# Cerebral Regulation & CSF Formation

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**Please check out this link before viewing the file to know if there are any additions/changes or corrections. The same link will be used for all of our work Physiology Edit**

# Cerebral circulation

✧The brain receive its blood supply from four main arteries:

1- two internal carotid arteries

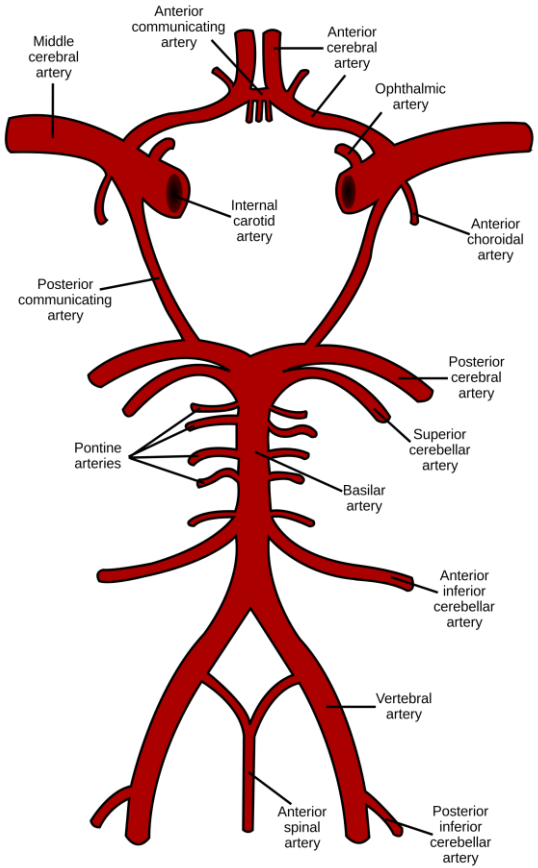
2- two vertebral arteries --> unite to form basilar artery.

✧The circle of The basilar artery and the two internal carotids form the circle of Willis.

✧Substances injected into one carotid artery distributed almost completely to the cerebral hemisphere of that carotid artery.

"Substances injected in the right internal carotid normally affect the right cerebral hemisphere"

✧Normally no crossing over occurs probably because the pressure is equal on both sides



# Innervation of the cerebral blood vessels

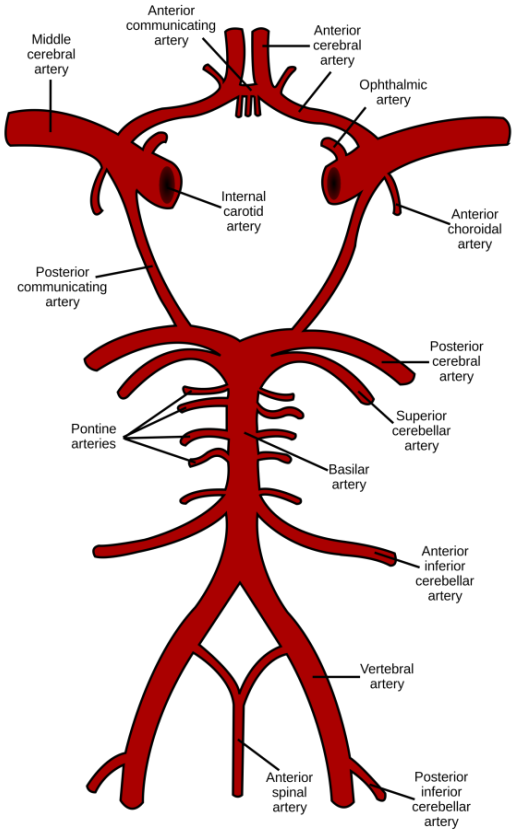
## ➢ SYMPATHATIC :

--> attenuate the increase in cerebral blood flow (CBF) in hypertension

## ➢ PARASYMPATHATIC :

Cholinergic neuron originate in sphenopalatine ganglia end on large arteries.

## ➢SENSORY NERVES.




**Attenuate:** reduce the force, effect

# Cerebral blood flow (CBF)

- **Why our body regulate the amount of blood to the brain?**

1. meat the brain metabolic demand.
2. and because too much blood can raise intracranial pressure(ICP) which can compress and damage delicate brain tissue.

- **Normal rate of CBF:**
  - 50 to 65 milliliters /100 grams of brain tissue / minute.
  - For entire brain 750-900 ml/min (15% of the cardiac output)

"each minute there are 750 to 900 ml of blood reaching the brain"

- **When does ischemia occur in the brain?**
  - If the CBF is below < 18-20ml/100 gram of brain tissue/ min

"occur if each minute there is less than 20 ml of blood reaching100g of brain tissue"

  - **DEATH OCCUR IN -->** If the CBF is below < 18-20ml/100 gram of brain tissue/ min

# Cerebral perfusion pressure (CPP)

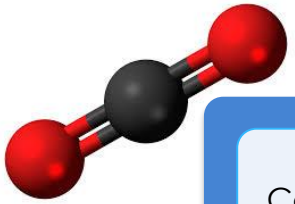
- **The net pressure of blood flow to the brain**

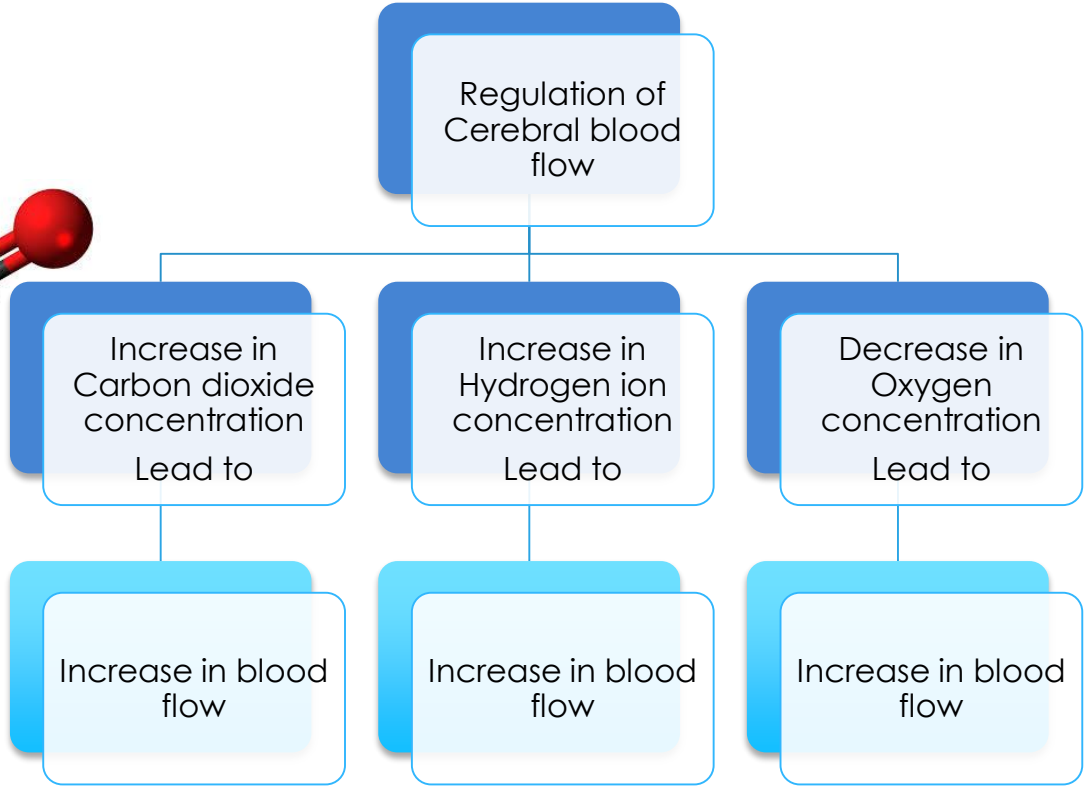
- **Is regulated by:**
  - Mean arterial pressure (MAP)
    - The force that pushes the blood to the brain.
  - Intrcranial pressure (ICP)
    - The force that puches the blood away from the brain.

- **How to calculate it?**
  - CPP = MAP – ICP

NORMAL VALUE of CPP = 70-90 mmHg

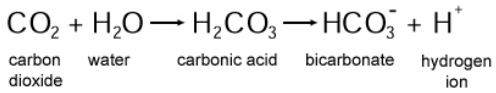
# Regulation of CBF





# 1. Increase in CO2 Or H+

- **70 % increase in arterial PCO2 approximately doubles the cerebral blood flow**
- **How does Co2 cause vasodilatation?**
  - Co2 first combine with water (H2O) to form carbonic acid, Which dissociate to hydrogen ion.




  - The hydrogen ion is responsible for causing vasodilatation.
  - And this dilatation is proportional to the concentration of hydrogen ion. "MORE H+ produces more dilitation"
  - This effect doesn't derive the blood flow to more than its double.
  - ANY substance that lead to acidity of the brain increase the hydrogen ion concentration, will increase the cerebral blood flow

e.g --> Lactic acid , Pyruvic acid

# Importance of Co2 , H+ regulation

- We Know that Acidosis depress CNS, or specifically the neurons.

- The vasodilatation due to H+ is protective for our body, WHY!!!
  - Increase the blood flow, which carries CO2 and H+ away from the brain, and that will decrease the possibility for developing CNS depression and maintain normal neural activity.

# 2. Decrease in oxygen concentration

- Hypoxia dilate the blood vessels and increase the blood flow.
- And vice versa, High amount of oxygen constrict the blood vessels

## Importance of Oxygen regulation

- **The rate of utilization(Using) of oxygen by brain tissue**
  = 3.5ml/ 100 gram/min

- Decrease in cerebral tissue PO2 below about 30 mm Hg immediately begins to increase cerebral blood flow. "NORMAL Value is 35-40mmHg"

- Brain function becomes deranged at lower values of PO2, especially at PO2 levels below 20 mm Hg.

# Autoregulation

- The brain maintains proper CPP through the process of autoregulation:
- The cerebral blood flow is maintained very well between arterial pressure limit 60 -140 mmHg.

Questions 

- What is the normal blood flow to the brain if the pressure is 70mmHg?

750-900ml/min

- What is the normal blood flow to the brain if the pressure is 130mmHg?

Also between 750-900ml/min

- What will happen to the arterioles if the blood pressure reaching 140mmHg?

Constrict

- What will happen to the arterioles if the blood pressure reaching 70mmHg ?

Dilate

# Autoregulation

- Now, When pressures are outside the range of 60 to 150 mmHg, the blood vessels' ability to autoregulate pressure through dilation and constriction is lost, and cerebral perfusion is determined by blood pressure alone without autoregulation. And thus, hypotension(below 60mmHg) can cause cerebral ischemia.

## Cushing Reflex:

- **What does this scary name means ?**
- When the intracranial pressure exceeds its level or become more than > 33mmHg .
- The cerebral blood flow (CBF) will decrease. "Because ICP prevent the flow of blood to the brain"
- The drop in CBF will lead to hypoxia and hypercapnea(high CO2) of the Vasomotor area.
- This area will try its best to elevate the blood pressure (THE REFLEX)

NORMAL VALUE of ICP = 1-15mmHg

# Measuring cerebral blood flow

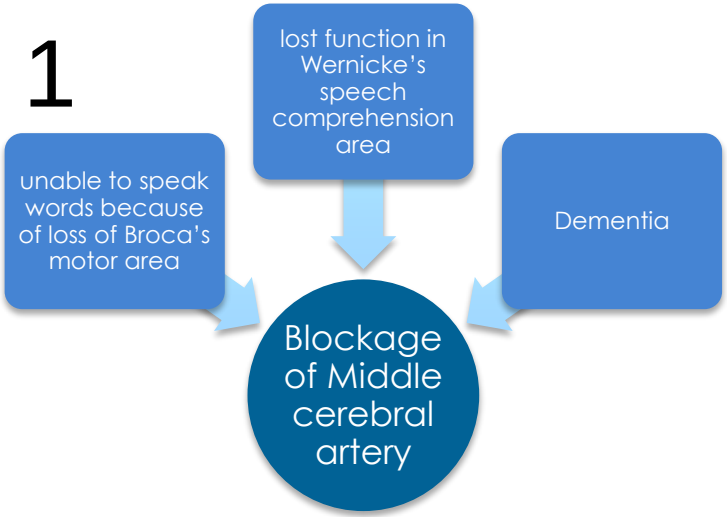
1. Functional imaging resonance
2. Positron emission tomography

- Both be used to measure CBF. These techniques are also used to measure regional CBF (rCBF) within a specific brain region.

- Radioactive xenon injection into carotid artery, pass into brain tissues show increase radioactivity in areas of increased blood flow due to local neuronal activity(blood flow increase in left motor area by movement of right hand)

# Overview of stroke

1

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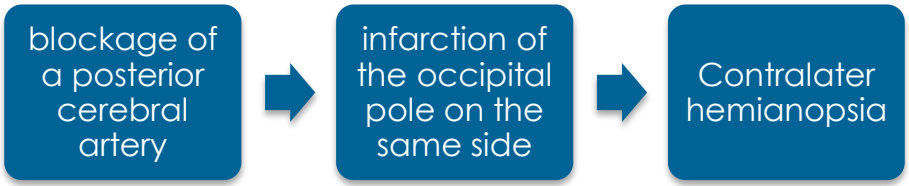


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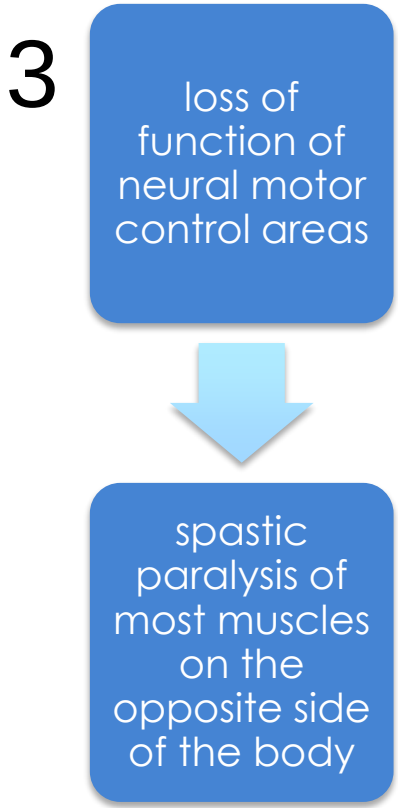
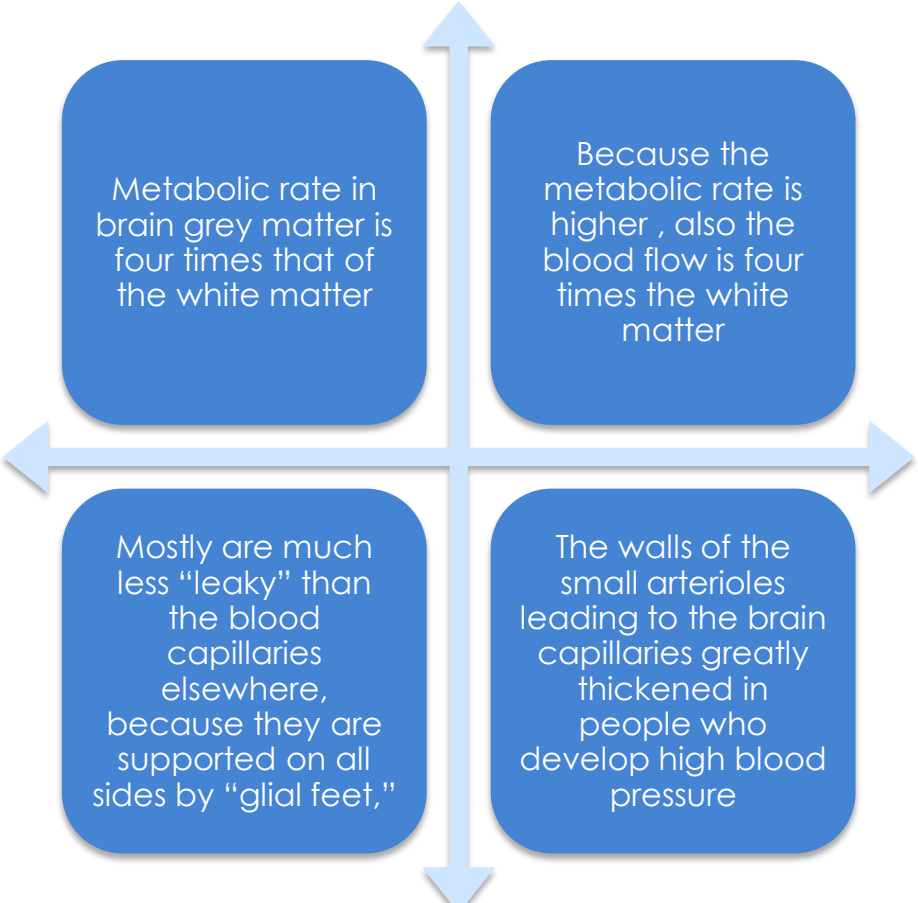


# Characteristics of cerebral microcirculation



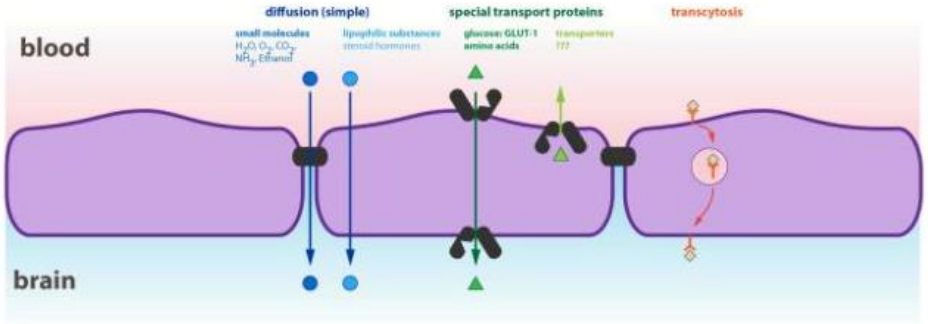
# Features of cerebral vessels

## ◆Choroid plexus:

There are Gaps between endothelial cells of the capillary wall allow CSF flow& no gaps between epithelial cells which is in direct contact with blood.

## ◆Capillaries in the brain substance:

Are non-fenestrated and there are tight junctions between endothelial cells to limit passage of substances through the junctions and supported by glial feets

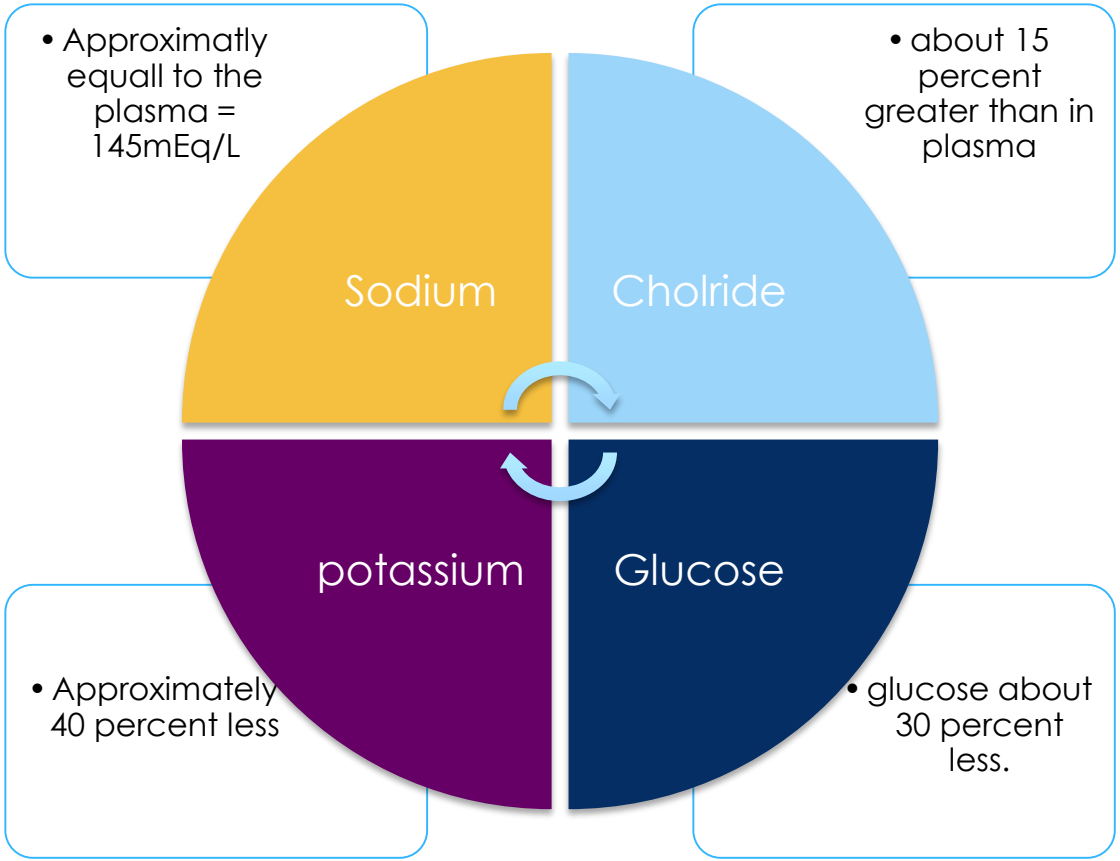


# Cerebrospinal fluid (CSF)

1. FORMED IN --> Choroid plexuses
2. ABSORBED by --> Arachnoid villi

- VOLUME --> 150 ml
- Rate of production = 500 ml/day
- Lumbar CSF pressure = 70-180 mm hg "is not equal to ICP"
- Absorption of CSF is proportionate to CSF pressure
- At pressure of 112 mm (normal average): filtration and absorption are equal.
- Below pressure of 68 mm CSF, absorption stops.

# Composition of CSF



# Function of CSF

## 1-Protective function(cushioning):

In air brain weight =1400 g, but in its water bath of CSF , brain weight = 50 g, making it suspended and floated effectively.

When the head receives a blow, the arachnoid slides on the dura and the brain moves, but its motion is gently absorbed by the CSF cushion and by the arachnoid trabiculae.

## 2-Facilitation of pulsatile cerebral blood flow.

## 3-Distribution of peptides, hormones, neuroendocrine factors and other nutrients and essential substances to cells of the body.

## 4-Wash away waste products.

# Blood brain barrier (BBB)

- A barrier between blood &CSF & brain tissue
  - **Choroid plexuses epithelial cells**
  - **brain tissue capillary membrane epithelial cells**
- Formed by the tight junctions between capillary endothelial cells of the brain capillaries and between epithelial cells in the choroid plexus.

- This effectively prevents proteins from entering the brain and slow the penetration of smaller molecules.

## Penetration of substances into the brain

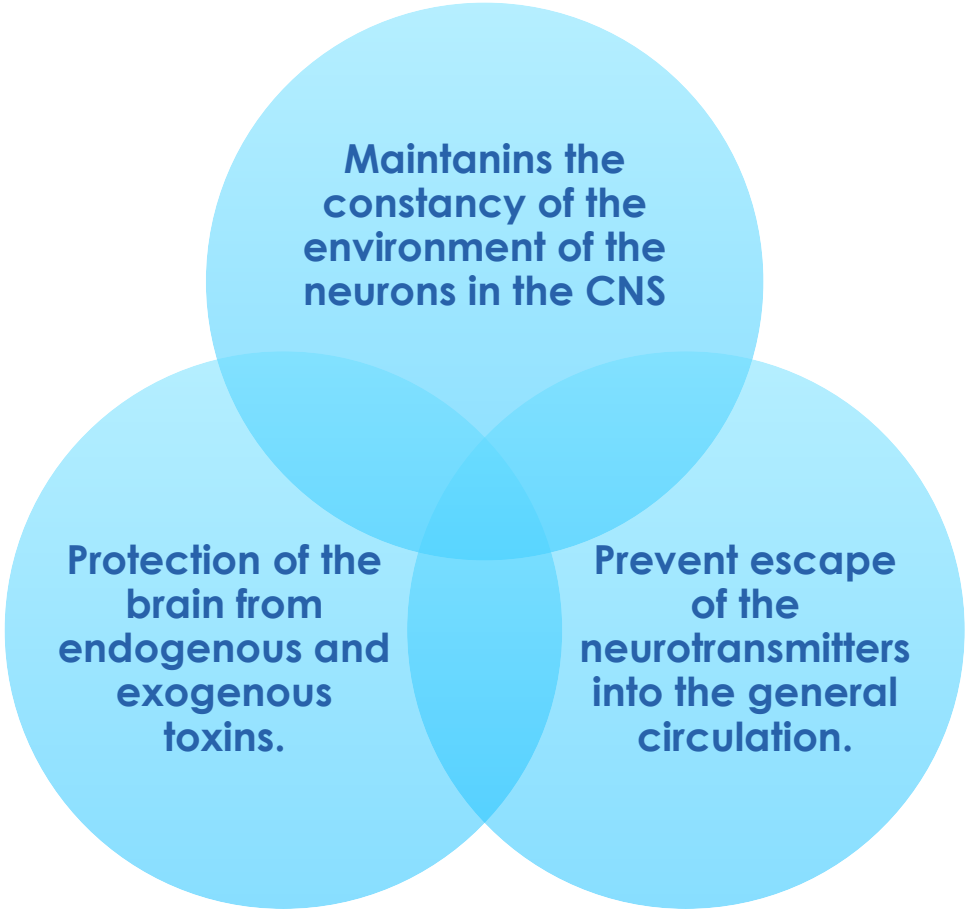
**1.Molecules pass easily:** $H_2O$, $CO_2$, $O_2$, lipid-soluble substances(as steroid hormones)

**2.Molecules not pass:** proteins, antibodies, non- lipid-soluble large molecules.

**3.Slight penetration:** cl, Na, K

**4.Glucose:** its passive penetration is slow, but is transported across brain capillaries by GLUT1

# Functions of BBB



# Brain Edema

- Accumulation of Extra fluid compresses the blood vessels, causing decreased blood flow and destruction of brain tissue.
- The most common cause is **brain concussion.**
- **Two circles involved:**
  - **Edema compresses the vasculature.**

    This in turn decreases blood flow and causes brain ischemia causes arteriolar dilation with further increase in capillary pressure, then causes more edema fluid

- **The decreased cerebral blood flow also decreases oxygen delivery.** This increases the permeability of the capillaries, allowing still more fluid leakage.

**TREAMENT:**

intravenously a concentrated osmotic substance, such as a concentrated mannitol solution. This pulls fluid by osmosis from the brain tissue. Another procedure is to remove fluid quickly from the lateral ventricles of the brain by means of ventricular needle puncture, thereby relieving the intracerebral pressure

**1- Causes vasodilatation**
A. Excess O2
B. Excess glucose
C. Less H
D. Excess lactate

**2-If the ICP < 7, This condition is**
A. Cushing reflex
B. Ischemia
C. thrombosis
D. Normal

**3-occulosion of the middle cerebral artery**
A. Paraplegia
B. Monoplagia
C. Increase muscle tone
D. Decrease muscle tone

**4-Facilitation of pulsatile cerebral flow a function of**
A. CPP
B. NRT
C. BLMC
D. CSF

**5- If the BP = 120mmHg, What is the Cerebral blood flow?**
A. 100ml/min
B. 800ml/min
C. 50ml/min.
D. 350ml/min

**6-Which of the following has direct effect in vasodilitation?**
A. Excess H+
B. Excess Co2
C. Excess O2
D. Glucose level

1.D
2.D
3.C
4.D
5.B
6.A

MCQs

**1- HOW can oxygen deficiency affect CBF?**

Decrease in cerebral tissue PO2 below about 30 mm Hg immediately begins to increase cerebral blood flow.

**2-Calculate CPP, If MAP = 100 , ICP =10**

CPP = 100-10= 90mmHg

**3- Which of cation or anion is found elevated in the CSF?**

CL

**4-The most common cause of brain Edema?**

brain concussion

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THANK YOU FOR CHECKING OUR WORK!

# BEST OF LUCK

## Done By:

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