C.N.S
DEVELOPMENT
LECT#1

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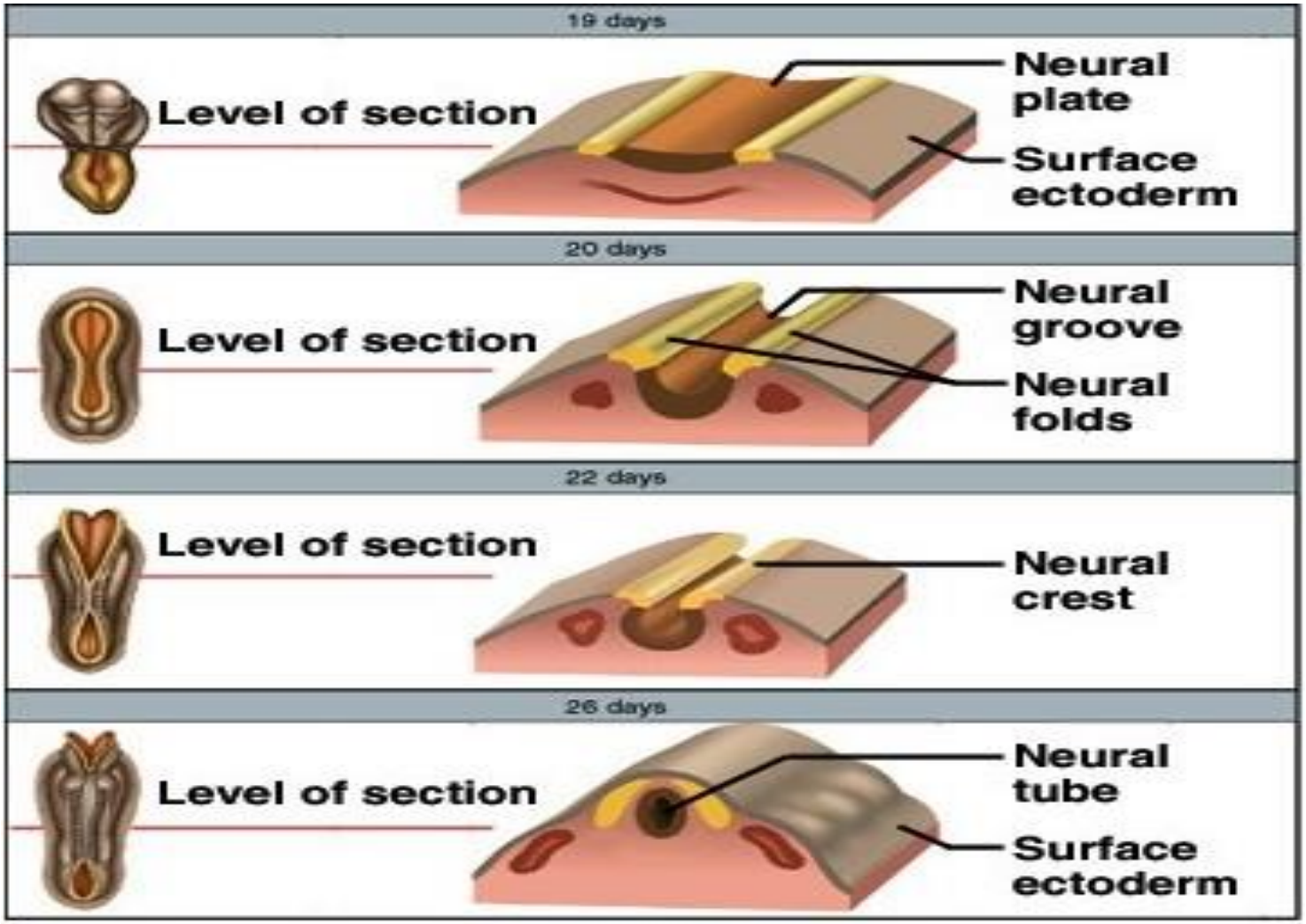
Learning objectives

- Neural tube formation, neural crest cells origin;
- Brain development
- Primary brain vesicles
- Secondary brain vesicles

Stages of Embryonic development



Neurulation

Neural Tube

- The nervous system develops when the **notochord** induces its overlying ectoderm to become **neuroectoderm** and
- This now develop into the **neural plate**.
- The neural plate folds along its central axis to form a **neural groove**
- lined on each side by a **neural fold**

- The two neural folds fuse together and pinch off to become the **neural tube**.
- Fusion of the neural folds begins in the middle of the embryo and moves cranially and caudally.
- The **cranial** open end of the tube is the **anterior (rostral) neuropore**, and
- the **caudal** open end of the tube is the **posterior (caudal) neuropore**.
- The anterior neuropore closes on or before **day 26** and
- the caudal neuropore closes before the **end of the fourth week**.

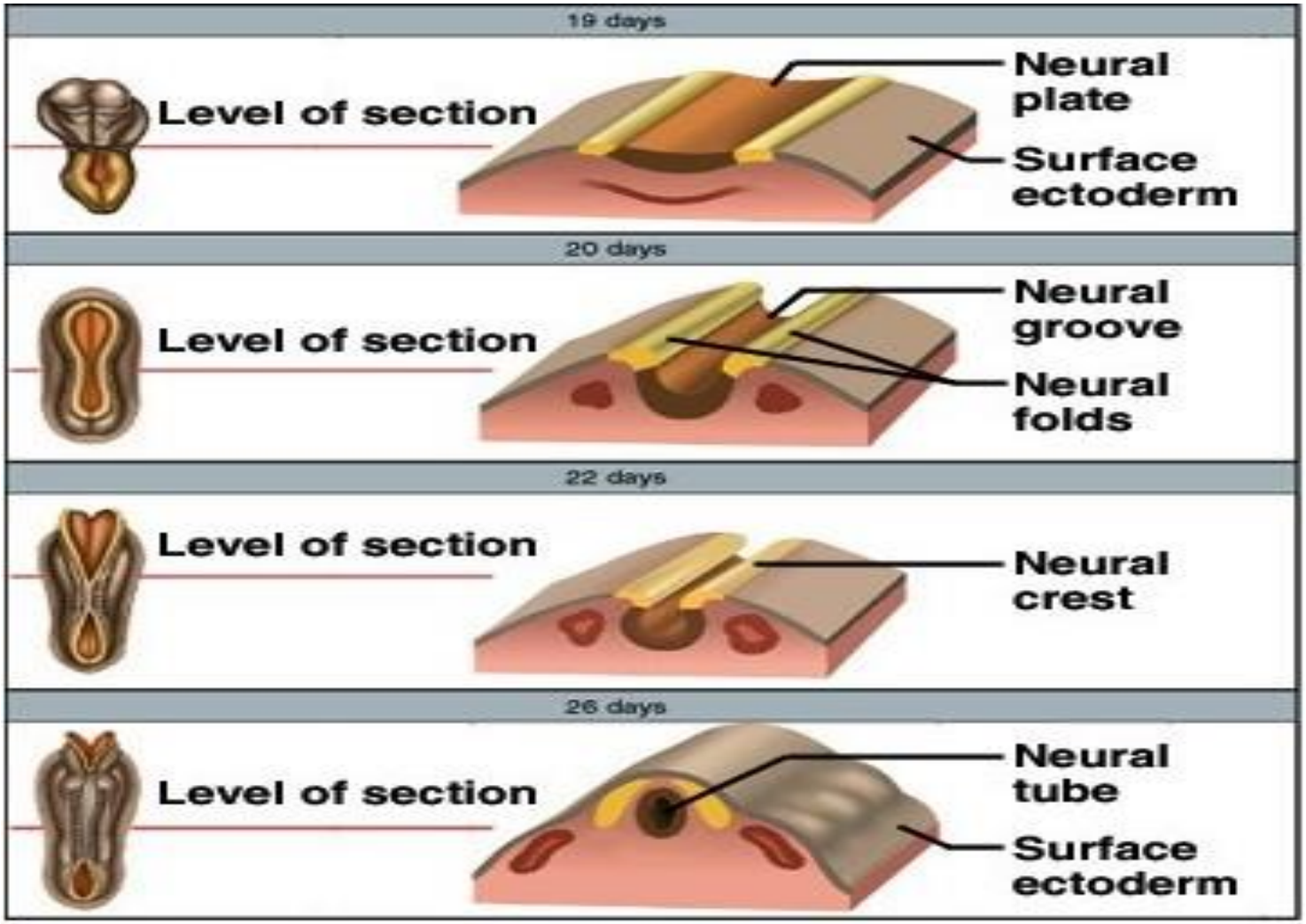
Neural Crest

- Some cells from the **neural folds** give rise to pleuripotent **neural crest** cells,
- they migrate widely in the embryo to give rise to many nervous structures:
- *Spinal ganglia (dorsal root ganglia)*
- *Ganglia of the autonomic nervous system*
- *Ganglia of some cranial nerves*
- *Sheaths of peripheral nerves*
- *Meninges of brain and spinal cord*
- *Pigment cells*
- *Suprarenal medulla*
- *Skeletal and muscular components in the HEAD*

Summary: Embryonic Development

- Nervous system develops from ectoderm
  - by 3rd week, neural plate becomes a groove with neural folds along each side
  - by 4th week, neural folds join to form neural tube
  - lumen of the neural tube develops into central canal of spinal cord & ventricles of the brain
  - cells along the margin of the neural groove is called the neural crest
    - develop into sensory and sympathetic neurons & schwann cells
  - NB: By 4th week, neural tube exhibits 3 anterior dilations

Stages of Embryonic development

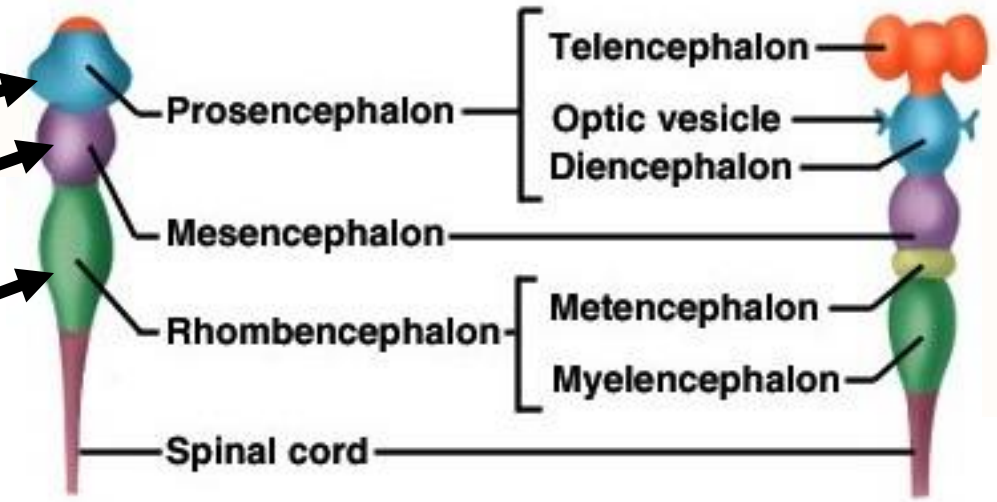


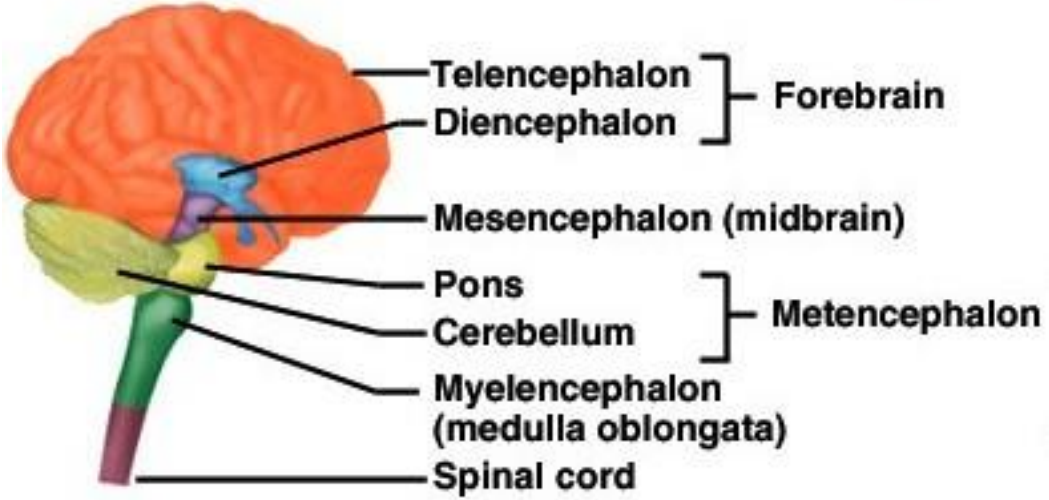
Brain development

- By wk 4, the neural tube forms three ***Primary Brain Vesicles***.
- The primary brain vesicles give rise to five ***Secondary Brain Vesicles***,
- which give rise to the various adult structures.

Brain Development

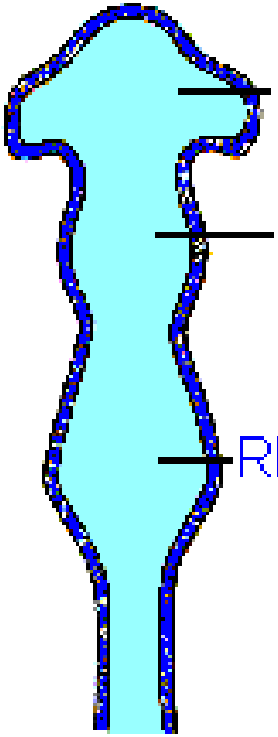
- 4th week
  - forebrain
  - midbrain
  - hindbrain
- 5th week
  - telencephalon
  - diencephalon
  - mesencephalon
  - metencephalon
  - myelencephalon





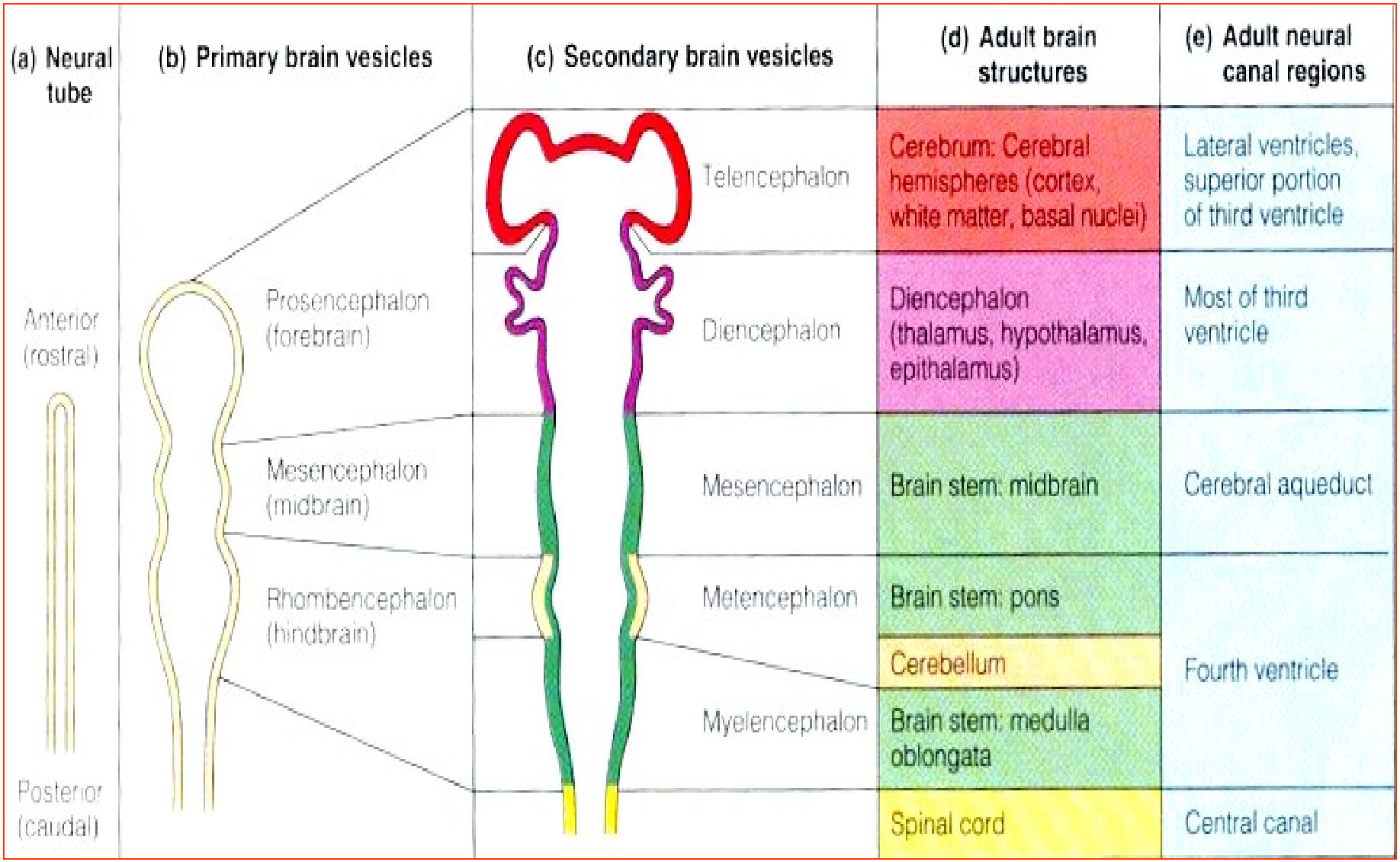
Day 23

Day 25



Longitudinal section of 25 day embryo showing three brain vesicles

Brain Development



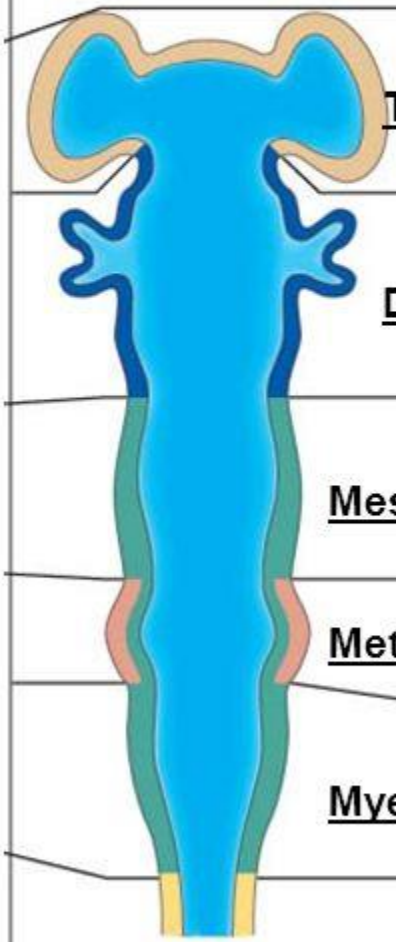
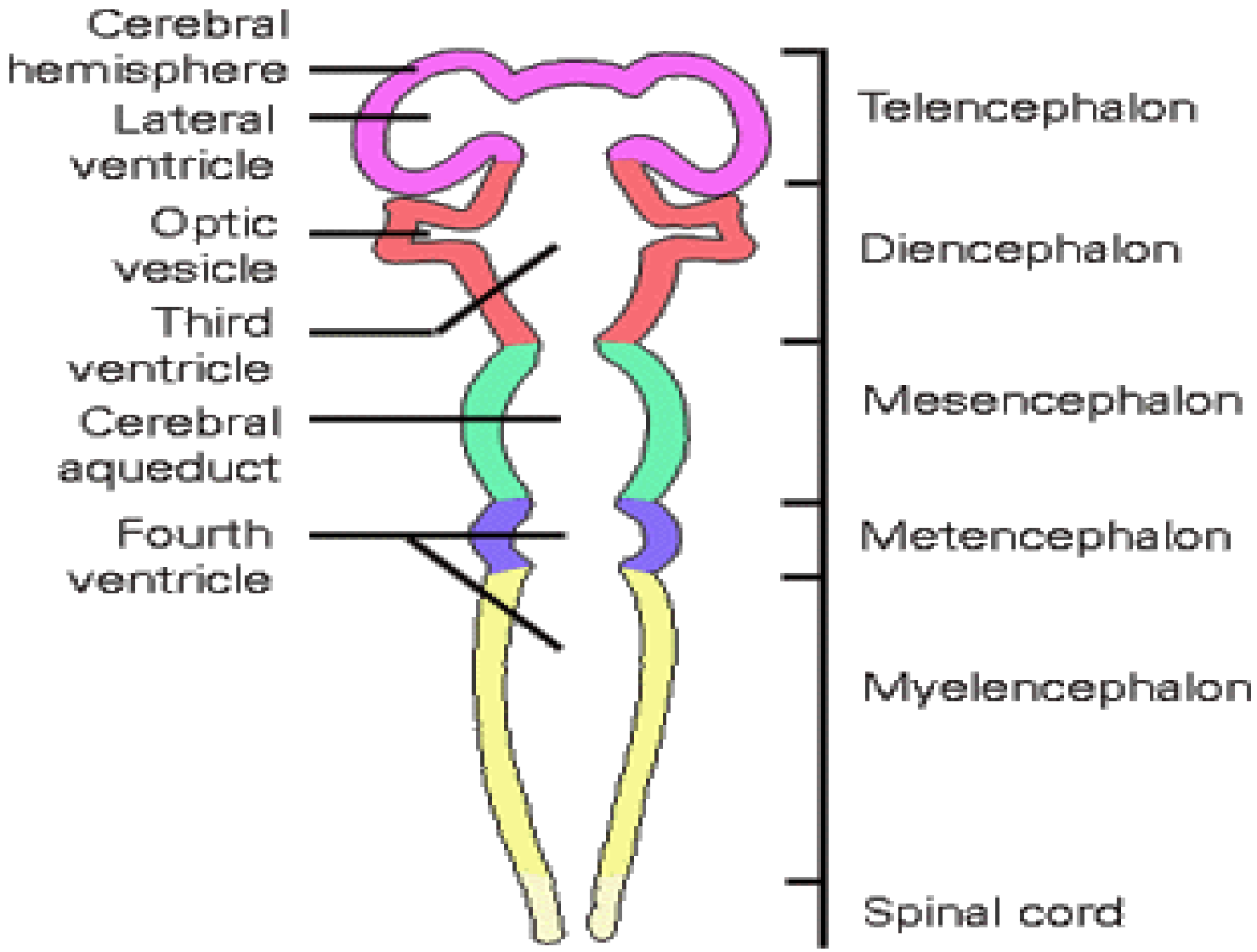
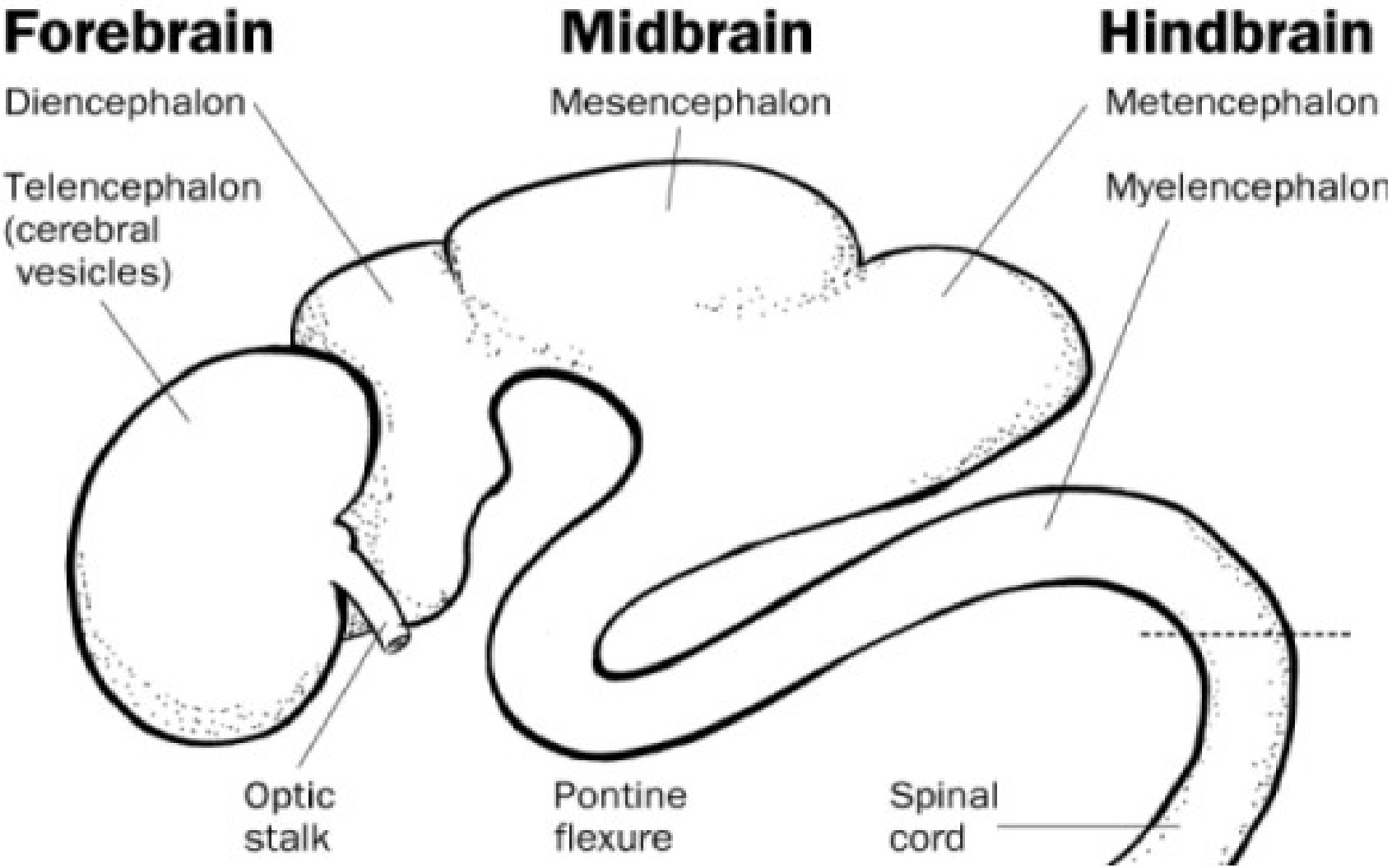
(c) Secondary brain vesicles	(d) Adult brain structures	(e) Adult neural canal regions
 Telencephalon	Cerebrum: cerebral hemispheres (cortex, white matter, basal nuclei)	Lateral ventricles
Diencephalon	Diencephalon (thalamus, hypothalamus, epithalamus), retina	Third ventricle
Mesencephalon	Brain stem: midbrain	Cerebral aqueduct
Metencephalon	Brain stem: pons	Fourth ventricle
	Cerebellum	
Myelencephalon	Brain stem: medulla oblongata	
	Spinal cord	Central canal

Figure 12.2c-e

Brain-5 vesicles/adult derivatives



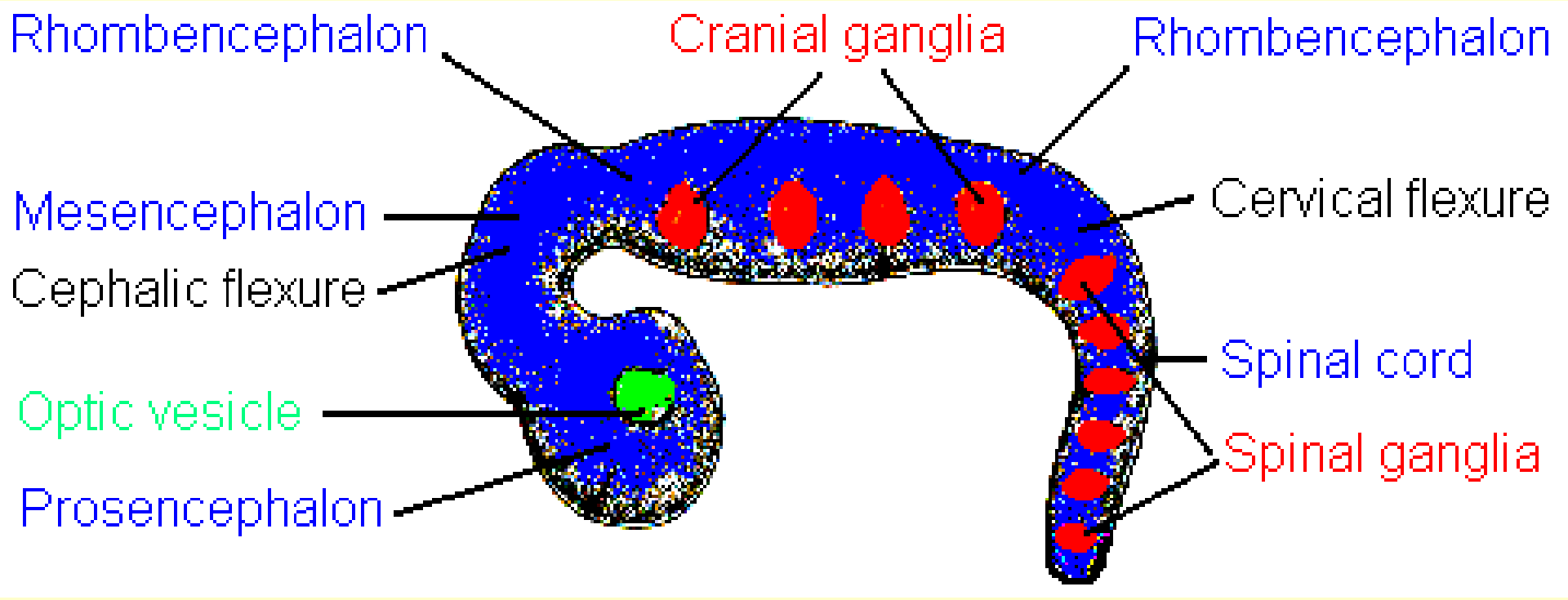
Week 5 brain stage development



Primary vesicles	Secondary vesicles	Adult structures
Forebrain vesicle (**prosencephalon**)	Telencephalon	Cerebral hemispheres, consisting of the cortex and medullary center, basal ganglia, lamina terminalis, hippocampus, the corpus striatum, and the olfactory system
	Diencephalon	Thalamus, epithalamus, hypothalamus, subthalamus, neurohypophysis, pineal gland, retina, optic nerve, mamillary bodies
Midbrain vesicle (**mesencephalon**)	Mesencephalon	Midbrain
Hindbrain vesicle (**rhombencephalon**)	Metencephalon	Pons and cerebellum
	Myelencephalon	Medulla

Flexures in neural tube

- During fourth week folding of the embryo is also taking place.
- So by the end of fourth week two flexures are obvious in neural tube.
  - Cephalic flexure. It located in mesencephalon region.
  - Cervical flexure. It is at the junction of Rhombencephalon and spinal cord.


Rhombencephalon
Cranial ganglia
Rhombencephalon
Mesencephalon
Cervical flexure
Cephalic flexure
Spinal cord
Optic vesicle
Spinal ganglia
Prosencephalon

Secondary brain vesicles

- During fifth week five secondary brain vesicles develop.

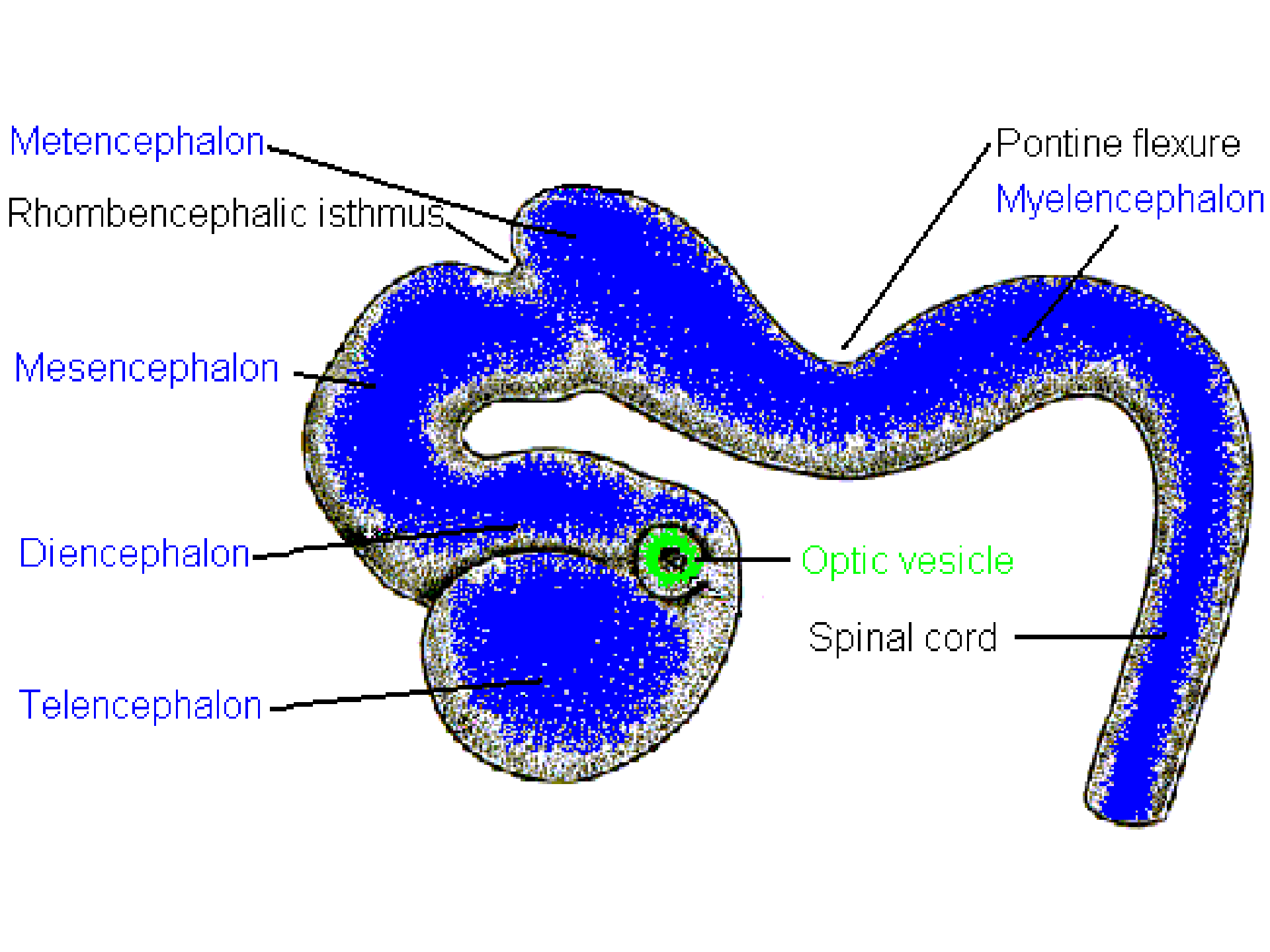
Prosencephalon divides into two secondary vesicles.

1. Telencephalon or endbrain vesicle
2. Diencephalons

Mesencephalon or midbrain vesicle does not divide.

Rhombencephalon divides into two secondary vesicles.

4. Metencephalon
5. Myelencephalon


Metencephalon
Rhombencephalic isthmus
Pontine flexure
Myelencephalon
Mesencephalon
Diencephalon
Optic vesicle
Spinal cord
Telencephalon

Ventricular System (Cerebrospinal Fluid System)

- Fluid filled cavities found within the developing brain system originate from lumen of the developing neural tube
- 5 cavities- lateral vent-1 pair
- -3rd vent
- -4th vent
- Lined by choroid plexus made of ependymal cells-BBB

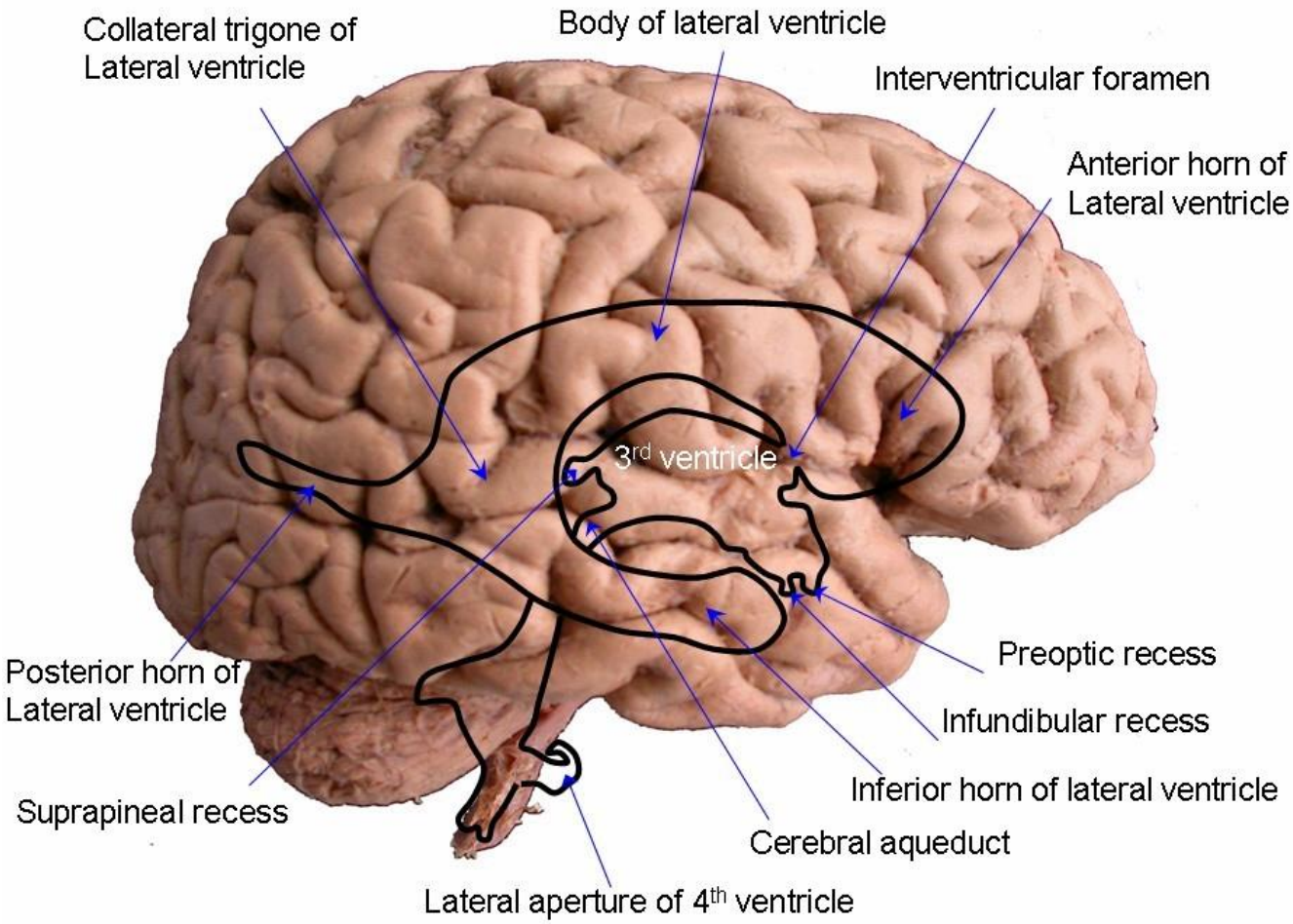
Ventricles in forebrain

- Lateral ventricles-one pair
- **Ventricles in brainstem:**
- Mesencephalon ◊ 3rd/cerebral aqueduct
- Metencephalon ◊ 4th ventricle
- Mylencephalon ◊ 4th ventricle

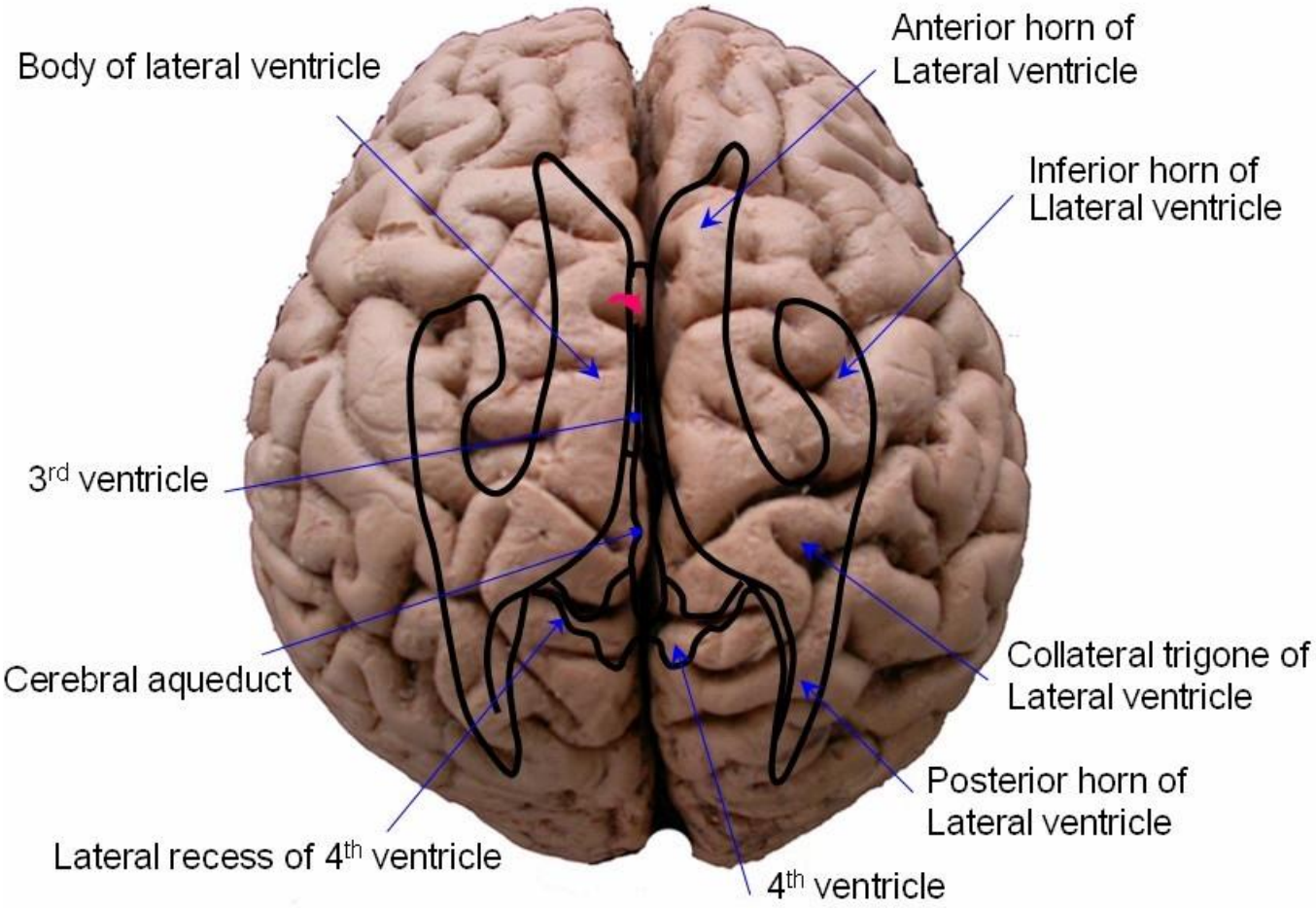
Ventricular communication in the brain

- Lateral-3rd vent ◊ foramen of Monro
- 3rd to 4th vent ◊ cerebral aqueduct of sylvius
- 4th to lateral aperture ◊ foramen of luschka
- 4th to median aperture ◊ foramen of mengedie

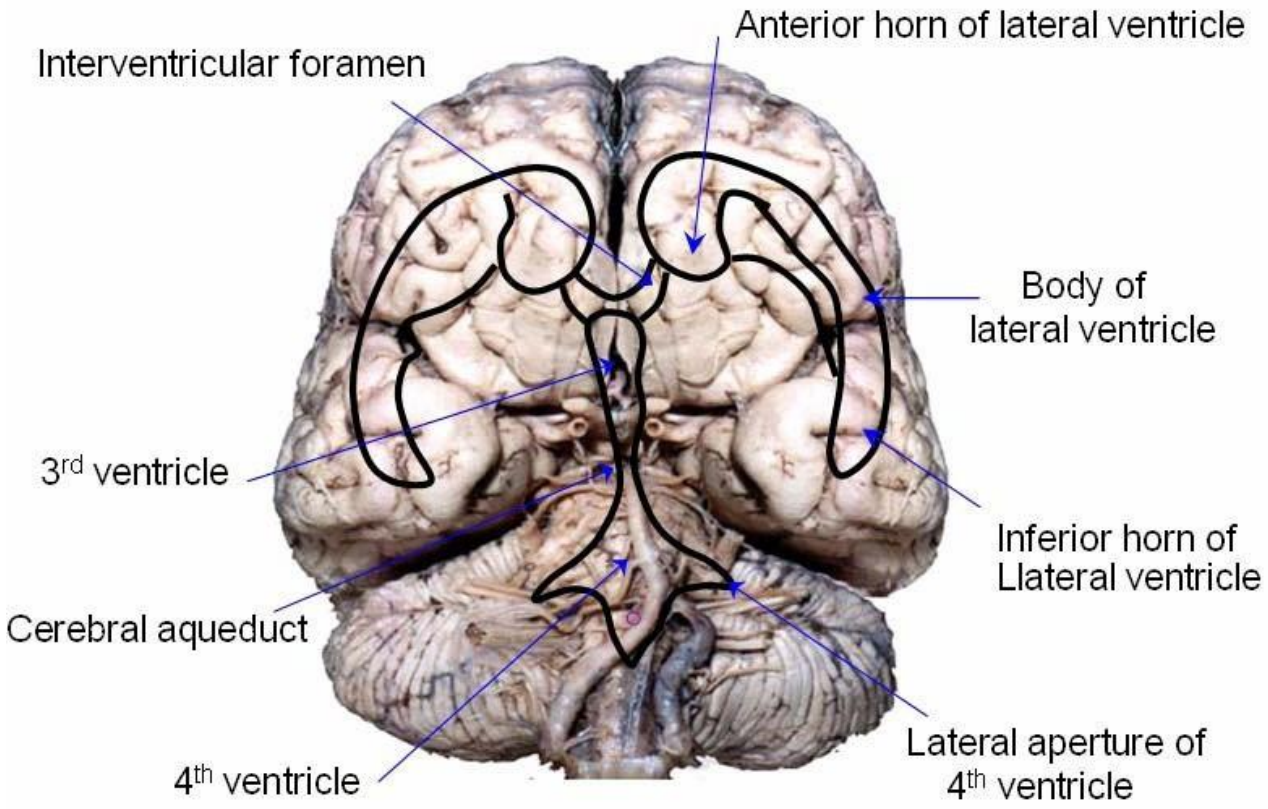
Lateral view

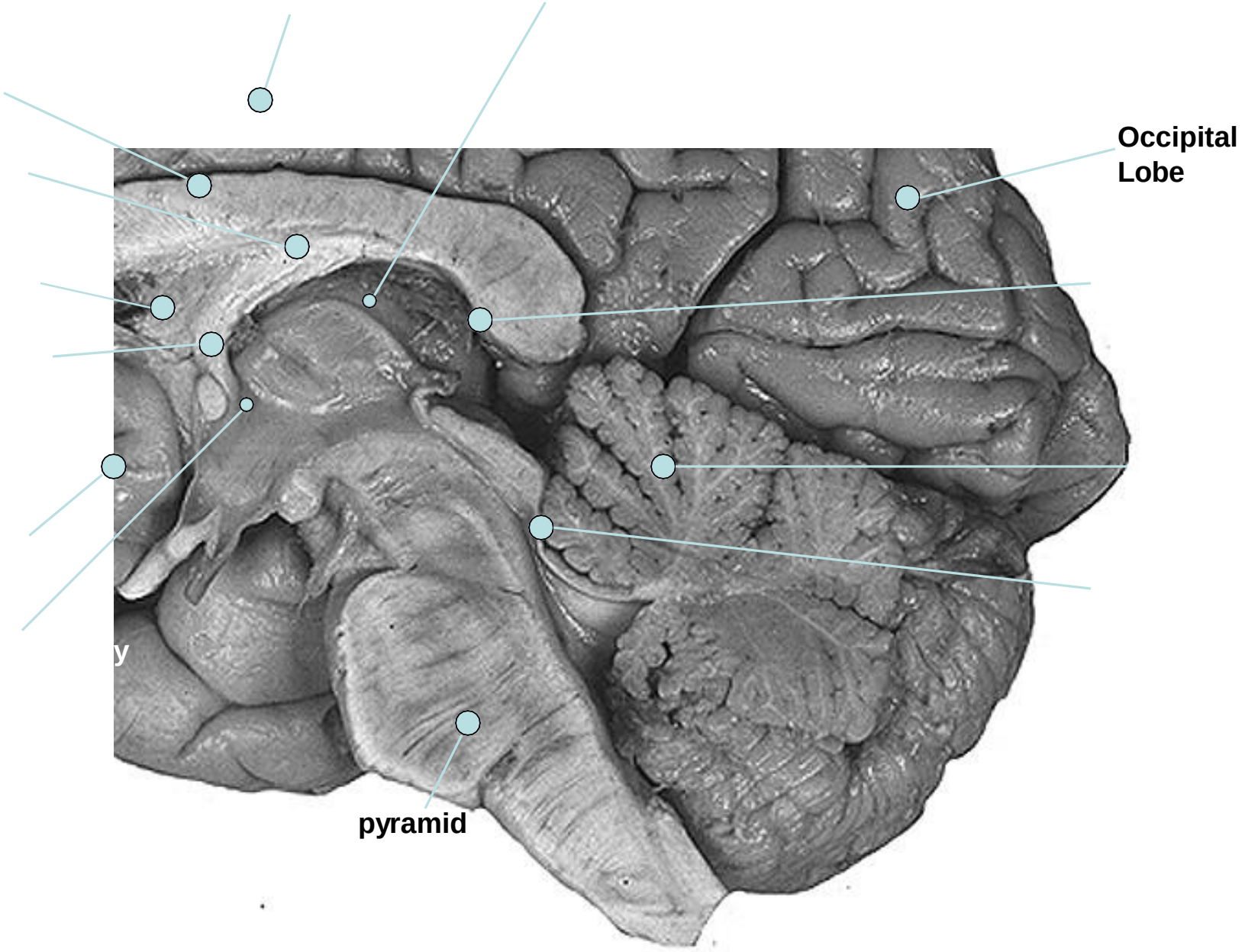


Superior view

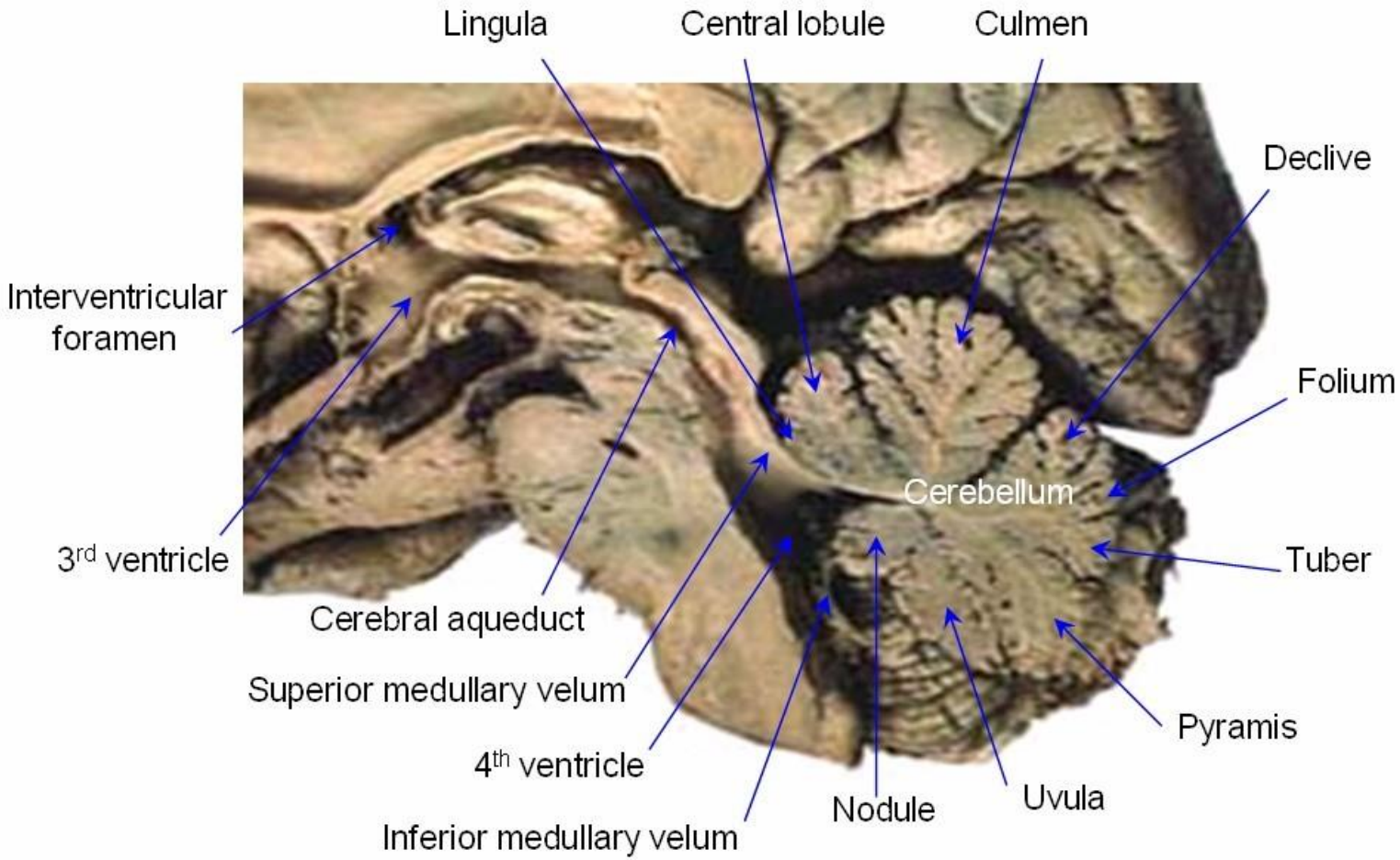


Anterior view




Occipital
Lobe
y
pyramid

Medial view


Lingula
Central lobule
Culmen
Declive
Interventricular foramen
Folium
Cerebellum
3rd ventricle
Tuber
Cerebral aqueduct
Superior medullary velum
Pyramis
4th ventricle
Nodule
Uvula
Inferior medullary velum