“The Brain” pt. 1

Note—All figures are available in the textbook

- Main points of today’s lecture—
  - Giving directions inside the brain
  - Meninges and blood vessels
  - Cerebro spinal fluid and ventricles
  - A developmental view
  - The forebrain

Giving directions inside the brain

- Mammal brains are very different from each other—most notably in size
  - But, all of the mammalian brains end in a “tube”—this is the spinal cord
  - All are noticeably made up of two big lobes
  - There is also a flap or “side lobe” present in all the brains
  - Humans in fact do not have the largest brains of all mammals, the blue whale holds that title

- Is it true that the bigger you are, the bigger your brain is?
  - YES! Brain weight and body weight are related linearly
  - The modern man has the biggest brain vs. its body size
  - Among all species there are differences in intelligence

- Albert Einstein donated his brain after his death, is his brain special compared to other brains?
When scientists studied Einstein’s brain they found there were two areas with noticeable differences from “normal brains”—the prefrontal cortex and the parietal lobe

- The prefrontal cortex is responsible for planning, attention, and working memory
- The parietal lobe is responsible for language and is the association cortex.
- Within these two areas there were not more neurons present, but rather more glial cells and sulci (grooves)

- **Fig 3.1** Physiological directions include—anterior, ventral, dorsal, posterior, lateral, medial, contralateral, and ipsilateral

- **Fig 3.2** Brain planes of section
  - The gray matter is cell bodies (somas) while the white matter is axons (myelin sheaths)
    - In the spinal cord the areas are reversed and the gray matter is on the inside while the white matter is on the outside

- Of the nervous system there are two parts—the central nervous system (CNS) and the peripheral nervous system (PNS)
  - The CNS is composed of the brain (skull) and the spinal cord (vertebral column/spine)
  - The PNS is composed of nerves and peripheral ganglia (small group of neurons outside cells)

**Meninges and blood vessels**

- **Fig 3.3** The brain is encased in a tough membrane that is like leather—the dura mater.
This is thick and un-stretchable

Beneath the dura mater is the arachnoid membrane, like a spider web, made of filaments that contact the pia mater

The pia mater is separated by the sub arachnoid space (filled with cerebro spinal fluid) and contains blood vessels


- Brain vasculature—extremely complex

  - Brain composes 2% of the body, but uses up 20% of the oxygen that is taken up by the lungs
  - Contains large network of capillary vessels
  - It is extremely dense—you can tell which neuron group is active by looking at where the blood flows
  - A stroke occurs when a blood vessel blows and blood touches a neuron which kills it

Cerbro spinal fluid and ventricles

- Fig 3.4 The cerbro spinal fluid path is as follows—the lateral ventricles flow to the 3rd ventricle which flows to the cererbro aqueduct which flows to the 4th ventricle which flows to the central canal and the subarachnoid space

  - Cerebro spinal fluid is produced by the choroid plexus which takes blood and extracts plasma structures to create cerebro spinal fluid
  - Cerebro spinal fluid is reabsorbed in sinuses into blood and is fully replaced every 6 hours
A developmental view

- **Fig 3.6** 18 days post-conception we are simply the neuroaxis, composed of progenitor cells
  - These cells are creating little pathways on which other cells are going to climb and the tube will grow in thickness (which will be composed of neurons, glial cells, etc.)
  - By 20 weeks the brain will look like a brain, just on a smaller scale
  - Progenitor (to give rise to) cells will divide symmetrically or asymmetrically
    - When they divide symmetrically the goal is to increase ventricle size
    - When they divide asymmetrically the goal is to create new brain tissue
  - Going back to brain size- the longer that asymmetrical division occurs results in a bigger brain
  - After 5 months the progenitor cells undergo apoptosis (programmed cell death)
  - During development the ventricles produce twice the amount of neurons than actually needed, those that go unused with undergo apoptosis

- **Fig 3.7** Recently research has shown there are ways to generate new neurons as an adult

- **Fig 3.5** Developing from neural tubes to a fully developed brain—
  - Telencephalon—cognitive and emotional areas
  - Diencephalon—early sensory and hormonal
  - Mesencephalon—motivation, regulation of behavior
  - Metencephalon—basic motor action and plans
  - Myelencephalon—interface with spinal cord

The forebrain
• The forebrain is composed of the telencephalon and the diencephalon
  o The telencephalon is 2 hemispheres
  o A hemisphere is composed of the cerebral cortex, basal ganglia, and limbic system
  o Fig 3.8 There are 3 major fissures
• Gyrus and sulci—increased surface area
• Fig 3.11 Connection between the two hemispheres is the corpus callosum
  o Composed of precise connections between the 2 hemispheres of brain
  o Allows for some specialized functions to be restricted to only one side of the brain
• Your brain controls the opposite side of your body—contralateral
  o Only olfaction—the sense of smell is ipsilateral
• Fig 3.10 There are four lobes of the cerebral cortex
  o Frontal
  o Parietal (remember Einstein’s brain?)
  o Temporal
  o Occipital
• Fig 3.9 Anything in front of the central fissure of the brain is about doing things, while anything behind the central fissure is about perceiving things
• Different parts of the body are represented by different groups of neurons, however the number of neurons in charge of a body part is not proportional to the size of that body part—sensory homunculus
• Phantom limb syndrome—neurons no longer receive any stimulus or input because that body part no longer exists
o These neurons do not want to die so they invade the next group of neurons that is closest to them

- Limbic system—goal is to control motivation and emotion
  - Composed of limbic cortex, amygdala, hippocampus, fornix, basal ganglia

- Fig 3.14 Basal ganglia controls movement