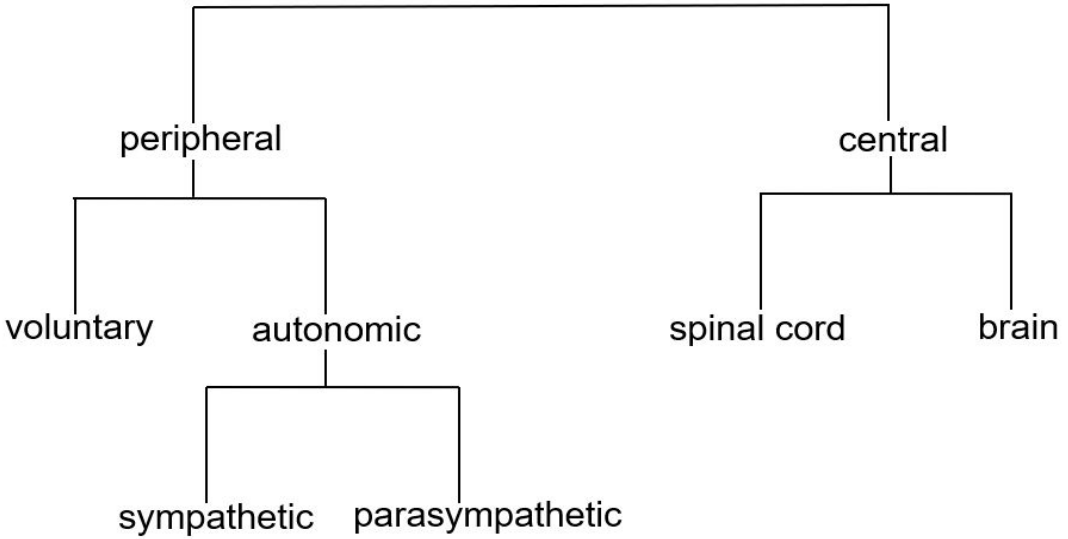
OCR (B) Biology A-level

5.2.1 - Nervous system and identification and consequences of damage

Flashcards

Outline the gross structure of the mammalian nervous system.

Outline the gross structure of the mammalian nervous system.



Name the two main divisions of the nervous system.

Name the two main divisions of the nervous system.

- **Central** nervous system (CNS)
  - Brain and spinal cord
  - Specialised system of nerve cells processes stimuli & propagates impulses
- **Peripheral** nervous system (PNS)
  - All neurons that are not part of the CNS

Name the two main divisions of the peripheral nervous system.

Name the two main divisions of the peripheral nervous system.

- **Somatic** (under conscious control)
- **Autonomic** (not under conscious control)

Name the two main divisions of the autonomic nervous system.

Name the two main divisions of the autonomic nervous system.

Sympathetic:

- Often stimulates effectors (fight-or-flight response)
- Neurotransmitter noradrenaline
- Ganglia close to CNS

Parasympathetic:

- Often inhibits effectors (rest/digest response)
- Neurotransmitter acetylcholine
- Ganglia far from CNS

Act antagonistically to regulate response of effectors.

Describe the structure of the central nervous system.

Describe the structure of the central nervous system.

Micrograph

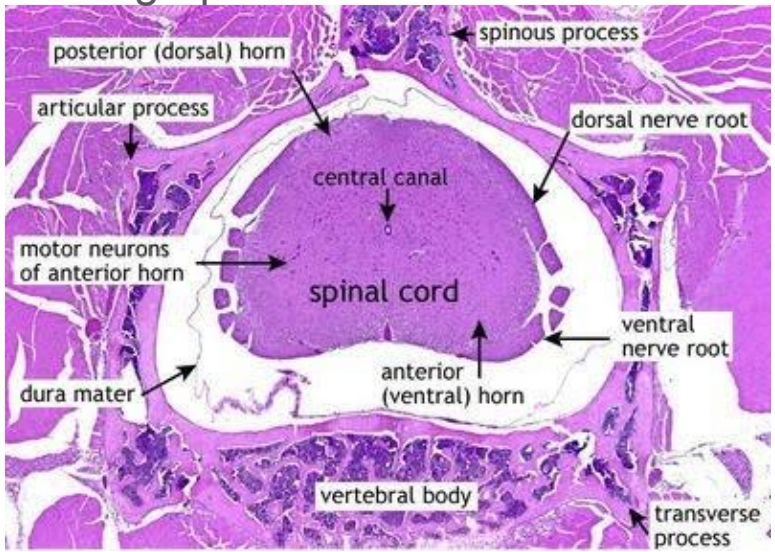


Image source: The A level Biologist, CC BY-NC-SA 4.0

Diagram

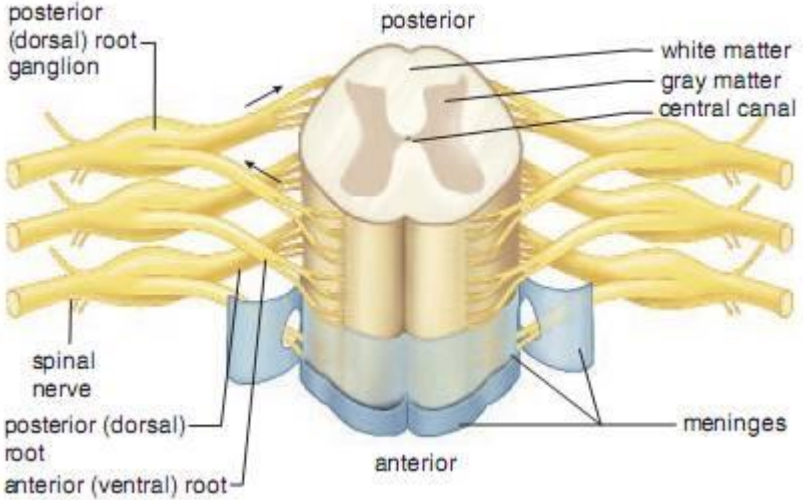


Image source: The A level Biologist, CC BY-NC-SA 4.0

Describe the structure of the peripheral nervous system.

Describe the structure of the peripheral nervous system.

Micrograph showing ganglia which have their sensory roots in the periphery & extend into CNS

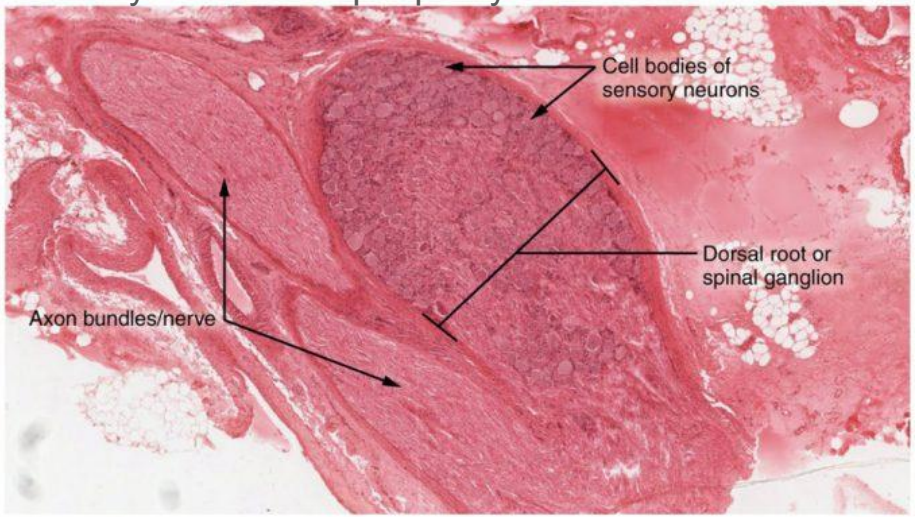


Image source: Rice University, CC BY 4.0

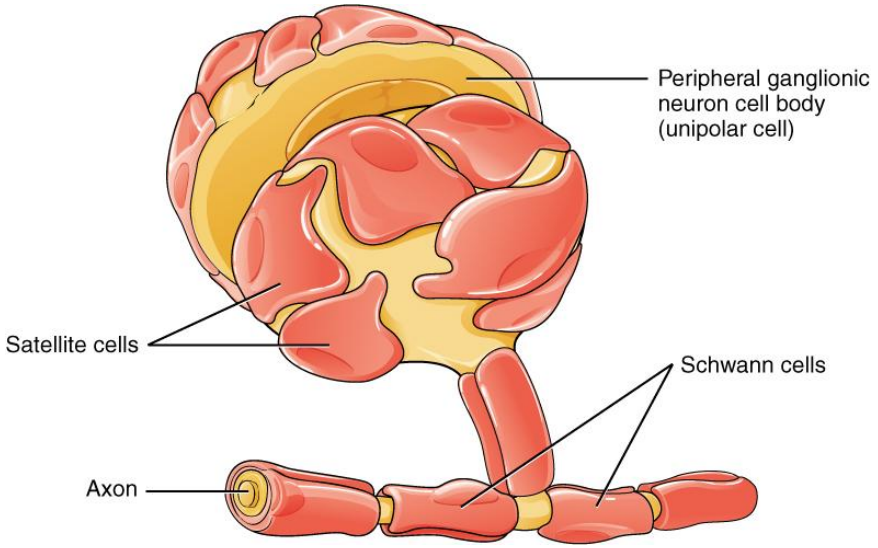


Image source: Open Stax College, CC BY 4.0

Describe the gross structure of the human brain.

Describe the gross structure of the human brain.

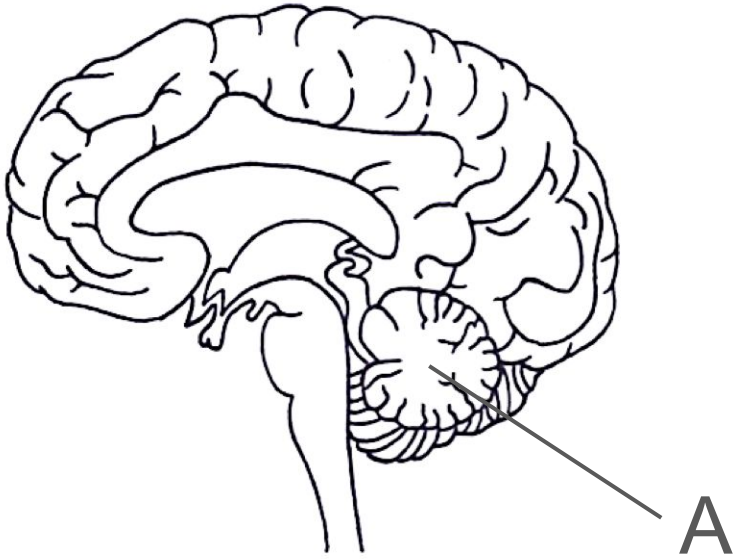
2 hemispheres joined by band of nerve fibres (corpus callosum).
Divided into lobes:

- **parietal lobe** at the top of the brain: movement, orientation, memory, recognition
- **occipital lobe** at the back of the brain: visual cortex processes signals from the eye
- **temporal lobe** beneath the temples: processes auditory signals

Identify the location and function of the cerebellum.

Identify the location and function of the cerebellum.

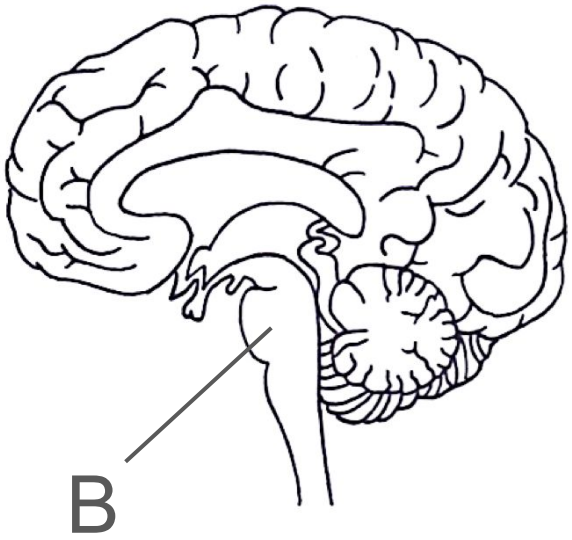
- Controls execution (not initiation) of **movement** e.g. timing, balance, coordination, posture
- Possible role in cognition e.g. attention & language



Identify the location and function of the medulla oblongata.

Identify the location and function of the medulla oblongata.

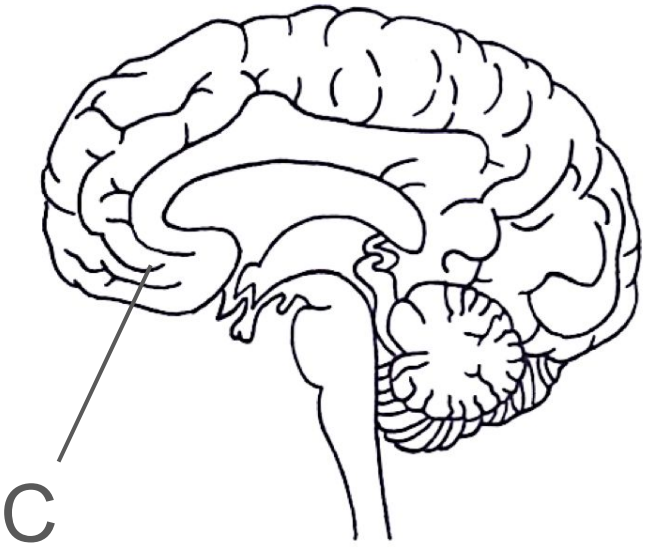
Controls a range of autonomous functions, including breathing and heart rate (location of cardioacceleratory centre).



Identify the location and function of the cerebrum.

Identify the location and function of the cerebrum.

Uppermost part of the brain. Organised into lobes which control voluntary functions e.g initiating movement, speech, thought.

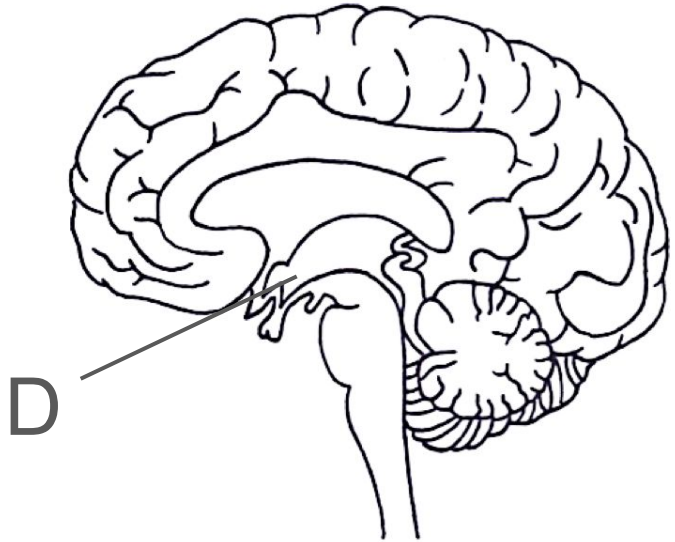


Identify the location and function of the hypothalamus.

Identify the location and function of the hypothalamus.

Includes anterior **pituitary gland** (secretes metabolic & reproductive hormones).

Involved in thermo & osmoregulation.



Describe the features of all neurons.

Describe the features of all neurons.

cell body: contains organelles & high concentration of RER

dendrons: branch into dendrites which carry impulses towards cell body

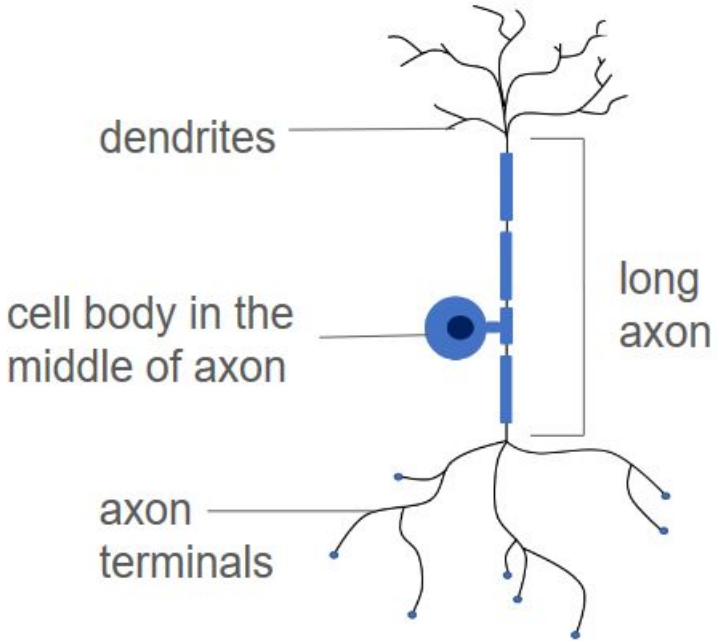
axon: long, unbranched fibre carries nerve impulses away from cell body

Describe the structure and function of a sensory neuron.

Describe the structure and function of a sensory neuron.

Usually unipolar.

Transmits impulses fror receptors to CNS.



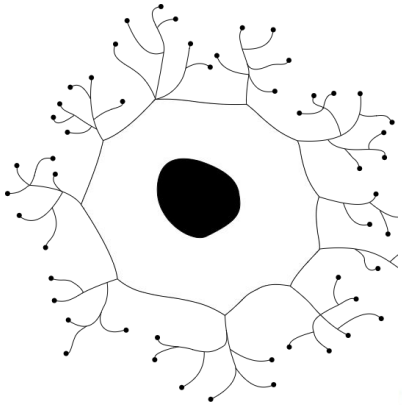
Describe the structure and function of a relay neuron.

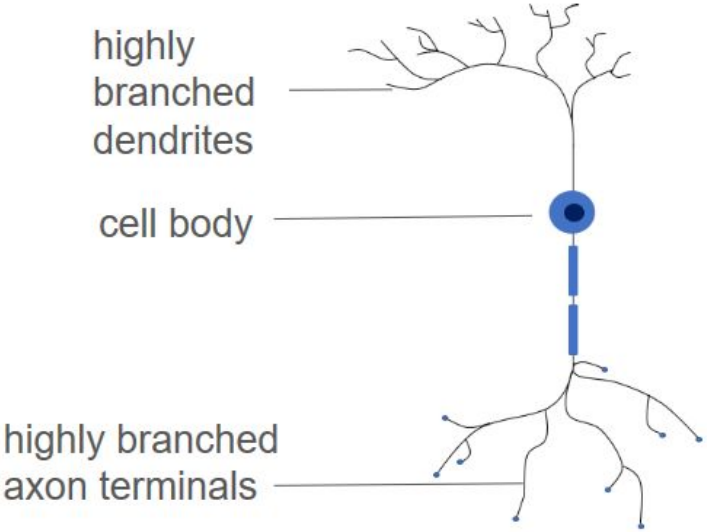
Describe the structure and function of a relay neuron.

Usually bipolar.

Transmits impulses between neurons.

Highly branched axons & dendrites.



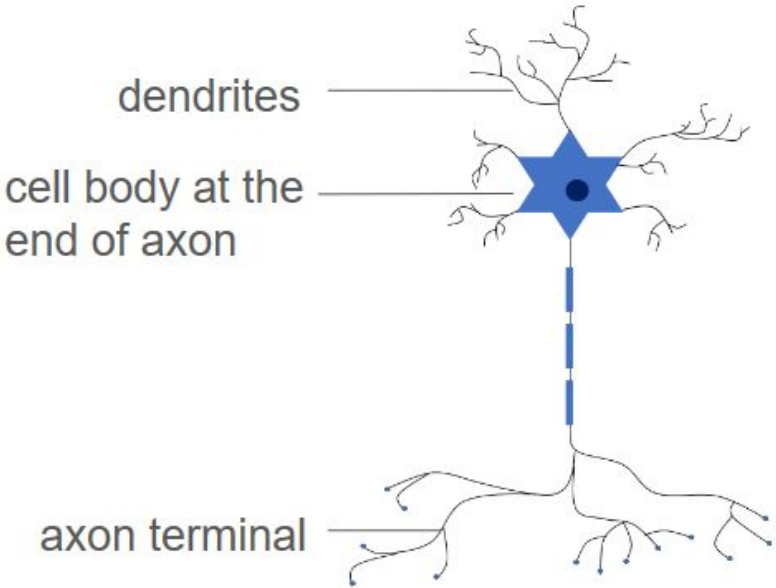


Describe the structure and function of a motor neuron.

Describe the structure and function of a motor neuron.

Usually multipolar.

Transmits impulses from relay neurons in the CNS to effectors.



Describe the additional features of a myelinated neuron.

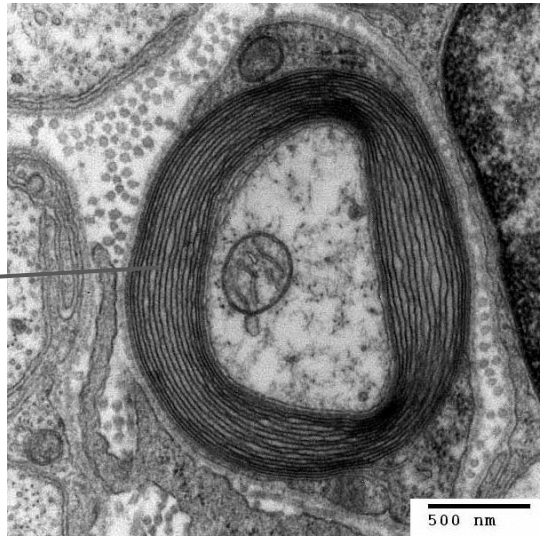
Describe the additional features of a myelinated neuron.

Schwann cells: wrap around axon; involved in electrical insulation, phagocytosis, nerve regeneration

Myelin sheath: made from myelin-rich membranes of Schwann cells

Nodes of Ranvier: small gaps between neighbouring Schwann cells where there is no myelin sheath

Electron micrograph of myelinated axon



Explain why myelinated axons conduct impulses faster than unmyelinated axons.

Explain why myelinated axons conduct impulses faster than unmyelinated axons.

Saltatory conduction: Impulse 'jumps' from one node of Ranvier to another (depolarisation cannot occur where myelin sheath acts as electrical insulator). Therefore, impulse does not travel along whole axon length.

What is resting potential?

What is resting potential?

Potential difference (voltage) across neuron membrane when not stimulated (-50 to -90 mV, usually about -70 mV in humans)

How is resting potential established?

How is resting potential established?

1. membrane is more permeable to K^+ than Na^+
2. sodium-potassium pump actively transports $3Na^+$ out of cell & $2K^+$ into cell

establishes electrochemical gradient: cell contents more negative than extracellular environment

Name the stages in generating an action potential.

Name the stages in generating an action potential.

1. Depolarisation
2. Repolarisation
3. Hyperpolarisation
4. Return to resting potential

What happens during depolarisation?

What happens during depolarisation?

1. Stimulus → facilitated diffusion of Na^+ into cell down electrochemical gradient.
2. p.d. across membrane becomes more positive.
3. If membrane reaches threshold potential (-50mV), voltage-gated Na^+ channels open. (positive feedback mechanism)
4. Significant influx of Na^+ ions reverses p.d. to +40mV.

What happens during repolarisation?

What happens during repolarisation?

1. Voltage-gated Na^+ channels close and voltage-gated K^+ channels open.
2. Facilitated diffusion of K^+ ions out of cell down their electrochemical gradient.
3. p.d. across membrane becomes more negative.

What happens during hyperpolarisation?

What happens during hyperpolarisation?

1. ‘Overshoot’ when K^+ ions diffuse out = p.d. becomes more negative than resting potential.
2. Refractory period: no stimulus is large enough to raise membrane potential to threshold.
3. Voltage-gated K^+ channels close & sodium-potassium pump re-establishes resting potential.

Explain the importance of the refractory period.

Explain the importance of the refractory period.

No action potential can be generated in hyperpolarised regions of membrane.

- Ensures unidirectional impulse.
- Ensures discrete impulses.
- Limits frequency of impulse transmission; larger stimuli have higher frequency.

Describe the shape of the graph showing changes in membrane potential during the generation of action potentials.

Describe the shape of the graph showing changes in membrane potential during the generation of action potentials.

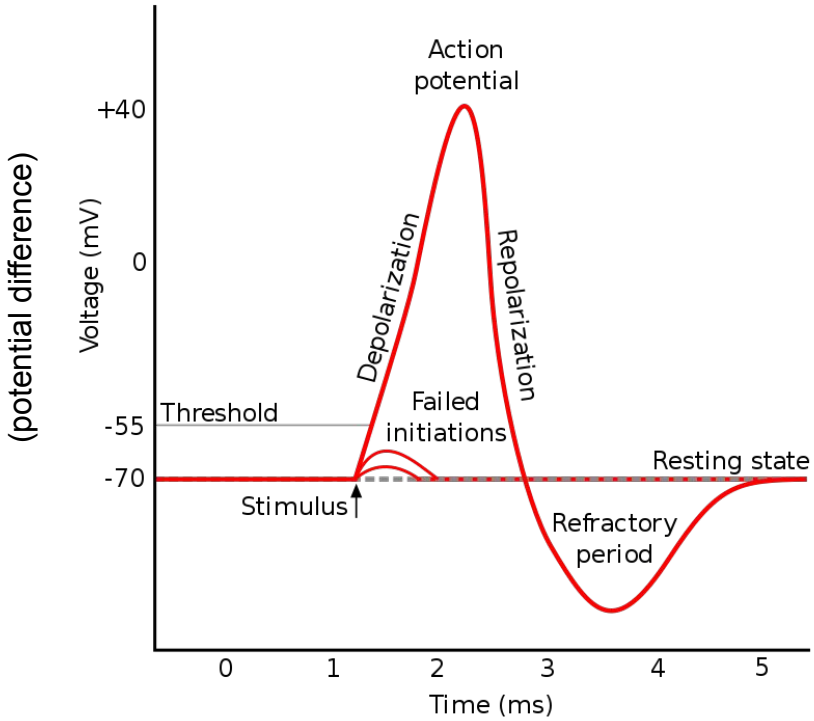


Image source: Wikimedia Commons, CC BY-SA 3.0

What is the function of synapses?

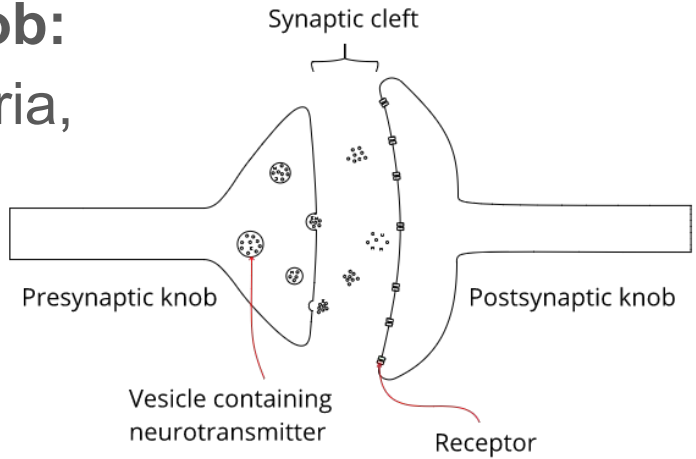
What is the function of synapses?

- electrical impulse cannot cross junction
- neurotransmitters send impulses between neurons/ from neurons to effectors for excitatory or inhibitory response
- summation of sub-threshold impulses
- new impulses can be initiated in several different neurons for multiple simultaneous responses

Describe the structure of a synapse.

Describe the structure of a synapse.

Presynaptic neuron ends in **synaptic knob:** contains high concentration of mitochondria, endoplasmic reticulum & vesicles of neurotransmitter



Synaptic cleft: 20-30 nm gap

Postsynaptic neuron: complementary receptors to neurotransmitter (ligand-gated Na^+ channels)

What happens in the presynaptic neuron when an action potential is transmitted between neurons?

What happens in the presynaptic neuron when an action potential is transmitted between neurons?

1. Wave of depolarisation travels down presynaptic neuron, causing voltage-gated Ca^{2+} channels to open.
2. Ca^{2+} cause vesicles of acetylcholine to move towards & fuse with presynaptic membrane.
3. Exocytosis of neurotransmitter into synaptic cleft.

What happens in the postsynaptic neuron when an action potential is transmitted between neurons?

What happens in the postsynaptic neuron when an action potential is transmitted between neurons?

1. After acetylcholine diffuses across synaptic cleft, it binds to specific receptors on postsynaptic membrane.
2. Ligand-gated Na^+ channels open.
3. If influx of Na^+ ions raises membrane to threshold potential, action potential is generated.

What happens in an inhibitory synapse?

What happens in an inhibitory synapse?

1. Neurotransmitter binds to and opens Cl^- channels on postsynaptic membrane & triggers K^+ channels to open.
2. Cl^- moves in & K^+ moves out via facilitated diffusion
3. p.d. becomes more negative: hyperpolarisation so no action potential is generated

Outline what happens in a simple reflex arc.

Outline what happens in a simple reflex arc.

receptor detects stimulus → sensory neuron → relay neuron in CNS coordinates response → motor neuron → response by effector

Survival benefit: rapid response to potentially dangerous stimuli since only 3 neurons involved, instinctive.

How does a reaction differ from a reflex?

How does a reaction differ from a reflex?

A reaction is voluntary and is coordinated by the brain.

A reflex is non-voluntary and does not involve the brain.

Describe the blinking reflex.

Describe the blinking reflex.

Brain stem reflex. Consensual response: both eyelids close rapidly when just 1 cornea is stimulated by bright light/ touch.

sensory neuron of trigeminal nerve → spinal nucleus of trigeminal nerve → interneurons → facial motor nerve → effector muscle orbicularis oculi

Describe the iris reflex.

Describe the iris reflex.

1. retinal photoreceptors detect high light intensity → impulse via parasympathetic nervous system → circular muscles contract & radial muscles relax → pupil constricts

2. retinal photoreceptors detect low light intensity → impulse via sympathetic nervous system → radial muscles contract & circular muscles relax → pupil dilates

Describe the plantar reflex.

Describe the plantar reflex.

Applying firm pressure to sole of foot from heel to toe triggers flexor response (toes curl downwards) in healthy adults. Extensor response (toes fan upwards) is common in healthy babies & toddlers, but can indicate nerve damage in adults.

How can assessing reflex actions be used in diagnosis?

How can assessing reflex actions be used in diagnosis?

Lack of reflex may indicate nerve damage or loss of consciousness

Suggest factors that influence reaction time.

Suggest factors that influence reaction time.

- age (gets increasingly quicker until late 20s then starts to become slower)
- distraction
- gender (males generally faster)
- level of fatigue
- drug intake

Effect of factors can be investigated using ruler drop test.

Name 5 scanning techniques that can be used to diagnose brain and spinal cord damage.

Name 5 scanning techniques that can be used to diagnose brain and spinal cord damage.

- magnetic resonance imaging (MRI)
- functional magnetic resonance imaging (fMRI)
- positron emission tomography (PET)
- computed tomography (CT) scans
- electroencephalography (EEG) scans

How does an MRI scan work?

How does an MRI scan work?

Uses powerful magnetic field to cause protons from hydrogen atoms in water molecules to align. Radio waves then knock protons out of alignment. When protons realign after radio waves turned off, emit radiation to receivers.

Signals used to produce a cross-sectional image. Can show excess fluid, diseased structures, size & position of tumours in soft tissue.

How does an fMRI scan work?

How does an fMRI scan work?

Uses MRI technology to study brain activity based on blood flow.

Oxyhaemoglobin absorbs high frequency radio signals; deoxyhaemoglobin reflects them.

Shows where most aerobic respiration occurs. Active areas have higher respiratory rate. Shows abnormal patterns of activity in the brain e.g. related to seizures.

How does a PET scan work?

How does a PET scan work?

A radioactive isotope (e.g. of carbon) is injected & used by the body to synthesise molecules.

When isotope decays, it emits gamma radiation to a detector. Active areas show higher radioactivity.

Shows tumours & amyloid plaques associated with Alzheimer's disease.

How does a CT scan work?

How does a CT scan work?

Uses X-rays to produce cross-sectional image. Denser structures absorb more radiation and appear lighter on image.

Bleeds appear white on image e.g. after a stroke.

How does an EEG scan work?

How does an EEG scan work?

Electrodes attached to scalp detect electrical signals between neurons, which are recorded by a machine.

Can detect & identify types of epilepsy. Used to investigate brain injury, inflammation & tumours.

Outline the consequences of damage to the CNS.

Outline the consequences of damage to the CNS.

- impaired memory
- loss of motor skills
- slurred speech
- problems with hormone production & secretion, results in hormonal imbalance

Suggest the ethical issues of determining brain death.

Suggest the ethical issues of determining brain death.

- Religious/ cultural definitions of death may differ
- Patients may misunderstand the term & therefore argue that life support machines should stay on (can damage patient-clinician relationship)

What is Parkinson's disease?

What is Parkinson's disease?

Neurodegenerative disorder affecting movement & cognitive function.

Loss of dopaminergic neurons in cerebral cortex of brain. Characterised by formation of Lewy bodies (clumps of alpha synuclein protein).

Results in fewer threshold impulses to neurons in motor cortex.

How is L-Dopa used to treat Parkinson's disease?

How is L-Dopa used to treat Parkinson's disease?

L-Dopa is a dopamine precursor that can cross brain blood barrier. It is used to produce more dopamine in the brain to replace the neurotransmitter lost by death of neurons.

How do heroin and cannabis affect synapses?

How do heroin and cannabis affect synapses?

Heroin has a similar shape to natural opiates. THC in cannabis has a similar shape to natural cannabinoid.

They bind to complementary receptors, which results in dopamine release.

How does methamphetamine affect synapses?

How does methamphetamine affect synapses?

Similar shape to dopamine = moves into cell via complementary transmembrane proteins & forces dopamine out of vesicles. Higher dopamine concentration in synaptic knob = more transport into synaptic cleft.

Dopamine accumulates & binds repeatedly to postsynaptic membrane receptors. Causes overstimulation.

How does alcohol affect synapses?

How does alcohol affect synapses?

Binds to GABA (inhibitory neurotransmitter) receptors causing Cl^- channels to open and a negative change in membrane potential. Hyperpolarisation prevents further transmission of impulses.

Prevents excitatory effect of glutamate by blocking receptors.

Explain the biological basis of psychological and physical drug dependency.

Explain the biological basis of psychological and physical drug dependency.

Number of dopamine receptors increases = more difficult for brain to naturally stimulate the same level of reward.

Lack of drug causes physical withdrawal symptoms e.g. nausea, fever.

Psychological ‘conditioning’ to associate drug use with an emotional stimulus.

Suggest the consequences of drug dependency.

Suggest the consequences of drug dependency.

For **individuals**: physical illness e.g. cancer; psychological illness e.g. psychosis; loss of employment; increase in risky behaviour; premature death

For **society**: expensive to treat; challenge to improve prevention programs & limit sale of illegal drugs; requires strict control of legal drugs e.g. opiates