MENINGES

- Dura mater – Falx cerebri, Falx cerebelli, Tentorium cerebelli, Diaphragma sellae
- Arachnoid mater
- Pia mater
- Cerebrospinal fluid

Membranes that surround and cover the brain are Meninges. Three in number. From outside inwards they are : 1. Dura mater, 2. Arachnoid mater, 3. Pia mater.

DURA MATER (PACHYMENINGES)

Hard covering, outermost thickest dense inelastic layer. Cerebral dura mater differs from spinal dura mater, because it has got two layers - outer endosteal and inner meningeal layer. These two layers are fused with each other except in certain regions where they separate to form *venous sinuses*.

Endosteal layer (Endocranium or Inner periosteum of skull bones).

Features –

1. Continuous (a) with pericranium through the sutures and foramina (b) with periosteum of orbit through the superior orbital fissure.
2. Adherent to inner surface of cranial bones by a number of fine fibres and vascular processes. This adhesion is most marked at *sutures, base of skull and around foramen magnum.*

Meningeal layer –

Provides sheaths for cranial nerves fusing with epineurium outside the skull and the sheath for optic nerve is continuous with Sclera.

The meningeal layer sends inwards four processes which divide the cranial cavity into

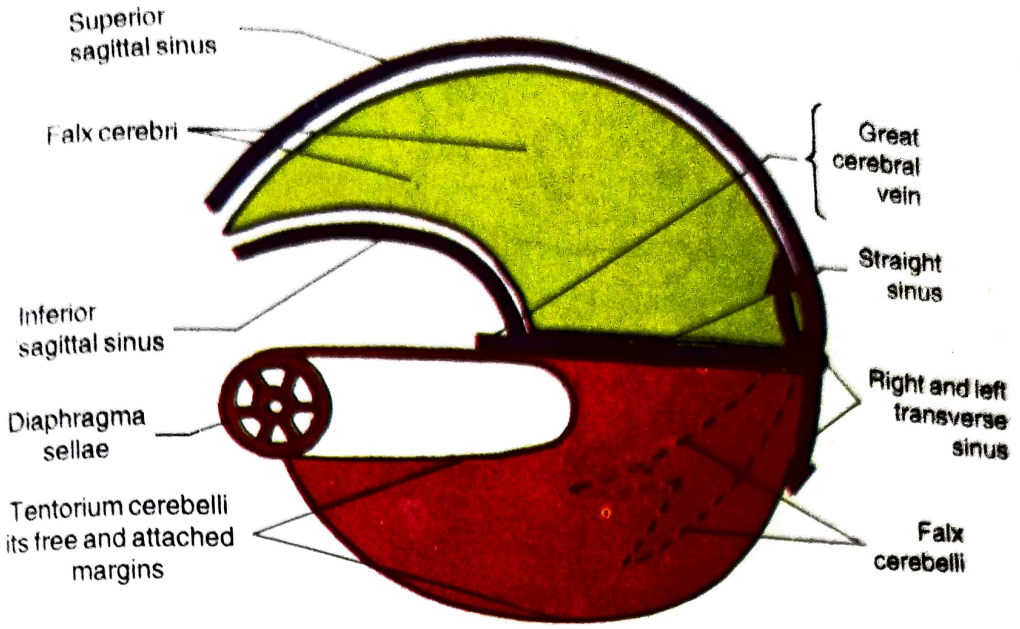


Fig 21.1 Process of Duramater.

freely communicating compartments lodging different parts of the brain. These processes are known as **Dural processes.**

The dural processes are four in number.

1. Falx cerebri,
2. Falx cerebelli,
3. Tentorium cerebelli ahd
4. Diaphragma sellae.

Falx cerebri

It is a *sickle shaped fold of dura mater* situated in median longitudinal fissure between two cerebral hemispheres.

Two ends -

1. Anterior end - *narrow* and attached to *crista galli of ethmoid bone.*
2. Posterior end broader and attached to *upper surface of tentorium cerebelli* in the median plane.

Two margins -

1. Upper margin - *convex* and *attached* to the lips of the sagittal sulcus to internal occipital protuberance of occipital bone.
2. Lower margin - *concave* and *free.*

Venous sinuses in relation to falx cerebri -

1. Superior sagittal sinus in the upper margin.
2. Inferior sagittal sinus in the lower free margin.
3. Straight sinus (Formed by great cerebral vein and inferior sagittal sinus) lies along at the broad posterior end attached to tentorium cerebelli.

Tentorium Cerebelli

It is a tent shaped fold of meningeal layer of dura mater and lies between *occipital lobes of cerebrum above and cerebellum below* and forms *roof of posterior cranial fossa.*

So it divides the posterior part of cranial cavity into supra and infra tentorial parts. The infratentorial part is important because it contains hindbrain and lower part of midbrain. Tumour at this site shows early signs of raised intracranial pressure due to blockage of the foramina of Luschka and Magendie.

Features :

A. Margins - Two :

(a) Anterior or free margin – concave, mostly free and forms the tentorial notch occupying midbrain and anterior part of the superior vermis. It is attached in front to the anterior clinoid process of sphenoid bone.

(b) Outer or attached margin – convex and attached to the lips of transverse sulci of occipital bone, postero-inferior angle of

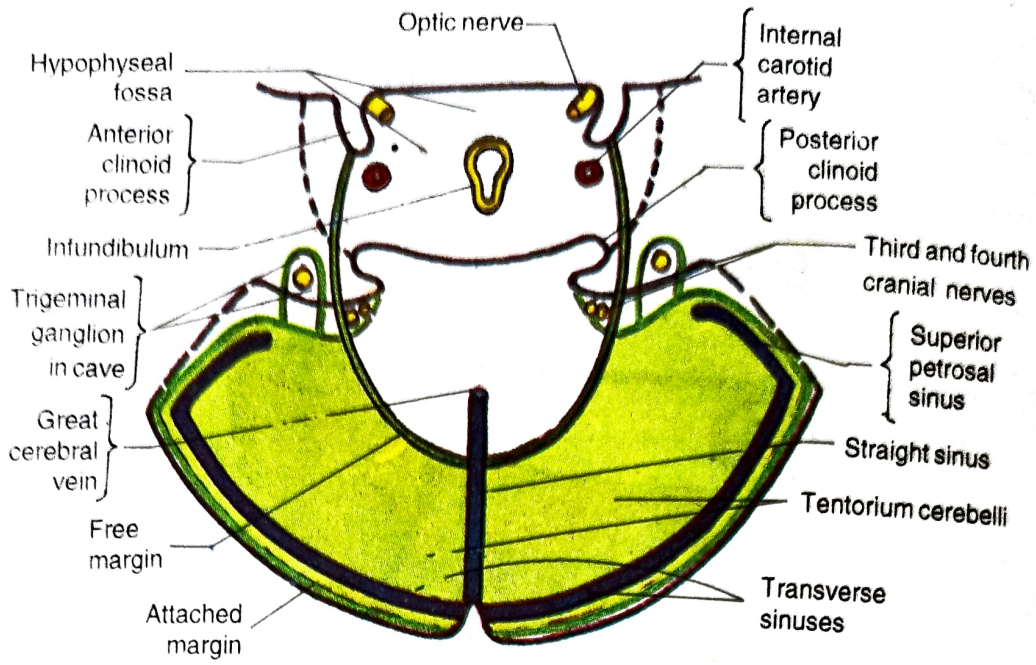


Fig 21.2 Tentorium cerebelli.

parietal bone, superior border of petrous part of temporal bone and finally to posterior clinoid processes. Venous sinuses which are contained in this margin are (i) Transverse sinus at the region of occipital bone and (ii) Superior petrosal sinuses at the superior border of petrous part of temporal bone.

B. At the crossing of the two margins a triangular area will be formed and this forms the posterior *part of roof of cavernous sinus*. This area is pierced by 3rd and 4th cranial nerves.

C. **Surfaces - two : upper and lower.**

(a) *Upper surface* is *convex* and slopes on either side from the median plane and contains *straight sinus* at its attachment with falx cerebri. It is related to *occipital lobes*.

(b) *Lower surface – concave*, related to *cerebellum and falx cerebelli* is attached to posterior part in the median plane.

D. **Meckel's cave or cavum trigeminale** – It is a special recess of dura mater formed by the evagination of the lower layer of tentorium cerebelli (forwards and laterally) beneath the superior petrosal sinus over the trigeminal impression on the anterior surface of petrous part of temporal bone near the apex.

This recess lies between endosteal and meningeal layers and contains the trigeminal ganglion with its roots.

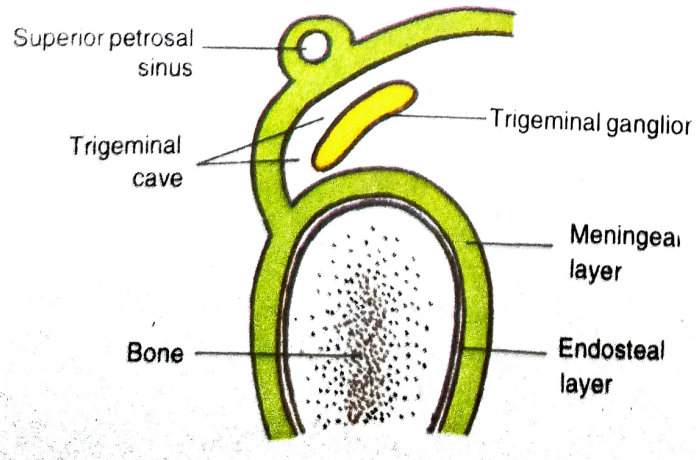


Fig 21.3 Meckel's cave.

Falx Cerebelli

Small sickle shaped fold of dura mater projecting into the posterior cerebellar notch.

Base - Attached to lower surface of tentorium cerebelli in the median plane.

Apex - Divides into two parts and gradually lost at margins of foramen magnum.

Margin -

(a) *Posterior* - convex and attached to internal occipital crest and encloses occipital sinus.

(b) *Anterior* - concave and free.

Diaphragma Sellae

Small circular horizontal fold of dura mater forming roof of hypophyseal fossa.

Features -

In front - Attached to tuberculum sellae and behind to dorsum sellae. On each side continuous with dura mater of middle cranial fossa.

Central aperture for transmitting infundibulum.

Blood supply of cerebral dura mater :

Endosteal layer is richly vascular, meningeal layer is fibrous and less vascular.

Vault - Middle meningeal artery.

Anterior cranial fossa - Meningeal branches of anterior ethmoidal, posterior ethmoidal and ophthalmic arteries.

Middle cranial fossa - Middle meningeal, accessory meningeal, internal carotid, ascending pharyngeal.

Posterior cranial fossa - Meningeal branches of occipital and vertebral, ascending pharyngeal.

Nerve supply -

Vault - Less nerve supply - few sensory fibres from ophthalmic division of trigeminal nerve.

Base or fossae - Richly innervated and quite sensitive to pain.

Anterior fossa - Anterior ethmoidal and partly from maxillary nerve.

Middle fossa - Anterior ½ by maxillary nerve.

Posterior ½ by mandibular and trigeminal.

Posterior fossa - Partly by ganglion of 9th and 10th cranial nerves and recurrent branches of $C_{1,2,3}$ nerves.

Applied anatomy of Dura mater (Cerebral) :

1. Intracranial pain sensitive structures are :
   (a) Large venous sinuses with tributaries.
   (b) Dural arteries.
   (c) Dural floor of anterior and posterior cranial fossae.
   (d) Arteries of the base of the brain.
2. Headache - Causes -
   (a) Dilatation of intracranial arteries and extracranial arteries.
   (b) Traction or distension of intracranial pain sensitive structures.
   (c) Infection or inflammation of intracranial or extracranial structures supplied by sensory nerve.
3. Extradural and subdural haemorrhages are common.

Extradural	Subdural
1. Less common	1. More common.
2. Arterial due to middle meningeal.	2. Venous.
3. Symptoms of cerebral compression - Late.	3. Symptoms appear early.
4. Lucid interval present.	4. No lucid interval.
5. Paralysis first appears in face and then spreads to lower parts of body.	5. Paralysis spreads in a haphazard way.
6. No blood in C.S.F.	6. Blood in C.S.F.

ARACHNOID MATER

It is a Greek word meaning 'Spider's web'.

It is a delicate avascular membrane which loosely surrounds the brain. It does not dip into the sulci or fissures of brain except in the median longitudinal fissure and stem of lateral sulcus. It is not identified in hypophyseal fossa.

It is separated from dura by subdural space and from pia by subarachnoid space containing cerebrospinal fluid.

Processes -

1. *Arachnoidal villi* - These are tortuous, finger-like processes of arachnoid mater arising from anterior surface of arachnoid, and push the dura before them or perforate it and ultimately project into the venous sinuses and large veins. They are covered by meningocytes which are specialised mesothelial cells and functionally concerned for absorption of C.S.F. either by filtration or dialysation to blood stream.

2. *Arachnoidal granulation* - They are also known as Pacchionian bodies. They are mere aggregations of enlarged arachnoidal villi with the *advancing of age*. So *found in adults* and *not in children*. They *indent the bones* forming *arachnoidal pits* in the *vicinity of superior sagittal sinus*. They have also the same *functions as absorption of C.S.F.*

Prolongations - It provides sheaths for cranial nerves.

Meningocytes - Specialised mesothelial cells - though called mesothelial yet there is evidence for ectodermal origin of these cells.

They are found in five situations -

(a) covering the arachnoidal villi.

(b) in the fibrous structure of dura (nests).

(c) arachnoidal sheath of posterior root of ganglion of the cord.

(d) in the arachnoidal sheath covering the stalk of choroid plexus of lateral ventricle.

(e) floating free in C.S.F.

Functions

(a) *Excretion of C.S.F.* into cerebral venous sinuses or on the outer surface of dura.

(b) *Phagocytic function* - engulf foreign particles.

(c) As a *reparative agents* - large dural defects are repaired in presence of intact *leptomeninges (Pia and arachnoid).*

(d) As *producers of bile pigment.* Tumours arising from it are known as *meningiomas.*

PIA MATER

Pia means tender.

It is a thin, delicate vascular membrane which intimately invests the brain and spinal cord.

(a) It dips into various sulci and fissure of brain and well-defined over the brain stem.

(b) It gives sheaths for cranial and spinal nerves.

(c) Forms perivascular sheaths to blood vessels entering and leaving the brain substance.

(d) It forms Tela choroidea which is a fold of pia mater enclosing choroid plexuses.

Tela choroidea of 4th ventricle is a double fold of pia enclosing choroid plexuses of 4th ventricle and situated in the interval between cerebellum and lower part of the roof of the 4th ventricle.

Tela choroidea of 3rd ventricle lies above the roof. So the tela choroidea of 3rd and lateral ventricle - pia mater investing choroid plexuses of the respective region.

(e) **Linea splendens** – A thickening of pia at the region of anterior median fissure of spinal cord where pia gives a septal process.

(f) **Ligamentum denticulatum** - Twentyone tooth-like processes of pia of spinal cord and extend to dura pushing arachnoid before them. They lie between anterior and posterior nerve roots. They maintain the lateral stability of the cord. The first one lies at the foramen magnum. The last one is forked and lies below 12th thoracic vertebra and posterior root of 1st lumbar nerve and lies in relation to it. So it is a guide to the surgeon.

Epidural space - Space between bone and dura mater. It is a space outside dura mater.

Subdural space - Space between bone and duramater and more concerned in the spinal cord. It is a potential space and contains thin film of serous fluid to moisten the apposed surfaces and help in the movement of dura over arachnoid. It is continued for a short distance on the nerves and is in free communication of lymph spaces of nerves.

Subarachnoid space – It is the space between arachnoid mater and pia mater.

Appearance – Sponge-like because it is traversed by a network of arachnoid trabeculae which connect arachnoid to pia mater.

Extent – It surrounds the brain and spinal cord and extends below *upto second sacral vertebra.*

Content – *Cerebrospinal fluid* and larger blood vessels and cranial nerves also pass through space.

Communications – With 4th ventricle by Foramen of Magendie (Median aperture at the roof of 4th ventricle) and by Foramen of Luschka (two lateral apertures - one on each lateral recess of 4th ventricle). The C.S.F. from 4th ventricle passes to subarachnoid spaces through these apertures.

Prolongations -

1. Into arachnoidal sheaths around nerves where it communicates with neural lymphatics specially in 1st, 2nd and 8th cranial nerves.
2. Into pial sheaths around the vessels entering the brain substance (perivascular space). In this way C.S.F. comes in direct contact with nerve cells.

Dilatations - It presents dilatations at the base of brain and brainstem known as subarachnoid cisterns. Such as cisterna cerebellomedullaris, cisterna pontis, interpeduncular cistern etc.

Subarachnoid Cisterns – These are wide intervals or dilatations of subarachnoid spaces forming intercommunicating pools at certain regions of the brain such as base of brain, around the brain stem.

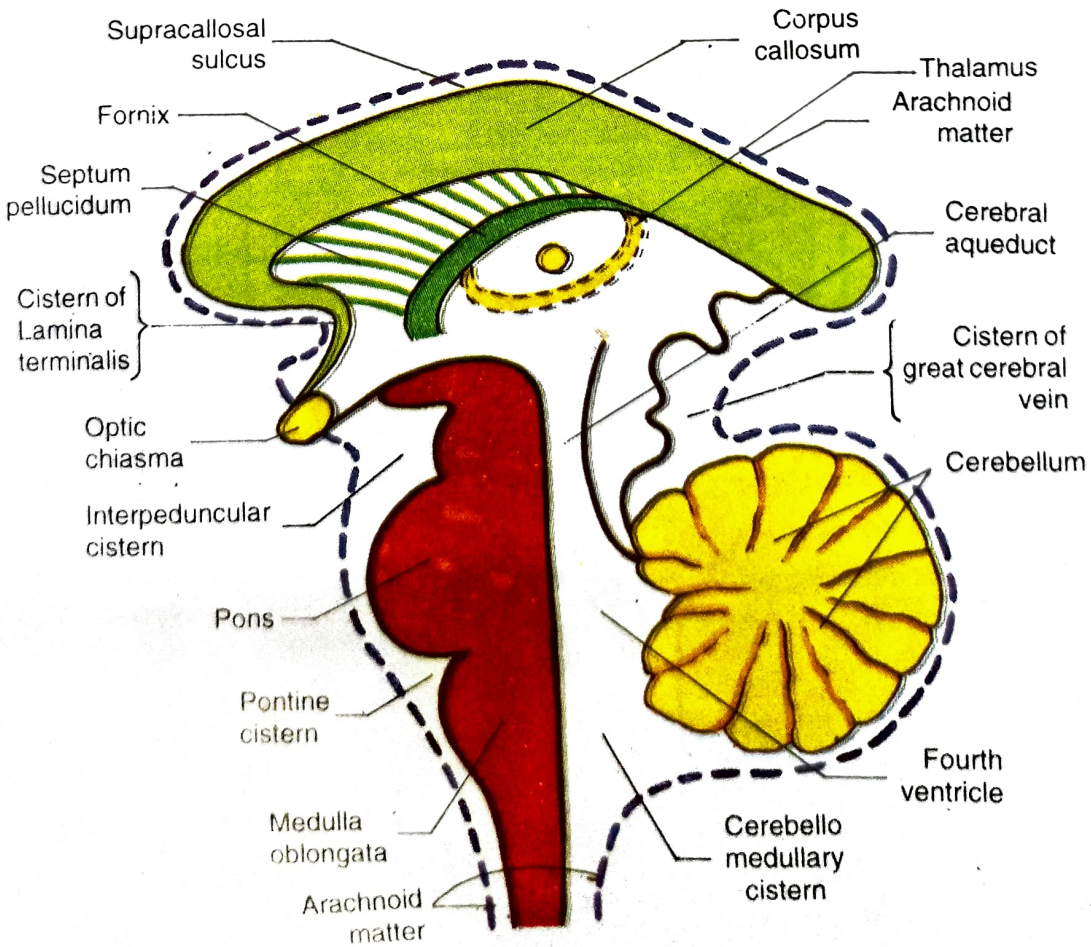
Characteristic – Subarachnoid tissue is scanty.

Function –

1. Water bed to the brain.
2. Protection to vital centres.
3. Arterial pulsations within cistern force C.S.F. from cisterns to surface of hemispheres, situated in the medulla oblongata by forming cushions around them.

Number –

1. Cisterna cerebellomedullaris – It is also known as cisterna magna and lies between undersurface of cerebellum and medulla. C.S.F. from 4th ventricle passes to this cistern through *Foramen of Magendie* and *Luschka*. It is the *site for cisternal puncture*. It is *triangular* on cross section. It is continuous below with *subarachnoid space of spinal cord.*



2. Cisterna Pontis - (*Pontine Cistern*) - an extensive space on the ventral surface of pons. Contains vertebral and basilar arteries. Continuous below with subarachnoid space, behind with cerebellomedullary cistern and in front with interpeduncular cistern.
3. Interpeduncular cistern (*Basal cistern*) contains circle of Willis.
4. Cistern of lateral sulcus – contains middle cerebral artery.
5. Cistern of great cerebral vein (*cisterna ambiens*) contains the same vein.
6. Cisterna chiasmatis – lies below and in front of optic chiasma.

Besides, cistern of lamina terminalis, supracallosal cistern are extension of cerebellomedullary cisterns and contain anterior cerebral artery. Lumbar cistern lies below conus medullaris of spinal cord.

Cerebro-spinal Fluid

It is a modified tissue fluid in the central nervous system and contained in the ventricles of brain, subarachnoid spaces of brain and spinal cord.

Formation - Formed mainly from choroid plexuses of lateral ventricle and lesser-amounts from choroid plexuses of 3rd and 4th ventricles and also from perivascular spaces. It may be secretory or filtration or dialysed products.

Circulation - From lateral ventricle

↓ to

3rd ventricle through foramen of Monro (Interventricular foramen)

↓ to

4th ventricle through cerebral aqueduct

↓ to

Subarachnoid space around brain and spinal cord

Through Foramen of Magendie and Foramen of Luschka.

Some amount may pass from 4th ventricle to central canal of spinal cord.

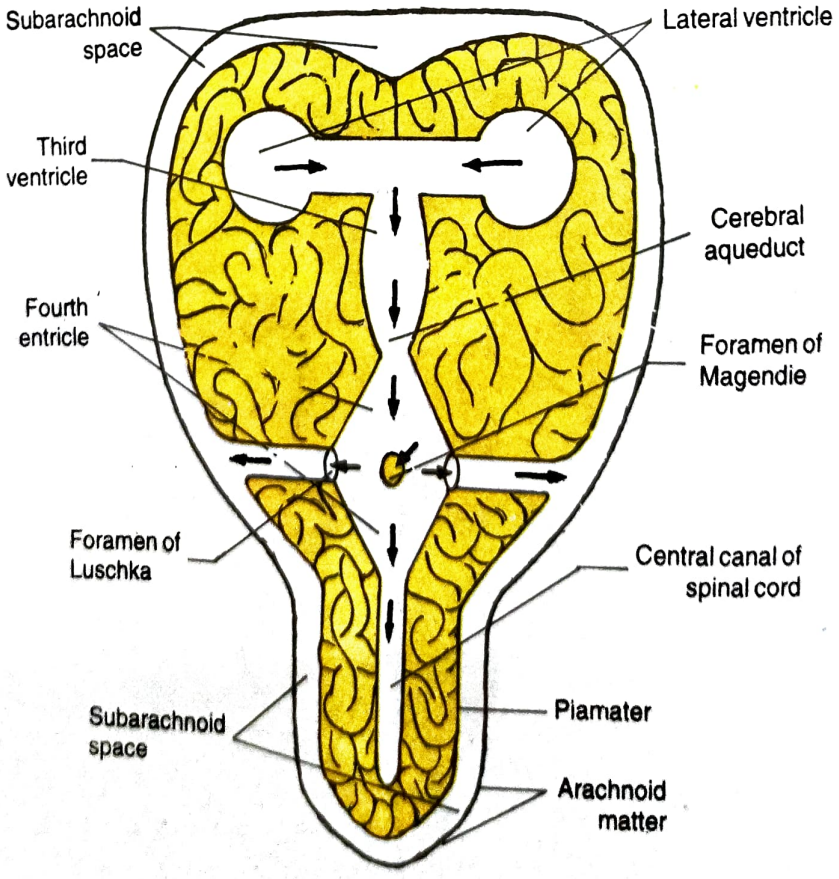


Fig 21.5 Circulation of Cerebro-spinal fluid.

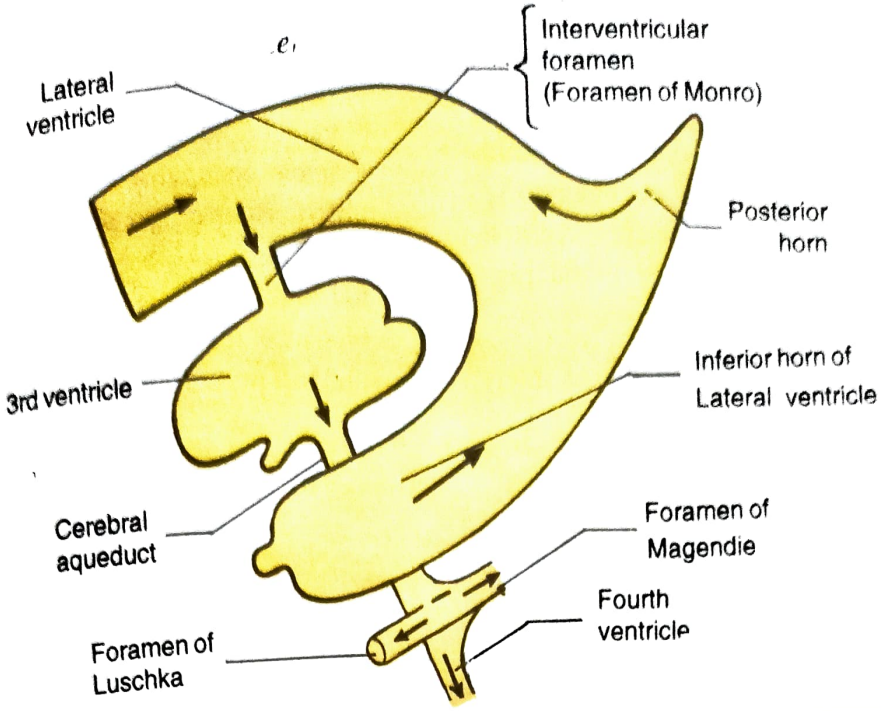


Fig 21.6 C.S.F. in ventricles of Brain.

Absorption -

(a) Absorbed chiefly by arachnoid villi and granulations and is thus drained into cranial venous sinuses.

(b) Also absorbed by perineural lymphatics around 1st, 2nd, 7th and 8th cranial nerves.

(c) Also by veins related to spinal cord.

Rate of formation – 20 cc/per hour.
500 cc/a day.

Total quantity about – 110 - 150 cc in adult

Pressure – 110-150 mm. of water

Composition –

Proteins –	20-40 mg. per 100 cc.
Sugar –	50-75 mg. per 100 cc.
Chlorides –	720-750 mg. per 100 cc.
Cells –	0-5 mg. per cubic mm.

Functions -

(a) Protective

(b) Nutritive

(c) Excretory to central nervous system.

Characteristics -

(a) Antibodies, opsonins are not found hence infections of brain are fatal.

(b) Bile is not found in it in case of deep jaundice.

(c) Strong selective processes are at work so drugs are not secreted to it except urotropine.

(d) Certain antibiotics and chemotherapeutics have high diffusion level from blood to C.S.F.

Applied -

1. It can be obtained by lumbar puncture, ventricular puncture and cisternal puncture.

Lumbar puncture - Between 3rd and 4th lumbar spine. needle is introduced so as to avoid injury to spinal cord which ends at the lower border of 1st lumbar vertebra. The needle passes through interspinous and supraspinous ligaments.

Cisternal puncture - The needle is passed through posterior atlanto-occipital membrane and C.S.F. is obtained from cerebello-medullary cistern.

2. Biochemical analysis of C.S.F. is of diagnostic value as in meningitis.

3. Drainage of C.S.F. at regular intervals is therapeutic value in meningitis and in certain intractable headaches of unknown aetiology.

4. Obstruction to flow of C.S.F. in ventricular system i.e. at interventricular foramen, cere-

bral aqueduct or foramina of 4th ventricle will lead to hydrocephalus in children and raised intracranial pressure.

5. *Loculation syndrome of Froin* - The fluid below the block coagulates spontaneously due to increased protein and becomes yellow (Xanthochromia) due to altered blood pigment. Cells are normal.

6. *Queckenstedt's Test* - Compression of internal jugular vein causes intracranial venous congestion which results in rise in C.S.F. pressure and this pressure is transmitted in subarachnoid space in spinal cord. But when a space occupying lesion such as a tumour obstructs in the vertebral canal this increased C.S.F. pressure due to compression of internal jugular vein is not transmitted below the block i.e. the pressure does not rise - thus by this test presence of obstruction is confirmed.