Year 13 HL

IB BIOLOGY

6.5 Neurons and Synapses

Name:

Teacher:

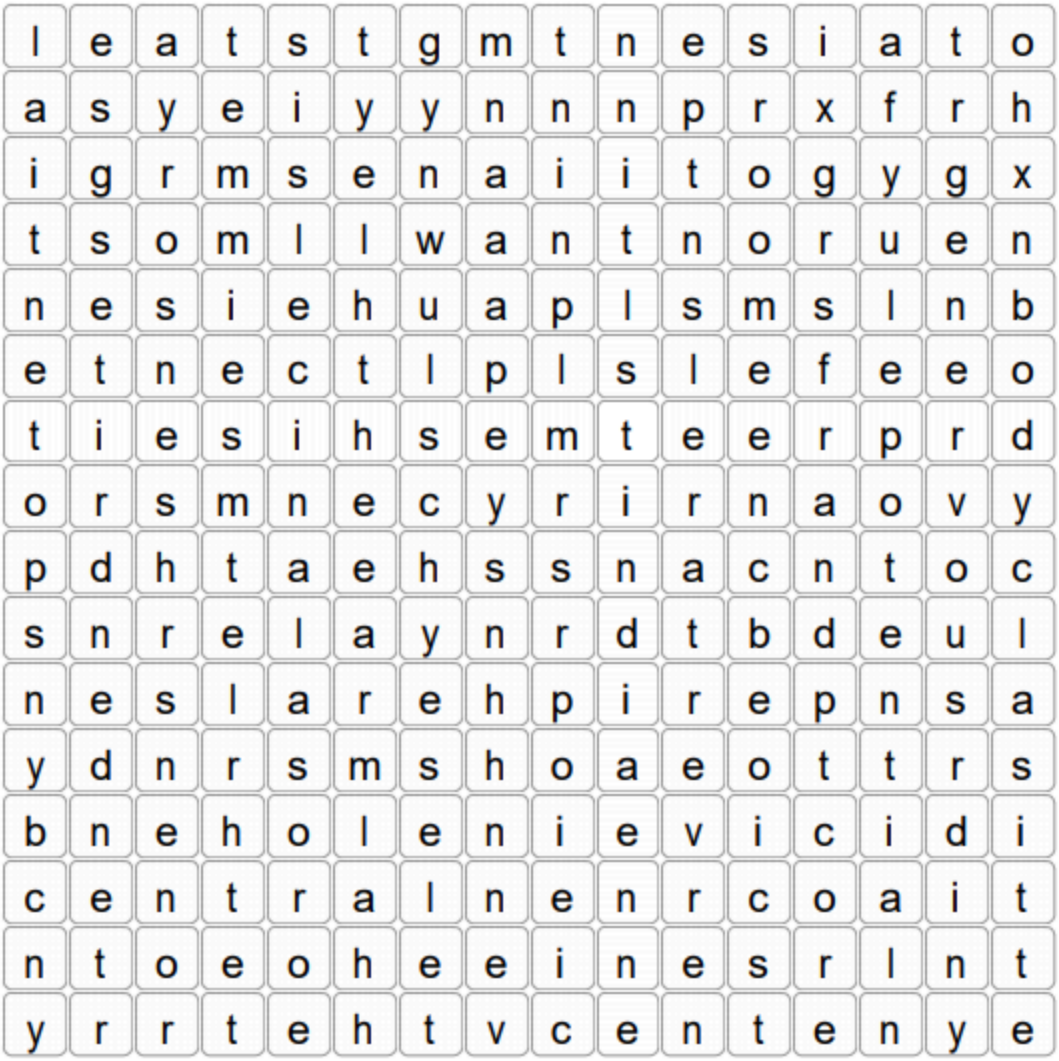
6.5 Neurons and Synapses

Understandings:

- Neurons transmit electrical impulses.
- The myelination of nerve fibres allows for saltatory conduction.
- Neurons pump sodium and potassium ions across their membranes to generate a resting potential.
- An action potential consists of depolarization and repolarization of the neuron.
- Nerve impulses are action potentials propagated along the axons of neurons.
- Propagation of nerve impulses is the result of local currents that cause each successive part of the axon to reach the threshold potential.
- Synapses are junctions between neurons and between neurons and receptor or effector cells.
- When presynaptic neurons are depolarized they release a neurotransmitter into the synapse.
- A nerve impulse is only initiated if the threshold potential is reached.

Applications and Skills:

- Application: Secretion and reabsorption of acetylcholine by neurons at synapses.
- Application: Blocking of synaptic transmission at cholinergic synapses in insects by binding of neonicotinoid pesticides to acetylcholine receptors.
- Skill: Analysis of oscilloscope traces showing resting potentials and action potentials.



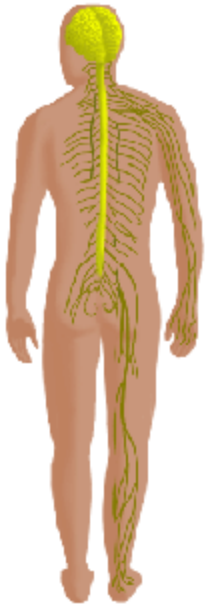
Words to find:

action, axon, body, brain, cell, cells, central, cord, dendrites, impulse, motor, myelin, nerve, nervous, neuron, peripheral, potential, potential, reflex, relay, resting, schwann, sensory, sheath, spinal, synapse, system.

Control Systems

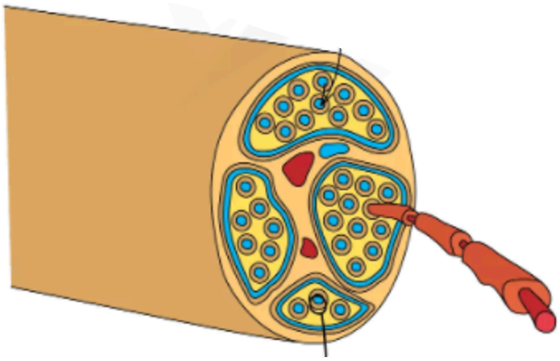
6.5.U1 Neurons transmit electrical impulses.

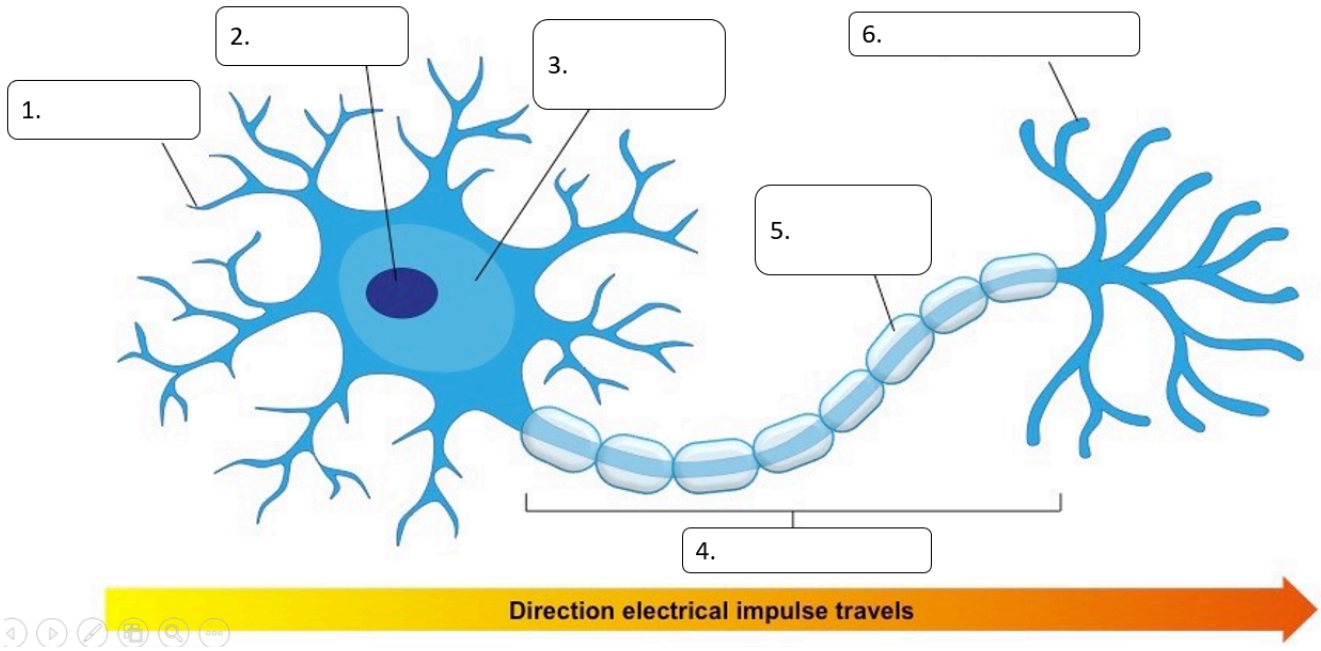
What are the two main parts of the nervous system and what are they made of?



Label the CNS, brain, spinal cord and peripheral nerves on the diagram:

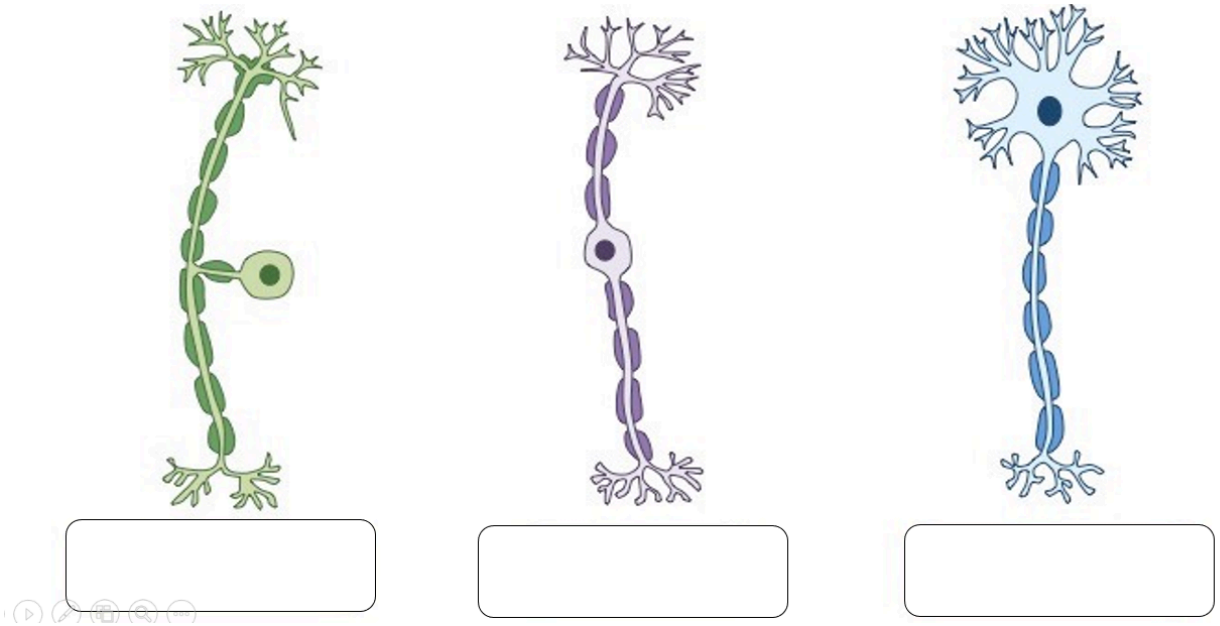
A _____ is a bundle of _____



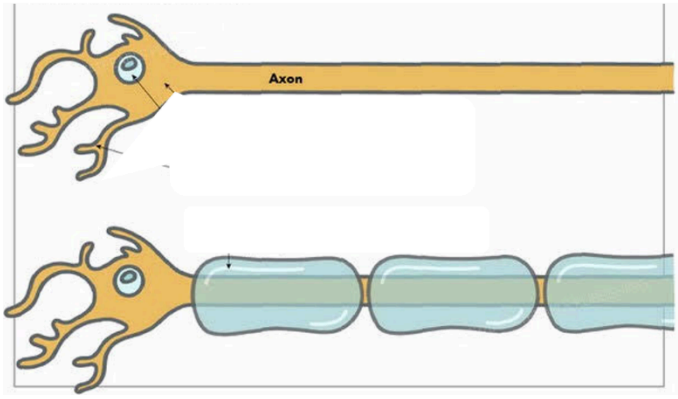


• **Dendrites** • **Myelin Sheath** • **Axon** • **Soma**		• convert chemical information from other neurons or receptor cells into electrical signals • elongated fibre that transmits electrical signals to terminal regions for communication with other neurons or effectors • improves the conduction speed of electrical impulses • A cell body containing the nucleus and organelles

Types of Neurons



6.5.U2 The myelination of nerve fibres allows for saltatory conduction.



Membrane Proteins

Complete the table:

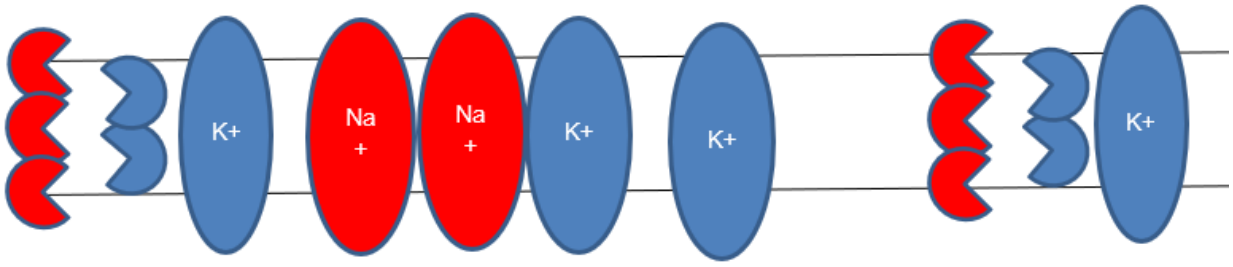
Membrane Protein	Function	Substances transported	ATP needed? Y or N

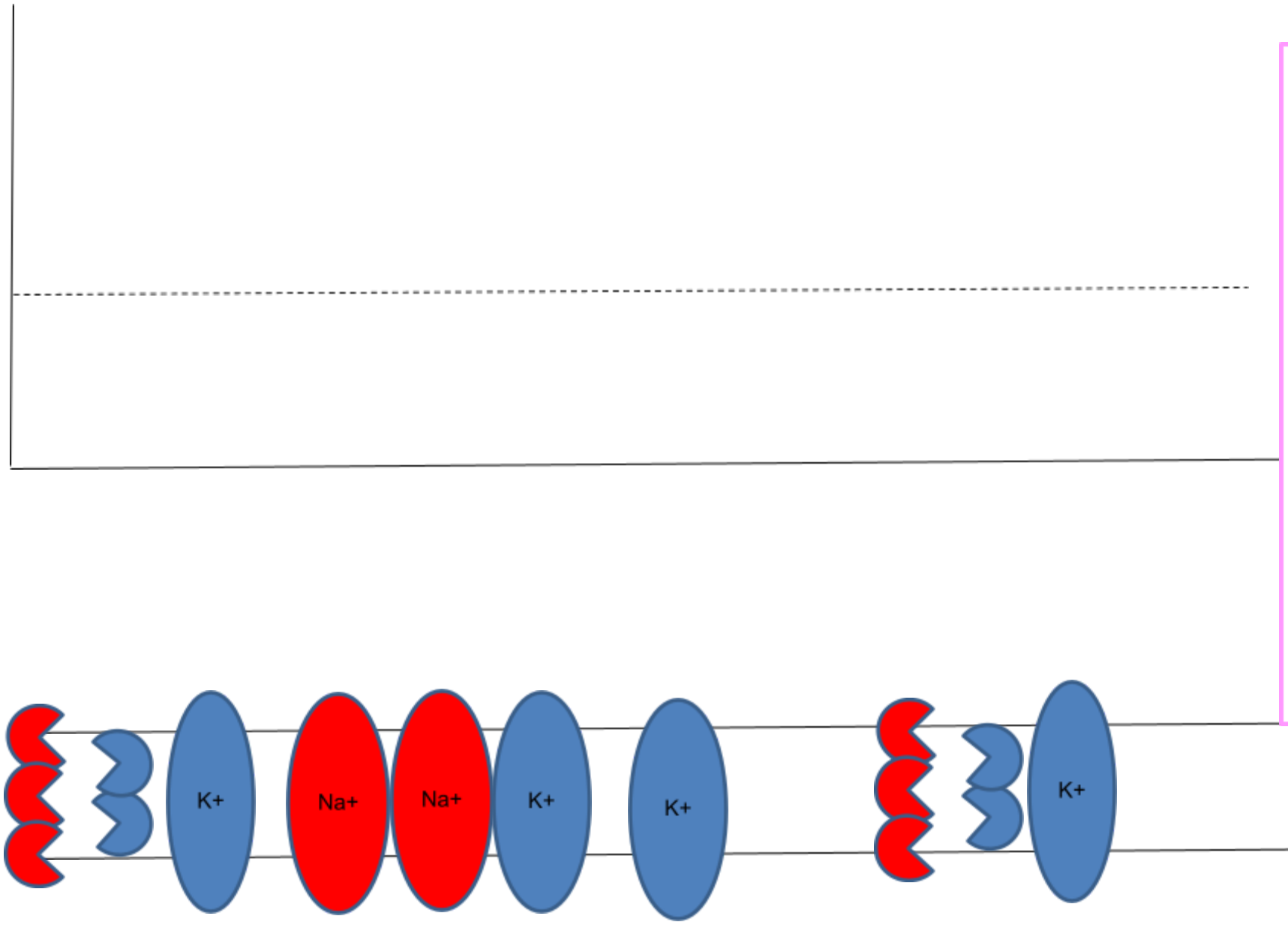
Draw the structure of a cell membrane

Neuron Structure

Draw and label a motor neuron in the space below.

Label the different channels and location of these



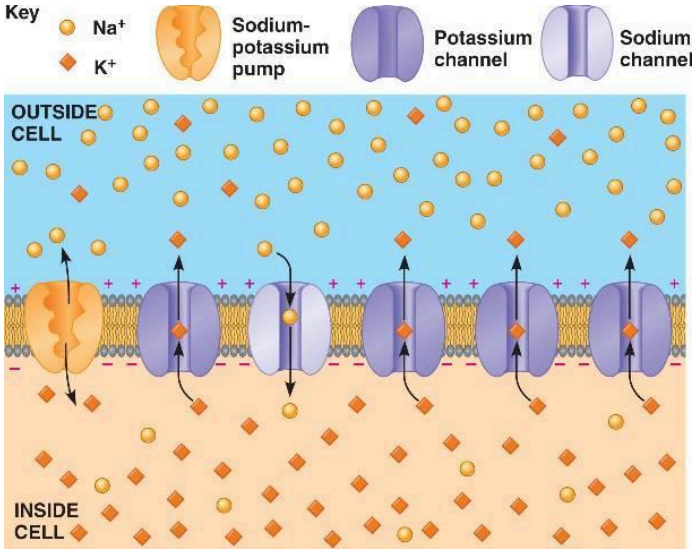


Voltage-Gated
Sodium Potassium
Pump
ATP
Active Transport
Anions
Cations
Leakage Gates
Potassium
Negative Axon
Depolarisation
Repolarisation
Refractory Period
Hyperpolarisation
Slow closing
Resting Potential
Generator Potential
Threshold
All-or-nothing
I
M
C

Go to http://sites.sinauer.com/neuroscience5e/animations02.01.html

Define:

Resting potential



Put the sentences in order to explain how a resting potential is achieved:

1	***This requires ATP***
2	***Sodium and potassium cation pumps transport Na+ out and K+ in***
3	***Concentration of Na+ is high outside the neuron***
4	***This results in the inside being more negative than the outside***
5	***Concentration of K+ is high inside the neuron***
6	***Membrane is more permeable to K+ than Na+***
7	***Difference in concentration of ions maintained by active transport against concentration gradient***
8	***Concentration of K+ inside neuron 20x greater than outside so K+ ions rapidly diffuse out until equilibrium reached***

How do neurons transmit a nervous impulse?

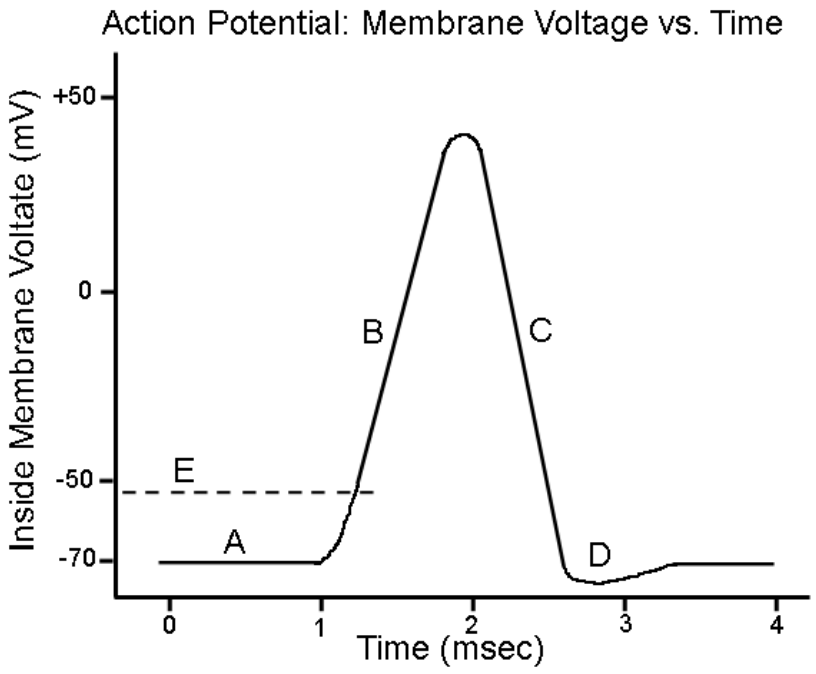
Watch the Action Potential animations:
http://outreach.mcb.harvard.edu/animations/actionpotential_short.swf
http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter14/animation__the_nerve_impulse.html

Define:
Action potential:

Define
Depolarisation:

***Repolarisation**:*

Label the graph showing the changes in potential difference across the nerve as a nervous impulse is transmitted. Words to use: ***Depolarisation, repolarisation, resting potential, action potential, threshold value, point of stimulus, refractory period and resting state.***



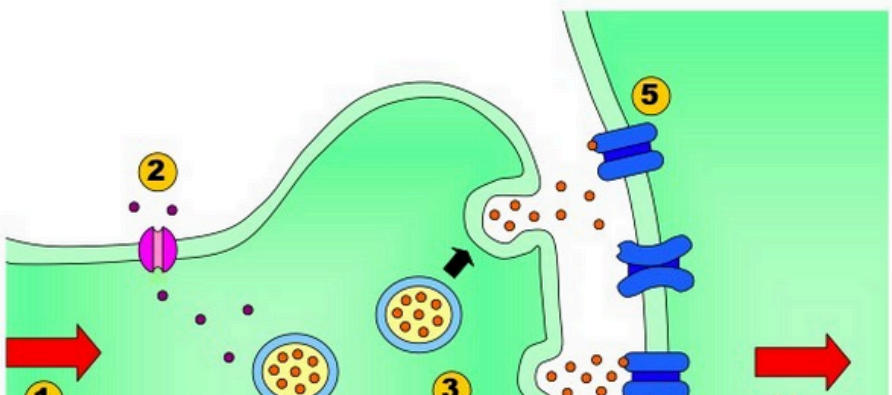
Synaptic Transmission

Define
Synapse:

Why do we need synapses?

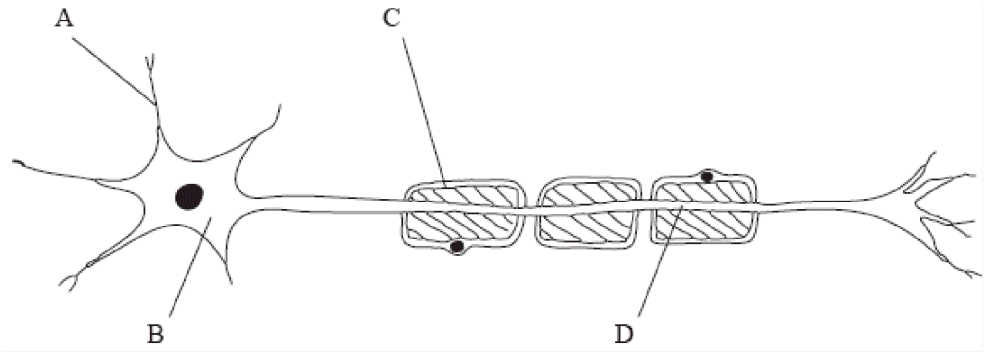
Label this diagram of a synapse:
Include these labels - **pre-synaptic neuron, post-synaptic neuron, mitochondria, vesicle, neurotransmitter, synaptic cleft, calcium ions, voltage gated calcium channels, action potential, sodium channel, neutrotransmitter receptor**

Identify what is happening at each stage:
1
2
3
4
5
6



1. Explain how is used neonicotinoid used to maintain insect's population. You may like to include a diagram to support your explanation
2. Briefly describe what Parkinson's disease is.
3. State the symptoms of Parkinson's disease
4. Explain how the drug L-dopa works.
5. Find a link between dopamine and Schizophrenia
6. Challenge: What are SSRI's and how do they assist in dealing with depression and anxiety?

1. On the diagram of the motor neurone shown below, which label identifies a dendrite?



(Total 1 mark)

2. Between which structures do sensory neurons carry nerve impulses?

A. From receptors to muscles

B. From effectors to the central nervous system (CNS)C

C. From the central nervous system (CNS) to receptors

D. From receptors to the central nervous system (CNS)

(Total 1 mark)

3. A process occurs in which the inside of a neuron develops a net positive charge compared with the outside. What is the name of this process?

A. Resting potential

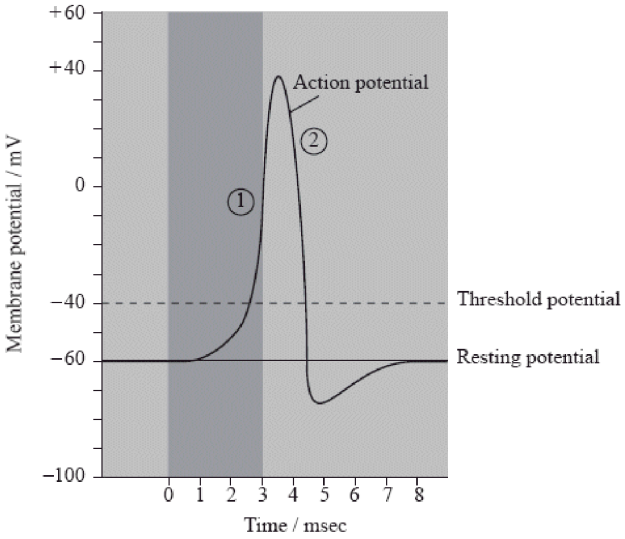
B. Repolarization

C. Depolarization

D. Hyperpolarization

(Total 1 mark)

4. The diagram below shows the changes in membrane potential during an action potential. What occurs at the stages labelled 1 and 2?



	1	2
A.	Na^+ ions diffuse in; inside becomes more positive	K^+ ions diffuse out; inside becomes more negative
B.	K^+ ions diffuse out; inside becomes more negative	Na^+ ions diffuse in; inside becomes more positive
C.	Na^+ ions diffuse out; inside becomes more negative	K^+ ions diffuse out; inside becomes more positive
D.	Na^+ ions diffuse in; inside becomes more positive	K^+ ions diffuse in; inside becomes more negative

(Total 1 mark)

5. A number of different proteins are involved in nerve function. Which of the following does **not** require a membrane protein?

A. Active transport of sodium

B. Diffusion of K^+ into the cell

C. Diffusion of the neurotransmitter across the synapse

D. Binding of the neurotransmitter to the post-synaptic membrane

(Total 1 mark)

6. Which event directly leads to an action potential?

A. Fusion of vesicles with the pre-synaptic membrane

B. Diffusion of neurotransmitter across the synaptic cleft

C. Membrane potential reaches the threshold potential

D. Breakdown of the neurotransmitter

(Total 1 mark)

7. What causes a resting potential to develop in a neuron?

A. Diffusion of sodium and potassium ions

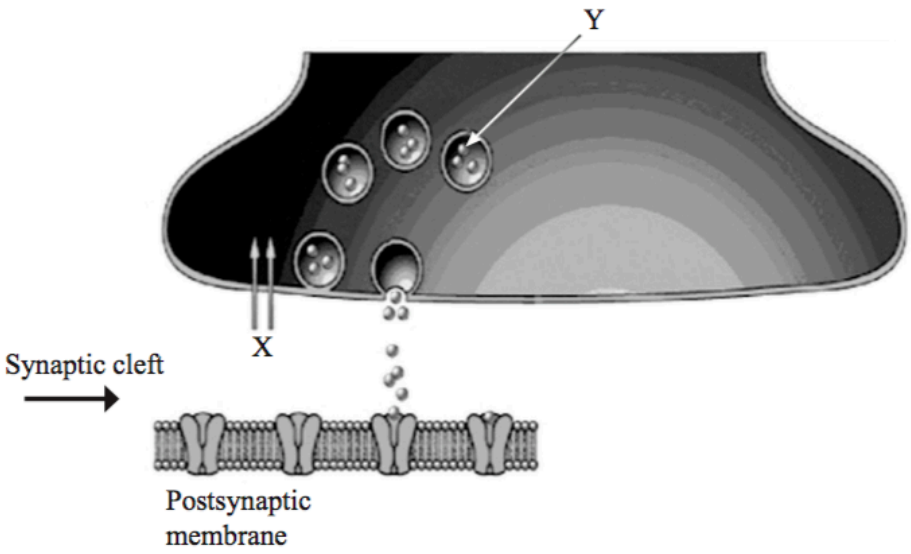
B. Active transport of sodium and potassium ions

C. Active transport of sodium and diffusion of chloride ions

D. Active transport of potassium and diffusion of chloride ions

(Total 1 mark)

8. In the diagram of synaptic transmission below, what is indicated by the letters X and Y?



	X	Y
A.	neurotransmitter enters synaptic knob	Ca^{2+} ions
B.	Ca^{2+} ions diffuse into the synaptic knob	neurotransmitter
C.	K^{+} ions diffuse into the synaptic knob	neurotransmitter
D.	Na^{+} ions diffuse into the synaptic knob	Ca^{2+} ions

(Total 1 mark)

9. What causes the formation of a nerve impulse on the post-synaptic membrane?

A. Ca^{2+} binding with a receptor site

B. K^{+} leaking into the post-synaptic membrane

C. Neurotransmitter binding with receptor sites

D. Neurotransmitter being removed from the synapse

(Total 1 mark)

10. Explain how an impulse passes along the membrane of a neuron.

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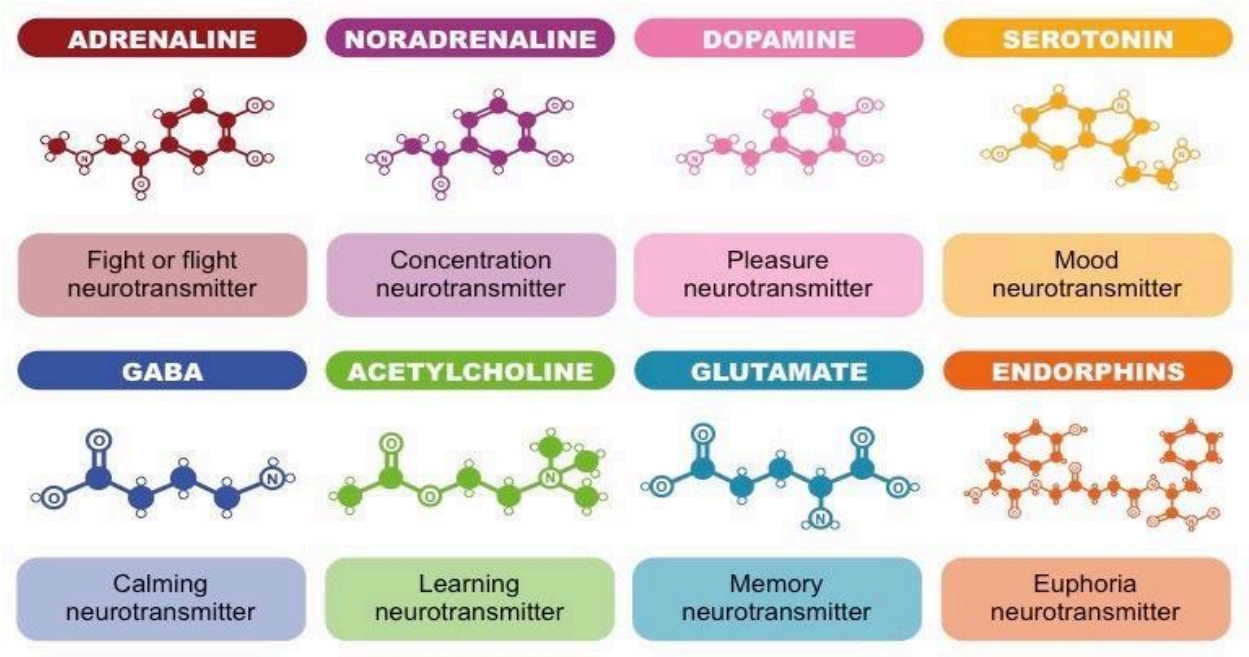
(Total 8 marks)

1. A[1]
2.D[1]
3.C[1]
4.A[1]
5.C[1]
6.C[1]
7.B[1]
8.B[1]
9.C[1]

10.resting membrane is polarized;
interior is –70 mV/negative relative to outside;
more sodium ions outside than inside;
more potassium ions inside than outside;
disturbance of membrane opens sodium ion channels;
sodium ions rush to inside of cell;causing depolarization;
sodium ion channels shut;
potassium ion channels open;
potassium ions rush out;
helping to restore polarized state of membrane;
sodium–potassium pumps maintain polarity;
process repeated along the length of neuron / sodium ions diffuse between region with an action potential and the region at resting potential;[8 max]



Drugs That Influence Neurotransmitters

Change in Neurotransmission	Effect on Neurotransmitter release or availability	Drug that acts this way
increase the number of impulses	increased neurotransmitter release	nicotine, alcohol, opiates
release neurotransmitter from vesicles with or without impulses	increased neurotransmitter release	amphetamines methamphetamines
release more neurotransmitter in response to an impulse	increased neurotransmitter release	nicotine
block reuptake	more neurotransmitter present in synaptic cleft	cocaine amphetamine
produce less neurotransmitter	less neurotransmitter in synaptic cleft	probably does not work this way
prevent vesicles from releasing neurotransmitter	less neurotransmitter released	No drug example
block receptor with another molecule	no change in the amount of neurotransmitter released, or neurotransmitter cannot bind to its receptor on postsynaptic neuron	LSD caffeine