Today’s plan:
- Giving direction inside your brain
- Meninges and blood vessels
- The cerebrospinal fluid and the ventricles
- A development view
- The forebrain

The smallest mammalian brain: mouse
Biggest mammalian brain: whale
Human brain: 3 lbs (1.4kg)

- Brains vary in size and in the number of folds in surface
- Mammalian brains are remarkably similar in overall structure

Why is the brain special to us (humans)? It’s not related to the neurons. The weight of the brain in ratio to the weight of the animal (this is where we differentiate from other mammals, we have a larger brain compared to our body size).

Prefrontal cortex (area 9): involved in planning, attention and working memory
Parietal lobe (area 39): association cortex (bunch of neurons that have the task of relating information to other information) and language

Einstein had much more glial cells and more sulci (grooves) than we did in area 9 and area 39. His IQ was 160.

Neuraxis: tube of neurons
Rostral = Anterior (towards the head or front)
Ventral: (towards the belly side)
Dorsal: (towards the spine side)
Caudal = Posterior (toward the back)
Lateral: (towards the side)
Medial: (towards the middle)
Contralateral: (opposite side)
Ipsilateral: (same side)
Sagittal plane: (goes through your nose)
Horizontal plane: (cuts horizontally)
Coronal plane: transverse (cuts brain like a crown)
One animal that is not symmetrical: sponge

Gray matter: cell bodies (soma)
White matter: axon (myelin sheaths)

Gray part on the outside and white part on the inside of the brain.

Spinal cord is opposite: gray part on the inside and white part on the outside

Nervous System divided into two sections: CNS and PNS
CNS: Brain and spinal cord
PNS: Nerves and peripheral ganglia

Brain protected by 3 layers: Meninges

**Meninges Layers**
Dura mater: thick, unstretchable
Arachnoid membrane: soft, spongy. (Subarachnoid space filled with CerebroSpinal Fluid)
Pia Mater: follows brain surface, contains blood vessels

What do you call a small infection of the meninges? Headache (migraine)

What do you call a large infection of the meninges? Meningitis

**Brain Vasculature**
- Brain (2% of the body) uses about 20% oxygen absorbed by the lungs
- Contains large networks of capillary vessels
- Dense: one can tell which group of neurons are active by looking at where blood flows (fMRI: glucose and oxygen).
- Migraine, stroke

**Cerebro-spinal Fluid**
Flow of CSF: Lateral ventricles → third ventricle → cerebral aqueduct → fourth ventricle → central canal

The ventricles are butterfly shaped.
Some CSF will leave the fourth ventricle and go to Subarachnoid space.
CSF produced by the choroid plexus from blood and flows all around the brain and the spinal
cord and is reabsorbed into the blood.
CSF: fully replaced every 6 hours and absorption in the sinuses (not the ones in your nose).

Hydrocephalus: occurs in 2/1000 children. Mostly congenital (occurs at birth), CFS is not
recycled and also as a result of meningitis. Valve is placed in the lateral ventricle and a tube
(shunt) is placed in the abdominal cavity to recycle the CFS.

Plasticity: ability to repurpose information in different areas of the brain that weren’t meant to
naturally process that information. In development children tend to have more plasticity than
adults.

**Neural Migration**

On the 18th day we start as a tune (neural tube) made of progenitor cells. By 20 weeks the brain
looks superficially like an adult brain. Neurons get born from progenitor cells. Cortex will then
form layers of neurons.

**Neural Development**

1. **Symmetrical cell division (lasts 7-8 weeks)**

   Progenitor cell divides into 2 progenitor cells and this will increase ventricular size

2. **Asymmetric cell division (lasts 3 months)**

   Progenitor cell divides into 1 progenitor cell and 1 brain cell which will create brain tissue
   Radial glial cells support migration of other cells
   Brain cells = neurons + glial cells
   - Longer a/symmetrical division stages = larger brains
   - After 5 months: Apoptosis: “suicide” signal for progenitor cells
   - Ventricles produce 2x more neurons than necessary. Unused neurons progressively die by
     apoptosis.

There is neurogenesis (the creation of new cells) in the adult brain.
In rats: Hippocampus (learning and memory) and olfactory bulb (sense of smell) will make new
neurons.
Learning and physical exercise increases neurogenesis. Stress/depression reduce neurogenesis.
**Developmental Stages**

Major decisions of the brain are provided for by major ventricles

Forebrain, Midbrain, Hindbrain, Spinal cord

Telencephalon: (forebrain will grow into this) cognitive and emotional areas
Diencephalon: (forebrain) early sensory and hormonal
Mesencephalon: (midbrain will grow into this) motivation, regulation of behavior
Metencephalon: (hindbrain will grow into this) basic motor actions and motor plans
Myelencephalon: (hindbrain) interface with spinal

Forebrain: cerebral cortex, basal ganglia, limbic system, thalamus, hypothalamus

Forebrain: telencephalon + diencephalon
Telencephalon: 2 Hemispheres
1 hemisphere: cerebral cortex, basal ganglia, limbic system