PSYC1011 (1B)

PSYCHOBIOLOGY

Behavioural neuroscience

1) NS overview
2) Intro to neuroanatomy
3) Action potentials and synapses
4) Basics of neurochemistry
5) Psychopharmacology
6) Neuroendocrinology

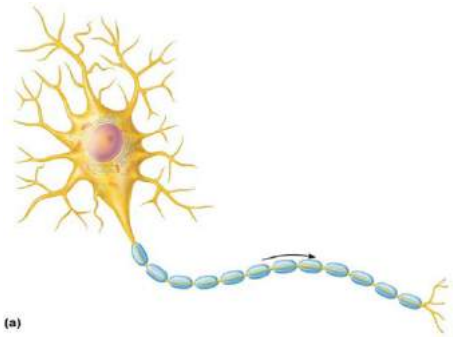
NERVOUS SYSTEM OVERVIEW

- What is a neuron?
- Anatomy
- Classification
  - Multipolar, bipolar, unipolar
- Function
  - Sensory, motor, interneurons
- How are they organised into the nervous system?
  - CNS
  - PNS
    - Differences between somatic / autonomic nervous systems
    - Differences between parasympathetic and sympathetic activation

A neuron

- Nerve cells transmit info
- Average, human brain has 86 billion neurons
- 160 000km end-to-end

MULTIPOLAR NEURON



Features

- Dendrites
  - Branch-like structures that receive info from other neurons
- Soma / cell body
  - Protects the **nucleus** and cell contents
  - **Phospholipid bilayer** maintains –ve charge within the cell
- Nucleus
  - ‘engine room’ of cell
  - contains genetic material
  - produces **neurotransmitters**
  - allows generation of energy for cell
- Axon hillock (leading from cell body - to axon)
  - gatekeeper of transmission
  - **graded potentials =** summed to determine if an **action potential** will be fired
- Axon
  - Long nerve fiber
  - Conducts electrical signals from cell body
- Myelin sheath (beads around axon)
  - Coating that insulates the axon
  - Increases signalling speed → signal ‘jumps’
  - Produced by **Schwann cells** (in CNS)
- Nodes of Ranvier
  - Bare axon
  - Allows transmission to continue down the axon
- Axon terminals / terminal buttons
  - Chemical messages sent from these terminals
  - **Pre-synaptic**

Clinical relevance – multiple sclerosis (MS)

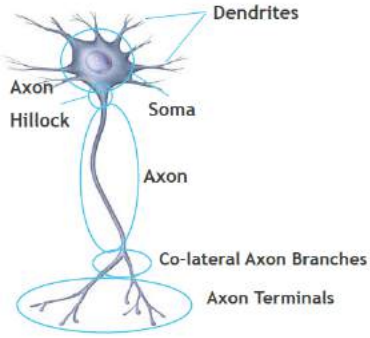
- Believed to be an auto-immune disease
- Leads to failure of cells that myelinate axons
- Reduces speed of signal transmission
- Symptoms
  - Musculoskeletal: weakness, spasms, ataxia
  - Central: fatigue, cogn impairment, depression, unstable mood
  - …

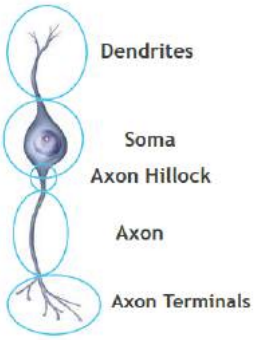
Classification

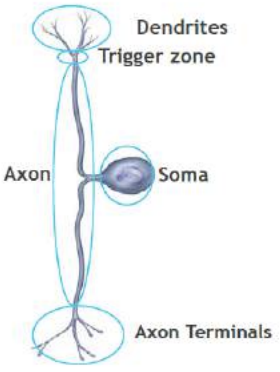
STRUCTURAL

Multipolar neuron

- dendrites
- axon hillock
- soma
- axon
- **co-lateral axon branches**
- axon terminals







Bipolar neuron

- single dendritic sprite
- soma
- axon hillock
- axon
- axon terminal

Unipolar neuron

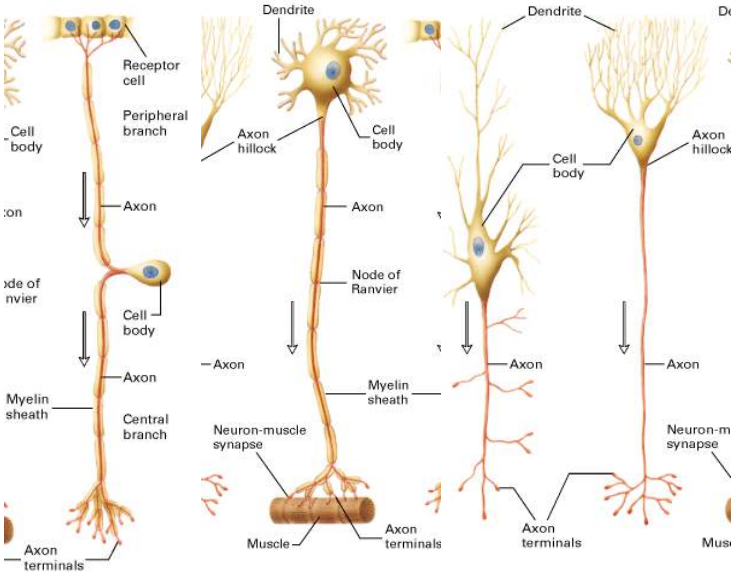
- dendrites
- **trigger zone** (axon hillock)
- longer axon
- soma
- axon terminal

FUNCTIONAL

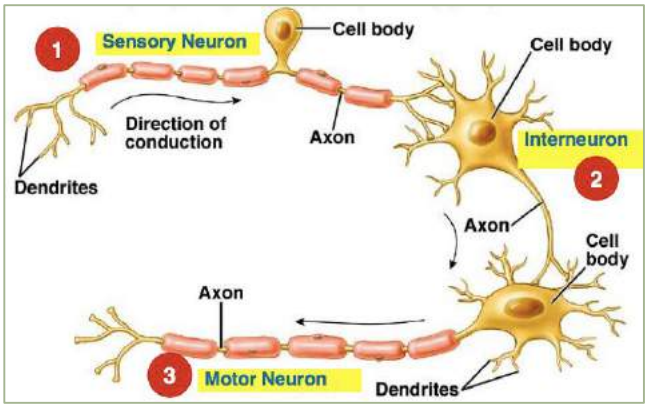
Sensory neurons
- activated by sensory input
  - vision – photoreceptors: light
  - somatic – mechanoreceptors: touch, pressure, temp
  - auditory – haircells / stereocilia: vibration
- tend to be unipolar or bipolar neurons
- send info to the brain from the periphery
  - i.e. **afferent signal**

Motor neurons
- send info from brain (motor cortex / brainstem) → periphery
  - **efferent signal**
- cell body located in the spinal cord
- axon projects to the periphery to control muscles
- multipolar neurons

Interneurons
- neurons that connect only to other neurons
- neurons within the brain
- generally multipolar neurons
- involved in **higher order** processing/ integration e.g. memory and cognition

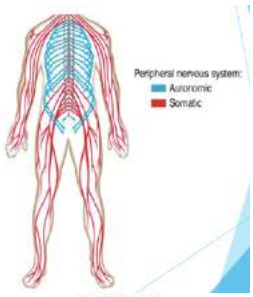


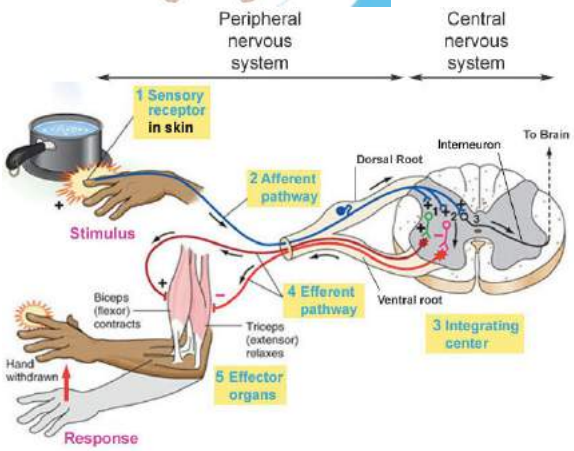
E.g. neural communication
- many types of neurons
- all these form the nervous system



Peripheral nervous system

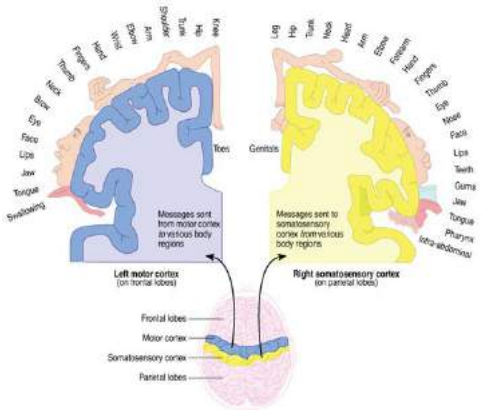
- Somatic nervous system
  - ctrl body mvmts via skeletal muscles / efferent
  - transmits sensory info from the periphery to the CNS / afferent
- Autonomic nervous system
  - Parasympathetic nervous system
  - Sympathetic nervous system



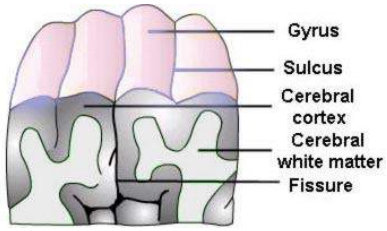


Somatic

- **Reflex arcs** ctrlld by the somatic nervous system



- **Controlled movement**
  - brain receives somatosensory input
  - info integrated + motor cortex initiates actions
  - somatic motor neuron control the actions of muscles
  - E.g. too much sodium (trigger) → sensory input → integration → motor output (drink water)
  - Motor + somatosensory cortex

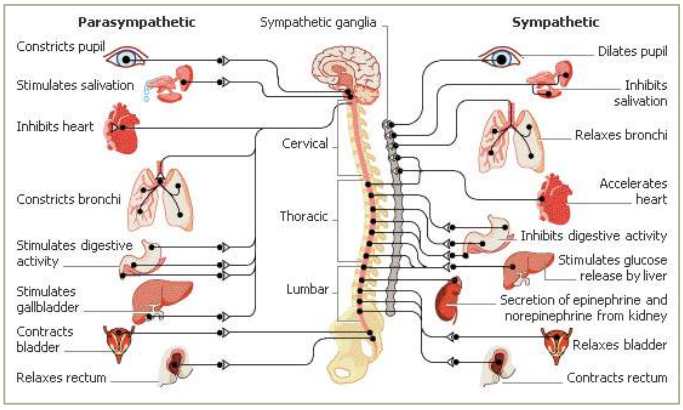


Autonomic

Parasympathetic nervous system
- Normal bodily functioning

Sympathetic nervous system

- Ready for action
- fight / flight response



INTRO TO NEUROANATOMY

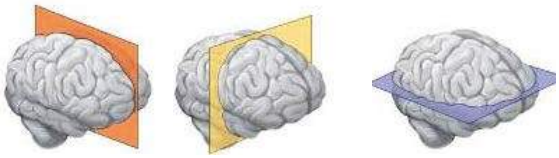
- Basic structure of the brain / navigation
  - Subcortical structures
- Evolution of the brain
- Functional anatomy:
  - primary fns of brain regions + effects of damage

Brain navigation

- ← rostral or anterior
- → caudal or posterior
- up: dosal or superior
- down: ventral or inferior

Sectioning in neuroanatomy

- **sagittal** / cross-sectional: mid saggital
- **coronal → primary in animal research**
- **axial** / horizontal → more common in neuronal, MRI studies

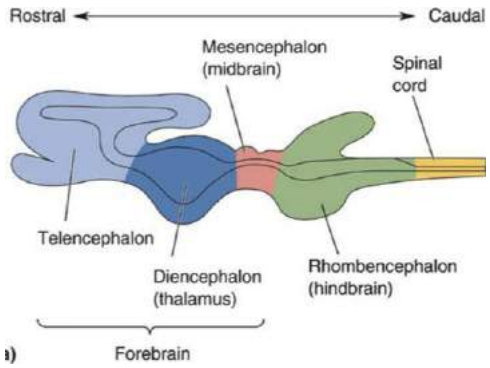


Sulci, Gyri and Fissures

- Gyrus
  - A ridge on the cerebral cortex
- Sulcus
  - A depression in the cerebral cortex
- Fissure
  - A deeper groove in the cerebral cortex

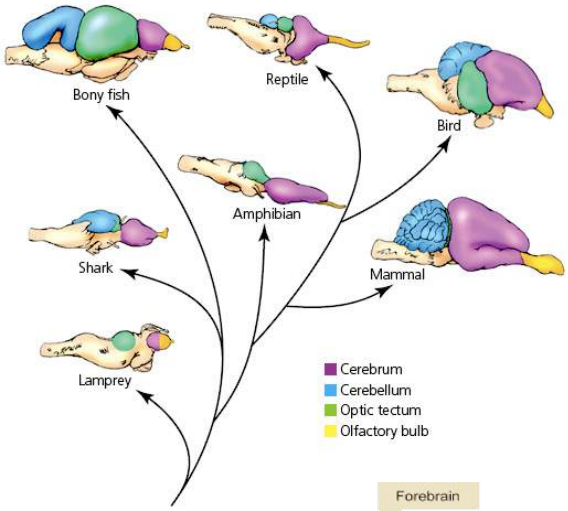
Brain Evolution

- Brain has evolved over hundreds of millions of yrs
- Similar hindbrain / midbrain
- Markedly changed / improved forebrain → higher order processes

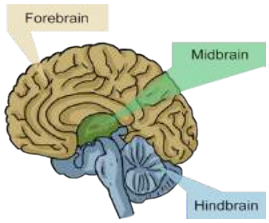


- yellow area = hind brain, basic functions / physiological processes
- sensory inputs: optic tectum and olfactory bulb

Brain development



- Hindbrain = control of vital functions
- Midbrain = a relay station
- Forebrain = everything else

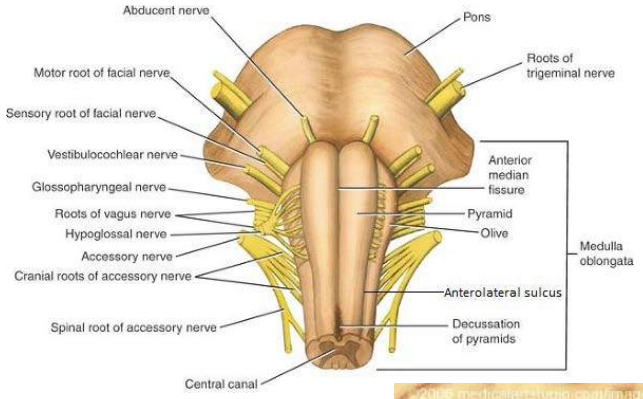


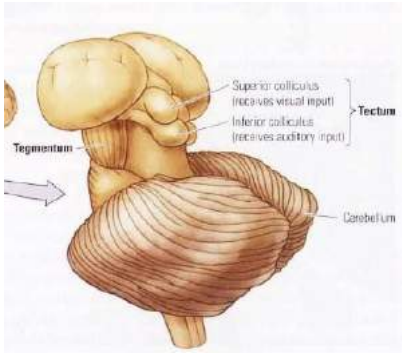
Hindbrain

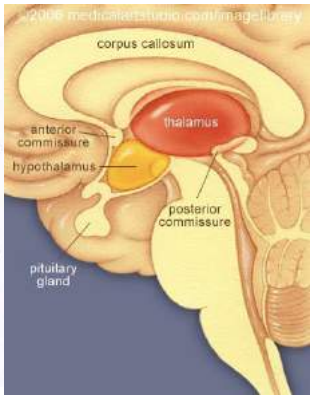
- Medulla
  - Autonomic centre of heart rate and blood pressure – notice all the nerves attached to it
  - Cranial nerve input
- Pons
  - Relay signals
  - Respiration
  - Cranial nerve integration
- Cerebellum
  - Fine motor control
  - **Cerebellar ataxia** occurs with damage to the cerebellum

Midbrain

- Tectum
  - **Superior colliculus:** Visual processing and control of eye movement
  - **Inferior colliculus:** Auditory processing
- Tegmentum
  - Unconscious processes
  - Movement

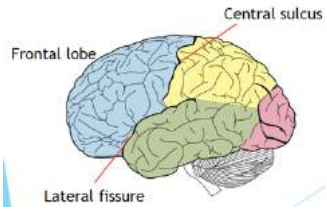






Forebrain

- hypothalamus
  - adjacent to pituitary gland
  - master controller of much of the endocrine system
  - homeostasis
- thalamus
  - relays sensory signals to the cerebral cortex
  - important filter
- amygdala
  - involved in emotion
  - fear responses
- hippocampus
  - the seahorse
  - involved in the formation / storage of new memories (episodic)
  - the story of **Henry Molaison**
  - surgical temporal lobe removal and hippocampal removal
    - following surgery: suffered anterograde amnesia (new), partial retrograde amnesia (past)
    - working memory and procedural memory intact
  - Morris water maze
    - Hippocampal lesion → much disorientated locating pathway
- cerebral cortex / cerebrum
  - **the frontal lobe**
    - executive fn, abstract thinking, problem solving
    - impulse control / social skills
    - motor cortex
    - Phineas Gage

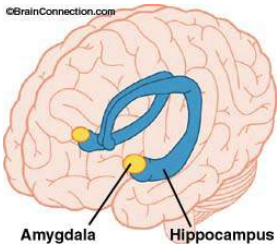


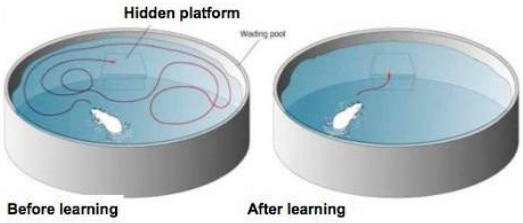
*Phineas Gage – steel rod pierced frontal lobe

- 'changed person' → unreliable, disregard for loved ones, poor social skills, unable to empathise, hypersexuality,
- lived 12 more years → behave normalised

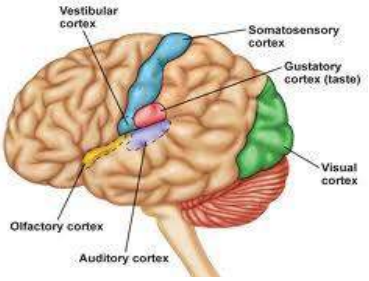
*Frontal lobotomy

- developed by **Egas Moniz** in id-20th cent
- lobotomies used mainly in 1930s to 1950s to treat wide range of mental illness
- sometimes produced state of passivity
- **Walter Freeman** – popularised procedure → 40 000 patients included young children





- **Motor cortex**
- **parietal lobe**
  - involved in somatosensory interpretation
  - hand, feet, mouth, tongue
  - plasticity – remapping & more representation in the remaining fingers, enable complete utilisation of somatosensory cortex – nothing wasted
- **temporal lobe**
  - contains primary auditory cortex
  - primary olfactory cortex



- **occipital lobes**
  - visual processing