

Mark schemes

1

- (a)
1. Calcium ions diffuse into myofibrils from (sarcoplasmic) reticulum;
 2. (Calcium ions) cause movement of tropomyosin (on actin);
 3. (This movement causes) exposure of the binding sites on the actin;
 4. Myosin heads attach to binding sites on actin;
 5. Hydrolysis of ATP (on myosin heads) causes myosin heads to bend;
 6. (Bending) pulling actin molecules;
 7. Attachment of a new ATP molecule to each myosin head causes myosin heads to detach (from actin sites).

5 max

- (b)
1. Releases relatively small amount of energy / little energy lost as heat; *Key concept is that little danger of thermal death of cells*
 2. Releases energy instantaneously;
Key concept is that energy is readily available
 3. Phosphorylates other compounds, making them more reactive;
 4. Can be rapidly re-synthesised; 5. Is not lost from / does not leave cells.

2 max

[7

- 1] (a)
1. Membrane more permeable to potassium ions and less permeable to sodium ions;

2

2. Sodium ions actively transported / pumped out and potassium ions in.

2

- (b)
1. (Pressure causes) membrane / lamellae to become deformed / stretched; 2. Sodium ion channels in membrane open and sodium ions move in; 3. Greater pressure more channels open / sodium ions enter.

3

- (c)
1. Threshold has been reached;
 2. (Threshold or above) causes maximal response / all or nothing principle.

2

- (d)
1. Less / no saltatory conduction / action potential / impulse unable to 'jump' from node to node;
 2. More depolarisation over length / area of membranes.

2 [9]

3

- (a) 0.32.

Correct answer = 2 marks

Accept 32% for 1 mark max

Incorrect answer but identifying 2pq as heterozygous = 1 mark

2

- (b) 1. Mutation produced *KDR minus* / resistance allele;
2. DDT use provides selection pressure;
3. Mosquitoes with *KDR minus* allele more likely (to survive) to reproduce; 4.
Leading to increase in *KDR minus* allele in population.

4

- (c) 1. Neurones remain depolarised;
2. So no action potentials / no impulse transmission.

2

- (d) 1. (Mutation) changes shape of sodium ion channel (protein) / of receptor(protein);
2. DDT no longer complementary / no longer able to bind.

2

[10] A Vesicle;

4

B Neurotransmitter;

C Synaptic cleft;

B Accept named neurotransmitter

[3]

5

(a) Any **two** from:

- light
- pressure
- touch
- temperature
- chemicals
- (loud) noise
- smell;

Two required for 1 mark

Do not accept unqualified reference to dust / particles / objects

Accept (rapid) movement (of particles / air) towards the eye

Accept humidity / moisture / tears

1

(b) 1. Standard deviations / standard errors;

2. (So) likely to overlap;

2

(c) 1. Would not know the patient's / human's normal blink rate so unable to make a comparison;

2. Blink rate could be affected by stress of seeing a doctor;

3. Many factors could affect blink rate so it would be difficult to tell if blink rate was due to illness

2 max

(d) 1. Not possible to predict intermediate values;

2. Only one result for each time period / not mean values;

2

(e) Collected paired data;

1

(f) 1. No / low influx of sodium ions;

2. So no depolarisation / action potential;

2. 'so no impulses' insufficient

2

(g) 1. Allows calcium ions in;

2. At end of presynaptic neurone;

3. Causing release of neurotransmitter;
 1. Accept Ca^{2+}/Ca ions but not $Ca/Ca+$
 2. The idea of the end of the presynaptic neurone must be given e.g. presynaptic knob

3

- (h)
1. Reference to large group size;
 2. Reference to matching a specific, named variable;
 3. Applying a statistical test to the data;
 1. Accept ≥ 20 / many / lots' but not 'several / less than 20'
 2. Accept any named variable other than age.
 3. Accept 'use SE / 95% confidence limits'

3

[16] (a) 1. Complementary to receptor for acetylcholine;

6

2. Binds to receptor;
3. On postsynaptic (membrane);
4. Prevents acetylcholine from binding;
5. No action potential in postsynaptic neurone;
 2. Accept description of 'binds'
 3. Must be in context of membrane
 5. Accept 'depolarisation' but not 'impulse'

3 max

- (b)
1. Takes longer to become unconscious than it does to stop blinking;
 2. No overlap of standard error;
 1. Accept reference to 0.24/0.28 and 0.48/0.44 in place of longer

2

- (c) Different body masses but need to have comparable effects;
- Do not accept 'same' effects or unqualified references to 'bias / comparison / fair test'.*

1

[6] (a) (i) C;

7

1

- (ii) D;

1

- (b) (Synaptic) vesicles (only) found in presynaptic (part of synapse);
- Accept bulb of synapse for presynaptic*
- Reject vesicles **in** the membrane*

- (c) (i) Has similar shape/structure to dopamine

OR

Complementary (to binding site on receptor);

Ignore competitive inhibitor

Accept tertiary structure

Reject active site

*Reject **same** shape as dopamine/as receptor*

1

- (ii) 1. (Binding) does not lead to opening of sodium ion channels;
2. (So) no depolarisation / threshold not reached / sodium ions do not diffuse in;

OR

3. Opens chloride ion channels;
4. Causing hyperpolarisation / preventing depolarisation

*Mark either 1 and 2 **OR** 3 and 4*

1. Accept stops dopamine opening sodium ion channels

1. Reject sodium unqualified

2. Accept no generator potential

3. Reject chlorine

[6] (a) (i) 1. Slower ²diffusion;

8

Accept description of diffusion eg 'movement down concentration gradient' but concept of slower is required

2. (Of) ions / Na⁺ / K⁺;

Reference to ions is required. Reject other named ions, eg calcium ions

Ignore references to synaptic transmission or rates of respiration

2

- (ii) 1. Myelination / saltatory conduction;
Accept reference to presence of nodes of Ranvier
2. Axon diameter;

2

- (b) Keep everything the same but not in bath / at room temperature / same clothing as for immersion / sitting in empty bath / sitting in water at room temperature;
Accept 'normal' or 'comfortable' as equivalent to room temperature

Ignore reference to body temperature

1

(c) (i) (Find) the most common result / time / the result / time that occurs the most;

1

(ii) Highest and lowest result / time;

Accept 'difference between highest and lowest results / times'

1

(d) 1. (Which is based on) mean of 20 people / large (enough) sample;
This point is possible for students that suggest the difference is significant

2. (But) SE bars / confidence limits overlap;

This point applies whether 1 × SE or 2 × SE is used

3. Reference to 0.297 ± 0.0424 / 0.326 ± 0.0366 / confidence limits = $2 \times SE$;

This point rewards knowledge of use of $2 \times SE$ (as per Students' Statistics Sheet)

4. (So) difference is **not** significant;

This point is only awarded after marking point 2 or marking point 3 has been given

3 max

[10] (a) One suitable suggestion; explained;

9

E.g.

1. Action potentials travel more slowly / don't travel;

Accept: fewer / no saltatory movement of potentials

2. So delay in muscle contraction / muscles don't contract / muscles contract slow(er);

OR

3. Action potentials / depolarisation 'leaks' to adjacent neurones; *Accept:*

neurones not insulated

4. So wrong muscle (fibres) contract.

2 max

(b) Lipid-soluble / pass through phospholipid bilayer.

Not just 'pass through membranes'

1

(c) 1. Prevents influx of calcium ions (into pre-synaptic membrane);

Need idea of moving into pre-synaptic membrane / synaptic knob

Accept Ca^{++} / Ca^{2+}

2. (Synaptic) vesicles don't fuse with membrane / vesicles don't release neurotransmitter;

Accept vesicles don't release acetylcholine

3. Neurotransmitter does not diffuse across synapse / does not bind to receptors (on post-synaptic membrane);

Accept: sarcolemma / muscle membrane for post-synaptic membrane

4. No action potential / depolarisation (of post-synaptic membrane) / sodium (ion) channels do not open / prevents influx of sodium ions.

Accept Na⁺

Accept prevents depolarisation of muscle cell

Ignore: descriptions of events at post-synaptic membrane involving calcium ions and muscle contraction

4

- (d) 1. They won't affect synapses in brain;
2. They won't cause problems with the brain's function / won't damage brain;

Accept: suitable named problem e.g. hallucination

Ignore: unqualified references to 'side effects'

Accept: reference to addiction / harm of smoking (cannabis)

3. (So only the) muscle / neuromuscular junctions treated / affected.

2 max

[9] (a) 1. Causes sodium ion channels to open;

10

1. *Reject if wrong sequence of events*

2. Sodium ions enter (cell and cause depolarisation);

Reject sodium on its own only once

2

- (b) 1. (If not removed) keeps binding (to receptors);

Accept answers based on what happens if it is transported out – ie what should happen

2. Keeps causing action potentials / depolarisation (in post-synaptic membrane);

2. Accept keeps Na⁺ channels open(ing)

2

- (c) 1. Movement in all groups (about) same before MDMA;

Q

2. MDMA increases movement in Group **L**;

2. *Accept normal mice for L*

3. Group **K** shows MDMA causes movement;

3. *Accept K is a control*

4. No / little increase in mice without receptor / Group M;

3 max

[7] (a) (i) UGC;

11

1

(ii) TGCTAC;

1

(b) (DNA) contains introns / non-coding bases / mRNA only contains exons / coding bases;

Assume that 'it' refers to DNA

Neutral: DNA contains introns and exons

Neutral: 'splicing'

Neutral: pre-mRNA contains introns

Ignore refs. to start and stop codons

1

(c) Different primary structure / amino acid sequence / amino acid coded for;

Reject: different amino acids produced / formed

Neutral: refs. to bonds

1

(d) 1. Acetylcholine not broken down / stays bound to receptor;

2. Na⁺ ions (continue to) enter / (continued) depolarisation / Na⁺ channels (kept) open / action potentials / impulses fired (continuously);

3. (Intercostal) muscles stay contracted / cannot relax;

'Muscles contract' is not enough

Accept: diaphragm stays contracted / cannot relax

3

[7] (a) 1. (Acetylcholine) released from / in presynaptic side;

12

2. Receptors in postsynaptic (side) / binds on postsynaptic (side);

2. Mark for diffusion only awarded in context of unidirectional movement.

2

(b) (i) 1. Rapid response;

2. Short duration;

Specific wording is not important. It is the principles that matter here.

Points may be made by referring to figures.

2

(ii)

	1	2	3
Percentage	80	0	0

Ignore % sign.

1

[5] (a) (Ion) channel proteins open, sodium in;

13

Changes membrane potential / makes inside of axon less negative / positive / depolarisation / reaches threshold;

More channels open / positive feedback;

Accept other phrases for ion channel proteins providing that it is clear that it is something through which ions pass. Reject carrier.

First marking point relates to opening.

Third point must relate to more (channels) opening.

3

(b) Potassium channels open;

Potassium out;

Sodium channels close;

Do not penalise candidate who refers to sodium or potassium. Ions are mentioned in question.

Reject pump

3

(c) Pump / active transport / transport against concentration gradient;

Of sodium from axon / sodium out / of potassium in;

Do not penalise candidate who refers to sodium or potassium. Ions are mentioned in question

2

[8]

(a) In table:

14

D
B
C

All 3 correct = 2 marks;; 2 correct =

1 mark;

0 or 1 correct = 0 marks

2

(b) (i) myelin insulates / prevents ion movement; saltation / describedre leaping node to node;

- (ii) cat has higher body temperature; *ignore references to homoiothermy' / warm-blooded*
faster diffusion of ions / faster opening of ion pores / gates / channels;

2

- (c) 1 increasing stimulus (potential) causes decrease in potential difference / rise in potential at P;
- 2 1 or 2 is sub-threshold / 1 or 2 does not give action potential / 3 or 4 is above threshold / 3 or 4 does give an action potential;
- 3 influx of Na⁺ ions; (*not just Na / sodium*)
- 4 voltage-gated channels (in axon membrane) opens / opens Na⁺ channels / membrane more permeable to Na⁺
(*NOT just Na / sodium*);
- 5 sufficient for stimulation of adjacent region of axon therefore impulse propagated (from P to Q);

5

- (d) 1 X / Acetylcholine → opening of Na⁺ channels / increases Na⁺ permeability and Na⁺ ion entry into Z;
- 2 Y / Cl⁻ entry - lowers potential / increases potential difference / makes potential more negative;
- 3 X stimulates and Y inhibits (Z);
- 4 balance of impulses from X and Y determines whether Z fires action potential / determines whether potential rises above threshold;

4

[15] (i) Binds to receptor / proteins; and opens Na⁺ channels;

15

Na⁺ enter and make membrane potential less negative / depolarised

2

- (ii) (Vesicles containing) neurotransmitter only in presynaptic membrane / neurone;
receptor / proteins only in postsynaptic membrane / neurone;

2

- (iii) GABA opens K⁺ and Cl⁻ channels so K⁺ passes out and Cl⁻ passes in;
Membrane potential more negative / hyperpolarised;
Requires increased stimulation / must open more Na⁺ channels / allow more Na⁺ to enter;
To reach threshold;

[8] (a) 1. automatic (adjustments to changes in environment) / involuntary;

16

2. reducing / avoiding damage to tissues / prevents injury / named injury e.g. burning;
3. role in homeostasis / example;
4. posture / balance;
5. finding / obtaining food / mate / suitable conditions;
6. escape from predators;

(ignore 'danger' or 'harm' unless qualified)

3 max

- (b) (i) 1. (impulse causes) calcium ions / Ca^{++} to enter axon;
2. vesicles move to / fuse with (presynaptic) membrane;
 3. acetylcholine (released);
 4. (acetylcholine) diffuses across synaptic cleft / synapse;
 5. binds with receptors on (postsynaptic) membrane;
- (reject active sites, disqualify point)*
6. sodium ions / Na^+ enter (postsynaptic) neurone;
 7. depolarisation of (postsynaptic) membrane;
 8. if above threshold nerve impulse / action potential produced

6 max

- (ii) neurone to neurone and neurone to muscle; action potential in neurone and no action potential in muscle / sarcolemma; no summation in muscle; muscle response always excitatory (never inhibitory); some neuromuscular junctions have different neurotransmitters; *(penalise 'nerve' once)*

2 max

[11] (a) action potential arrives / depolarisation occurs;

17

calcium ions enter synaptic knob; vesicles fuse with membrane; acetylcholine diffuses (across synaptic cleft); binds to receptors;

4 max

- (b) inside becomes more negatively charged / hyperpolarised; stimulation does not reach threshold level / action potential not produced; depolarisation does not occur / reduces effect of sodium ions entering;

3

- (c) (i) inhibits enzyme (which breaks down GABA); more GABA available (to inhibit neurone);

OR

binds to (GABA) receptors;
inhibits neuronal activity / chloride ions enter (neurone);

(ii) receptors have different tertiary / 3D structure / shape not complementary;
GABA cannot bind; inhibition of neuronal activity does not occur / chloride ions
do not enter;

3

(d) motor area; left cerebral hemisphere;

2

[14]

(a) membrane relatively impermeable / less permeable to sodium ions / gated channels are

18

closed / fewer channels; sodium ions pumped / actively transported out; by
sodium ion carrier / intrinsic proteins; inside negative compared to outside / 3
sodium ions out for two potassium ions in;

(if sodium mentioned but not in context of ions, negate 1 mark)

4

(b) (i) 1.6;

1

(ii) $18 \div 1.6 = 11.25$; multiply by 1000 to convert from ms to s / 11
250;

(correct method = 1 mark, i.e. $\frac{\text{distance}}{\text{time}}$)

or $\times 1000$)

(correct answer based on (b)(i) = 2 marks)

2

(iii) time for transmission / diffusion across the neuromuscular
junction / synapse; time for muscle (fibrils) to contract;

1 max

(c) movement by diffusion; binding to receptors on (post-synaptic) membrane;
causing sodium channels to open / sodium ions to move in to muscle (cell);

3

(d) (i) toxin binds to / competes for / blocks the acetylcholine
receptors; acetylcholine can not depolarise the membrane / the toxin does not
cause depolarisation;

*(allow references to generating action potentials instead of
depolarisation, do not allow references to impulses in muscles)*

2

(ii) acetylcholinesterase is unable to breakdown
acetylcholine; acetylcholine still available to depolarise the
membrane / generate action potentials in the membrane;

2

[15] (a) Cocaine (binding) changes shape of transporter/prevents dopamine binding;

19

Reject references to active site

Transporter cannot move (bound) dopamine (through membrane / protein / into cell);
Dopamine remains / builds up in synapses (leading to feelings of pleasure);

3

(b) (i) Polymerase chain reaction / PCR;

1

(ii) Single-stranded DNA;

Reject reference to a single strand of DNA

Bases / sequence complementary to DNA / gene to be identified;

(Radioactively / fluorescent) labelled so that it can be detected;

2 max

(c) Mutation changes base sequence of gene / DNA;

Accept references to active site

(Thus) changing amino acid sequence;

Changes tertiary structure / shape of protein/transporter;

Cocaine binding site changes/cocaine cannot bind;

Dopamine can still bind (and be transported);

3 max

[9]

2+

20

(a) (Nerve impulse causes) Ca²⁺ to enter presynaptic neurone/membrane;

(Ca²⁺ entry) causes fusion of vesicles with presynaptic membrane / causes exocytosis / release of transmitter;

2 (b) Vesicles / neurotransmitter / dopamine (only) in / from A;

OR

Receptors (only) on B;

1

(c) (i) Dopamine and cocaine have similar shapes (in part);

Cocaine can fit transporter;

Reject ref. to 'active site'

2

(ii) Cocaine blocks transport of dopamine out of gap / into A;

Dopamine concentration rises / is maintained / remains;

Ignore ref. to 'active site'

Continues to stimulate/bind to receptors;

Causes continued firing of impulses (in B);

3 max

[8]