SEM IV ZOOA

CC8 UNIT 6:
NERVOUS SYSTEM AND SENSE ORGANS
(Part - 1)

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Comparative Account of Brain in Vertebrates

The brain is an organ that serves as the Centre of Nervous System in all Vertebrate animals. It is located in the head, usually close to the sensory organs for senses such as vision.

All vertebrate brains share a common underlying form which appears most clearly during early stages of development. In its earliest form the brain appears as three swellings at the front end of the neural tube; these swellings eventually become the forebrain, midbrain and hindbrain (prosencephalon, mesencephalon and rhombencephalon resp). In the initial stages of brain development, the three areas are roughly equal in size. In many classes of vertebrates, such as Fish and Amphibians, the three parts remain similar in size in the adult, but in Mammals the forebrain becomes much larger than the other parts, and the midbrain becomes very small.

Functions of Brain

1. **Olfactory lobes**: Sense of smell.

2. **Cerebral hemispheres**: Seat of intelligence and memory.

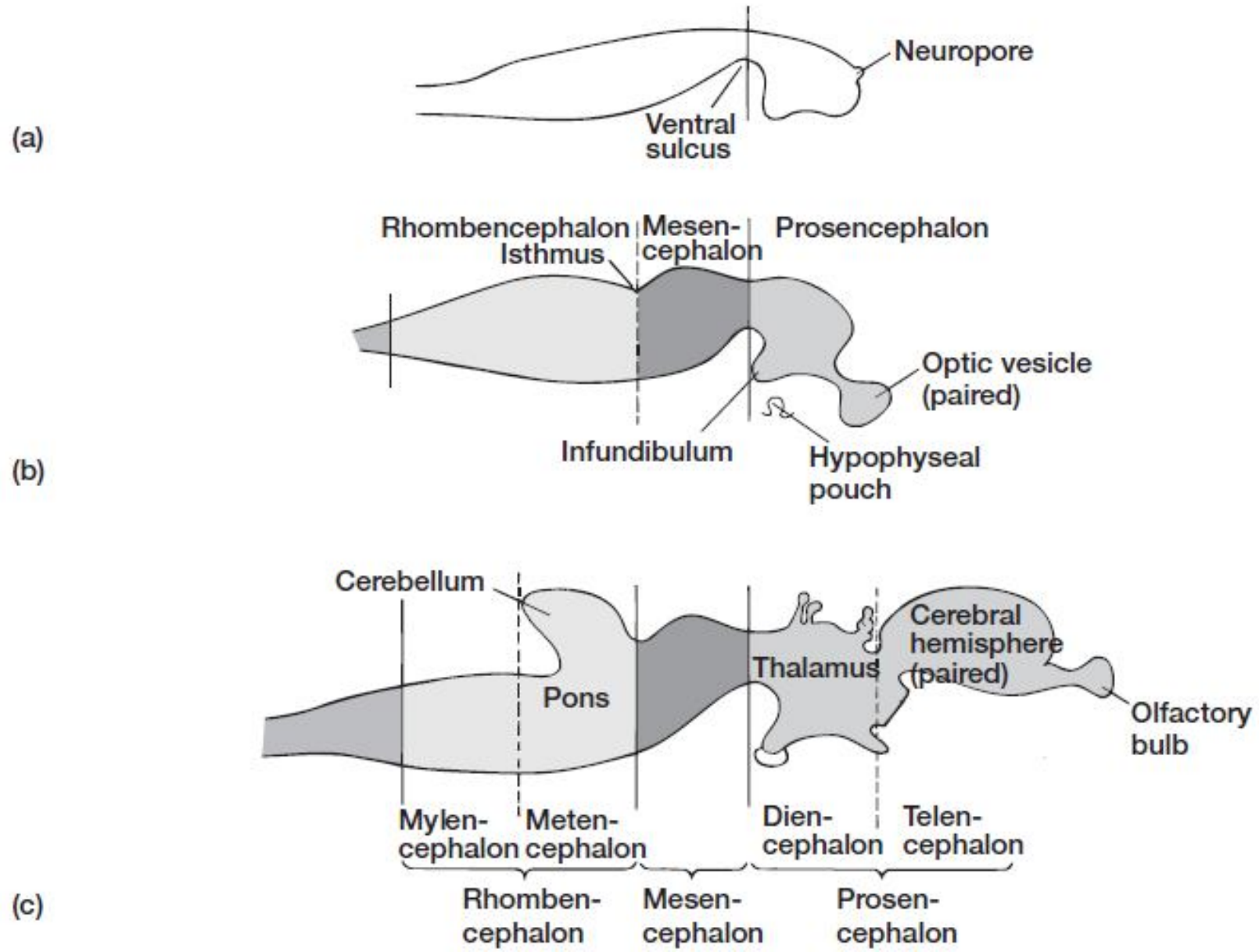
3. **Diencephalon:** Controls the general metabolic functions of the body.

4. **Optic lobes**: Sense of vision.

5. **Cerebellum**: Co-ordinates the movements of voluntary muscles.

6. **Medulla oblongata**: Controls the involuntary functions of the body.

Brain of all vertebrates, from Fish to Man, is built in series in different vertebrates in accordance with the habits and behavior of the animals.


(a)
Neuropore
Ventral sulcus
(b)
Rhombencephalon
Isthmus
Mesen-cephalon
Prosencephalon
Optic vesicle (paired)
Infundibulum
Hypophyseal pouch
(c)
Cerebellum
Pons
Thalamus
Cerebral hemisphere (paired)
Olfactory bulb
Mylen-cephalon
Meten-cephalon
Dien-cephalon
Telen-cephalon
Rhomben-cephalon
Mesen-cephalon
Prosen-cephalon

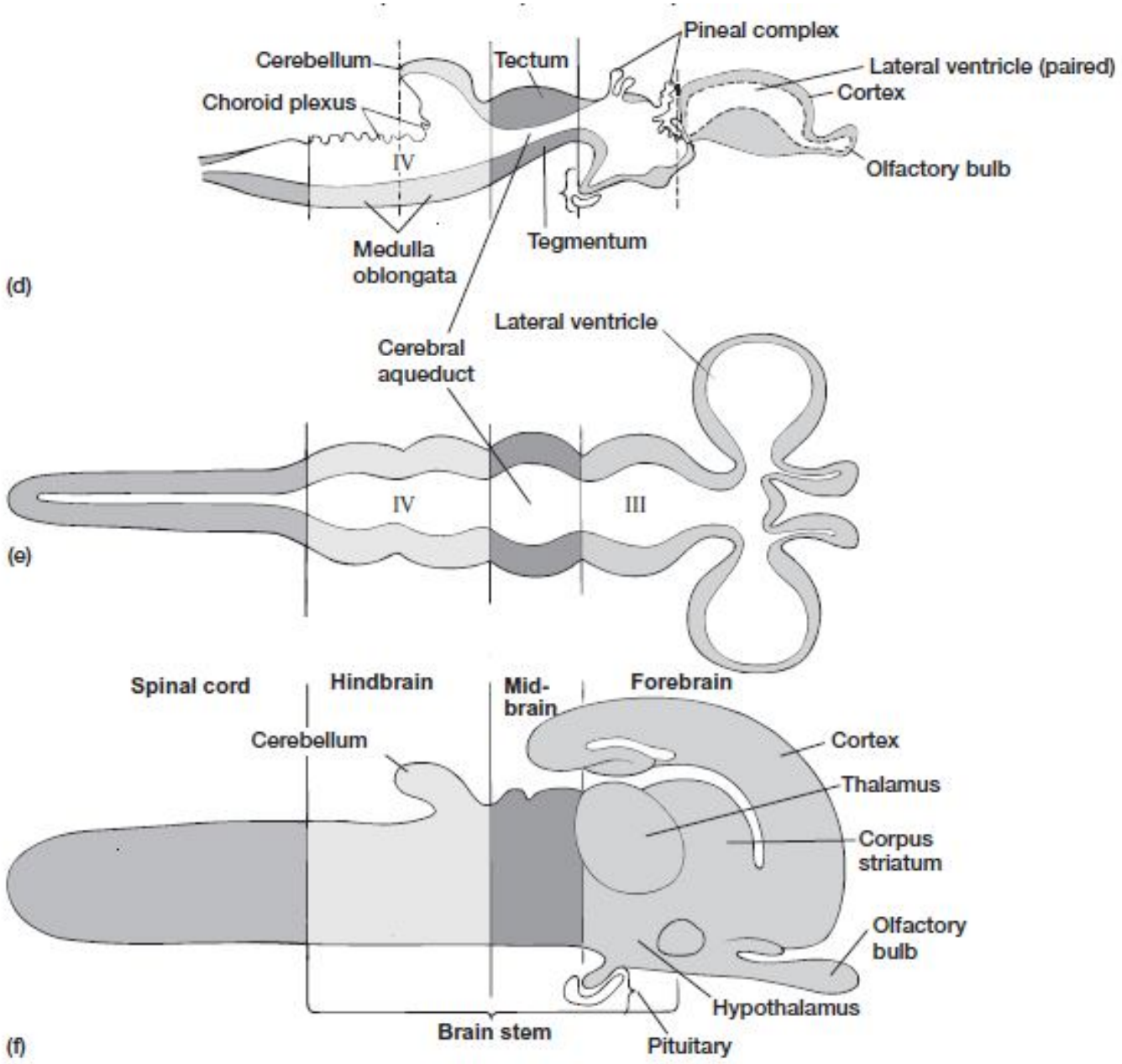
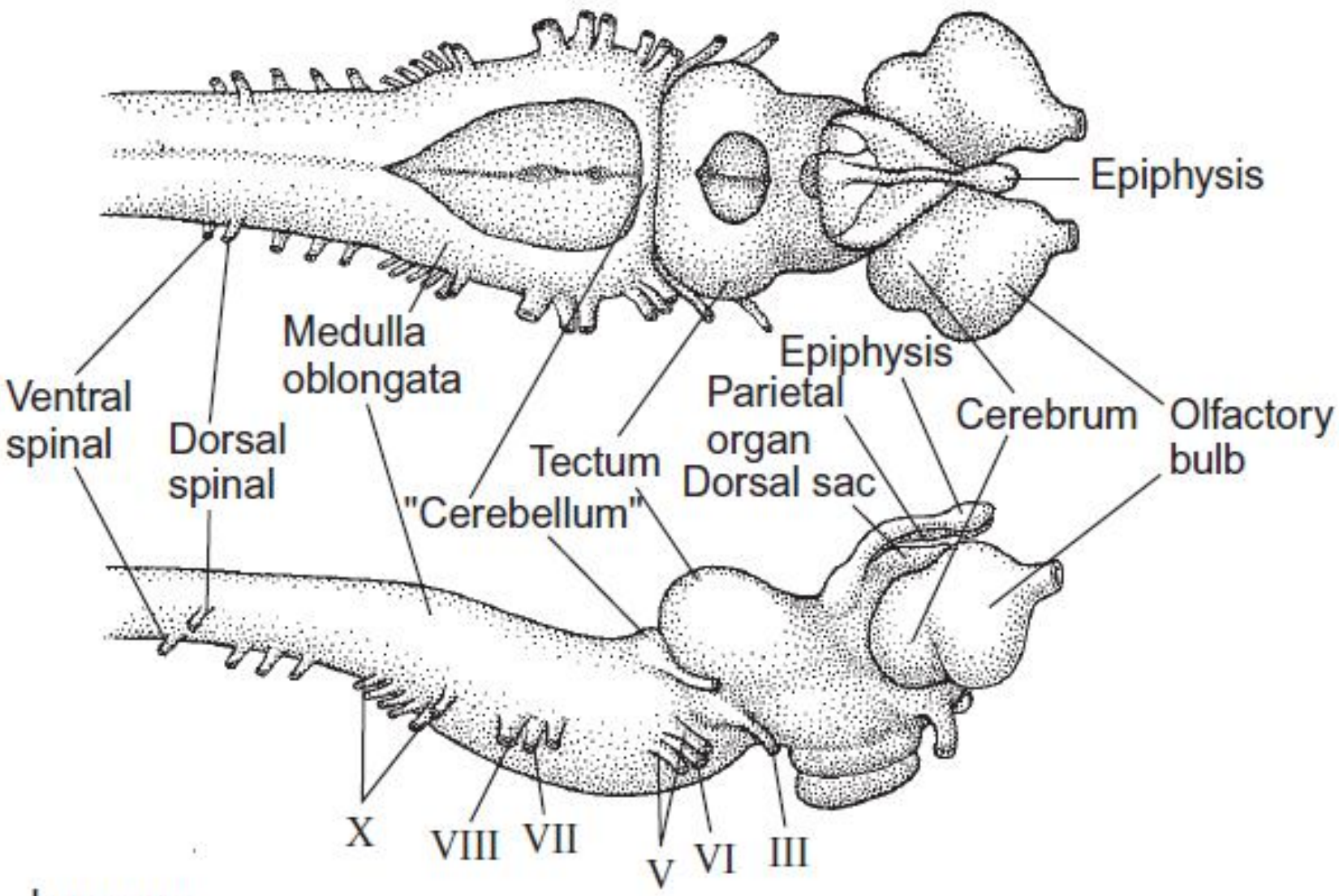


FIGURE 16.25 **Development of the central nervous system.** (a–d) Embryonic development. (e) Fluid-filled ventricles within the central nervous system. (f) Anatomical regions of the adult brain.

Cyclostomes:

The brain exhibits the typical pattern that is found throughout the Vertebrate series. Some of the structures that are well developed in the higher forms occur in a relatively primitive condition. The brain is divisible into three primary parts viz; Forebrain, Midbrain and Hindbrain. The forebrain includes large paired olfactory lobes. The Cerebral hemispheres are small attached to the diencephalon. The midbrain possesses a pair of large optic lobes rather dorsally placed. The hind brain is differentiated into a small transverse dorsal band, the Cerebellum and much larger ventral Medulla Oblongata. The ventricles within the brain are four as in other vertebrates. In fundibulum bears a hypophysis and pituitary body.


Epiphysis
Medulla oblongata
Epiphysis
Parietal organ
Ventral spinal
Dorsal spinal
Tectum
Cerebrum
Olfactory bulb
"Cerebellum"
Dorsal sac
X
VIII
VII
V
VI
III

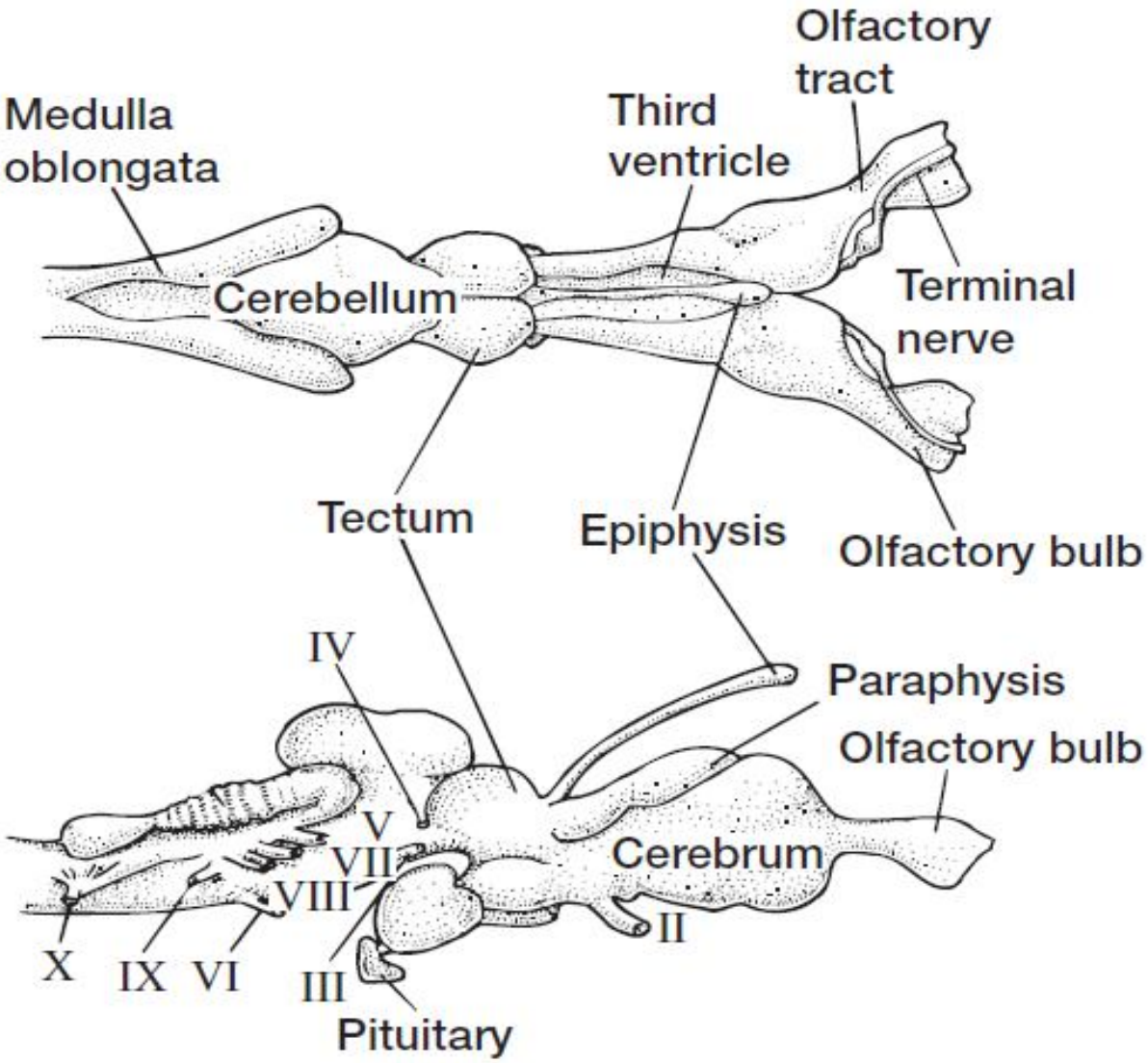
(a) Lamprey

Fishes

Brain of Fishes is more advanced than Cyclostomes. However, subdivisions of brain are seen in their primitive relations.

Elasmobranchs (Cartilaginous Fishes)

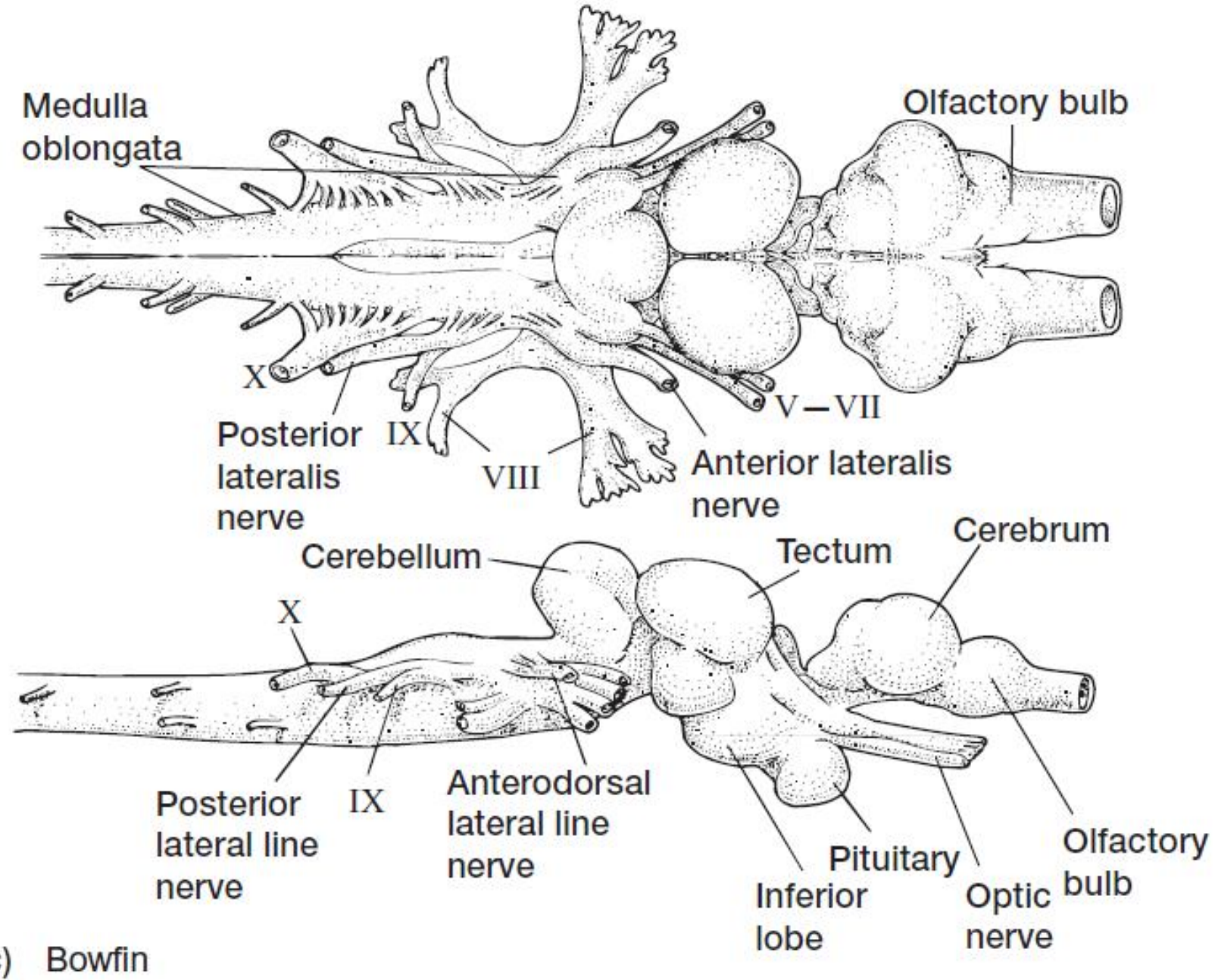
In Cartilaginous Fishes, the olfactory organs are enormous so that olfactory lobes of brain are correspondingly large, attached to Cerebrum by short but stout olfactory tracts. Optic lobes and pallium are relatively moderate in size. Midbrain cavity is quite large and extends into optic lobes. Pineal apparatus is well developed. Features of Hindbrain are less pronounced. Cerebellum is especially large due to active swimming habit.


Olfactory tract
Medulla oblongata
Third ventricle
Cerebellum
Terminal nerve
Tectum
Epiphysis
Olfactory bulb
IV
Paraphysis
Olfactory bulb
V
VII
VIII
Cerebrum
II
X
IX
VI
III
Pituitary

(b) Shark

Osteichthyes (Bony Fishes)

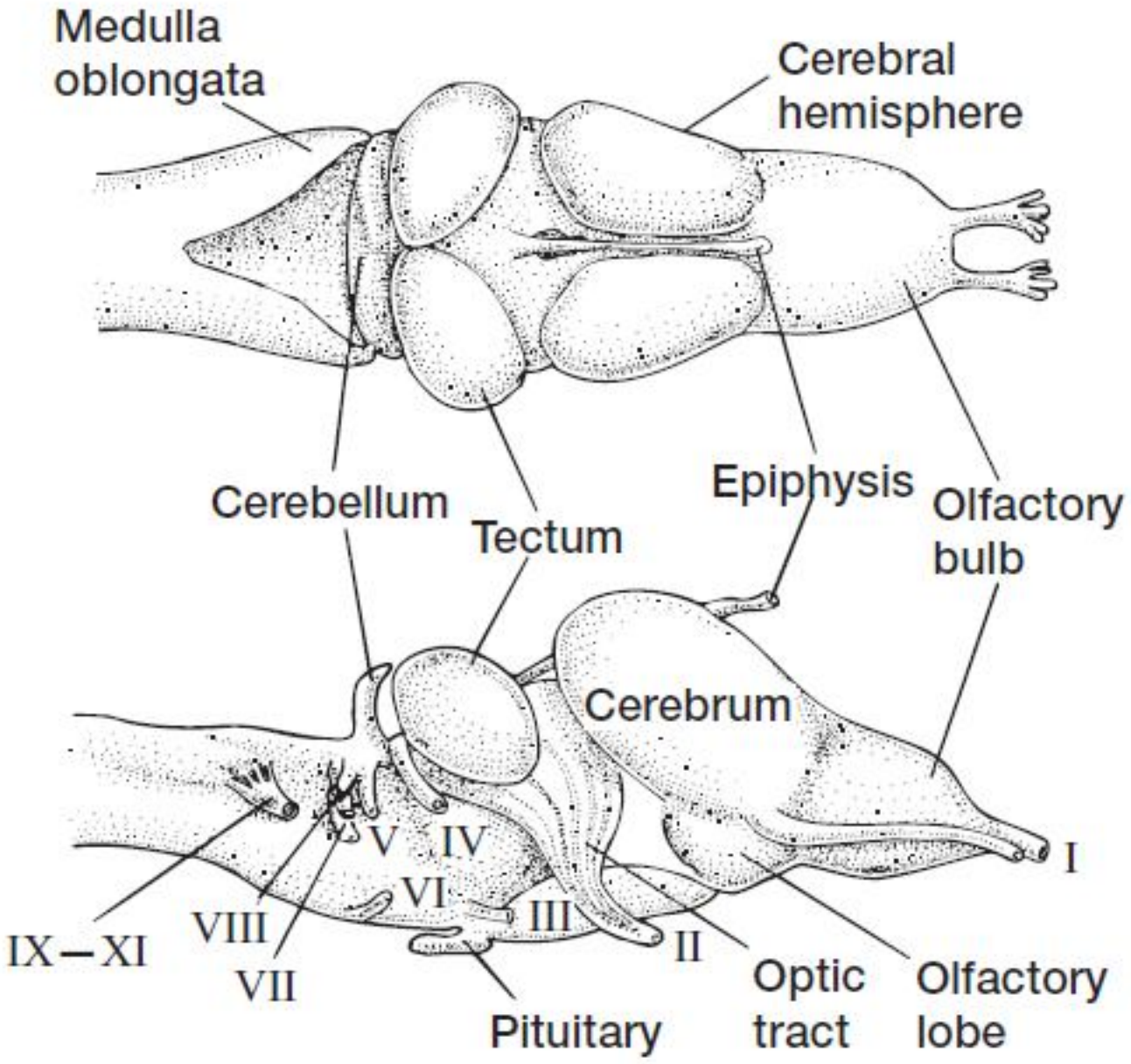
In bony Fishes brain is more specialized than in Elasmobranchs. Olfactory lobes, Cerebral hemispheres and Diencephalon are smaller while optic lobes and cerebellum larger than in a shark. The anterior part of the Cerebellum forms valvula cerebella which extend under the optic lobes; it is characteristic of bony Fishes and controls active movements. The medulla oblongata is well developed with special lobes for entry of lateral line nerves.


Medulla oblongata
Olfactory bulb
X
Posterior lateralis nerve
IX
VIII
V—VII
Anterior lateralis nerve
Cerebellum
Tectum
Cerebrum
X
Posterior lateral line nerve
IX
Anterodorsal lateral line nerve
Pituitary
Inferior lobe
Optic nerve
Olfactory bulb

(c) Bowfin

Amphibians

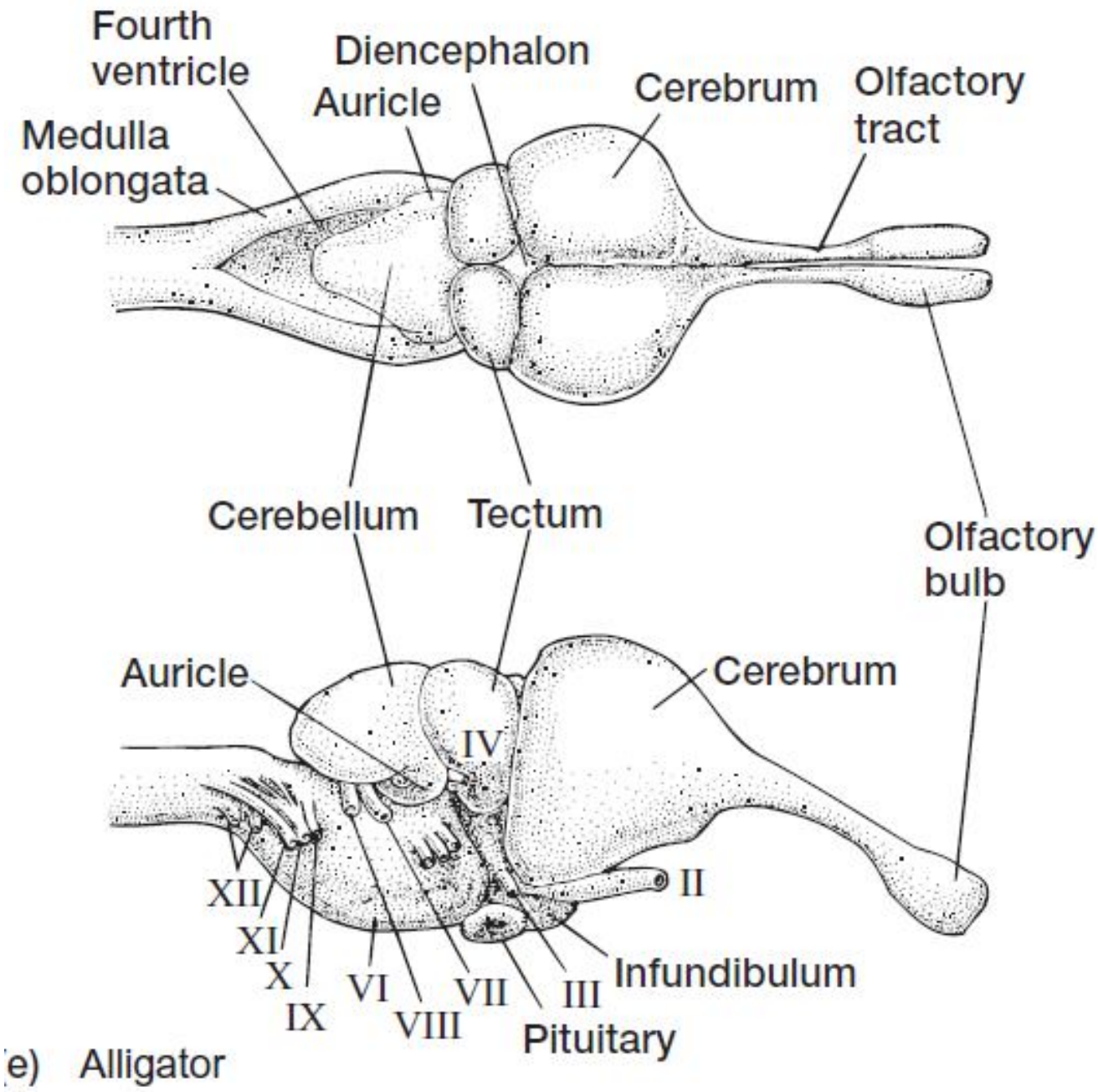
The brain of Amphibians is remarkably unspecialized and is scarcely more advanced than that of cartilaginous fishes and lung fishes The cerebral hemispheres are more separate from one another than in fishes, so they share little common ventricle. Smaller olfactory lobes and larger optic lobes indicate a greater reliance on sight rather than smell. **Corpus striatum** (floor of cerebrum) receives greater number of sensory fibres projected forward from thalamus than in fishes. The walls of midbrain are thickened and reduce the lumen into a narrow passage called **aqueduct**. Medulla is small and cerebellum is poorly developed. A small pineal body is present in all the modern Amphibians.


Medulla oblongata
Cerebral hemisphere
Cerebellum
Tectum
Epiphysis
Olfactory bulb
Cerebrum
V
IV
VI
III
II
I
VIII
VII
IX–XI
Pituitary
Optic tract
Olfactory lobe

(d) Frog

Reptilians

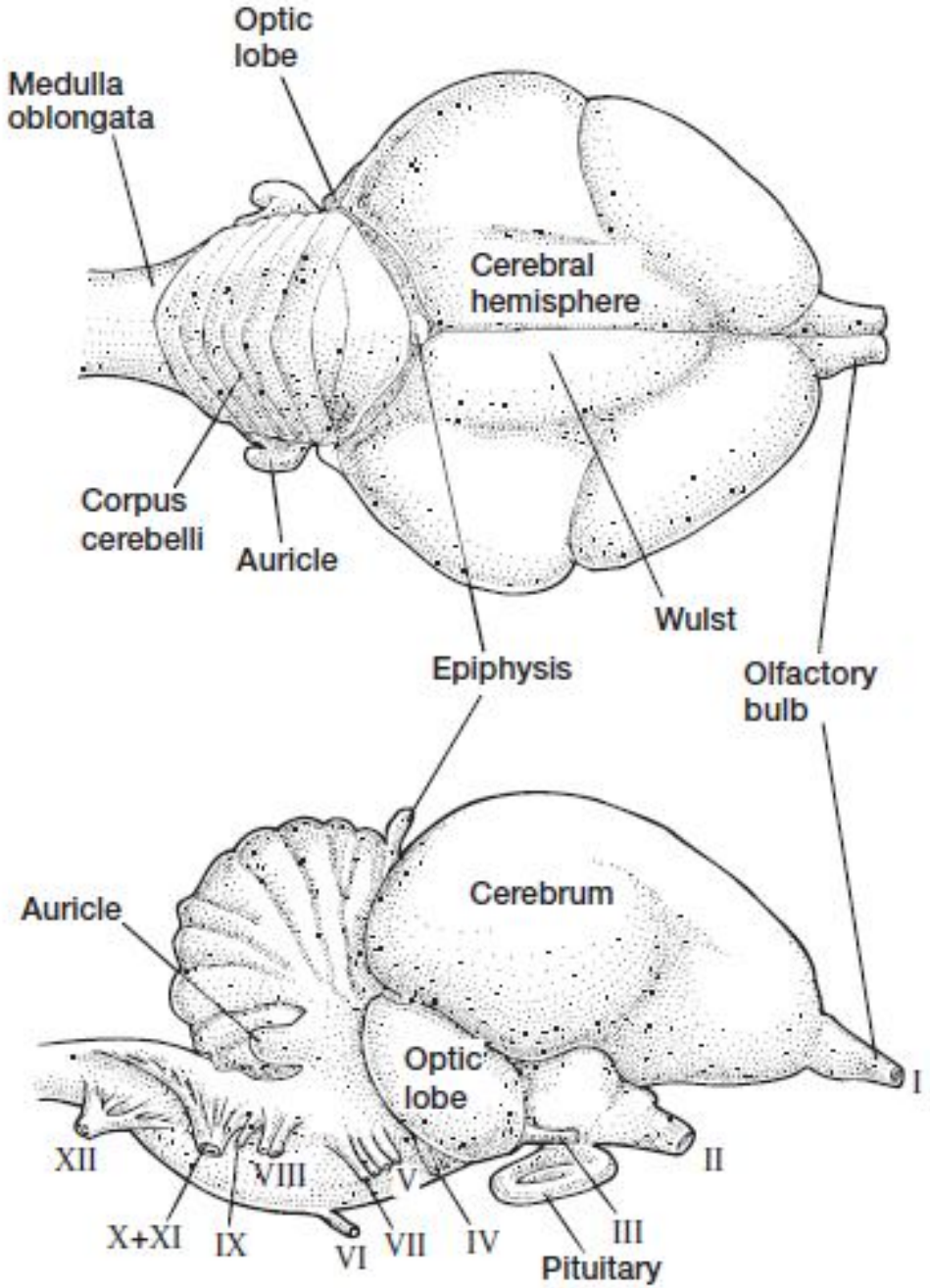
Reptilian brain shows advancement in size and proportions over that of Amphibians because of complete terrestrial mode of life. The brain is a narrow elongate, and nearly straight. Olfactory bulbs tend to be smaller than for fishes. Olfactory tracts are long. A fine **vomeronasal nerve** from the organ of **Jacobson** goes to the olfactory bulbs. A pair of auditory lobes is found posterior to optic lobes which are not hollow. The Cerebrum is large because of the expansion of the **corpus striatum** and associated neocortex. Cerebellum is somewhat pear shaped and larger than in Amphibians.


Fourth ventricle
Diencephalon
Auricle
Cerebrum
Olfactory tract
Medulla oblongata
Cerebellum
Tectum
Olfactory bulb
Auricle
Cerebrum
IV
II
XII
XI
X
IX
VI
VIII
VII
III
Infundibulum
Pituitary

e) Alligator

Birds

Avian brain is proportionately larger than that of a Reptile, and is short and broad. Olfactory lobes are small due to poor sense of smell. Two cerebral hemispheres are larger, smooth and project posteriorly over the diencephalon to meet the cerebellum. The enlargement of cerebral hemispheres is due to very large and complex **corpora striata** which are characteristic of birds. The cerebral hemispheres are responsible for an intelligent behavior in birds, and they control the reflex behavior governing the lives of birds. The dorsal thalamus is even more developed than in Reptiles. Optic nerves, chiasma and tracts are large. Optic lobes are particularly large and are layered within. They have connections from all sense organs and with the cerebrum. Squeezed between the cerebrum and cerebellum, the optic lobes have uniquely lateral position. The Cerebellum is larger than in other vertebrates except some mammals. It is highly convoluted, and the organ is high and narrow. Related to the marked development of the cerebellum are the appearance of the **pons** under the brainstem and enlargement of the **olivary nuclei** within the broad medulla.


Optic lobe
Medulla oblongata
Cerebral hemisphere
Corpus cerebelli
Auricle
Wulst
Epiphysis
Olfactory bulb
Auricle
Cerebrum
Optic lobe
I
II
III
Pituitary
IV
V
VI
VII
VIII
IX
X+XI
XII

(g) Goose

Mammals

The brain reaches its highest development in mammals with better integration and mastery over the environment, the cerebral hemispheres reaching the status of a dominant integrating part of the brain and acting as coordinating centers of the brain. The cerebral hemispheres are smaller and smooth in

Prototheria and larger in Metatheria and become greatly enlarged and divided into lobes in Eutheria.

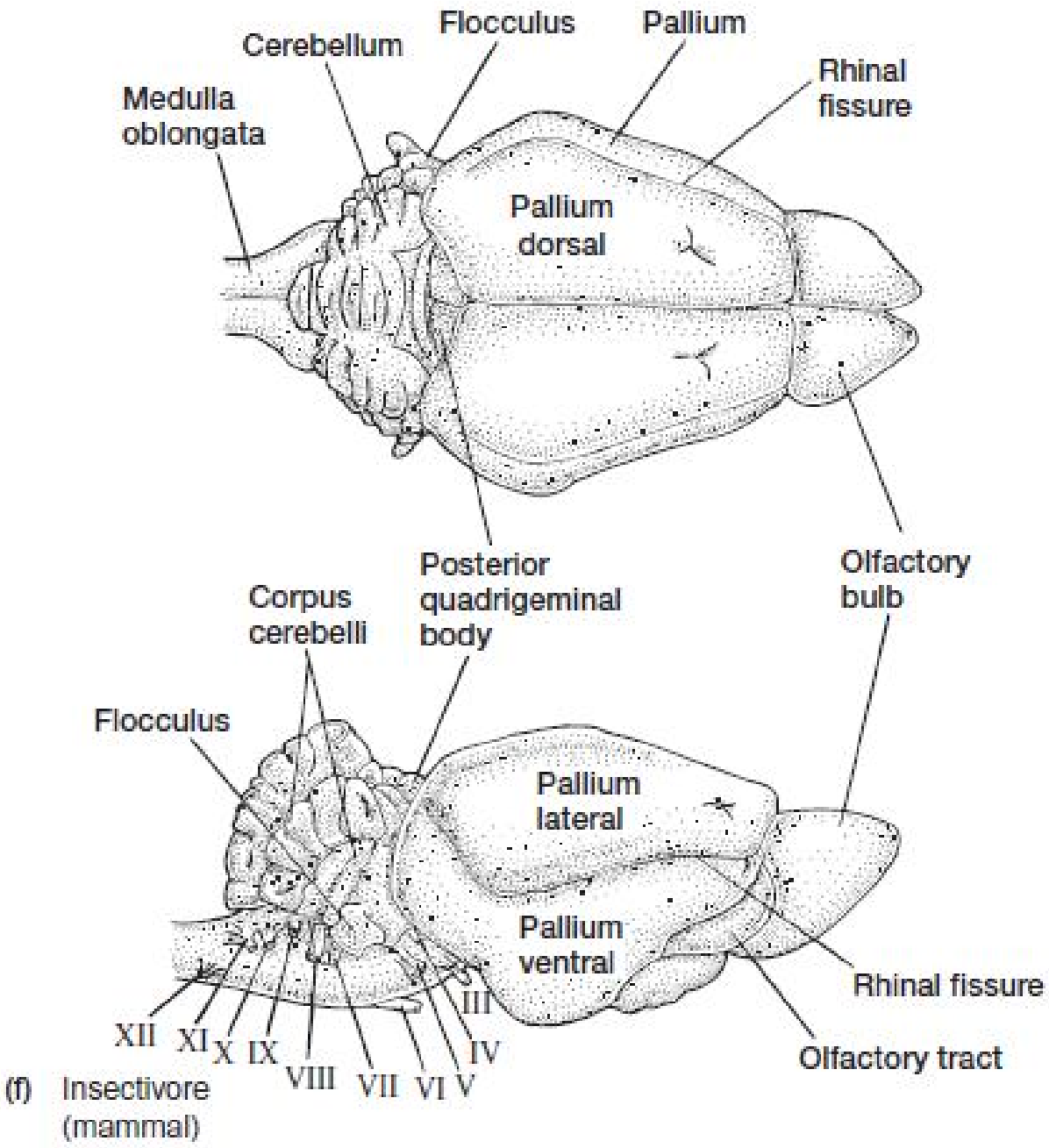
In mammals such as man and sheep, surface of cerebral hemispheres is immensely convoluted with a number of elevations separated by furrows. This folding increases the surface area or gray matter containing nerve cells, resulting in greater intelligence without adding to the size of the brain. Olfactory lobes are relatively small but clearly defined and covered by the hemispheres. Diencephalon and midbrain are also completely covered by the cerebral hemispheres.

Mammals

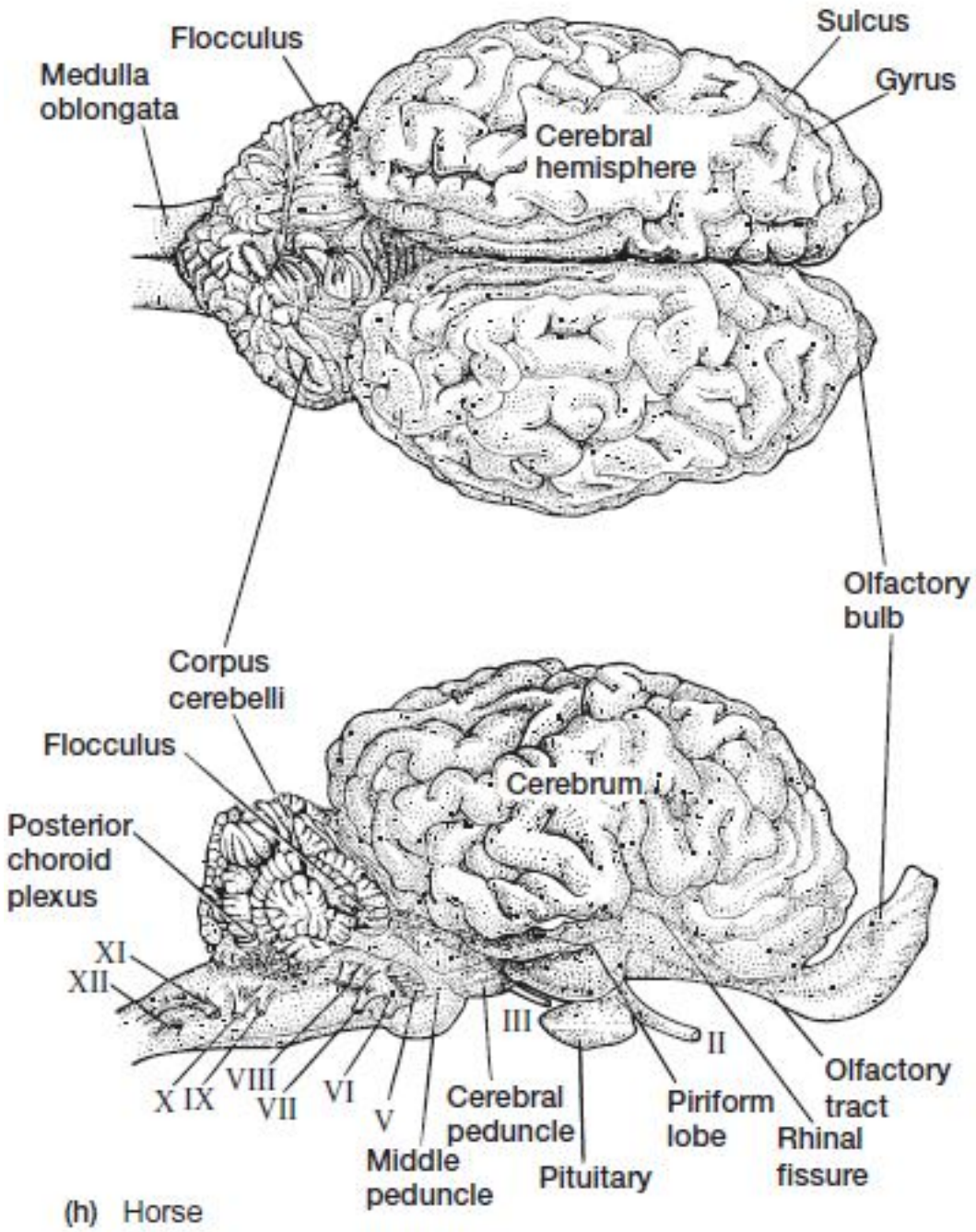
Characteristic of mammals are 4 solid optic lobes, called corpora quadrigemina, on the roof of the midbrain. The third ventricle or iter of midbrain is a laterally compressed vertical passage, called cerebral aqueduct. Cerebellum is also large, conspicuously folded and may overlie both midbrain and medulla. Usual folds are a median vermis, two lateral flocculi and their mushroom-like projections, the paraflocculi.

The other chief topographical features of mammalian hindbrain include the pyramids carrying voluntary motor impulses from higher centers, the pons varoli with crossing fibres connecting opposite sides of cerebrum and cerebellum, and the trapezoid body of transverse fibres relaying impulses for sound.

The medulla oblongata lies ventrally and is much thickened. It has centers which control respiration, heart beat and blood vessels; it also has conduction pathways for impulses passing from the cerebral hemispheres to the spinal cord and again in the opposite direction. The hindbrain contains centers for the regulation of digestion, respiration and circulation.



(f) Insectivore (mammal)


Flocculus
Medulla oblongata
Sulcus
Gyrus
Cerebral hemisphere
Olfactory bulb
Corpus cerebelli
Flocculus
Cerebrum
Posterior choroid plexus
XI
XII
X IX
VIII
VII
VI
V
III
II
Cerebral peduncle
Middle peduncle
Pituitary
Piriform lobe
Olfactory tract
Rhinal fissure

(h) Horse

Diagrammatic Representation of Comparative Account of Brain in Vertebrates

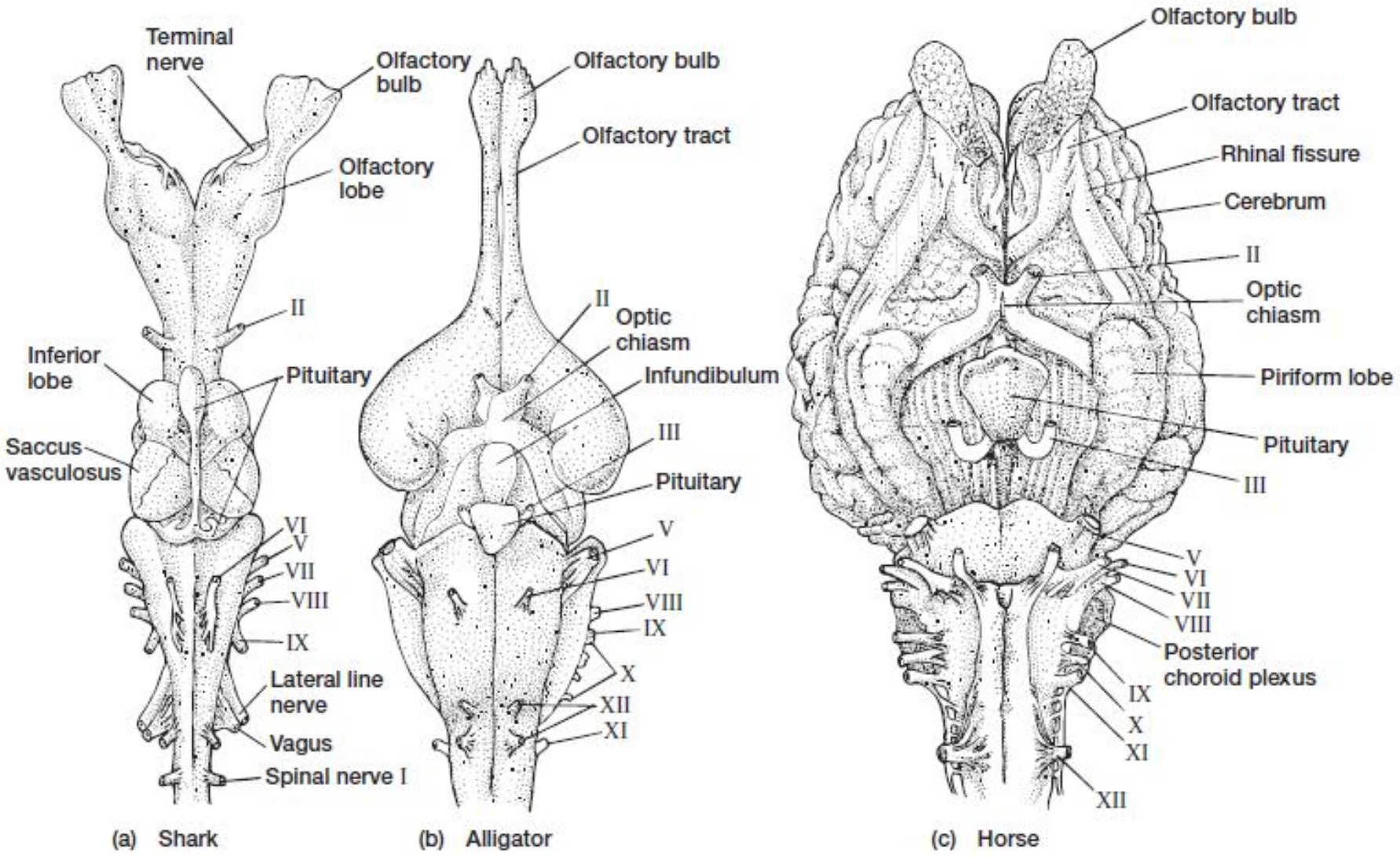
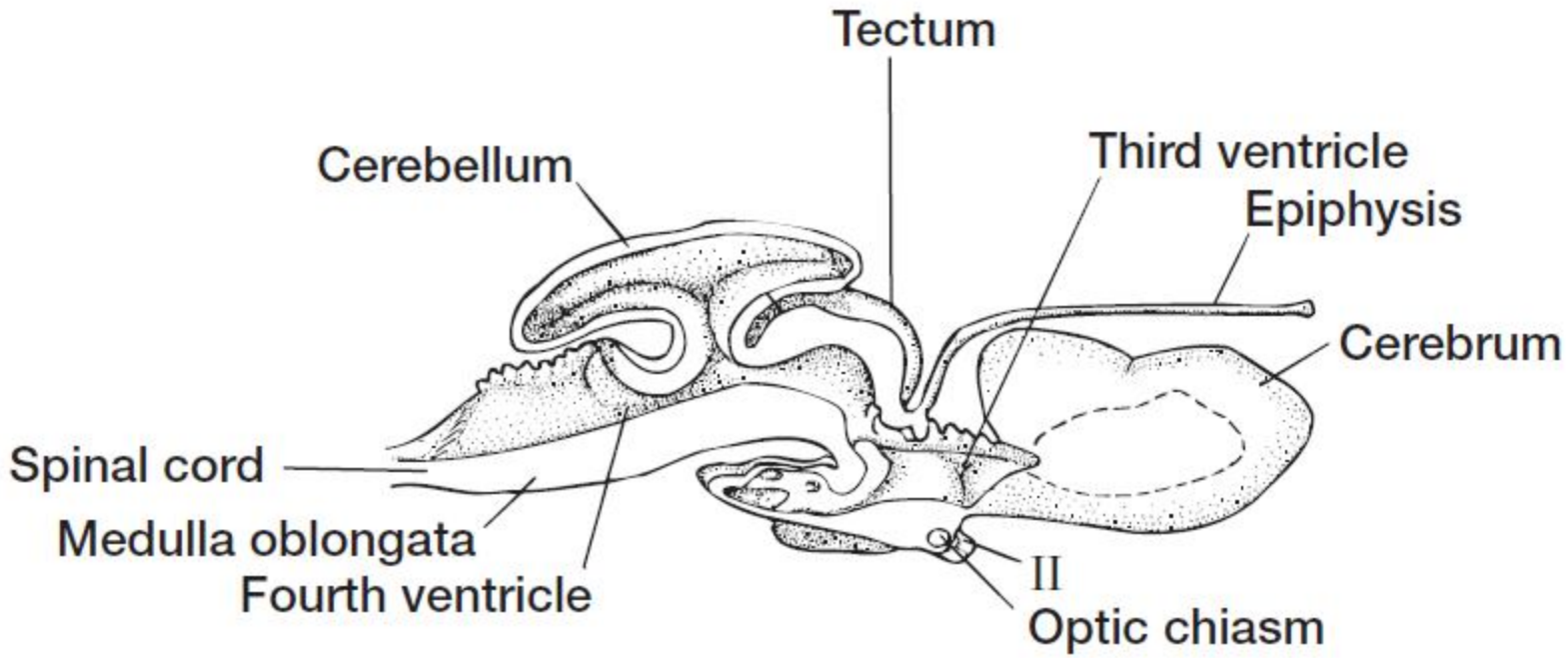


FIGURE 16.36 **Vertebrate brains, ventral views.** (a) Shark (*Scymnus*). (b) Alligator (*Alligator*). (c) Horse (*Equus*).

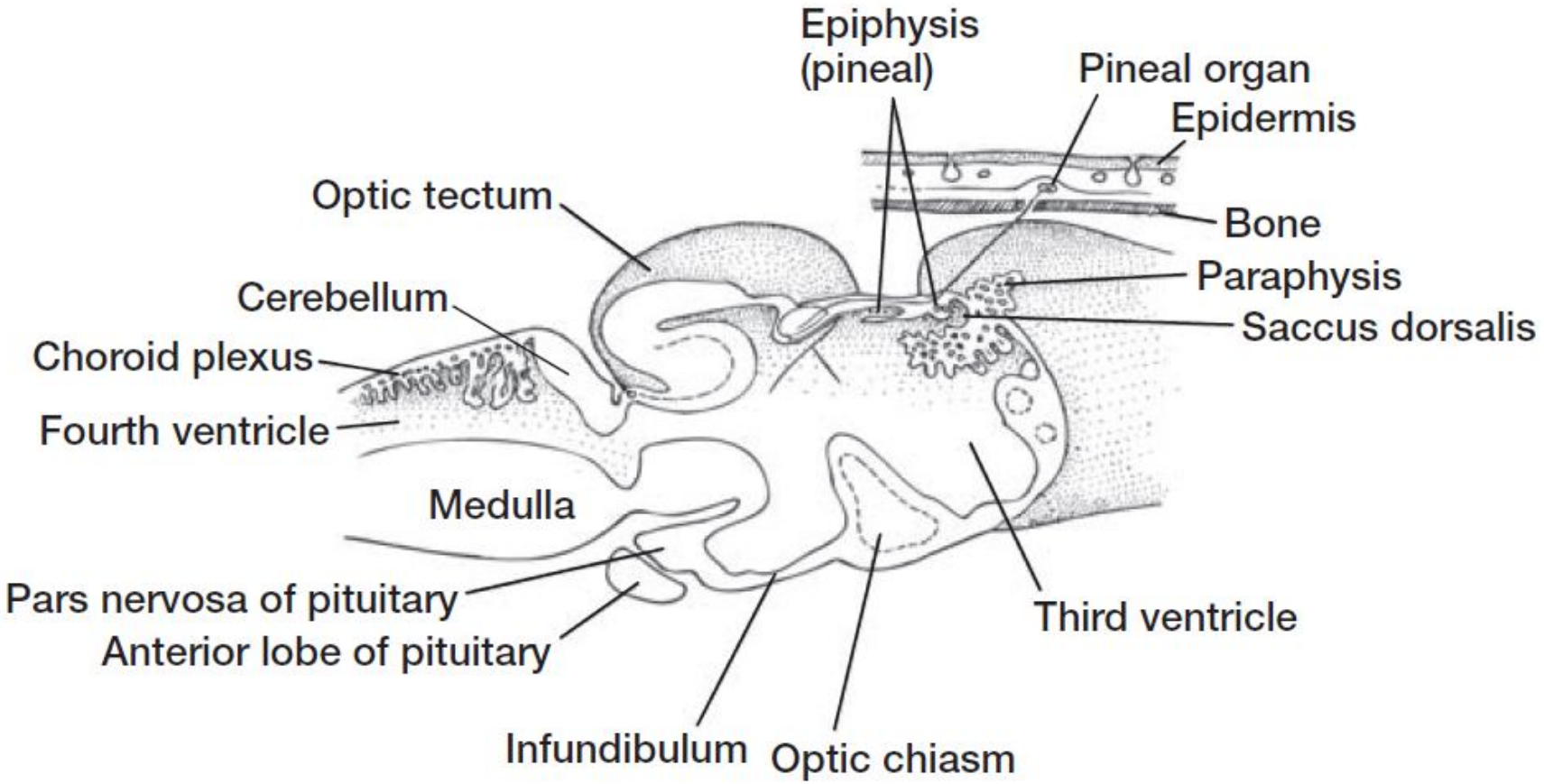
After Romer and Parsons.

Diagrammatic Representation of Comparative Account of Brain in Vertebrates



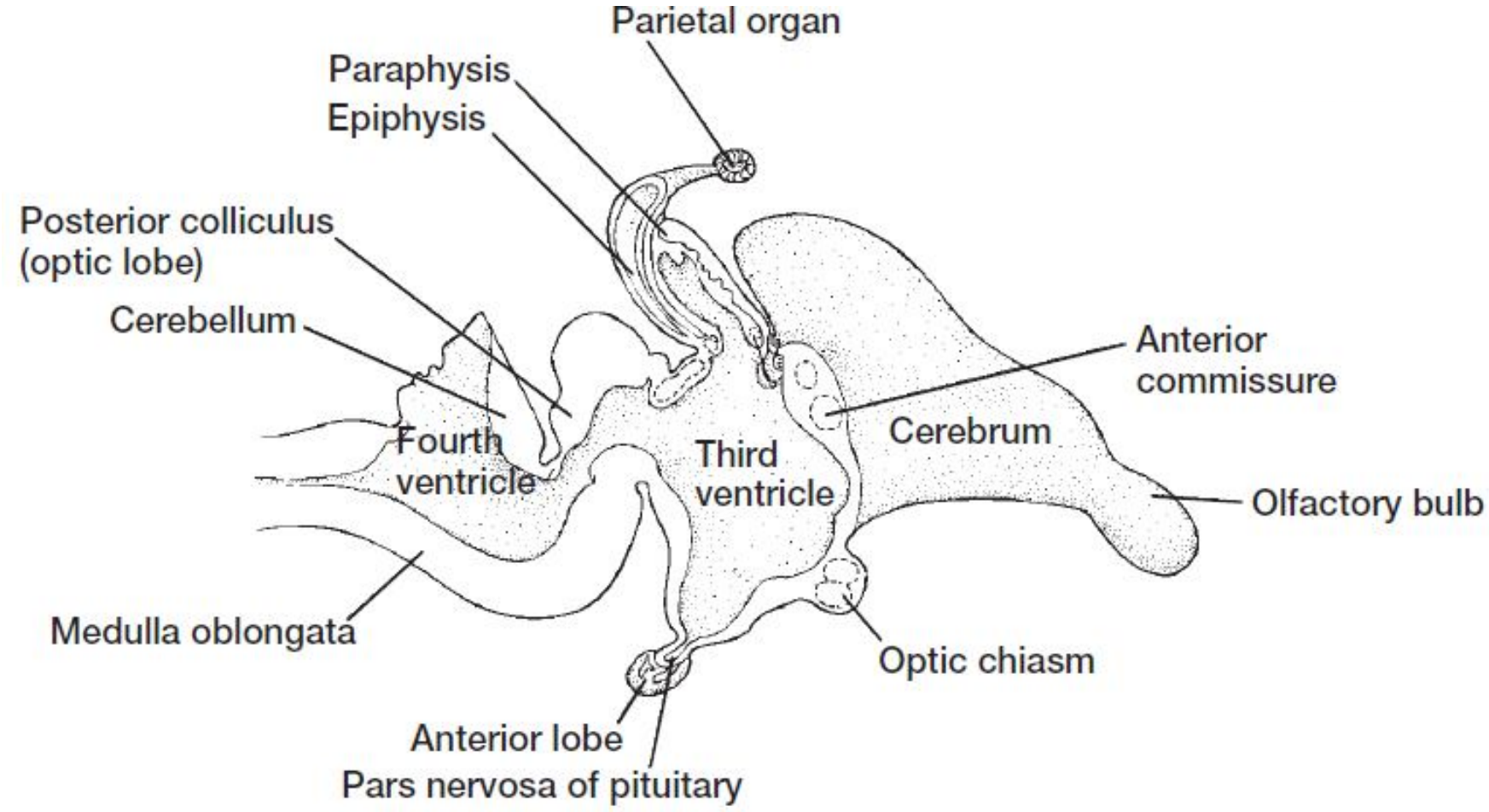
(a) Shark

Diagrammatic Representation of Comparative Account of Brain in Vertebrates



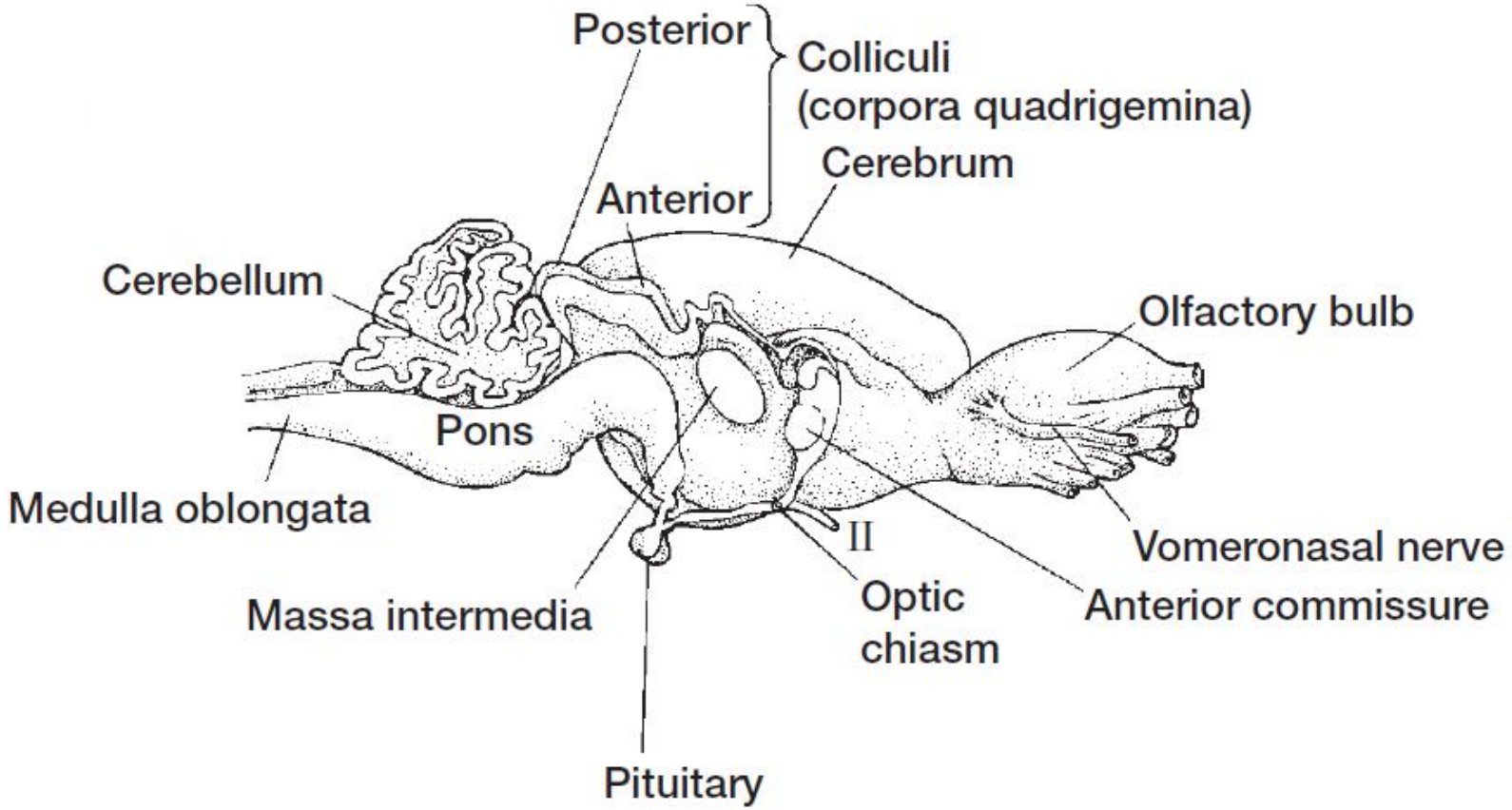
(b) Frog

Diagrammatic Representation of Comparative Account of Brain in Vertebrates



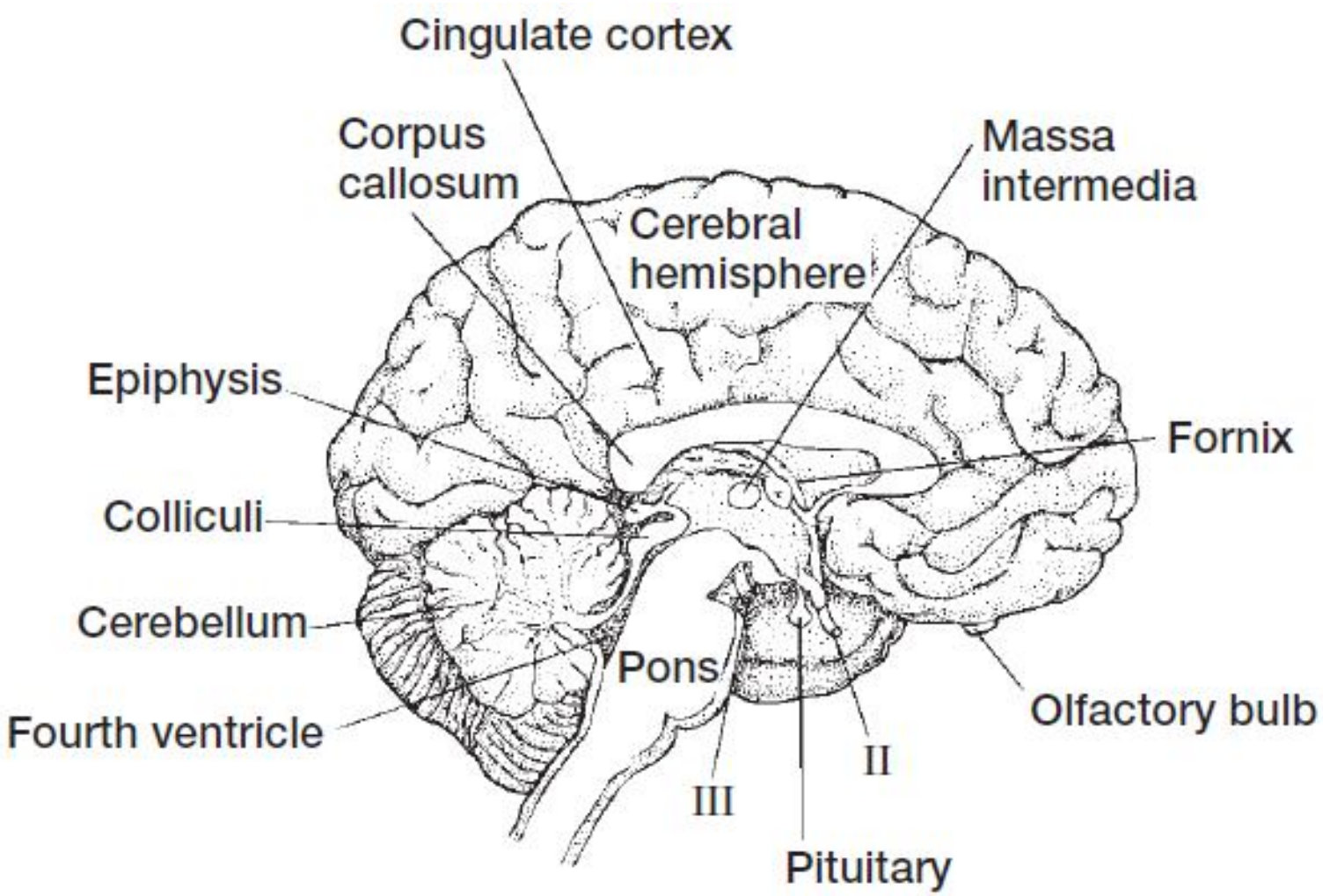
(c) Lizard

Diagrammatic Representation of Comparative Account of Brain in Vertebrates



(d) Opossum

Diagrammatic Representation of Comparative Account of Brain in Vertebrates



(e) Human

REFERENCES:

Kardong, K. Vertebrates. Comparative Anatomy, Function and Evolution. *The Nervous System*.