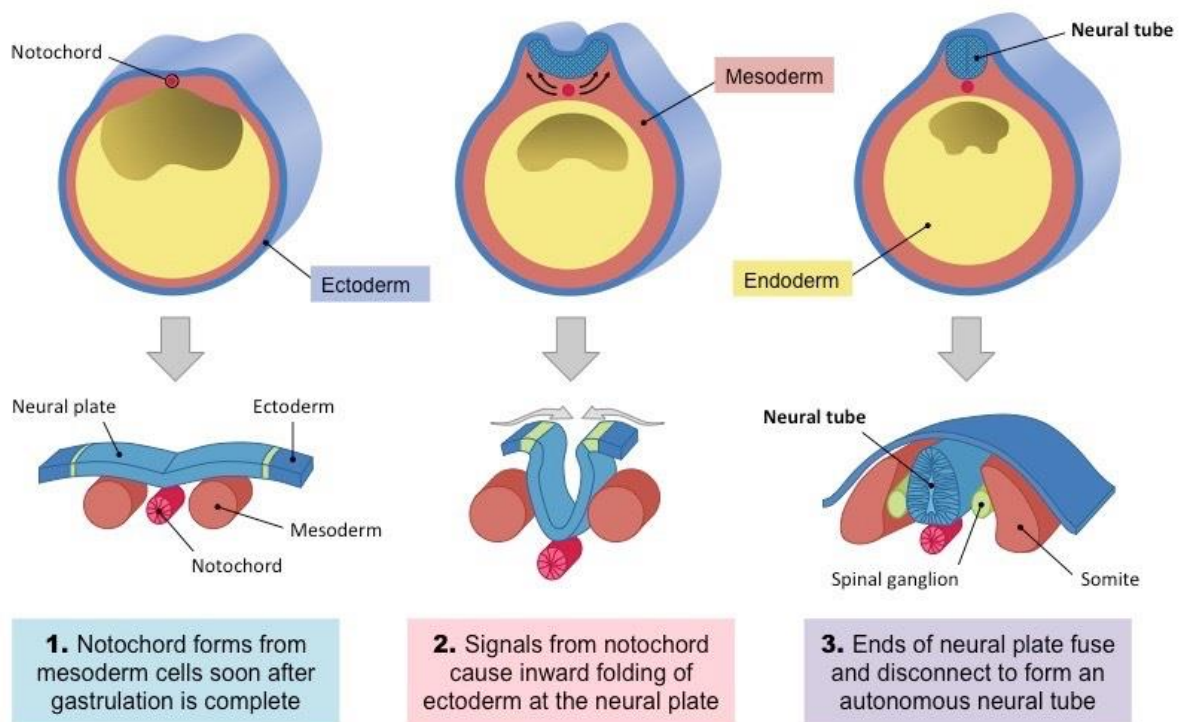
1-1- definition

Neurulation is a stage of embryonic development during which the central nervous system is established in the dorsal region of the embryo.

1-2- The stages of neurulation

Neurulation occurs in three stages (figure 1):

- A. Neural plate stage.
- B. Neural groove stage.
- C. Neural tube stage.



- All tissues are derived from three initial germ layers (ectoderm, mesoderm, endoderm) formed via *gastrulation*
- In chordates, a flexible notochord will develop during gastrulation and lead to the subsequent formation of a neural tube

The formation of a neural tube in embryonic chordates occurs via the process of *neurulation*

- Cells located in the outer germ layer (ectoderm) differentiate to form a neural plate

- The neural plate then bends dorsally, folding inwards to form a groove flanked by a neural crest
- The infolded groove closes off and separates from the neural crest to form the neural tube
- The neural tube will elongate as the embryo develops and form the central nervous system (brain and spinal cord)
- The cells of the neural crest will differentiate to form the components of the peripheral nervous system
- The neural tube differentiates into the central nervous system (brain + spinal cord) and the neural crest gives rise to the peripheral nervous system and part of the craniofacial skeleton. At this stage, the embryo is a neurula.

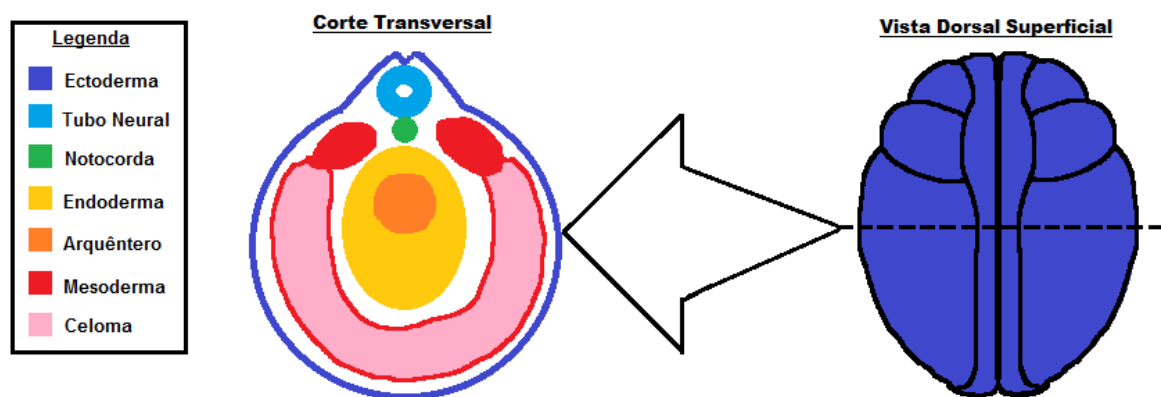


Figure 2: Cross-section in a young neurula

Evolution of the neural tube.

The neural tube undergoes changes:

The cephalic portion expands and delineates 3 primary vesicles which are the prosencephalon, the mesencephalon, and the rhombencephalon. The neural tube remains in the form of a simple tube and will give rise to the future spinal cord. At this very moment, two spherical regions appear at the level of the prosencephalon, the optic vesicles, which will become eyes.

The prosencephalon subdivides into two: diencephalon and telencephalon. The diencephalon will form structures such as the thalamus and the hypothalamus. It is in the diencephalon, more precisely in the thalamus, that the optic vesicles are connected. The telencephalon forms the deep nuclei and the cerebral hemispheres.

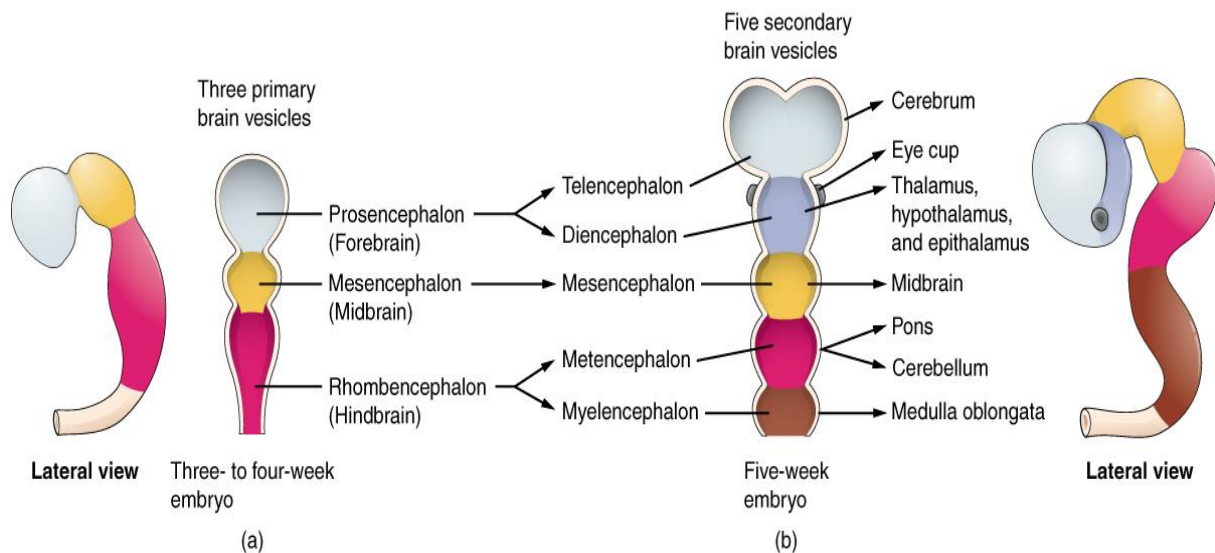


Figure 3: Evolution of the neural tube.

2- Organogenesis

2-1- Definition

Organogenesis is the process of organ formation in a metazoan during embryonic development. It takes place from the three fundamental embryonic layers: the ectoderm, the mesoderm, and the endoderm. Several processes, such as differentiation and induction, are involved in organogenesis to give rise to tissues that form organs.

2-2- Derivatives of the embryonic layers

The following table summarizes the fate of the three embryonic germ layers.

Ectoderm	mesoderm	Endoderm
<ul style="list-style-type: none"> -Epidermis of the skin and its derivatives (including sweat glands, hair follicles) -Epithelium lining the anterior and posterior digestive tract -Cornea and lens 	<ul style="list-style-type: none"> -Chorde -Squelette -Muscles squelettiques -Muscles du tube digestif -Appareil excréteur 	<ul style="list-style-type: none"> -Lining epithelium of the digestive tract -Lining epithelium of the respiratory system -Lining of the urethra, bladder and genital tract -Liver

<ul style="list-style-type: none"> -Nervous tissue -Sensory receptors in the epidermis -Adrenal medulla -Tooth enamel -Epithelium of the epiphysis and pituitary gland 	<ul style="list-style-type: none"> -Système circulatoire et Lymphatique -Appareil génital (sauf les cellules germinales qui se différencient en général très précocement dans l'embryon) -Derme de la peau -Revêtement de la cavité Corporelle -Corticosurrénale 	<ul style="list-style-type: none"> -Pancreas -Thymus -Thyroid gland and Parathyroid
---	---	--