



Topic Test: OxfordAQA
International A level Biology
Control

Name: _____

Class: _____

Date: _____

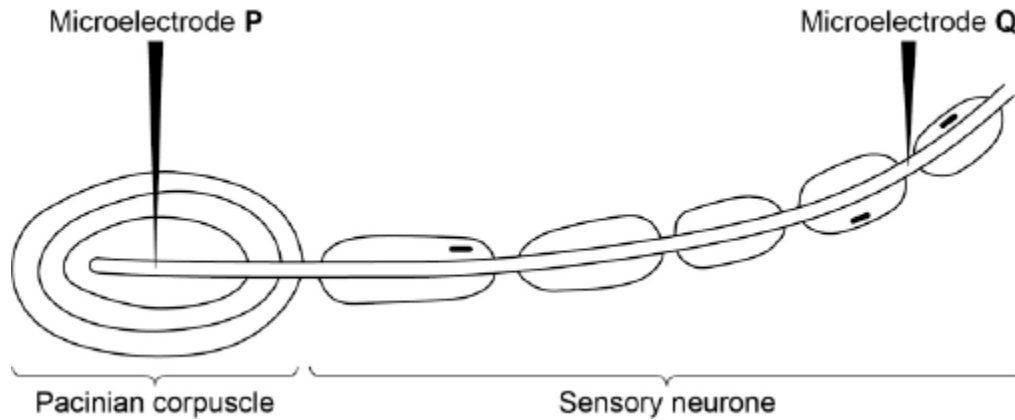
Time: **84 minutes**

Marks: **70 marks**

Comments:

- 1 A biologist investigated the stimulation of a Pacinian corpuscle in the skin of a fingertip. She used microelectrodes to measure the maximum membrane potential of a Pacinian corpuscle and its sensory neurone when different pressures were applied to the fingertip.

The figure below shows the Pacinian corpuscle, its sensory neurone and the position of the microelectrodes.



The table below shows some of the biologist's results.

Pressure applied to the fingertip	Membrane potential at P / millivolts	Membrane potential at Q / millivolts
None	-70	-70
Light	-50	-70
Medium	+30	+40
Heavy	+40	+40

- (a) Explain how the resting potential of -70 mV is maintained in the sensory neurone when no pressure is applied.

(2)

(b) Explain how applying pressure to the Pacinian corpuscle produces the changes in membrane potential recorded by microelectrode **P**.

(3)

(c) The membrane potential at **Q** was the same whether medium or heavy pressure was applied to the finger tip. Explain why.

(2)

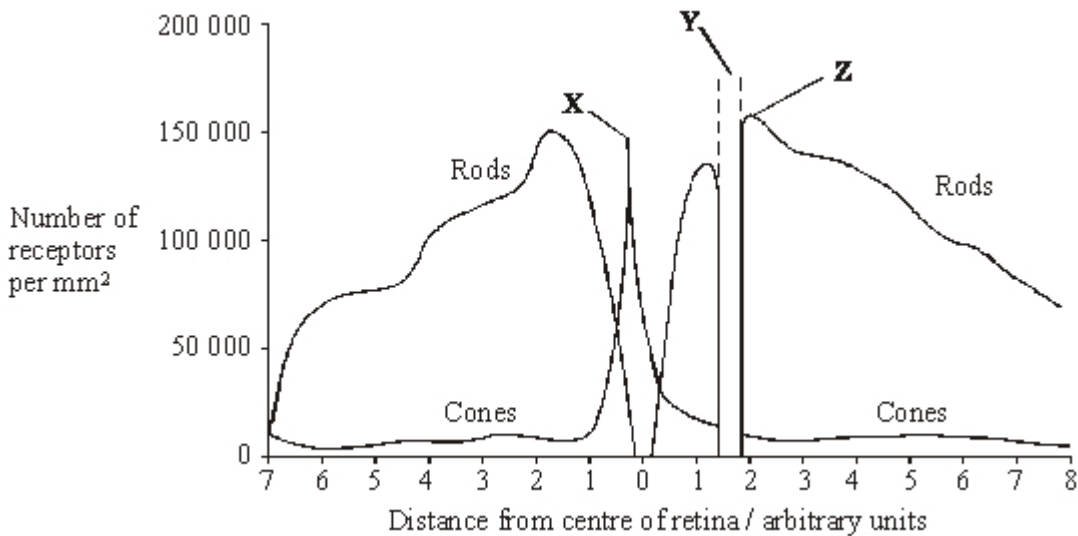
(d) Multiple sclerosis is a disease in which parts of the myelin sheaths surrounding neurones are destroyed. Explain how this results in slower responses to stimuli.

(2)

(Total 9 marks)

2

The graph shows the distribution of rod cells and cone cells across the retina of a human eye.



Use the diagram to explain why

(i) no image is perceived when light is focused on the retina at Y;

(1)

(ii) an image formed at X is perceived in more detail than an image formed at Z.

(2)

(Total 3 marks)

3

(a) **Figure 1** shows part of a myofibril from skeletal muscle.

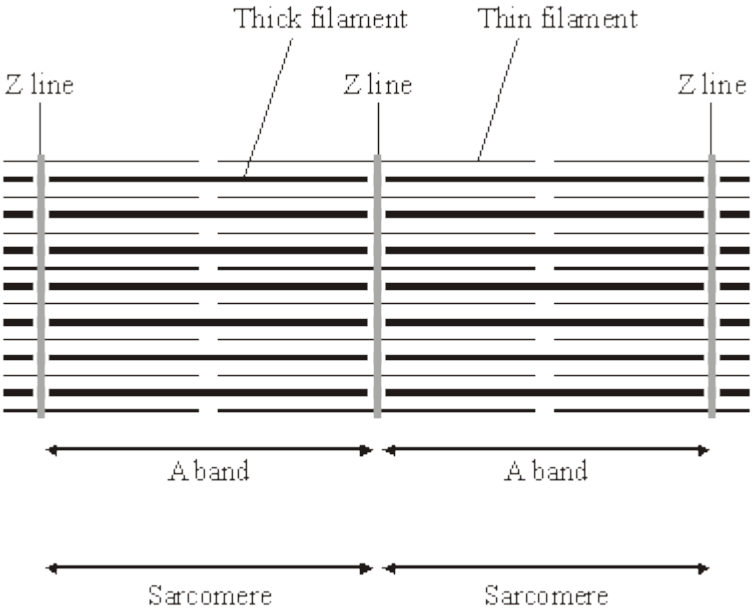


Figure 1

(i) Describe **two** features, visible in the diagram, which show that the myofibril is contracted.

- 1. _____

- 2. _____

(2)

(ii) Explain the role of calcium ions and ATP in bringing about contraction of a muscle fibre.

- Calcium ions _____

- ATP _____

(3)

- (b) **Figure 2** shows the structure of a neuromuscular junction. The vesicles contain acetylcholine.

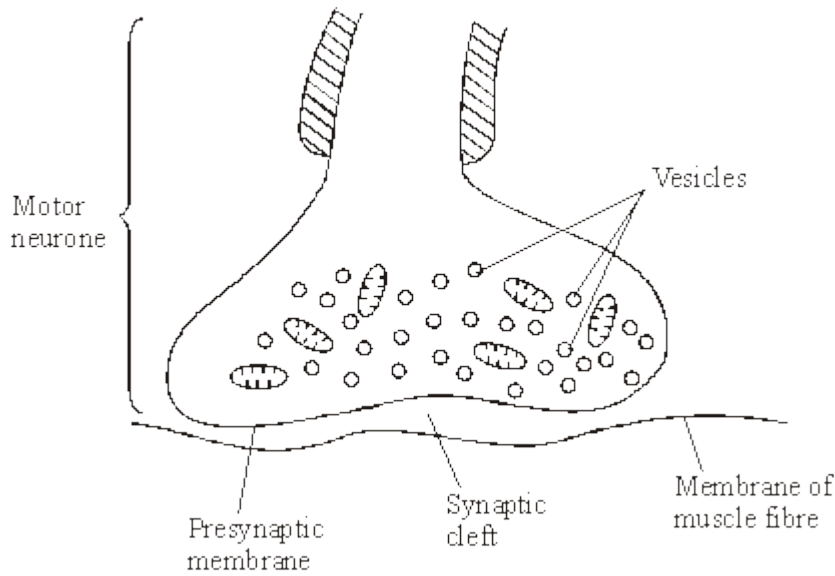


Figure 2

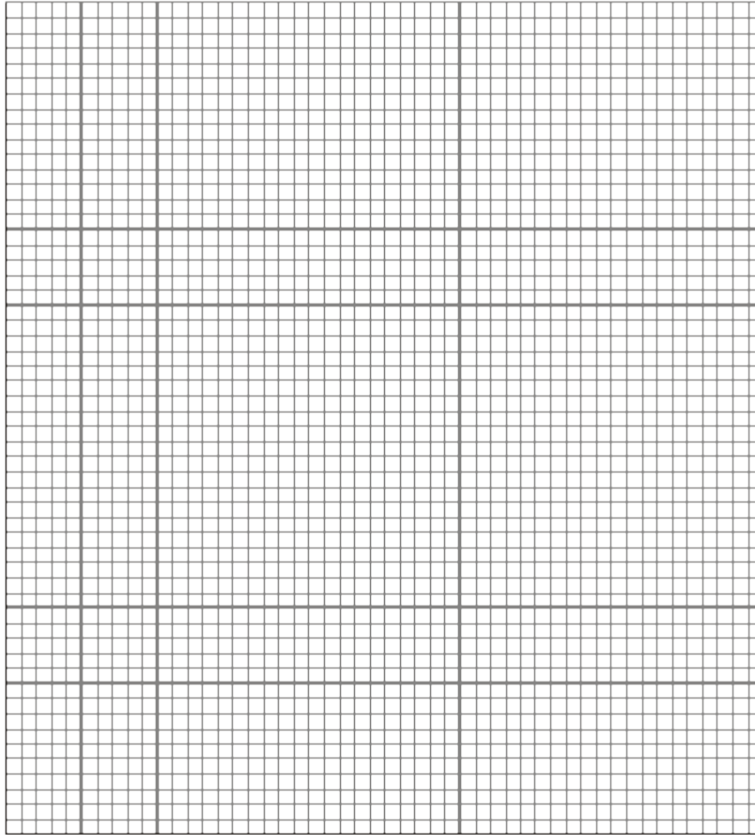
- (i) An action potential is generated at the cell body of the motor neurone. Explain how this action potential passes along the motor neurone to the neuromuscular junction.

(3)

- (ii) When the action potential arrives at the neuromuscular junction, it results in the secretion of acetylcholine into the synaptic cleft. Explain how.

(3)

- (c) Between the ages of 20 and 50, 10% of total muscle mass is lost. Between the ages of 50 and 80, a further 40% of the original total muscle mass is lost. Most of the muscle lost consists of fast fibres.
- (i) Plot a graph on the grid below to show the percentage of muscle mass remaining between the ages of 20 and 80. Assume that the rate of muscle loss in each age range is constant.



(3)

- (ii) Explain why explosive exercises, such as sprinting and weightlifting, will be more affected by this muscle loss than aerobic exercises, such as jogging.

(1)

(Total 15 marks)

4

A student investigates tropisms in the roots of tomato plants.

(a) What is a tropism?

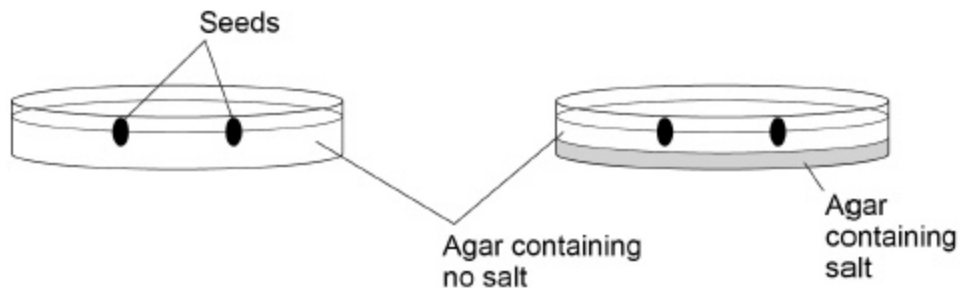
(2)

The student:

1. places four tomato plant seeds of the same variety in a solution of dilute bleach for five minutes
2. rinses the seeds in sterile distilled water
3. uses sterile forceps to gently press two seeds onto a sterilised agar plate that contains **no salt**
4. uses sterile forceps to gently press the other two seeds onto a different, sterilised agar plate that contains **no salt in the top half of the agar but salt in the bottom half**
5. places the agar plates in a 45° position in a well-lit area for 48 hours
6. observes the tropism of the roots.

Figure 1 shows the two agar plates at steps 3 and 4.

Figure 1



(b) Why are sterile conditions important in this investigation?

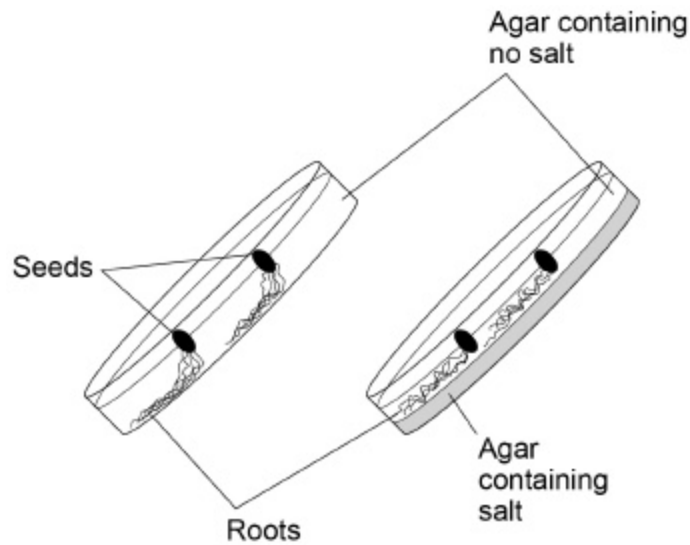
(2)

- (c) Suggest why the seeds are gently pressed onto the agar but are not completely covered with the agar.

(2)

Figure 2 shows the observed tropisms of the tomato plant roots after being placed in a 45° position (steps 5 and 6 in the method).

Figure 2



- (d) What do these results suggest about the tropisms of the roots of tomato plants?

(3)

(e) Give **two** reasons why the results may not be valid.

1. _____

2. _____

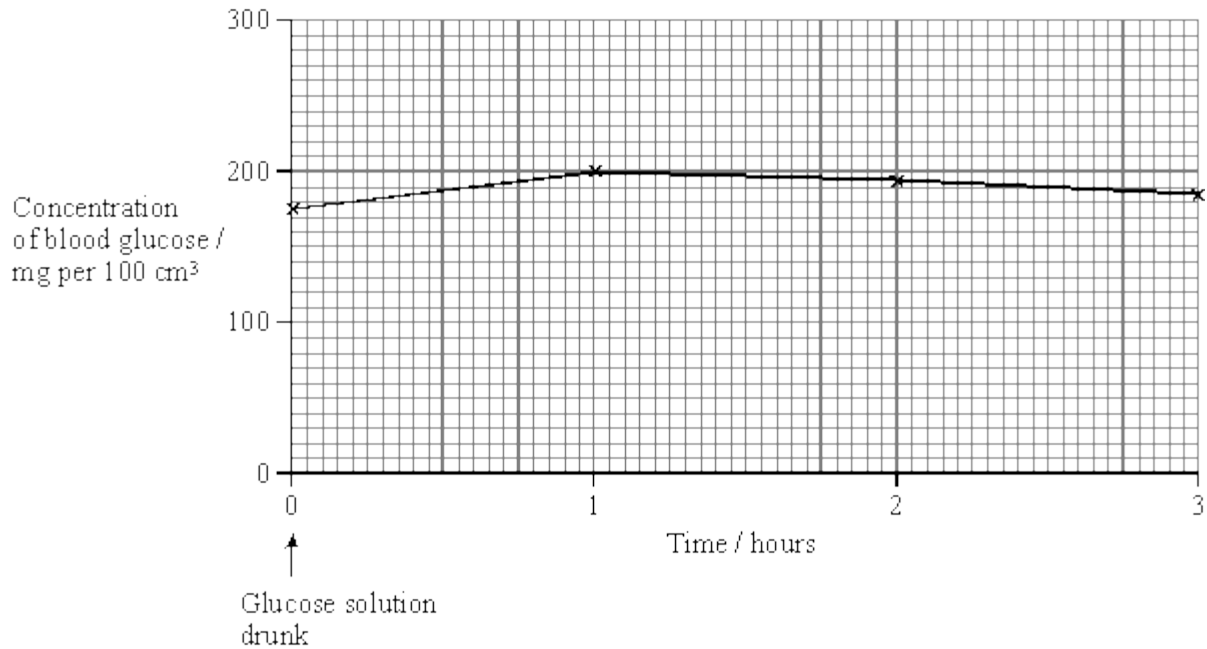
(2)
(Total 11 marks)

5

(a) Describe how insulin reduces the concentration of glucose in the blood.

(3)

Some people produce no insulin. As a result they have a condition called diabetes. In an investigation, a man with diabetes drank a glucose solution. The concentration of glucose in his blood was measured at regular intervals. The results are shown in the graph.



(b) Suggest **two** reasons why the concentration of glucose decreased after 1 hour even though this man's blood contained no insulin.

1. _____

2. _____

(2)

(c) The investigation was repeated on a man who did not have diabetes. The concentration of glucose in his blood before drinking the glucose solution was 80 mg per 100 cm³. Sketch a curve on the graph to show the results you would expect.

(1)

- (d) The diabetic man adopted a daily routine to stabilise his blood glucose concentration within narrow limits. He ate three meals a day: breakfast, a midday meal and an evening meal. He injected insulin once before breakfast and once before the evening meal.

The injection he used before breakfast was a mixture of two types of insulin. The mixture contained slow-acting insulin and fast-acting insulin.

- (i) Explain the advantage of injecting both types of insulin before breakfast.

(2)

- (ii) One day, the man did not eat a midday meal. Suggest **one** reason why his blood glucose concentration did not fall dangerously low even though he had injected himself with the mixture of insulin before breakfast.

(1)

(Total 9 marks)

6

Tissue within the heart is able to control the regular contraction of the atria and ventricles.

- (a) Describe how tissue within the heart coordinates the cardiac cycle.

(5)

(b) The rate of respiration increases during exercise.

Explain how this causes the heart rate to increase.

(5)

(Total 10 marks)

7

(a) Explain the reason for each of the following in the polymerase chain reaction (PCR).

(i) DNA is heated to 95 °C.

(1)

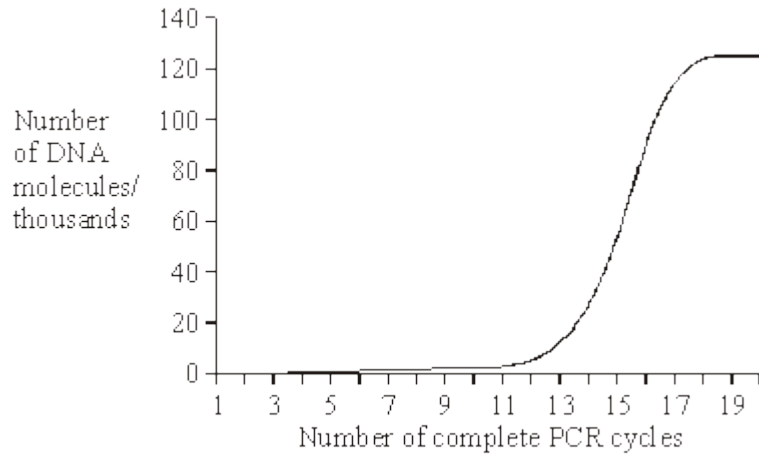
(ii) DNA polymerase used is heat-stable.

(1)

(iii) The reaction mixture is cooled to 40 °C.

(1)

- (b) The graph shows the number of DNA molecules made using PCR, starting with one molecule.



- (i) Explain the shape of the curve from cycles 1 to 16.

(2)

- (ii) Suggest **one** explanation for the levelling out of the curve from cycles 17 to 20.

(2)

(Total 7 marks)

8

- (a) Plasmids are often used as vectors in genetic engineering.

- (i) What is the role of a vector?

(1)

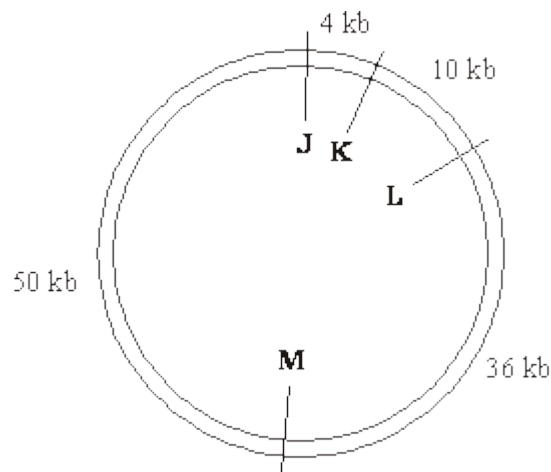
- (ii) Describe the role of restriction endonucleases in the formation of plasmids that contain donor DNA.

(2)

- (iii) Describe the role of DNA ligase in the production of plasmids containing donor DNA.

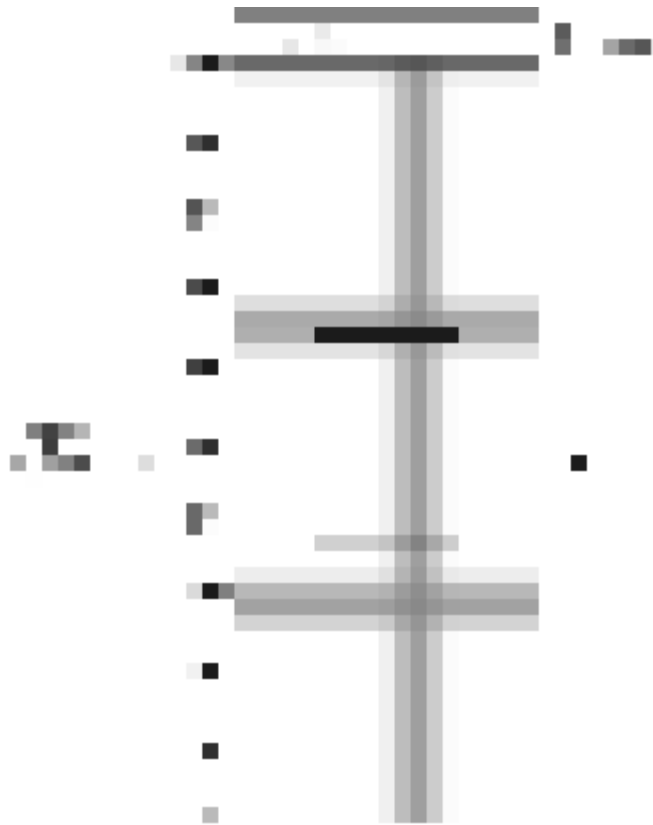
(1)

- (b) There are many different restriction endonucleases. Each type cuts the DNA of a plasmid at a specific base sequence called a restriction site. The diagram shows the position of four restriction sites, **J**, **K**, **L** and **M**, for four different enzymes on a single plasmid. The distances between these sites is measured in kilobases of DNA.



1 kb = 1 kilobase

The plasmid was cut using only two restriction endonucleases. The resulting fragments were separated by gel electrophoresis. The positions of the fragments are shown in the chart below.



(i) Which of the restriction sites were cut?

(1)

(ii) Explain your answer.

(1)

(Total 6 marks)

Mark schemes

- 1** (a) 1. Membrane more permeable to potassium ions and less permeable to sodium ions;
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]**
- 2** (i) no (photo)receptor cells at **Y** / no rods and cones; 1
- (ii) **X** has many / only cones / more cones than **Z**;
which each synapse to a single neurone / bipolar cell / no retinal convergence;
OR
Z has mainly rods / more rods than cones;
which share / converge on neurones / bipolar cells; 2
- [3]**
- 3** (a) (i) H band not visible / reduced / little / no thick filament / myosin only region / ends of thin filaments / actin close together;
I band not visible / reduced / little / no thin filament / actin only region;
A band occupies nearly all sarcomere / thick filament / myosin close to Z line;
Large zone of thick-thin overlap; max 2
- (ii) *Calcium ions*:
Bind to troponin;
Remove blocking action of tropomyosin /
expose myosin binding sites;
- ATP*:
Allows myosin to detach from actin / to break cross bridge;
[allow attach and detach]
Releases energy to recock / swivel / activate myosin head / drive power stroke; max 3

- (b) (i) Depolarisation of axon membrane / influx of Na^+ establishes local currents;
Change permeability to Na^+ / open Na^+ gates of adjoining region;
Adjoining region depolarises / influx of Na^+ ;
3
- (ii) Depolarisation of (presynaptic) membrane;
 Ca^{2+} channels open / increased permeability to Ca^{2+} causing influx of Ca^{2+} ;
Vesicles move towards / fuse with presynaptic membrane;
[If ions mentioned once assume candidate is referring to ions throughout; if no mention of ions penalise once only]
3
- (c) (i) 1. Correct axes labelled, correct orientation, linear scale;
2. Key points (100%, 90% and 50%) plotted correctly;
3. Plots joined by straight lines;
[allow reasonable hand-drawn straight lines]
3
- (ii) Fast fibres used (in explosive exercise);
[allow reverse for slow fibres]
1
- [15]**

4

- (a) Growth response;
To (a) directional stimulus/stimuli;
Ignore: references to a direct stimulus
Accept: towards or away from a stimulus
Accept: directional response (to a stimulus) for a maximum of 1 mark
2
- (b) To prevent the growth of micro-organisms/bacteria/pathogens;
Insufficient: references to results being affected

(That could) prevent (seed) germination;
Insufficient: references to contamination by micro-organisms/bacteria/pathogens
Accept: negative impact on (seedling) growth such as death/rot/limited growth
2
- (c) Sticks to agar, so that seeds do not fall off when plate is placed vertically;
Accept: references to seeds remaining in (a fixed) position

So that the seeds could still obtain oxygen/roots can still grow/not damaged;
Accept: idea that seeds are (still) able to respire aerobically/do aerobic respiration
2

- (d) Grow in direction of/towards (pull of) gravity;
Accept: tropism for growth throughout
Ignore: references to bends/moves throughout
Ignore: pulled by gravity
Accept: positively geotropic/gravitropic

Grow/move away from salt;
Accept: negatively chemotropic/halotropic

Salt has more of an effect (than gravity);
Accept: converse statement for gravity

3

- (e) Small sample size/not representative;

Only one variety of tomato plant investigated;
Accept: idea that experiment has only been done once
Accept: idea that not enough tests have been done
Accept: other varieties of tomato plant may respond in a different way
Accept: idea that (some) roots could interfere/disrupt other roots' growth
Accept: references to distance of downward growth being very short

2

[11]

5

- (a) insulin binds to specific receptors (on membranes);
 insulin activates carrier proteins / opens channels / causes more channels to form;
 insulin increases the permeability of liver / muscle cells / tissues to glucose;
 insulin action results in glucose conversion to glycogen / glycogenesis;

3 max

- (b) glucose is used in cell respiration / as energy source / in metabolism;
(must qualify how glucose is used)

glucose enters cells / converted to glycogen in cells;
 glucose is excreted / in urine;
(do not credit no reabsorption of glucose in kidneys)

2 max

- (c) line from 80 mg, increasing but keeping below line for diabetic, dropping to 80 mg;
(line must stabilise at, or fluctuate around 80 mg)

1

- (d) (i) fast acting insulin reduces blood glucose from breakfast;
slow acting insulin reduces blood glucose from other meals
before the evening meal / eliminates the need to inject at lunch;
(must be a reference to the meals)
*(one mark if neither of the above but a clear reference is
made to glucose conversion to glycogen);*

2

- (ii) glucagon is still active;
glycogen converted to glucose / glycogenolysis;
insulin injected at breakfast causes cells to take up glucose
too slowly for levels to become dangerously low;
person is not active so little glucose used in respiration;
(do not credit statements about consuming large breakfasts)

1 max

[9]

6

- (a) SAN generates wave of electrical activity/impulses (across atria) causing atrial contraction;

Accept: depolarisation/excitation for wave of electrical activity/impulses throughout

Reject: 'signal(s)' for 'impulse(s)' throughout but penalise only once

Non-conducting tissue (between atria and ventricles) prevents wave of electrical activity/impulses reaching ventricles immediately;

Accept: AVN imposes a delay on electrical activity/impulse passage delaying ventricular contraction

Wave of electrical activity/impulses can only pass to ventricles via AVN (due to high electrical resistance of fibrous tissue);

Delay (at AVN) ensures atria empty/ventricles fill (before ventricles contract);

(AVN) sends wave of electrical activity/impulses down Bundle of His;

Wave of electrical activity/impulses spreads out through Purkinje fibres/tissue to ventricular cardiac muscle,

Ventricles contract from apex/base/bottom;

Accept: ventricles contract upwards

Accept: a correct description which omits reference to specialised terms for 3 marks.

Accept: heart is myogenic for 1 mark if no other MPs awarded.

*Accept: reference to SAN, AVN, Purkinje fibres/tissue **and** Bundle of His for 1 mark if no other MPs awarded*

Accept: Purkyne for purkinje throughout.

5 max

(b) Carbon dioxide/CO₂ concentration/level increases (in blood);

Accept: pH falls/H⁺ increases/acidity increases

*Accept: references to high levels of carbon dioxide/CO₂
(in the blood)*

(Detected by chemoreceptors) in aortic/carotid bodies/medulla;

*Accept: (detected by) chemoreceptors in aorta/carotid
arteries*

(Chemoreceptors send) impulses to medulla (oblongata)/cardiovascular centre (of medulla);

Increased frequency of impulses (to/from medulla);

Reject: 'signals' for 'impulses' but penalise only once

Accept: more impulses/increased rate of impulses

Along sympathetic pathway/nervous system (to SAN);

5 max

[10]

7

(a) (i) to separate polynucleotide strands / form single strands;

1

(ii) not denatured (at 95°C);

1

(iii) for binding of primers / nucleotides (to DNA strands);

1

(b) (i) doubling (of DNA) each cycle;
but very low numbers to start with, so appears flat then
exponential growth;

2

(ii) suggestion; with explanation e.g.:

nucleotides being used up;
so less / nothing to make complementary chains;

primers used up;
so cannot start complementary chains;

enzymes losing activity / denatured;
so no polymerisation of complementary strands;

2 max

[7]

8

- (a) (i) transfer / carry genes from one organism to another / into bacteria / cells; 1
- (ii) cut open plasmid;
cut donor DNA, to remove gene / length of DNA;
cut donor DNA and plasmid with the same enzyme / enzyme that cuts at the same base sequence;
sticky ends / (overhanging) ends with, single strand / bases exposed;
association / attachment / pairing of complementary strand; 2 max
- (iii) annealing / splicing / backbones joined / phosphodiester bonds; 1
- (b) (i) L and M; 1
- (ii) fragments 64 and 36(kilobases obtained) 1

[6]