AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.6.2.1 NERVE IMPULSES

SCORE	PERCENTAGE
/232	%

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_____

_____

(3)
(Total 9 marks)

Mark schemes

1.

(a) 1. Higher concentration of potassium ions inside **and** higher concentration of sodium ions outside (the neurone)

OR

potassium ions <u>diffuse</u> out

OR

sodium ions <u>diffuse</u> in;

Accept 'more' for 'higher concentration'.

Accept 'sodium ions can't diffuse in (due to alternative explanation).

2. (Membrane) more permeable to potassium ions (leaving than sodium ions entering)

OR

(Membrane) less permeable to sodium ions (entering than potassium ions leaving);

Accept for 'less permeable to sodium ions' is 'impermeable to sodium ions' or 'sodium gates/channels are closed' (alternative explanation).

3. Sodium ions (actively) transported out and potassium ions in;

reference to <u>ions</u> or Na^+ and K^+ is required. If mentioned once allow for all mark points.

*If an answer provides two or three of these mark points **without** any reference to <u>ions</u> – award **one** maximum mark.*

Accept 3 Na^+ out and 2 K^+ in but reject if numbers used are incorrect.

3

(b) 1. Myelination provides (electrical) insulation;

Reject thermal insulation.

Accept description of (electrical) insulation.

2. (In myelinated) saltatory (conduction)

OR

(In myelinated) depolarisation at nodes (of Ranvier);

3. In non-myelinated depolarisation occurs along whole/length (of axon);

Accept action potentials for depolarisation.

'Messages' or 'signals' disqualifies first of these marks credited.

3

(c) 1. No/less ATP produced;

2. No/less <u>active</u> transport

OR

Sodium/potassium pump inhibited;

*Accept Na^+ not/fewer moved out **and** K^+ not/fewer moved in.*

3. Electrochemical gradient not maintained

OR

(Facilitated) diffusion of ions causes change to 0 mV

OR

(Results in) same concentration of (sodium and potassium) ions (either side of membrane)

OR

No net movement of (sodium and potassium) ions;

Accept reaches electrical equilibrium/balance.

Accept concentration gradient of sodium and potassium ions not maintained.

3

[9

] (a) 1. (Refers to) saltatory conduction **2.**

OR

(Nerve) impulses/depolarisation/ions pass to other neurones

OR

Depolarisation occurs along whole length (of axon);

Accept suitable description that refers to (transmission) from node to node (of Ranvier).

Accept action potential for depolarisation.

1 and 2. Accept action potentials for impulses.

1, 2 and 3. Reject first mark awarded if answer refers to messages/signals for impulses. Reject even if impulse/s also referred to.

2. (Nerve) impulses slowed/stopped;

3. (Refers to) <u>neuromuscular</u> junction

OR

(Refers to) <u>sarcolemma</u>;

3

(b) 1. Slower/fewer impulse(s) along sympathetic/parasympathetic (pathway/neurones);

Accept action potentials for impulses.

Reject no impulses.

1, 2 and 3. Ignore 'information' but reject first mark awarded if answer refers to messages/signals for impulses. Reject even if impulse/s also referred to.

2. (Impulses) from cardiac centre
OR
(Impulses) from medulla;

3. To SAN;

3

(c) 1. It/DNA is <u>complementary</u> to (m)RNA;

Accept (transcription) results in <u>complementary</u> (m)RNA.

Ignore miRNA/siRNA/transcriptional factors.

2. Binds to mRNA (for huntingtin);

3. Prevents <u>translation</u>;

Ignore transcription.

3

(d) 1. Small sample size
OR
Only 46;

2. Only four-months
OR
short period (of trial);

3. Huntingtin/protein reduced
OR
Huntingtin/protein still produced
OR
Huntingtin/protein not removed;

Accept huntington for huntingtin.

Ignore miRNA/siRNA/transcriptional factors.

4. Allele/gene/mutation/mRNA (for Huntington's) still present
OR
(May be) temporary
OR
Drug treatment repeated;

5. Brain already damaged
OR
Brain damage may continue;

2 max

(e) 1. (Drug/DNA) will directly/quickly reach <u>brain</u>

OR

(Cerebrospinal) fluid bathes the <u>brain</u>;

2. (Drug/DNA) not destroyed by acid

OR

(Drug/DNA) not digested (by enzymes);

Reject protein is digested.

Ignore location of enzymes.

Accept Drug/DNA denatured.

2

(f)

***Mark in pairs** but if no mark credited allow one mark for any reference to transcription or gene expression being affected.*

1. (Increased) methylation of DNA/gene/allele;

Reject acetylation of DNA.

Accept gene expression for transcription but ignore gene switched on/off.

Ignore methylation of histones.

Accept DNA-histone complex as equivalent to <u>histone(s)</u>.

2. Inhibits/prevents transcription;

OR

3. Decreased methylation of DNA/gene/allele;

4. Stimulates/allows transcription;

OR

5. Decreased acetylation of <u>histone(s)</u>;

6. Inhibits transcription;

OR

7. Increased acetylation of <u>histone(s)</u>;

8. Stimulates/allows transcription;

2 max

[15]

3. (a) 1. (Nerve impulse / depolarisation of membrane) causes Ca^{2+} channel (proteins) to open;

2. Ca^{2+} enter by (facilitated) diffusion;
3. Causes (synaptic) vesicles to fuse with (presynaptic) membrane;

Accept single reference to ions to cover 1 and 2

Penalise once for no reference to ions

1. Reject carrier proteins

3. Reject ref to release of vesicles

3. Ignore vesicles bind to membrane (but accept merge with)

3

(b) 1. Myosin head attaches to actin **and** bends / performs powerstroke;
2. (This) pulls mitochondria past / along the actin;
3. Other / next myosin head attaches to actin (and bends / performs powerstroke);

1. Accept change shape / change angle

2. Ignore pulls actin along

2. Ignore refs to cytoskeleon

Accept plural or singular statements

2 max

(c) 1. (Mitochondria) supply (additional) ATP / energy;
2. To move vesicles / for active transport of ions / for myosin to move past actin
OR
Re-synthesis / reabsorption of neurotransmitter / named neurotransmitter;

1. Reject produces energy

2. Ignore ref. to ATP for opening calcium ion channels/makingvesicles fuse with membrane

2

[7] (a) Only 3 neurones / nerve cells (in reflex arc)

4. **1**

(b) 1. Rapid;

2. Protect against damage to body tissues;

3. Do not have to be learnt;4. Help escape from predators;

5.

Enable homeostat

i c c o n t r o l .

2 max

(c) 1. Neurotransmitter only made in / stored in / released from pre-synaptic neurone;

2. (Neuro)receptors only on the post-synaptic membrane;

2

(d) 1. Axon **P** is myelinated;

2. So shows saltatory conduction / impulses jump between nodes of Ranvier

OR

3. Axon **P** has a larger diameter;

4. So less resistance to flow of ions.

*Mark as 1 & 2 **OR** 3 & 4*

2

[7

] (a) 1. Membrane more permeable to potassium ions and less permeable to sodium ions; **5.**

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' fromnode to node;
2. More depolarisation over length / area of membranes.

2 [9]

(a) 0.32.

6.

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]

7.

(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]

8. (a) (i) C;

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*

1

(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

2

[6]

9.

(a) One suitable suggestion; explained;

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 contractslow(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 <u>ions</u> (into pre-synaptic membrane);

Need idea of <u>moving into</u> pre-synaptic membrane / synaptic knob

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

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

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 <u>ions</u>.

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. (In myelinated) action potential / depolarisation only at node(s);

10.

2. (In myelinated, nerve impulse) jumps from node to node / saltatory;

3. (In myelinated) action potential / impulse does not travel along whole length;

The question is about speed of transmission, not repolarisation or related matters

Accept converse for non-myelinated

3

(b) 1. Probability of obtaining this difference by chance;

Reject 'results' once only

This statement often split round 2.

2. Is less than 5% / less than 0.05 / less than one in twenty;*Accept is 4.7% / 0.047 but reject less than 4.7% / 0.047*

Accept correct greater than 95% / greater than 0.95 arguments

3. Difference is significant;*Reject 'results' once only*

2 max

(c) 1. (All) dementia results lower (than control group) / non-dementia result higher;

2. Error bars do not overlap so differences are (possibly) significant;

Neutral results

Accept not due to chance / statistically significant

In this context, accept references to standard deviation

3. Dementia may be due to other factors / not only due to a lack of myelin;*Accept suitable named factor e.g. genetic*

4. (Because) big / significant differences in myelin in different dementia;*Not just 'different'*

5. Only small sample sizes / only one study / more data required;

4 max

[9] (a) (i) 1. Slower <u>diffusion</u>;

11.

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 asfor 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) <u>mean</u> 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 × SE;

This point rewards knowledge of use of 2 × 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) 1. Causes sodium ion channels to open;

12.

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]

13.

(a) (Ion) channel proteins open, sodium in;

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]

14. (a) In table:

D	*All 3 correct = 2 marks;; 2 correct =*
B	*1 mark;*
C	*0 or 1 correct = 0 marks*

2

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

2

(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 potentialdifference / 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 Zfires action potential / determines whether potential rises above threshold;

4

[15] (a) closed open closed;

15. closed closed open;

2

(b) active transport / pump of Na^+ out of axon; diffusion of K^+ out of axon / little diffusion of Na^+ into the axon;

2

(c) can not pass through phospholipid bilayer;because water soluble / not lipid soluble / charged / hydrophilic / hydrated;

2

[6]

16. (a) Transports Na^+ and K^+ ;
By active transport / pump / against concentration gradient;
Restores ion balance after an action potential;
[*reject* K^+ out and Na^+ in]

2

(b) (i) each protein has a specific tertiary structure / shape;because the ions have different sizes / shape / charge;
[*reject* receptors binding]

2

(ii) fewer protein B molecules, which transport sodium ions / more protein A molecules, which transport potassium ions;

1

[5] (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 reachthreshold 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);

2 max

(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]

18.

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

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]

19.

(a) sodium gates or channels open / increase in permeability of axon membrane to sodium ion; sodium ions enter axon;

2

(c) non-myelinated – next section of membrane depolarised / whole membrane;
myelinated – depolarisation / ion movement only at nodes;
impulse jumps from node to node / saltatory conduction;

3

[5]

20.

(a) membrane relatively impermeable / less permeable to sodium ions / gated channels are 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 ÷ 1.6 = 11.25;multiply by 1000 to convert from ms to s / 11 250;

(correct method = 1 mark, i.e. $\frac{distance}{time}$ *or × 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) (epithelial cell) of tubule cells carry out active transport;

21.

transport chloride / sodium ions out (of filtrate);
against concentration gradient; into
surrounding tissue / tissue fluid;
creates / maintains water potential gradient for water reabsorption;
countercurrent multiplier;

5 max

(b) if water potential of blood falls, detected by receptors in hypothalamus;
leads to ADH released from pituitary gland;
ADH makes cells of collecting duct / distal convoluted tubule permeable to water;

(accept DCT)

water leaves filtrate by osmosis;
smaller volume of urine produced;

(accept converse if water potential of blood rises)

4 max

(c) (autonomic reflex), autonomic ganglion involved; extra synapse outside the spinal cord; inhibitory rather than

excitatory neurone; more neurones involved;

2 max [11]

22.

(a) (i) A to B:

Mark (i) and (ii) as a whole

Sodium channels open / membrane more permeable to sodium (ions);

Max 3 for each section

Sodium ions enter;
By diffusion / from high to low concentration;

Allow 'diffusion' point ONCE only

Ref. sodium ions have positive charge / cause change from negative to positive potential; *Accept refs to sodium and potassium*

(ii) After B:

Sodium channels close;
Potassium channels open / membrane more permeable to potassium ions;
Potassium ions leave;
By diffusion / from high to low concentration (ONCE only);

4 max

(b) (More) respiration;

Reject anaerobic respiration

(More) energy supplied / (more) ATP supplied;

Reject 'produce' energy

For active transport of ions / 'sodium (-potassium) pump' / pumping out sodium ions / for neurotransmitter synthesis / for vesicle movement; *Accept named e.g.*

3

[7]

23.

(a) Correct answer: 6 / 6.25 / 6.3;

Ignore working

Allow 1 mark if decimal point in wrong position

OR

$\frac{1000}{160}$ / $\frac{1}{160}$

Allow 1 mark

2

(b) Ref. to 'refractory period' ;

Requires greater stimulation;
To reach threshold / threshold cannot be reached / to cause depolarisation;

K^+ channels are open / more negative potential than resting potential / membrane is hyperpolarised;

Na^+ channels are inactive/are closed / sodium channels will not open;

3 max

[5]

24. (a) Potassium channels open (and K^+ ions diffuse out); *Accept references to sodium channels opening;*

Sodium channels close (and stops Na^+ ions diffusion in);

Leading to depolarisation;

Accept sodium pump (starts) to pump out sodium ions

2

(b) (Absolute) refractory (period);

1

(c) (i) Causes them to contract;

And relax;

Rapidly/twitch;

2 max

(ii) Cause continuous muscle contraction;

Accept a reasonable suggestion of harm – linked to muscle contraction

At high force;

Causing failure to breathe/heart stops pumping/ damage to bones or joints;

2 max

[7]

25. (b) Cocaine (binding) changes shape of transporter/prevents dopamine binding;

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

(c) (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

(d) 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]