Regional blood flow

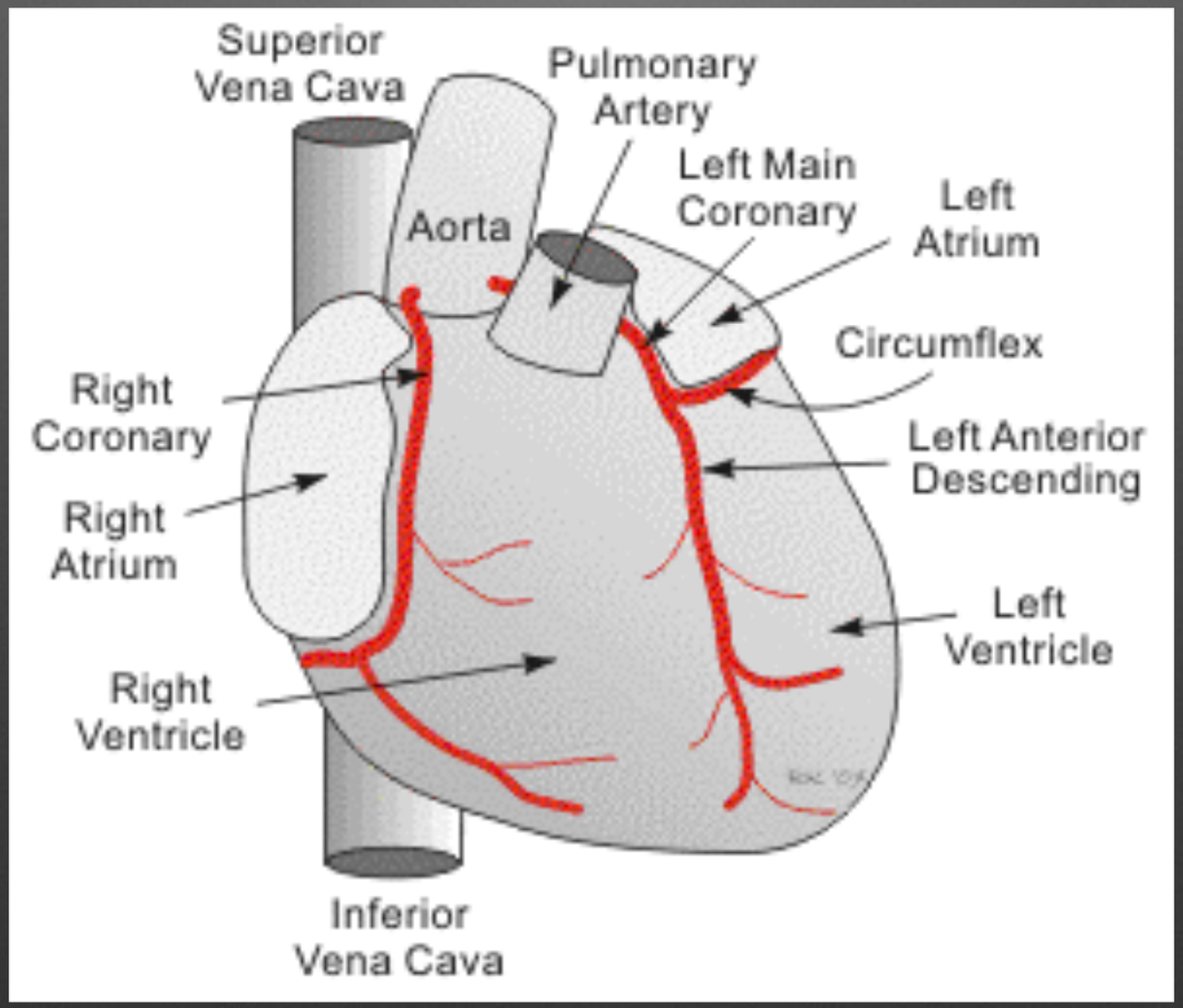
Skeletal muscle

- Extreme increases during exercises
- Flow increases and decreases with each muscular contraction - as a result of compression of the blood vessels by contracted muscle
- Muscle capillaries open during strenuous exercise
- Local regulation by oxygen
    - decreased oxygen in muscle greatly enhances flow
    - tremendous increase in muscle blood low is caused by local chemical effects acting directly on the muscle arterioles to cause vasodilation
    - reduction n O2 causes local arteriolar dilation
- Nervous control - sympathetic vasoconstriction causes decreased flow flow through resting muscles to half of normal

Coronary circulation

- Normal coronary blood flow
  - Resting is 225ml/min
  - Capillary blood flow in left ventricle falls in systole, which is opposite to other parts of the body - during diastole cardiac muscle relaxes and no longer obstructs blood flow so that blood flows rapidly during all of diastole
- Control of coronary blood flow
  - Local metabolism is the primary controller
  - Oxygen demand
  - Nervous control - direct effets of Ach and noradrenaline/adrenaline on penetrating vessels

Coronary Circulation



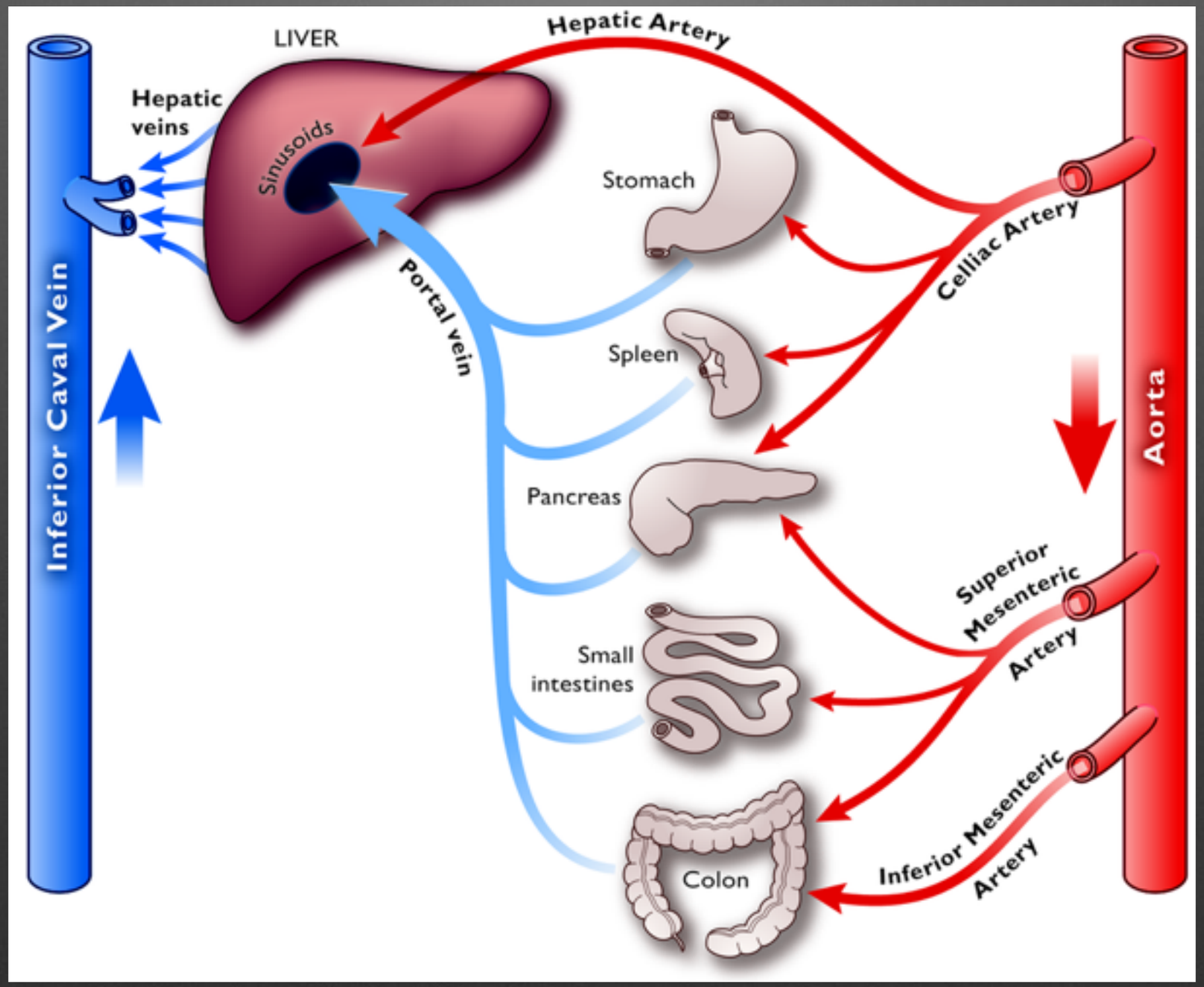
Splanchnic circulation

- Includes blood through the gut itself, spleen, pancreas, and liver and returns via the portal vein to the liver.
- SMA and IMA supply the walls of the small and large intestine by way of an arching arterial system
- Factors effecting blood flow
    - Related to local activity - during absorption of nutrients, blood flow in the villi and adjacent regions of the submucose is increased
- Possible causes of increased blood flow
    - Vasodilator substances released during digestion - CCK, VIP, Gastrin
    - GIT Glands - released bradykinin, kallidin
    - Decreased O2 concentration
- Countercurent flow in the villi means that 80% of the oxygen short circuits into the venues and as such is not available for local metabolic functions of the villi

Splanchnic circulation

- Nervous control -
    - Parasympathetic nerves to the stomach and lower colon increase the local blood flow at the same time that it increases glandular secretion - increased blood flow probably secondary to increased glandular activity
    - Sympathetic stimulation causes intense vasoconstriction - normally after a few minutes there is an auto regulatory escape with ischemic vasodilator effects becoming predominant in there effect on local blood flow - shutting off splanchnic circulation becomes critical in heavy exercise as it increases venous return

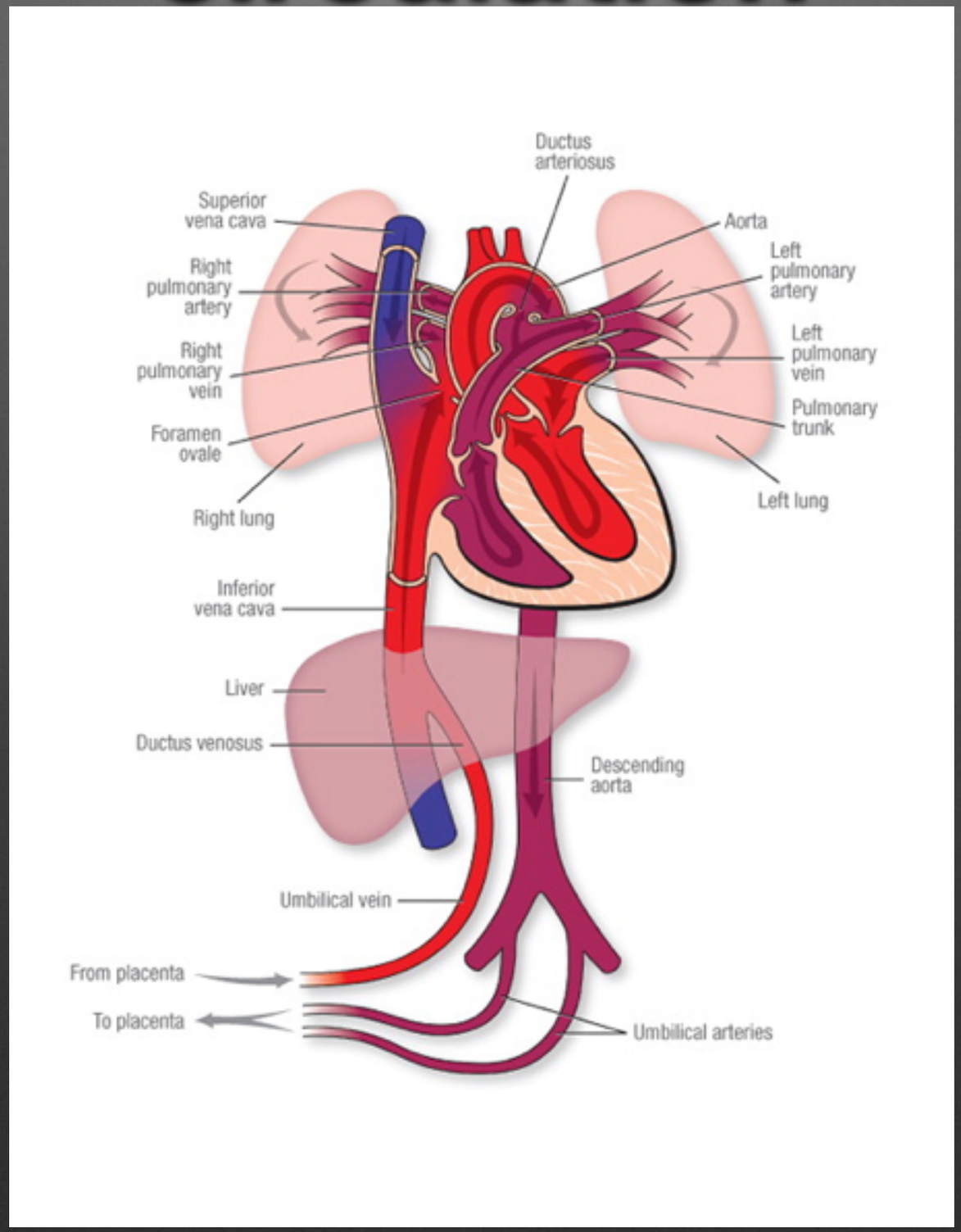
Splanchnic circulation



Skin circulation

- Blood vessels are distributed profusely beneath the skin and plays a large role in thermal regulation and heat loss
- White reaction - a sharp object drawn lightly on the skin causes whitening due to pre capillary sphincters contracting. Appears in 15s
- Triple response - firm stroke by sharp object
  - Red 10 seconds - reddening due to capillary dilation
  - Wheal - few minutes - swelling, mottled reddening - due to increased capillary permeability
  - Flare - redness spreading out from injury due to arteriolar dilation

Placental and foetal circulation



Placental and foetal circulation

- Placenta is the lungs of the foetus - 55%of foetal CO2 goes through placenta
- 2 umbilical arteries - deoxygenated
- 1 umbilical - oxygenated
- Umbilical vein —> ductus venosum —> IVC —> fetal portal blood
- High resistance in pulmonary circulation and patent foramen oval —> blood shunts from RA to LA, and any blood that does go to the pulmonary artery gets shunted via ductus arteriosus to the aorta —> the ductus attaches to the aorta after the R common carotid branches off the aortic arch (therefore measure the saturations on the right hand of a neonate because that better reflects the saturations reaching the brain)

Changes to circulation at birth

- Stimulus at birth causes the baby to take a breath —> pulmonary circulation opens —> low resistance blood is diverted into it. Once umbilical cord is cut - the total peripheral resistance increases for LV
- Foramen ovale valve closes almost immediately and DA closes (few hours - functional, permanent - 24 - 48 hours)

Cerebral circulation

- Regulation - 3 metabolic factors
  - CO_2
  - Hydrogen ion
  - O_2

- CO_2 and Hydrogen ions
  - CO_2 increases cerebral blood flow almost entirely by first combining with water to form carbonic acid with subsequent dissociation to form hydrogen ions
  - Hydrogen ions cause vasodilation
  - Increased hydrogen ion concentration greatly depresses neuronal activity
  - This increased blood flow is crucial for increasing the removal of CO_2 and Hydrogen ions away from the cerebral circulation

Cerebral circulation

- Oxygen concentration
  - Low O2 causes vasodilation
  - A cerebral PO2 less than 30mmHg (normal 35 - 45) causes cerebral vasodilation

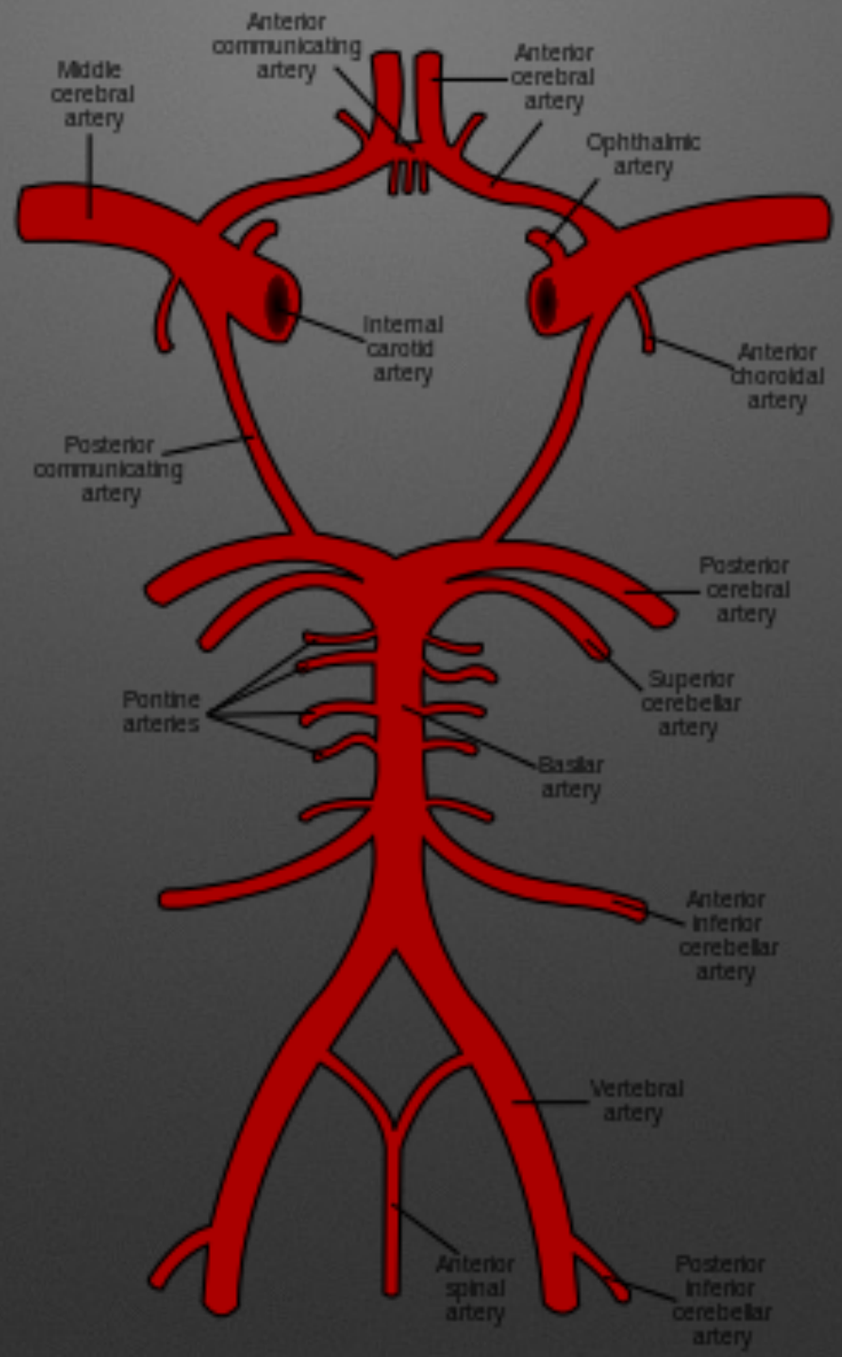
Cerebral circulation

- Pressure regulation
  - Cerebral blood flow is well auto regulated within the arterial systems between 60 - 140mmHg
    - If arterial blood flow falls below 60 mmHg then cerebral circulation becomes compromised
    - If the pressure rises above the upper limit of regulation the blood flow increases rapidly and can cause severe over-stretching and rupture of cereral vessels

Cerebral circulation

- Role of the sympathetic nervous system
  - Has a strong sympathetic innervation which passes upwards from the superior cervical sympathetic ganglia
  - Will increase the pressure for a given blood flow

Circle of Willis

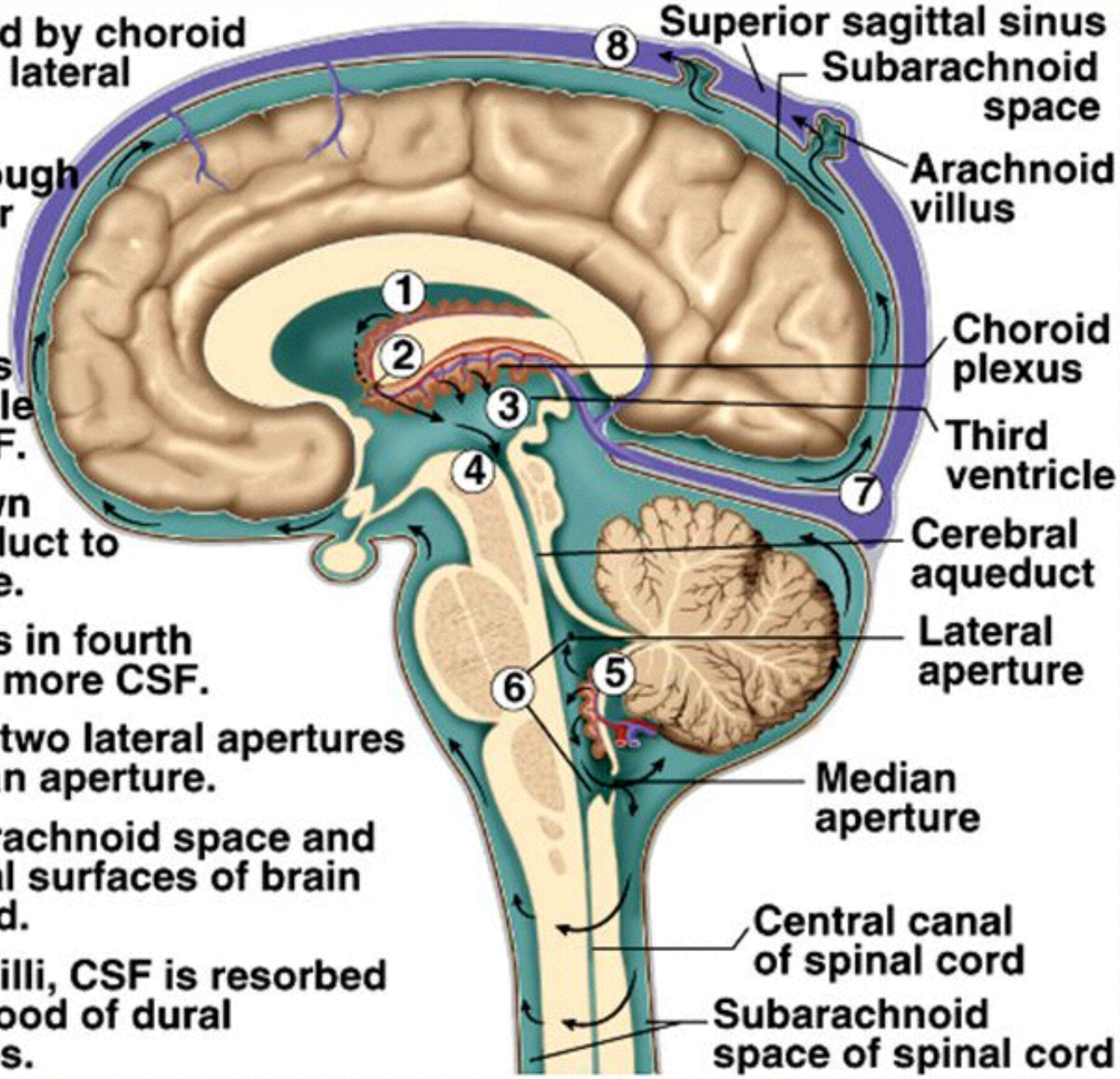


Measurement of cerebral blood flow

- Typically 750 ml/min or 15% of CO
- Can be measured by fMRI or PET scanning

Flow of Cerebrospinal Fluid

1. CSF is secreted by choroid plexus in each lateral ventricle.
2. CSF flows through interventricular foramina into third ventricle.
3. Choroid plexus in third ventricle adds more CSF.
4. CSF flows down cerebral aqueduct to fourth ventricle.
5. Choroid plexus in fourth ventricle adds more CSF.
6. CSF flows out two lateral apertures and one median aperture.
7. CSF fills subarachnoid space and bathes external surfaces of brain and spinal cord.
8. At arachnoid villi, CSF is resorbed into venous blood of dural venous sinuses.



CSF system

- Made in all four ventricles but mainly lateral
- Made in the choroid plexus by ependymal cells
- 500ml made per day but only 100 - 150 ml in circulation, constantly re absorbed by the arachnoid granulations into venous circulation
- Lateral ventricle —> interventricular foramen —> 3rd ventricle —> cerebral aqueduct —> 4th ventricle —> foramen luschka and magendie —> subarachnoid space

Intracranial Pressure

- Moroe - Kellie doctorine
    - Brain is a closed box and its volume is constant so any increase in one of the components (blood, csf, or brain tissue) has to be compensated by a decrease in the other otherwise ICP will go up
    - Brain = 1400g, CSF = 75mL, Blood = 75mL
    - In this way brain can compensate for around 100mL
    - Normal ICP is 7 - 15mmHg