

Lecture notes for Neuroscience

Lecture 1: History *

Ancient Egyptians: Idea of flow (too much or too little) → centre of flow was the heart → soul is from the heart

Hippocrates: everything comes from the brain (emotion and thoughts)

Galen: accepted brain as the seat intellect (Hippocrates) but also with flow/humors (instinct functions – liver, passion – heart)

Aristotles: cardio-centric view of mind, opposed to Hippocrates → centred beings in the heart(warmth), disregarded the brain

Descarte's – Thought nerves and the brain was a pump of liquid, mechanisms rather than spiritual explanations

Prof. paul broca: Bits of the nervous system that is associated with functions → realised that left frontal lobe of brain was responsible for speech → “Tan” (patient)

What does nervous system do?

- Reveal universe(sensory) → brain provides interpretation ... **exteroception** (detecting the outside world)
- Provide capacity for action
- Control homeostatic regulation

Lecture 2: How we can study it?*

Neuroscience – multi-disciplinary science united by its subject – the nervous system

- CNS: brain and spine PNS: all nerves and clusters of neurons
- White matter: axon and fatty sheath Grey matter: cell bodies
- Most neurons are multipolar, 200 different types

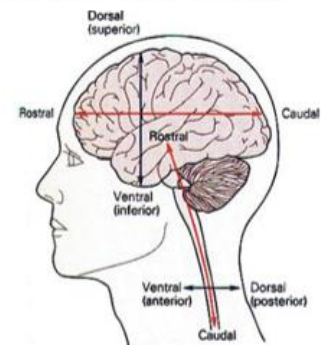
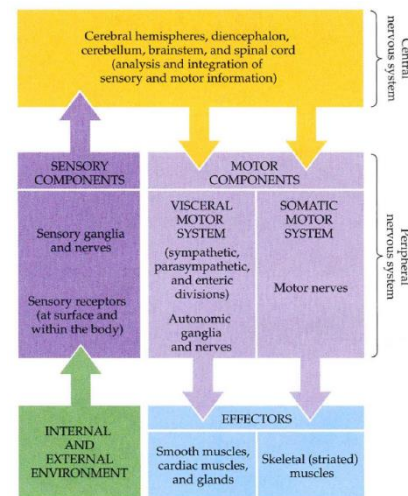
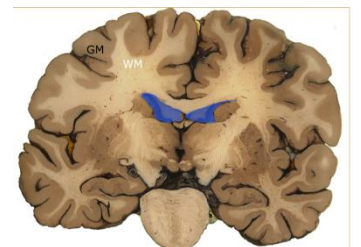
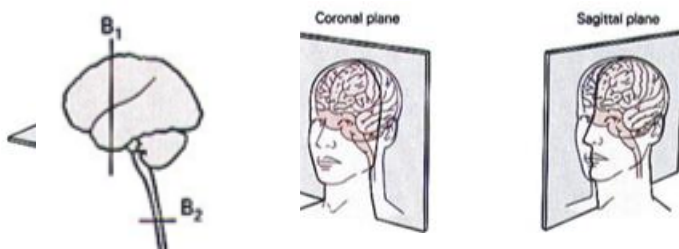
Luigi Galvani – Italian doctor → demonstrate that nerves convey electricity

- Experiments with frogs
- Simple unit of behaviour (reflexes)

Lecture 3: anatomy revision

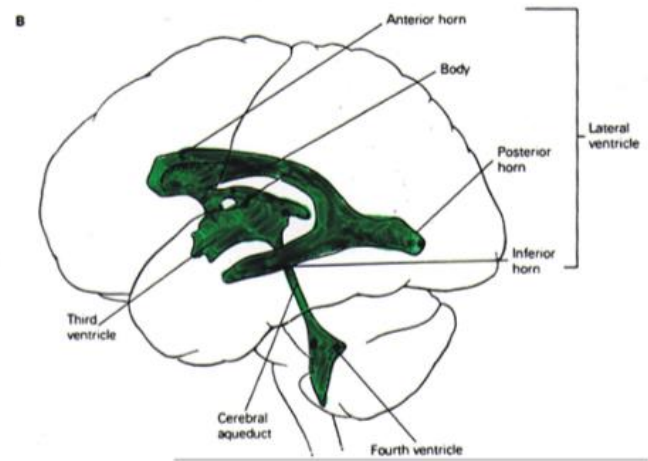
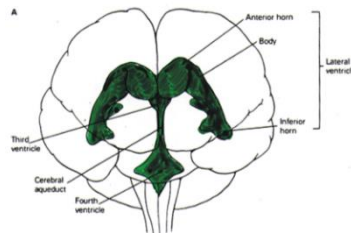
Para-sagittal – right next to midline

- Neuro-axis curves around thus transverse section can be vertical and horizontal



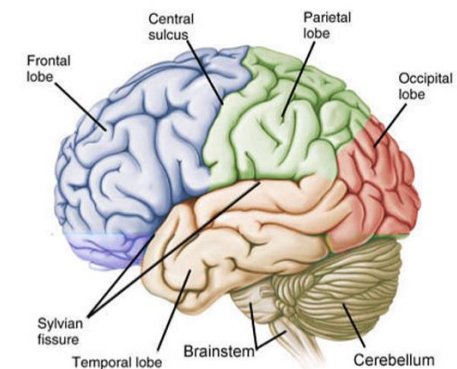
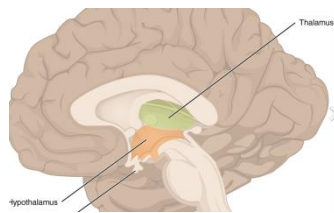
Ventricles

- Ventricles follow the C- shape of the brain
- 3rd and lateral ventricle is connected
- 3rd ventricle is a thin blade of fluid
- Appears black on CT scan

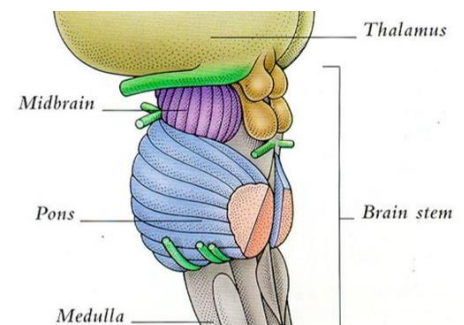
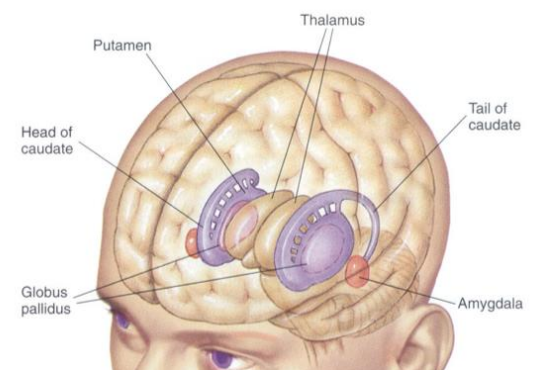


Main divisions of the CNS

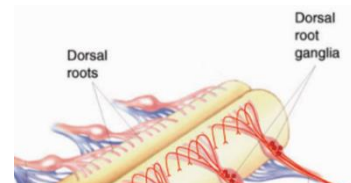
- Corpus callosum – bridges both sides
- Sub cortical structures include: basal ganglia, amygdala, hippocampus, thalamus
- Cerebrum
 - o Lobes: frontal, parietal, occipital, temporal
 - o Sylvian fissure
 - o Central sulcus- defining line between frontal and parietal
 - Forward of it- motor cortex then planning
 - Backwards of it: sensory and vision
- Diencephalon (Hypothalamus and thalamus)



- Basal ganglia
 - o C shape
 - o Main components: striatum (caudate nucleus and putamen), globus pallidus, substantia nigra, nucleus accumbens and subthalamic nucleus
- Hippocampus
 - C shape, bilateral
 - Memory
- Cerebellum
 - o Also has a “deep cerebellar nuclei” inside and two halves
- Brainstem
 - o Medulla, pons and midbrain
 - o Pons: bridge that connects to the cerebellum (cut off in pic)
- Spinal cord

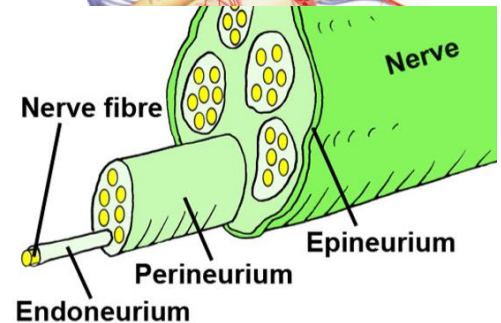


- **Afferent fibres:** sensory, to the spine, red, dorsal, have cell bodies in ganglia
- **Efferent fibres:** motor, away from spine, blue, ventral, cell bodies in the spine



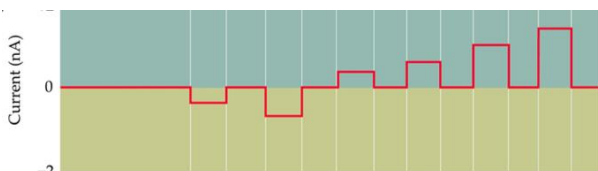
Cellular components of neural tissue

- Neurons
 - Nerves- clusters of axons in the periphery
 - Epineurium – external connective tissue
 - Perineurium- connective tissue
 - Endoneurium- thin protein coat
- Microglia
 - Innate immune cells
 - Macrophages in CNS
 - Ramified (resting) → ameboid (active)
- Macroglia
 - Oligodendrocytes (CNS)- insulation, white matter
 - Schwann cells (PNS) – insulation
 - Astroglia
 - Recycle and synthesise neurotransmitters
 - Maintain ECF (ionic composition)
 - Maintain protective environment
 - As many astrocytes as there are neurons

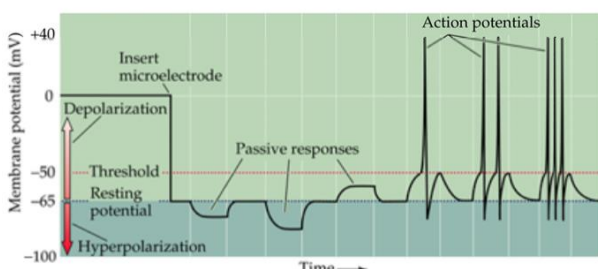


Neuronal function

- Graded and action potentials
- Synapses (2 types)
 - Electrical synapses – rare in mammals
 - Only excite post synaptic cells
 - Passive (no energy)
 - Fast (no latency from diffusion and E dependent processes)
 - Good for synchronisation
 - Chemical synapses
 - Variety (>100 neurotransmitters that can have different effects)
 - Energy dependent (synthesis, release, reuptake)
 - Slow (from E dependent processes)
- Neurotransmission : complex molecular synthesis and transport mechanisms

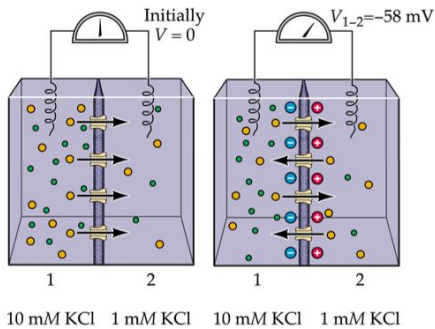


- The bigger the current the more action potentials



- Ion transporters and channels (Na and K)

- Electrochemical equilibrium



- Gradient is propagated across the cell

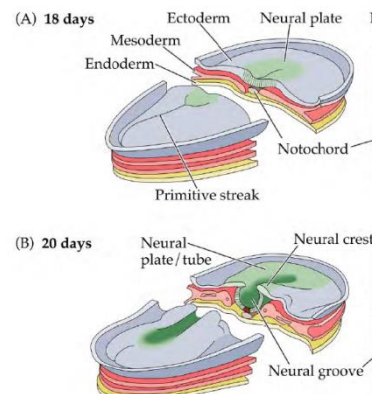
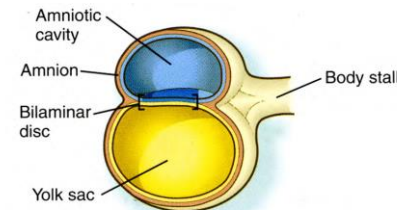
- Myelin sheath makes the signal faster because there are only Aps happening at nodes
- Neurotransmitter synthesis → made in cells body, travel through axon to dendrite

Lecture 4: Development of the Nervous System*

- Trilaminar embryo: flat 3 layers disc of cells (endoderm, mesoderm, ectoderm)
 - o Nervous system appears in ectoderm via Neuralation

Neuralation

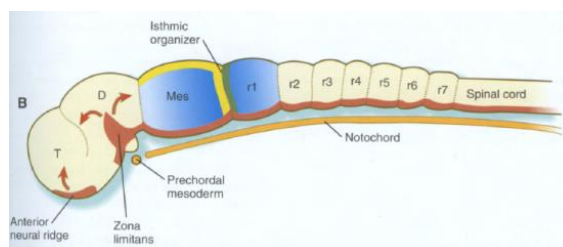
- Neural tube first appears as patch of specialised cells (1 cell thick) – **Neuroepithelium (stem cells of NS)**
- Neural plate forms a crease which invaginates (fold)
- Forms **neural tube**
 - o 1st structure to identify as NS
 - o Forms brain and spinal cord
 - o Hollow
 - o Formation has a rostral to caudal gradient (rostral is older)
- Neural tube breaks free of ectoderm



Neural fold closure



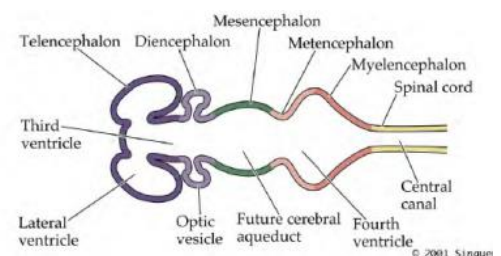
- Order in which the grooves close
- **Anacephaly** – no head, point 2 doesn't close → brain doesn't form
- **Spina bifida**- looks like a blister, fail to shut region 5, thin film of epithelium



Segmentation of Neural tube

- Rostral end of tube swells [vesiculation] → 3 vesicles
 - o Prosencephalon (forebrain)
 - Splits further to form telencephalon(cortex and basal ganglia) and **diencephalon**
 - Retinae form as optic vesicles
 - o Mesencephalon (Midbrain)
 - o Rhombencephalon (hindbrain)
 - Into 7 segments
 - Then splits into metencephalon and myelencephalon (pons and medulla).
 - o The rest is spinal cord
- Note: optic vesicles (retina)
- The brain then forms a series of thin – walled bubbles around the fluid filled cavity of the brain

distinct



Neural crest

- Cells at the top of neural tube form neural crest which migrate away
- Establish PNS outside brain and spinal cord
 - PNS
 - Dorsal root ganglia
 - Sympathetic and parasympathetic ganglia
 - Enteric ganglia (gut)
 - All glial cells in PNA (schwann cells)
 - Melanocytes (pigment)
 - Muscle, cartilage and bone of face, pharynx
 - Dentine(part of teeth)

