

## Brain in Vertebrates

All the multicellular organisms particularly vertebrates develop a very effective system to receive and transmit the stimuli, to co-ordinate and control the different activities of the organism which is called as nervous system. The brain is the main and anterior most part of the central nervous system.

In response to the aggregation of sense organ in the head region the brain becomes enlarged and differentiated to a varying degree. The first step in the differentiation of the brain is that

- (i) the mid-dorsal ectoderm form a longitudinal thickening called as neural plate.
- (ii) The neural plate sinks downwards while its edges grow upwards to form neural fold which grow towards each other and fuse to form neural tube.
- (iii) The anterior most wider/thickened part of neural tube called encephalon becomes moulded into three dilated lobes called primary cerebral vesicles. Of these vesicles, the upper is called prosencephalon (Forebrain), the middle is called mesencephalon (mid brain) and the hind one as rhombencephalon (hind brain). These three primary vesicles give rise to various parts of the brain by thickening and folding etc.
- (iv) The adult brain has also a series of cavities called ventricles filled with cerebrospinal fluid.

Prosencephalon

Telencephalon → cerebral hemisphere, olfactory lobe, corpus striatum, pallidum, olfactory bulb.

Diencephalon → epithalamus, thalamus, hypothalamus and appendages.

Mesencephalon - optic lobe, crura cerebri,

Rhombencephalon

Metencephalon - cerebellum, medulla oblongata

Myelencephalon - part of medulla oblongata.

## Meninges : (मैनिंगीस)

Meninges are protective membranous wrapper made up of connective tissue which surrounds the brain and spinal cord. The complexity of the meninges increases with the advancement of lower to higher group of organisms.

In fishes, meninges consists of a single membrane - primitive meninx (meninx primitiva). In amphibians, reptiles and birds meninges include a thick, outer dura mater of mesoderm and a thin secondary meninx (pia mater) while in mammals it consists of <sup>outer</sup> dura mater, <sup>web like</sup> median arachnoid and inner pia mater.

The ventricles, subarachnoid space and subdural space are filled with cerebrospinal fluid. The primary source of this fluid is choroid plexus projects into ventricles at specific sites.

[The average human has about 150ml of cerebrospinal fluid that is replaced several times per day, flushing the CNS. The recent speculation suggest that it might carry chemical messages important in regulating the organism's daily circadian rhythm.]

## Brain in different vertebrates :

### In Cyclostomata :

(i) The primitive <sup>fore brain</sup> (prosencephalon) becomes differentiated into telencephalon and diencephalon, the mid-brain continues as the mesencephalon and the original hind brain divides into metencephalon and myelencephalon, but all these divisions are not well marked and is without marked flexure.

(ii) The telencephalon is small consisting paired olfactory lobes and weakly differentiated corpora striata.

The cerebral hemisphere are small with rudimentary ventricles. The two sides of the brain are connected by anterior commissure in the region of lamina terminalis. The diencephalon forms small infundibulum and thalami (Pineal organ). The epithalamus is connected to pineal organ by a pair of habenular ganglia.

(iii) The optic lobes are one pair with large optic ventricle. The roof of the mesencephalon consists of choroid plexus.

(iv) In Petromyzon, the metencephalon include small transverse band like cerebellum but no pons, while in Myxine both are absent. The myelencephalon or medulla oblongata is well developed and has the 4th ventricle with its roof is vascular and differentiated as the choroid plexus.

### In Elasmobranch :

(i) Brain is large and compact and well differentiated.

(ii) Olfactory lobes are well developed and connected

with the cerebrum by stalks called caudate or tracts.

(iii) Cerebral hemispheres large and anteriorly joined across midline. Their thickened roof is termed as pallium while the ventro-lateral wall as corpora striata. Its posterior margin is marked by a transverse velum above and by the pre-otic recess below. Cerebrum has two lateral ventricle.

(iv) The roof of the diencephalon forms anterior choroid plexus and also bears an elongated pineal body which often penetrates the roof of the skull. Parietal organ is absent. Infundibulum is distinct bearing hypophysis. Two lobi inferiores are present on the sides of infundibulum and two vascular sensory lobes called sacculus vasculosus also present posterior to lobi inferior.

(v) The mesencephalon has two large bilateral optic lobes. Its floor form crura cerebri. choroid plexus absent.

(vi) Cerebellum is large; its upper surface is divided into lobes by narrow grooves forming vesiform bodies called corpora vesiformia.

(vii) The roof of the medulla oblongata provided with choroid plexus.

(viii) Ventricles are well developed in most of the elasmobranch, but in some cases lateral and 3rd ventricles are not well marked.

(ix) 10 pairs of cranial nerves developed from brain.

## In Teleost :

- (+) The brain is small and more compact and specialized than elasmobranch.
- (i) Olfactory lobes, cerebral hemispheres and diencephalon are smaller whereas optic lobes and cerebellum are larger in bony fishes.
  - (ii) Olfactory peduncles absent and are in direct contact with cerebrum.
  - (iii) The roof of the cerebrum has thin, non-nervous pallium and floor is with prominent corpora striata.
  - (iv) In diencephalon, the pineal body develops on pineal stalk and infundibulum forms lobi inferiores and saccus vasculosus and also bears hypophysis.
  - (v) Optic lobes large.
  - (vi) Cerebellum large, forming valvula cerebelli which extends beneath the optic lobes.
  - (vii) Cranial nerves 10 pairs.

## In Amphibia :

- (i) Large elongated olfactory lobes merge without constriction into cerebral hemisphere.
- (ii) Cerebral hemispheres are separated by a longitudinal fissure, pallium is thick and corpora striata also thick; their ventricle reduced due to thickening of dorsal and lateral wall. Anterior commissure connects the corpora striata and other commissure also present above it and a posterior commissure lies between diencephalon

and optic lobes.

- (iii) Diencephalon short, pineal body and well developed infundibulum with pituitary (hypophysis) present, saccus vasculosus absent.
- (iv) Optic lobes well developed, its lumen (ventricle) reduced to a narrow passage - the aqueduct due to thickening of the wall.
- (v) Cerebellum is reduced to form a transverse band; medulla oblongata well developed.
- (vi) 10 pairs of cranial nerve present.

### 9m Reptiles

- (i) Olfactory lobe reduced and merged with cerebral hemisphere, besides anterior and posterior commissures a hippocampal commissure also present, ventricles reduced.
- (ii) diencephalon small and rounded, both parietal body and pineal body may present.
- (iii) optic lobes large, in snakes each optic lobe divides into anterior and posterior parts and form corpora quadrigemina, crura cerebri present ventrally.
- (iv) Cerebellum is slightly large, in Alligators it forms flocculi. The roof of the cavity of medulla oblongata contains muscular posterior choroid plexus.
- (v) Cranial nerves 12 pairs.

• Lateral thickened wall of diencephalon forms optic thalamus. Its thin walled roof forms ant. choroid plexus. On the ventral side infundibulum & hypophysis present; optic chiasma situated anterior to infundibulum.

The increase in the size of cerebellum indicates enlarged instinctive activities. Reptiles respond more quickly than amphibians.

## In Aves :

Brain is short, broad and highly specialized —

(i) Olfactory lobe reduced or degenerate (due to poorly developed sense of smell.)

(ii) Cerebral hemisphere are very large with well developed cerebral cortex; Corpora striata is more prominent reducing the lateral ventricles.

(iii) diencephalon is dorsally covered by cerebral hemisphere and cerebellum; pineal body present;

(iv) optic lobes large and placed on sides; on the roof of the cavity ant. choroid plexus also present. + optic commissure from cerebellum

(v) Cerebellum is very large and consists of well defined median lobe — the vermis and two lateral

lobes — the flocculi.

(vi) Medulla oblongata is small

⊙ The convolution of cerebellum indicate delicate sense of equilibrium and the great power of muscular ~~coordination~~ coordination.

## In Mammals :

The mammalian brain reaches its highest development with better integration and mastery

(i) Olfactory lobes degenerate or relatively small and remain separate from cerebrum by rhinal fissure.

(ii) Cerebral hemisphere

(a) C.h. ~~are~~ larger than other vertebrates, a longitudinal median fissure separates the two hemisphere from each other.

(b) each hemisphere is divided into anterior frontal lobe and posterior-lateral temporal lobe by an oblique sylvian fissure.

(c) The surface of the cerebral hemisphere is smooth in lower mammals (Prototherian & Metatherians) but highly convoluted in higher mammals due to presence of gyri (elevation or ridges) and sulci (furrows).

(d) The two hemisphere are connected together by a transverse band, the corpus callosum, the characteristics of mammalian brain.

(iii) Corpora striata elongates posteriorly and rest upon thalamus.

(iv) epiphysis become glandular forming pituitary body

(v) The optic lobe divided into corpora quadrigemina (with two anterior colliculi and two posterior colliculi).

(vi) Cerebellum is also massive and folded forming a median vermis, two lateral lobes and two floculi with mushroom like projection called arbor vitae on the ventral side of cerebellum a thick transverse band of nerve fibres is present called pons varoli, characteristic of mammal.

(vii) Medulla oblongata is relatively short and thickened

(viii) Cranial nerves 12 pairs.