AQA A-LEVEL BIOLOGY

BIOLOGY



EXAM QUESTION PACK

UNIT 5 OLD SPECIFICATION PAPERS

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AQA

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Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

A-level BIOLOGY

Unit 5 Control in cells and in organisms

Thursday 23 June 2016 Morning Time allowed: 2 hours 15 minutes

Materials

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Advice
- You are advised to spend no longer than 40 minutes on the essay.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 (a) The following statements are about events during an action potential.

A Potassium ions diffuse out across the neurone membrane.
B Sodium ions diffuse in across the neurone membrane.
C Sodium ion channels open.
D Active transport of sodium and potassium ions restores resting potential.
E Potassium ion channels open.
F Hyperpolarisation of the membrane occurs.

1 (a) (i) Which of the events, **A** to **F**, starts depolarisation?
Put the correct letter in the box.

[1 mark]

1 (a) (ii) Which of the events, **A** to **F**, requires the hydrolysis of ATP?
Put the correct letter in the box.

[1 mark]

1 (b) Synaptophysin is a protein involved in the production of synaptic vesicles.

Scientists can use the presence or absence of synaptophysin to identify presynaptic and postsynaptic membranes in synapses.

Explain why they are able to use synaptophysin for this purpose.

[1 mark]

Do not write outside the box

1 (c) Dopamine is a neurotransmitter. Production of too much dopamine is associated with schizophrenia. A drug used to treat schizophrenia binds to dopamine receptors in synapses. This binding does not lead to the formation of an action potential.

1 (c) (i) Suggest why the drug used to treat schizophrenia is able to bind to the same receptor as dopamine.

[1 mark]

_____

_____

1 (c) (ii) Suggest why binding of the drug does **not** lead to production of an action potential.

[2 marks]

_____

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6

Turn over for the next question

Do not write outside the box

2 (a) It is important that mammals maintain a constant core temperature.

Explain why.

[3 marks]

2 (b) Scientists investigated control of body temperature in rats. Rats have two patches of brown adipose tissue (BAT) under the skin of their shoulders. In BAT, respiration takes place in mitochondria but no ATP is formed. The scientists looked at the response of BAT to cooling of the rat's skin.

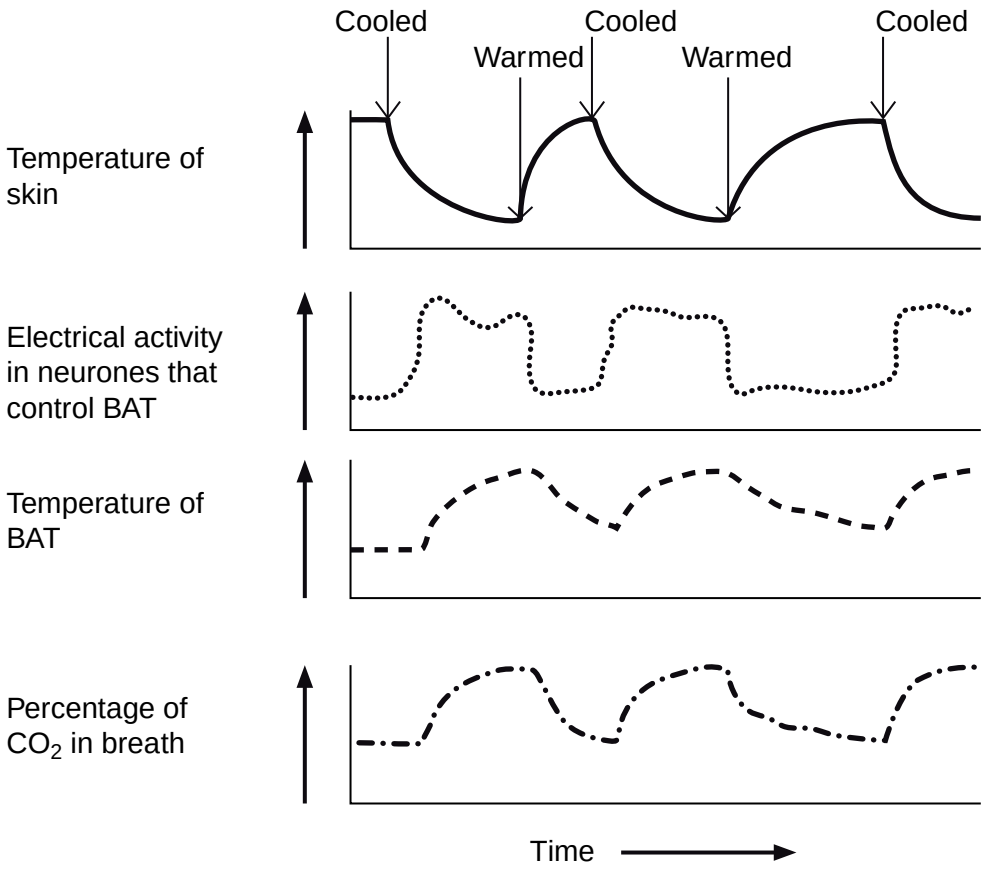
The scientists cooled and warmed an area of a rat's skin. At the same time, they recorded the following.

- Electrical activity in neurones that control the activity of BAT.
- The temperature of the BAT.
- The percentage of carbon dioxide in the rat's breath.

Figure 1 shows their results.

Do not write outside the box

Figure 1



The response involving BAT raises the rat's core temperature if the skin becomes cooler.

Use evidence from **Figure 1** to suggest and explain how.

[4 marks]

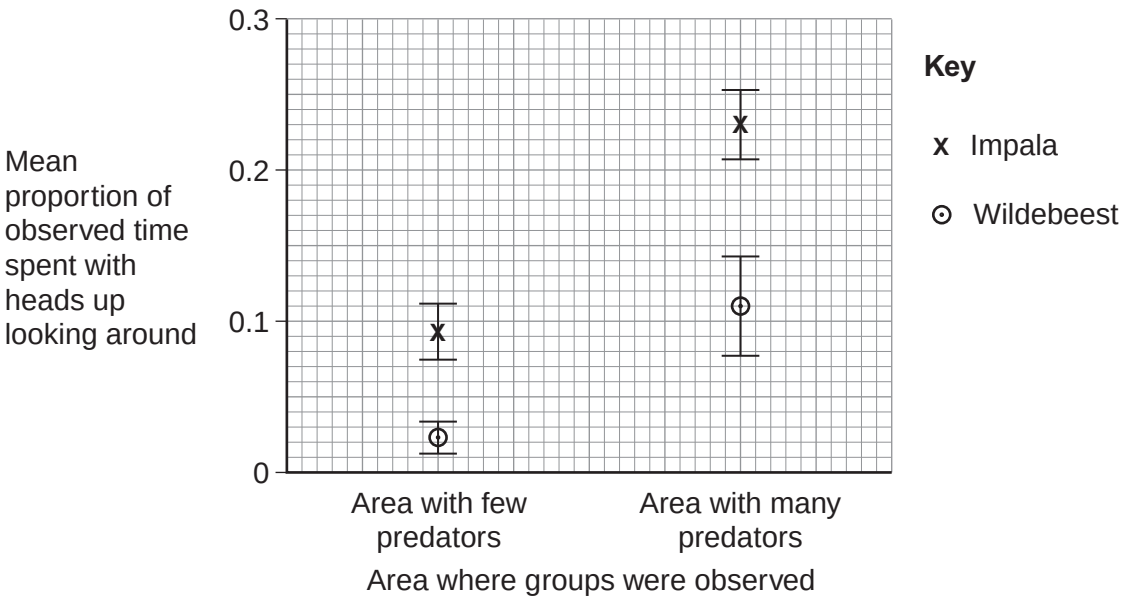
7

3 Impala and wildebeest are species of herbivore that live in large groups. They spend most of their time feeding with their heads near the ground.

Scientists investigated the relationship between the number of predators in an area and the mean proportion of time these herbivores spent with their heads up, looking around rather than feeding. They obtained data from groups of impala and wildebeest in two areas. In one area there were few predators and in the other area there were many predators.

Figure 2 shows their results. The bars show standard deviations.

Figure 2



3 (a) The scientists observed both groups of animals for 75 hours.

Use data from **Figure 2** to calculate the difference in the mean number of hours spent by each species looking around in the area where there were **many** predators.

Show your working.

[2 marks]

Difference _____ hours

Do not write outside the box

3 (b) The scientists concluded that these herbivores spend more time looking for predators in areas where there are many predators.

Do these data support this conclusion? Give reasons for your answer.

[4 marks]

3 (c) The behaviour of the herbivores in having their heads up has a benefit but it also has costs. The benefit is being able to see, and escape from, predators.

Suggest and explain **one** cost to the herbivores of this behaviour.

[2 marks]

8

Turn over for the next question

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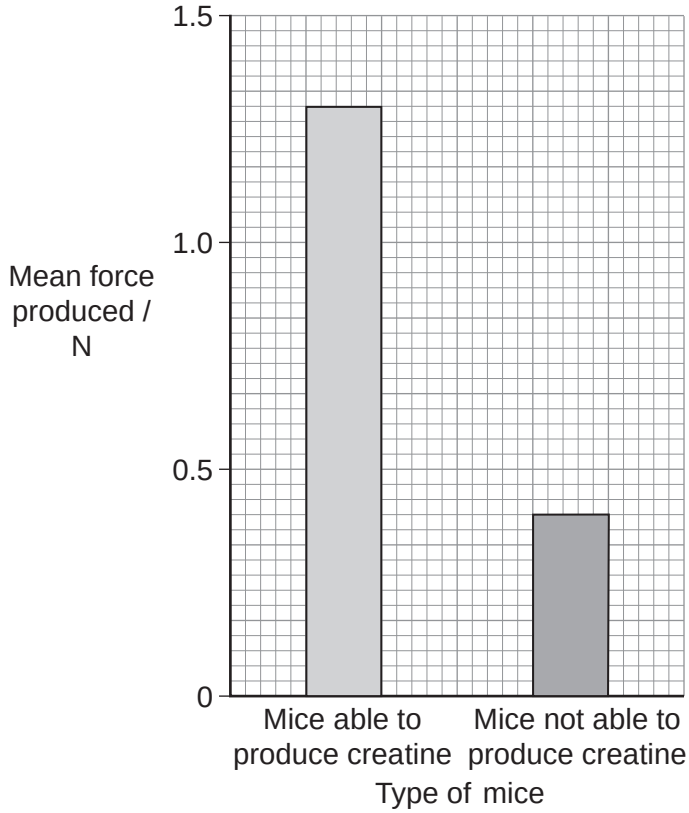
4 (a) What is the role of ATP in myofibril contraction?

[2 marks]

Scientists investigated the effect of not being able to produce creatine on the force produced by muscle. They used mice with a mutation that made them not able to produce creatine.
The force produced when these mice gripped with their paws was compared with the force produced by normal mice that were able to produce creatine.

Figure 3 shows the scientists' results.

Figure 3



Do not write outside the box

4 (b) (i) What was the percentage fall in the mean force produced by mice not able to produce creatine, compared with the normal mice? Show your working.

[2 marks]

Answer _____ %

4 (b) (ii) Suggest an explanation for these results.

[2 marks]

_____

_____

_____

_____

4 (c) The mice that were not able to produce creatine were homozygous for a recessive allele of a gene. Mice that are heterozygous for this allele are able to produce forces similar to those of normal mice that are homozygous for the dominant allele of the same gene.

Explain why the heterozygous mice can produce forces similar to those of normal mice.

[2 marks]

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8

Turn over for the next question

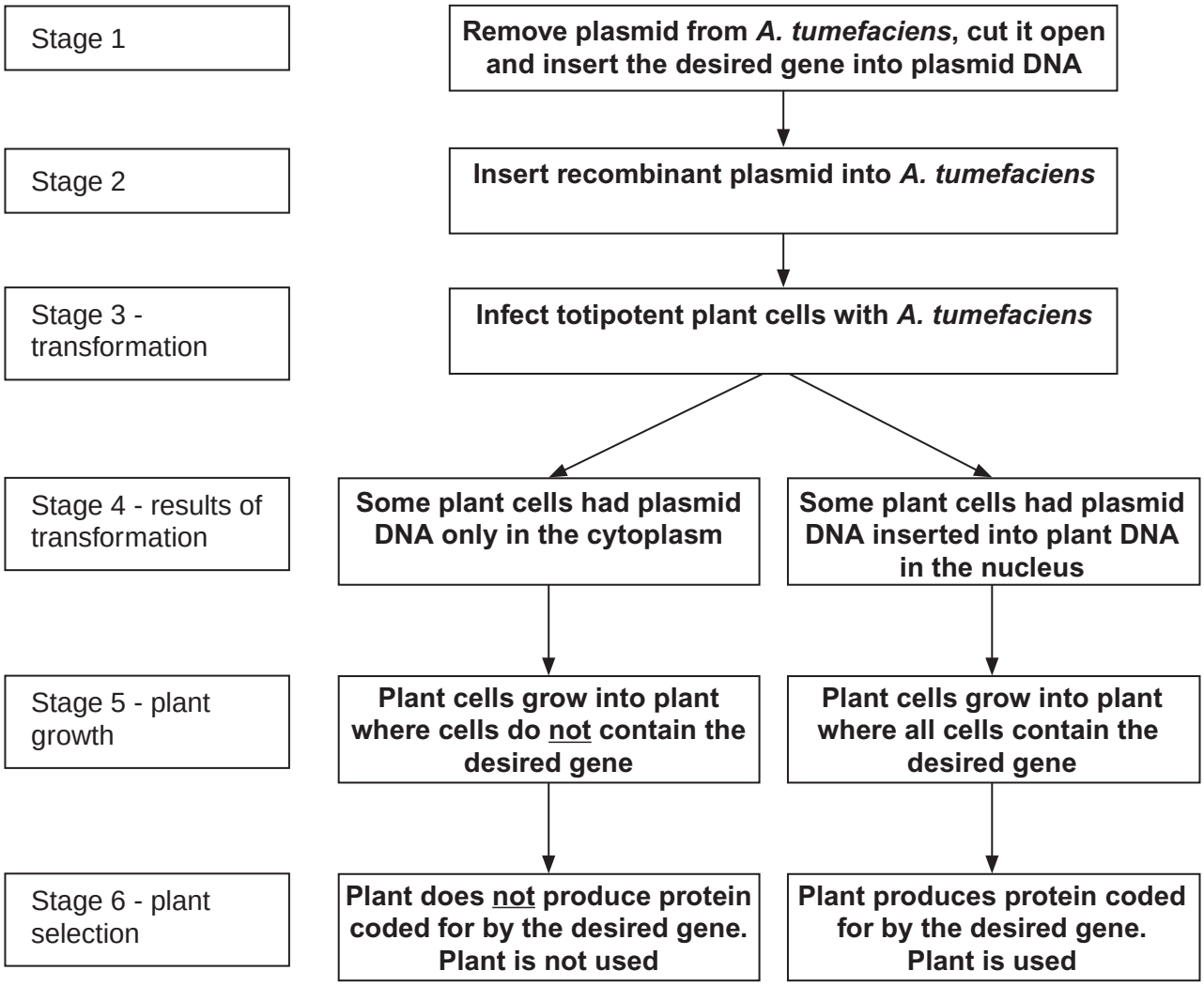
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5 *Agrobacterium tumefaciens* is a bacterium that is often used in recombinant DNA technology to produce transformed plants that benefit humans.

A. tumefaciens contains a plasmid which can be used as a vector to transfer a desired gene into plant cells. These plant cells may then develop into plants which produce the protein coded for by the desired gene.

Figure 4 outlines this process.

Figure 4



Do not write outside the box

5 (a) (i) In stage 1, an enzyme is used to cut open the plasmid.
Name the type of enzyme used to cut open the plasmid.

[1 mark]

5 (a) (ii) In stage 1, another enzyme is used to insert the desired gene into the plasmid DNA.
Name the type of enzyme used to insert the gene into the plasmid.

[1 mark]

5 (b) In stage 4, some plant cells had plasmid DNA only in their cytoplasm. In other plant cells, the plasmid DNA had become inserted into plant DNA in the nucleus.

In stage 5, only cells with plasmid DNA inserted into the plant DNA in the nucleus grew into plants where all the cells contained the desired gene.

Explain why some of the plants in stage 5 contained the desired gene in all of their cells and others did not.

[3 marks]

5 (c) The **desired gene** in **Figure 4** was from an insect. In stage 6, the plant containing this gene was able to use it to synthesise an insect protein.

The plant is able to synthesise the insect protein. Explain why this is possible.

[3 marks]

8

Do not write outside the box

6 (a) Give **two** ways in which people with type 1 diabetes control their blood glucose concentration.

[2 marks]

1 _____

_____

_____

2 _____

_____

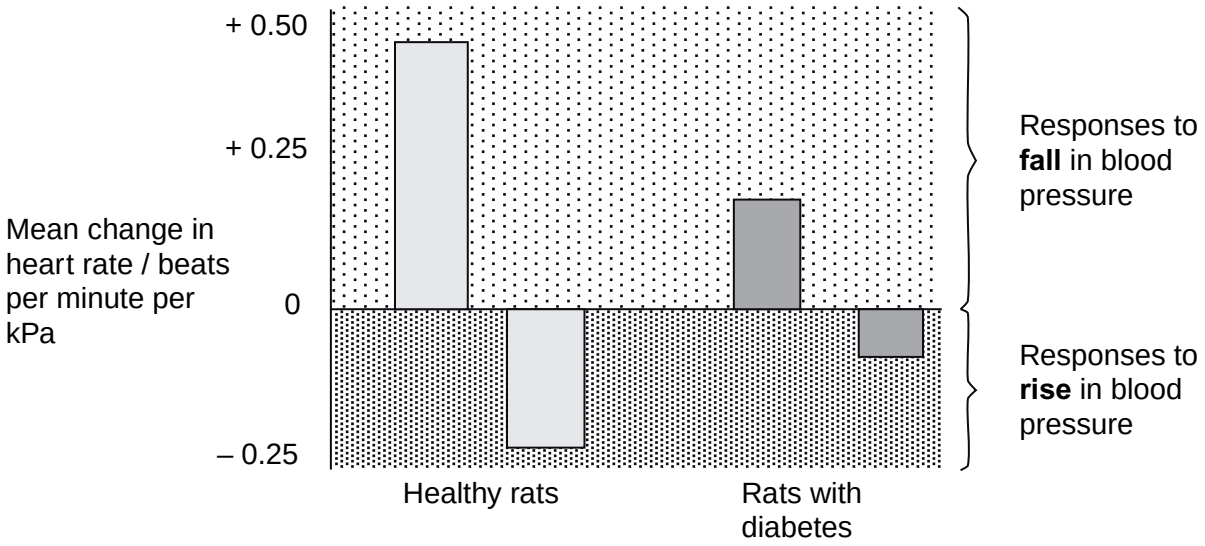
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6 (b) Scientists investigated the effect of diabetes on the control of heart rate in response to changes in blood pressure in rats.

The scientists found the mean changes in heart rates of healthy rats and rats with diabetes in response to rises or falls in blood pressure.

Figure 5 shows their results in the form they were presented.

Figure 5



Do not write outside the box

Diabetes can damage the nervous system. The response of the rats with diabetes is different from the response of the healthy rats. Use your knowledge of the control of heart rate by the nervous system to suggest an explanation for these results.

[4 marks]

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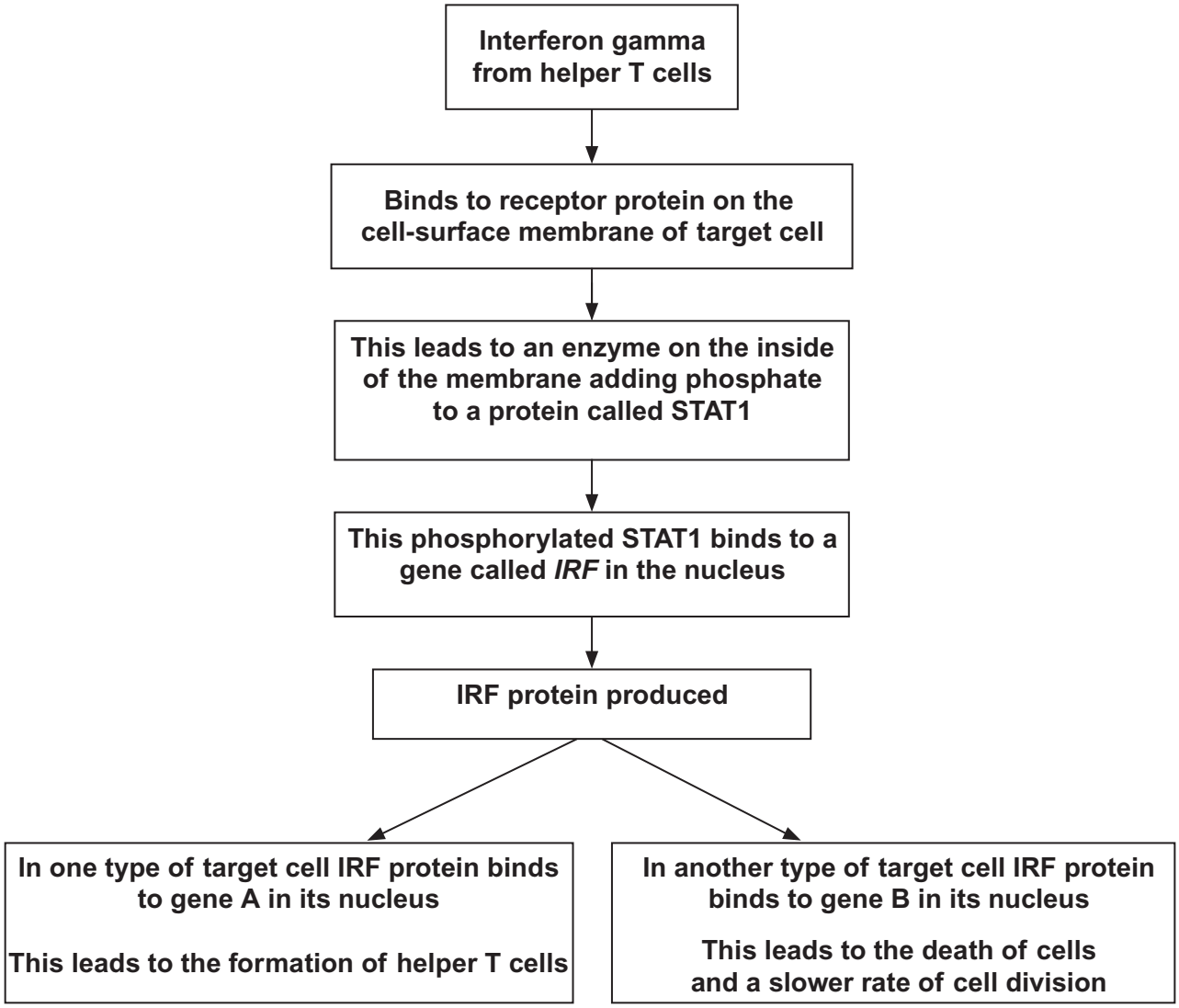
Turn over for the next question

Do not write outside the box

7 Interferon gamma is a substance secreted by some types of white blood cells, including helper T cells. It regulates the production of a number of proteins by target cells. Which protein is produced depends on the type of target cell.

Figure 6 shows how interferon gamma regulates three genes.

Figure 6



Do not write outside the box

7 (a) Use information in **Figure 6** to suggest how the binding of interferon gamma to its receptor protein leads to the production of phosphorylated STAT1.

[2 marks]

7 (b) Name the **two** transcription factors in **Figure 6**.

[2 marks]

1 _____

2 _____

7 (c) The regulation of the formation of helper T cells by interferon gamma is an example of positive feedback.

Explain why it is an example of positive feedback.

[2 marks]

7 (d) The *IRF* gene can be a tumour suppressor gene.

Use the information in **Figure 6** to explain how the *IRF* gene acts as a tumour suppressor gene.

[3 marks]

9

Do not write outside the box

8 *Mycobacterium tuberculosis* causes tuberculosis. The DNA of *M. tuberculosis* contains a direct repeat (DR) region. The DR region consists of 43 different, non-coding base sequences called spacers. Each spacer is found in a specific place in the DR region. In different strains of *M. tuberculosis*, some of these spacers have been lost.

8 (a) (i) The DR region consists of non-coding base sequences.

What is meant by a non-coding base sequence?

[1 mark]

_____

_____

8 (a) (ii) Name the process by which the base sequence of a spacer is lost from a DR region.

[1 mark]

_____

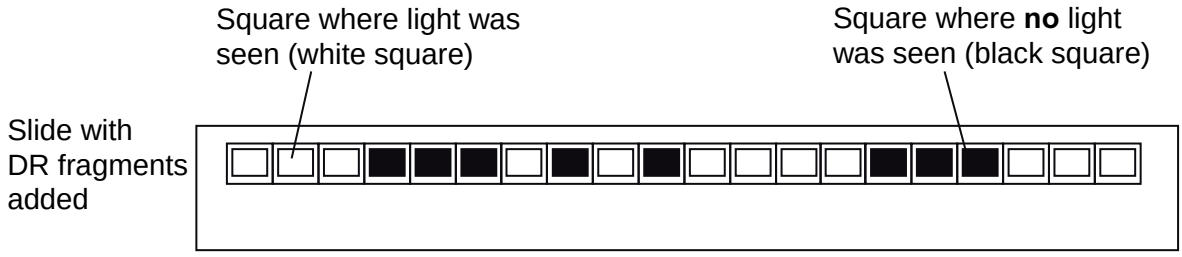
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Scientists investigated the DR regions of different strains of *M. tuberculosis*. They produced a DNA probe for each of the 43 spacer sequences. Each probe was:

- labelled with a fluorescent marker that gave off light if the probe attached to its complementary spacer
- attached to a particular square on a slide.

They obtained samples of the DR region from each strain. These were cut into small single-stranded DNA fragments. The fragments from each strain were added to a slide with the DNA probes attached. **Figure 7** shows their results for one strain of *M. tuberculosis* with 20 of the probes.

Figure 7



Do not write outside the box

8 (b) The scientists cloned the DR region DNA *in vitro* before testing for the presence of spacers.

Give the name of the method they used to clone the DNA *in vitro*.

[1 mark]

_____

8 (c) Explain how the use of DNA probes produced the results in **Figure 7**.

[3 marks]

_____

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8 (d) Doctors can use the method with DNA probes to identify the specific strain of *M. tuberculosis* infecting a patient. This is very important when there is an outbreak of a number of cases of tuberculosis in a city.

Suggest and explain why it is important to be able to identify the specific strain of *M. tuberculosis* infecting a patient.

[2 marks]

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8

Turn over for the next question

Do not write outside the box

9 Multiple sclerosis (MS) is a condition caused when the body's own immune system attacks the myelin sheath around axons. The cell bodies of the neurones themselves can also be damaged or destroyed. People with MS usually have periods of time when their MS gets no worse, followed by relapses when it gets worse.

Scientists investigated the effects on neurones of damage to myelin. The scientists obtained a modified antigen from the myelin sheath of humans and injected it into mice. After a number of days, this injection of antigen resulted in the myelin sheaths in the mice being damaged. Some cell bodies of neurones were also damaged.

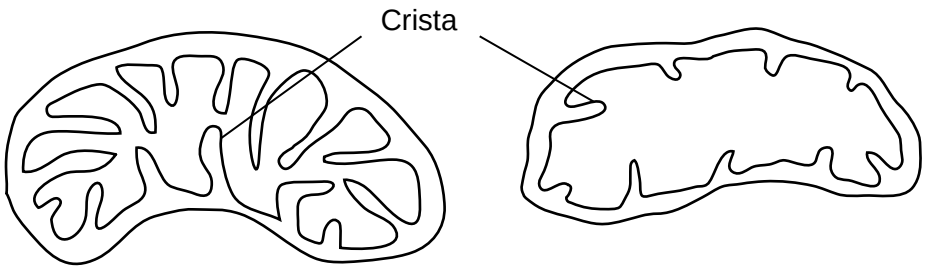
9 (a) Suggest how the injection of the antigen resulted in the myelin sheaths being damaged.

[3 marks]

9 (b) The scientists compared the ultrastructure of normal and damaged neurones. They found that damaged neurones contained many mitochondria with an unusual ultrastructure.

Figure 8 shows a mitochondrion with normal ultrastructure and one with the unusual ultrastructure.

Figure 8



Mitochondrion with normal ultrastructure

Mitochondrion with unusual ultrastructure

Do not write outside the box

Suggest why having a large number of mitochondria with this unusual ultrastructure could lead to neurones dying.

[3 marks]

9 (c) The scientists took a large number of photographs of thin sections through neurones. Using these photographs, they found that 40% of mitochondria had the unusual ultrastructure in damaged neurones.

9 (c) (i) What sort of microscope would the scientists use to take the photographs? Give **one** reason for your answer.

[1 mark]

Type of microscope _____

Reason _____

9 (c) (ii) Suggest how the scientists found the percentage of mitochondria with the unusual ultrastructure.

[3 marks]

Do not write outside the box

9 (d) Another group of scientists investigated the use of a drug called teriflunomide to treat MS. They recruited a large number of volunteers who had MS and divided them into three groups, **A**, **B** and **C**, at random. For each group, they recorded factors such as age, how many relapses they had and how long it was since they were diagnosed with MS.

9 (d) (i) Explain why the scientists made these comparisons.

[1 mark]

9 (d) (ii) Each group of volunteers was given a different treatment for 2 years. The treatment given to each group was as follows.

- **Group A** was given a placebo that contained no drug.
- **Group B** was given 7 mg of teriflunomide per day.
- **Group C** was given 14 mg of teriflunomide per day.

The scientists determined the mean number of relapses per person, per year for each group.

Table 1 shows their results.

Table 1

Group	**Mean number of relapses of MS per person per year (± 95% confidence limits)**
A (placebo)	0.55 (± 0.10)
B (7 mg teriflunomide)	0.37 (± 0.07)
C (14 mg teriflunomide)	0.36 (± 0.06)

Do not write outside the box

The scientists concluded that teriflunomide was effective in the treatment of MS.
Evaluate this conclusion.

[4 marks]

15

Turn over for the next question

Do not write outside the box

Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) The control of processes in cells and the importance of these controls.

[25 marks]

OR

10 (b) The importance of ions in biology.

[25 marks]

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END OF QUESTIONS

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AQA

A-LEVEL
Biology

BIOL5 – Control in cells and in organisms
Mark scheme

2410
June 2016

Version: 1.0 Final

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Question	Marking Guidance	Mark	Comments
1(a)(i)	C;	1	
1(a)(ii)	D;	1	
1(b)	(Synaptic) vesicles (only) found in presynaptic (part of synapse);	1	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);	1	Ignore competitive inhibitor Accept tertiary structure Reject active site Reject **same** shape as dopamine/as receptor
1(c)(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	2	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

Question	Marking Guidance	Mark	Comments
2(a)	1. (Maintain) optimum temperature for enzymes; 2. If temperature rises (above normal/optimum), enzyme activity falls; 3. If temperature falls (below normal), then low kinetic energy/fewer enzyme-substrate collisions; 4. Maintains (high) rate of (biochemical) reactions/metabolic rate/respiration;	3 max	2. Accept protein(s) denature 2 Accept denature 2 Accept high temperature 4 Requires idea of maintaining/keeping constant 4 Accept named process that is maintained at high rate 4 Requires idea of homeostasis, i.e. keeping a constant state
2(b)	1. Cooling causes more (electrical) activity (in neurones controlling BAT); 2. (More) heat from aerobic respiration (in BAT); 3. (Higher respiration) shown by increase in carbon dioxide production; 4. Heat from electron transfer chain / no (oxidative) phosphorylation; 5. Heat taken by blood to rest of body (raising core temperature);	4 max	Ignore any parts of answer that refer to warming of skin

Question	Marking Guidance	Mark	Comments
3(a)	9 (hours);; If multiply 75 by 0.11 and 0.23 but wrong answer, then 1 mark	2	Accept for **one** mark if multiply 75 by two wrong proportions near to 0.11 ± 0.01 and 0.23 ± 0.01 or multiply by the difference between the two (wrong) proportions
3(b)	(Yes because) 1. Both/Each species (mean) time spent looking around greater where many predators; 2. Differences (appear to be) significant because SDs do not overlap; (No because) 3. Wildebeest spend same (mean) time looking around where many predators as impalas where few predators; 4. Don't know what they are looking for (when heads up); 5. Habitats might be different in different areas (which could affect the behaviour);	4max	Accept 'mean proportion' means 'time' 1. Require idea of both, not just quoting numbers 2. This point must be in the context of point 1 2. Do not accept results significant 2. Accept 'because bars do not overlap' 2. Do not accept SE for SD 3 Accept overlap in SD as equivalent to same time 5. Ignore 'other factors' unqualified and discussions of experimental variables
3(c)	1. Less time spent feeding **OR** More energy lifting head/looking round; 2. (So) less food/biomass for respiration **OR** less energy for growth/reproduction/care of young; **OR** 3. Raising head makes them more visible to predators; 4. So more likely to be attacked/eaten/killed;	2	2. Accept any appropriate suggestion of less energy for something to do with life of the herbivore 2 Allow less food/biomass for growth/reproduction 2 Ignore references to energy for respiration

Question	Marking Guidance	Mark	Comments
4(a)	1. (Reaction with ATP) breaks/allows binding of myosin to actin/ actinomyosin bridge; 2. Provides energy to move myosin head;	2	1. Credit 'breaks' or 'allows' binding to actin (because cyclical) 2 Allow in context of 'power stroke' or 're-cocking' (because cyclical) 2. Ignore contraction on its own
4(b)(i)	Any value between 68.5 and 69.49 (%);; If get difference of 0.9 but calculation of percentage incorrect, then award 1 mark;	2	
4(b)(ii)	(Mutant mice) 1. Unable to make phosphocreatine/ less phosphate available to make/recycle ATP; 2. So less energy/so less ATP available for contraction/fast muscle fibres;	2	1 and 2. Reject production/creation of energy once 2. Accept less energy for grip 2. Accept no energy/no ATP for contraction/fast muscle fibres
4(c)	1. (Heterozygous) have one dominant/normal allele (for creatine production); 2. (This) leads to production of enough/normal amount of creatine;	2	1. Accept has one allele/one copy of the gene for/that is making creatine

Question	Marking Guidance	Mark	Comments
5(a)(i)	Restriction endonuclease;	1	
5(a)(ii)	(DNA) ligase;	1	
5(b)	(For those plants that contained the desired gene in the nucleus/plant DNA) 1. (DNA of desired gene) copied/replicated with host DNA/inside nucleus; 2. Passed on by mitosis/plant grows by mitosis; 3. Produces genetically identical cells/clones;	3	Ignore references to protein synthesis or plasmids not taking up the gene 1. Accept DNA replication during mitosis 1. and 2. Accept converse for plants with the gene in the cytoplasm 3. Neutral 'identical unqualified' 3. Accept description, e.g., DNA is the same
5(c)	1. Genetic code is universal/triplets in DNA always code for same amino acid; 2. It/insect DNA can be transcribed; 3. Can be translated (process/mechanism same in all organisms/cells);	3	2. Accept (basic) transcription (process/mechanism) same in all organisms/cells; 2. Accept descriptions of process 3. Accept descriptions of process

Question	Marking Guidance	Mark	Comments
6(a)	1. Treat with insulin (injection/infusion); 2. (Control) diet/control sugar intake;	2	 2. Accept '(regular) exercise'
6(b)	1. Damage to <u>autonomic</u> (nervous) system in diabetic rats; 2. (Could be) pressure receptors/baroreceptors (in arteries/aorta/carotid body) don't work as well; 3. Damage to medulla **OR** Change in (number of) impulses to/from medulla; 4. (When pressure drops damage to) sympathetic system, so doesn't speed up (enough); 5. (When pressure rises damage to) parasympathetic system, so doesn't slow down (enough);	4 max	Accept answers in terms of what happens in healthy rats **only** if then qualified by statement these things don't happen/happen less in rats with diabetes. 1. Accept damage to ANS 2. Ignore reference to chemoreceptors 4 and 5 appropriate system and effect on heart rate both needed

Question	Marking Guidance	Mark	Comments
7(a)	1. Binding (of interferon gamma) changes shape/tertiary structure of receptor (protein); 2. This activates/switches on the enzyme; 3. Use of ATP (to phosphorylate STAT1);	2 max	1. Accept reference to second messenger mechanism/process 3. Context is important
7(b)	1. Phosphorylated STAT1; 2. IRF (protein);	2	Accept in either order 1. Must be phosphorylated but accept STAT1P 2. Ignore references to phosphorylated
7(c)	1. Causes more helper T cells to form; 2. (So) more interferon (gamma) production (by helper T cells);	2	1. and 2. require idea of more
7(d)	1. (Tumour suppressor gene) slows cell division/causes death of damaged/tumour/cancer cells; 2. *IRF* gene leads to formation of IRF (protein) that binds to gene B; 3. (Gene B protein) causes death of damaged/mutated cells OR slows division;	3	2. 'It' means *IRF* gene 3. Context is important 3. If clearly stated **and** includes the protein, scores 2 marks because it subsumes point 1

Question	Marking Guidance	Mark	Comments
8(a)(i)	Does not code for amino acid/tRNA/rRNA;	1	Accept 'does not code for production of protein/polypeptide' Reject 'that produces/makes amino acid'
8(a)(ii)	Deletion mutation;	1	Accept 'deletion' Ignore references to splicing
8(b)	(The) polymerase chain reaction;	1	Accept PCR
8(c)	1. Probes are single stranded / have a specific base sequence; 2. Complementary base sequence on (specific) spacer **OR** 3. Complementary/specific to (particular) spacer; 4. (In white squares probe) binds (to single-stranded spacer) and glows/produces light/fluoresce;	3	2. Need idea of complementary to spacer 3. Accept converse for dark squares

8(d)	1. To see if strain is resistant to any antibiotics; 2. So can prescribe effective/right antibiotic; **OR** 3. To see whether (any) vaccine works against this strain/ see which vaccine to use/ to produce specific vaccine; 4. (So) can vaccinate potential contacts/to stop spread; **OR** 5. Can test other people to see if they have the same strain/ to trace where people caught TB; 6. Allowing control of spread of disease/vaccinate/treat contacts (of people with same strain) before they get TB;	2 max	Do not allow mix and match of points from different alternative pairs

Question	Marking Guidance	Mark	Comments
9(a)	1. Antigen stimulates immune response / activates B/T cells; 2. B/T cells divide OR antibodies produced; 3. Antibodies/T cells attack myelin sheaths;	3	Ignore references to antigen binding to myelin
9(b)	1. Fewer cristae/smaller surface area (of cristae); 2. So less electron transport/oxidative phosphorylation; 3. (So) not enough ATP produced **OR** Not enough energy to keep neurones alive;	3	1. Accept 'inner membrane' as 'cristae' 2. Accept fewer ATP synthase enzymes 2. Accept lower rate of electron transfer/oxidative phosphorylation 3. Accept less use/stimulation of neurone leads to death of cell 3. Accept no/less ATP produced/no energy to keep neurones alive 3. Ignore references to glycolysis/ Krebs cycle
9(c)(i)	(Transmission) electron (microscope) – **no mark** Need high resolution (to see structure of mitochondria)	1	Accept 'scanning electron microscope' /TEM/SEM Accept – optical microscope not high enough resolution
9(c)(ii)	1. Took photographs/areas at random; 2. Counted total number (of normal) and number of unusual mitochondria; 3. Divided number of unusual mitochondria by total number and multiply by 100;	3	1. Accept (very) large number of areas/photos/samples MP 3 = 2 marks (includes MP2)
9(d)(i)	1. To see if the groups were similar; 2. So these factors can be taken into account/ to look for correlations between these factors and MS/effect of drug; 3. To see the effect of the drug;	1 max	Ignore references to confounding variables

9(d)(ii)	1. Teriflunomide produces significant decrease in number of relapses per year (because confidence limits do not overlap with placebo); 2. 7 mg per day/(group) B as effective as 14 mg per day/(group) C (so don't need higher dose) **OR** Two groups/B and C not significantly different; 3. Still get relapses/ only reduces number of relapses/doesn't stop relapses, **OR** Doesn't cure MS; 4. Only 2 years, so results might not be representative / so not enough time to get reliable relapse mean/rate; OR All/placebo below 1 (relapse per year), so many had no relapses and can't tell whether drug worked or not; 5. Only one study, so results unreliable/not representative; **OR** Large sample size, so means/data reliable/representative;	4 max	Reject references to SE and SD once only Ignore 'results' significant/not significant

Question	Marking Guidance	Mark	Comments
10(a)	The control of processes in cells and the importance of these controls. **O** 3.1.3. and 3.2.4. Organelles and processes **T** 3.1.3. Transport across membranes 3.1.3. Cholera **I** 3.1.5. Immune response **M** 3.2.2. Meiosis **C** 3.2.5. Mitosis and cell cycle and DNA replication **Tr** 3.2.7. Passage of water through plant **E** 3.4.2. ATP 3.4.3. Photosynthesis 3.4.4. Respiration **G** 3.2.10. Antibiotics and genetic variation 3.4.8. Inheritance **N** 3.5.1. Receptors 3.5.2. Nerve impulses and synapses **Mc** 3.5.3. Muscle contraction **H** 3.5.4. Control of blood glucose concentration – hormones – plant growth substances **Cd** 3.2.6. Cell differentiation 3.5.6. Polypeptide synthesis and gene mutations **Gt** 3.5.7. Gene expression 3.5.8. Gene therapy	25	**H** If a candidate writes at great length about plant growth substances and hormones, then the topic can be split to allow more credit.

10(b)	The importance of ions in biology. **P** 3.1.3, 3.2.2. Phosphate in structure of phospholipids, structure of membranes, nucleotides, DNA and RNA **T** 3.1.3. Water potentials and osmosis, chloride ions and cholera 3.1.3. Co-transport involving sodium ions **H** 3.2.4. Haemoglobin and iron **Tr** 3.2.7. Passage of water through plants, symplast and root pressure **Ph** 3.4.1. ATP and ADP 3.4.3. Protons in photosynthesis, including reduced NADP and phosphorylated intermediates **R** 3.4.4. Protons in respiration, reduced NADS and FAD and phosphorylated intermediates 3.4.4. Glycolysis and lactate **F** 3.4.5. Use of (NPK) fertilisers 3.4.6. Nitrogen cycle **N** 3.5.1. Chemoreceptors, heart rate and Pacinian function 3.5.2. Nerve impulses and synapses **M** 3.5.3. Calcium ions and muscle contraction, and phosphate from ATP **G** 3.5.8. Genetic fingerprinting, electrophoresis	25	

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
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10	
TOTAL	

AQA

General Certificate of Education
Advanced Level Examination
June 2015

Biology BIOL5R

Unit 5 Control in cells and in organisms

Wednesday 17 June 2015 9.00 am to 11.15 am

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Time allowed
- 2 hours 15 minutes

R

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the boxes or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Advice
- You are advised to spend no longer than 40 minutes on the essay.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 (a) A sarcomere is made up of different molecules.
Complete **Table 1** by naming the molecule that carries out the function described.
[3 marks]

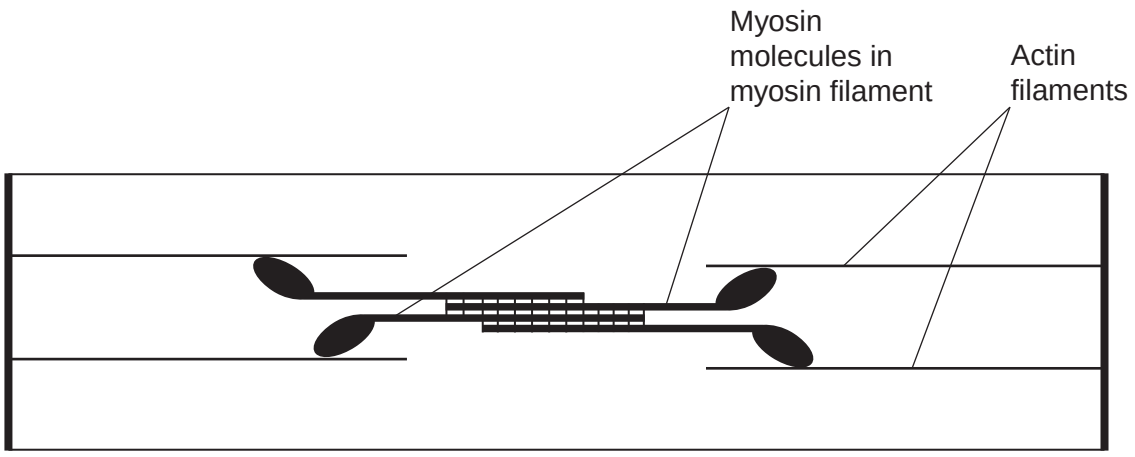
Table 1

Function	**Name**
Attaches to Z line at the end of the sarcomere	
Breaks down ATP	
Covers binding site on actin in relaxed myofibril	

Do not write outside the box

1 (b) The diagram in **Figure 1** shows the arrangement of actin and myosin in a sarcomere.

Figure 1



One form of muscle disease is caused by a mutated allele of a gene. This leads to production of myosin molecules that are unable to bind to other myosin molecules.

If myosin molecules are unable to bind to other myosin molecules, this prevents muscle contraction.
Use **Figure 1** and your knowledge of how muscles contract to suggest why.

[3 marks]

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2 (a) Describe how LH is involved in the control of the mammalian oestrous cycle.

[2 marks]

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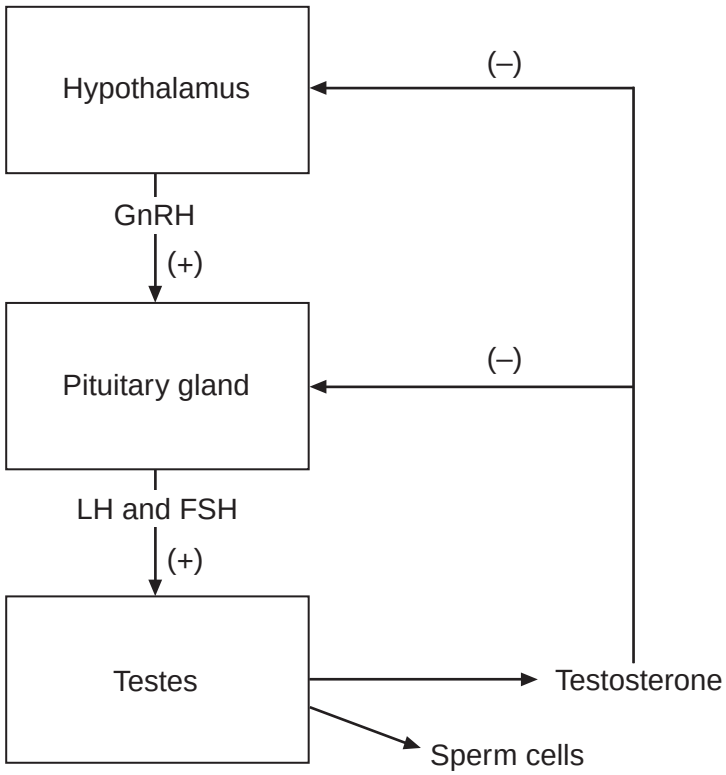
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Testosterone is a hormone produced by male testes.

Figure 2 shows the system controlling the concentration of testosterone in a man's body.

Figure 2



Do not write outside the box

2 (b) If the concentration of testosterone in a man's blood starts to rise above normal, this system leads to a reduction in testosterone.

Use **Figure 2** to explain how.

[3 marks]

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2 (c) There have been trials with a male contraceptive pill that prevents a man producing sperm cells. This pill contains testosterone and is taken each day.

Use **Figure 2** to explain how this contraceptive pill prevents a man producing sperm cells.

[2 marks]

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7

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ANSWER IN THE SPACES PROVIDED

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3 (a) (i) A mutation of a tumour suppressor gene can result in the formation of a tumour.

Explain how.

[2 marks]

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3 (a) (ii) Not all mutations result in a change to the amino acid sequence of the encoded polypeptide.

Explain why.

[1 mark]

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3 (b) Some cancer cells have a receptor protein in their cell-surface membrane that binds to a hormone called **growth factor**. This stimulates the cancer cells to divide.

Scientists have produced a monoclonal antibody that stops this stimulation.

Use your knowledge of monoclonal antibodies to suggest how this antibody stops the growth of a tumour.

[3 marks]

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4 Second-hand smoking (SHS) occurs when people breathe in air containing tobacco smoke. Scientists investigated the effect of SHS on expression of a specific gene. Expression of this gene prevents or reduces the risk of allergic reactions.

They recruited a large number of school students who were non-smokers.
For each student, they determined:

- whether the student's parents were smokers
- the amount of expression of this specific gene.

The scientists' results are shown in **Table 2**, in the form in which they were presented.

Table 2

	Mean amount of expression of gene / arbitrary units (± standard error)
School students whose parents smoke	4.80 (± 0.09)
School students whose parents do not smoke	7.20 (± 0.08)

4 (a) The data about parents' smoking habits were obtained using a questionnaire.

Suggest **two** ways in which the use of a questionnaire may have affected the reliability of these data.

[2 marks]

1 .....

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4 (b) The scientists concluded that smoking by parents increases the risk of allergic reactions in their children.

Use the information provided to explain how these data support their conclusion.

[3 marks]

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4 (c) For each student, the scientists also determined how much methylation was present within the specific gene. DNA methylation is the attachment of substances called methyl groups to cytosine or adenine. This prevents transcription.

Suggest how methylation of DNA can prevent expression of a gene.

[3 marks]

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ANSWER IN THE SPACES PROVIDED

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5 (a) Describe how a Pacinian corpuscle produces a generator potential when stimulated.

[3 marks]

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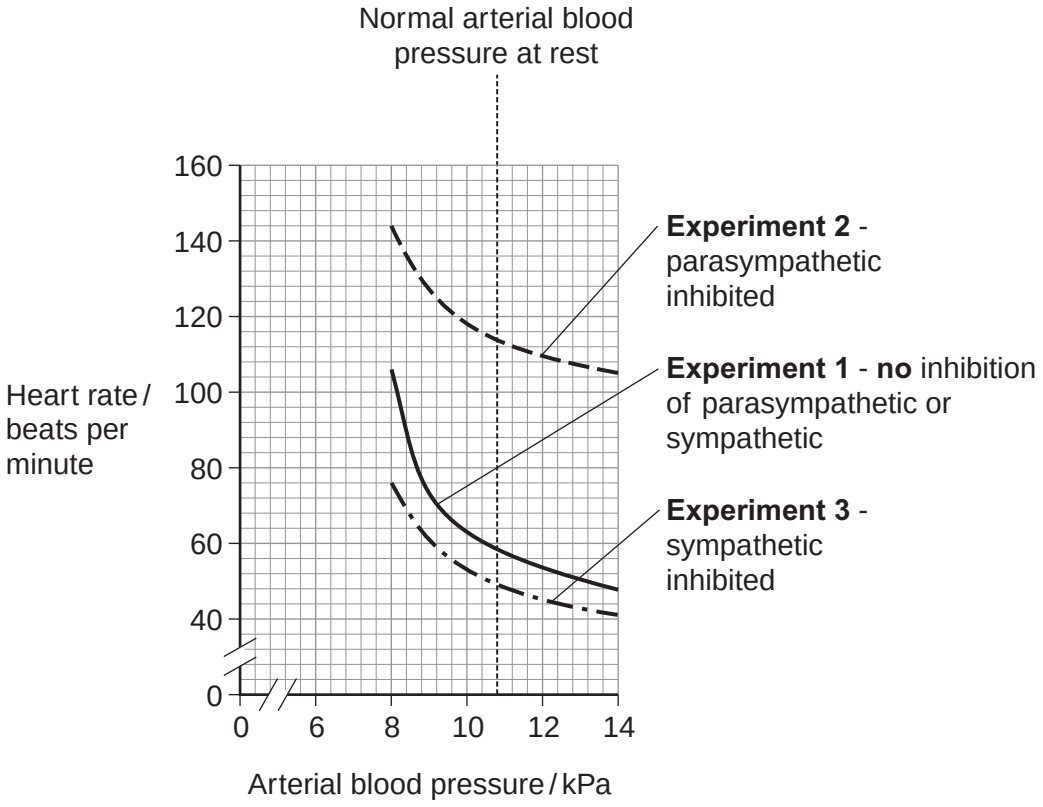
Question 5 continues on the next page

Doctors investigated the relationship between heart rate and arterial blood pressure. They recruited healthy volunteers. For each volunteer, they recorded their normal arterial blood pressure at rest. With each volunteer, they then carried out the following experiments.

Experiment 1 They recorded heart rate at different blood pressures.
Experiment 2 They repeated **experiment 1** after injecting a drug that inhibited the parasympathetic nervous system.
Experiment 3 They repeated **experiment 1** after injecting a drug that inhibited the sympathetic nervous system.

Figure 3 shows the results for one volunteer.

Figure 3



Do not write outside the box

5 (b) Calculate the ratio of heart rate in **experiment 2** to heart rate in **experiment 3** at an arterial blood pressure of 10 kPa.
Show your working.

[2 marks]

Answer = ...

5 (c) What do these data suggest about the control of heart rate by the parasympathetic and sympathetic nervous systems in response to changes in arterial blood pressure?

[3 marks]

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6 Multiple sclerosis (MS) is a disease that involves damage to the myelin sheaths of neurones. Movement in MS sufferers may be jerky or slow.

6 (a) Damage to the myelin sheaths of neurones can lead to problems controlling the contraction of muscles.

Suggest **one** reason why.

[2 marks]

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Scientists investigated the use of substances called cannabinoids to control muscle problems caused by MS.

6 (b) Cannabinoids are hydrophobic molecules. In the body, they easily pass into neurones. Explain why.

[1 mark]

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Do not write outside the box

6 (c) Cannabinoid receptors are found in the **pre-synaptic** membrane of neuromuscular junctions. When a cannabinoid binds to its receptor, it closes calcium ion channels.

Suggest how cannabinoids could prevent muscle contraction.

[4 marks]

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6 (d) Cannabinoids include substances found in cannabis that can enter brain tissue. Scientists are developing artificial cannabinoids that can enter neuromuscular junctions but cannot enter brain tissue.

Suggest why these artificial cannabinoids would be better to use than cannabis when treating someone with MS.

[2 marks]

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[Extra space] .....

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7 (a) Give **one** similarity and **one** difference between a taxis and a tropism.

[2 marks]

Similarity .....

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Difference .....

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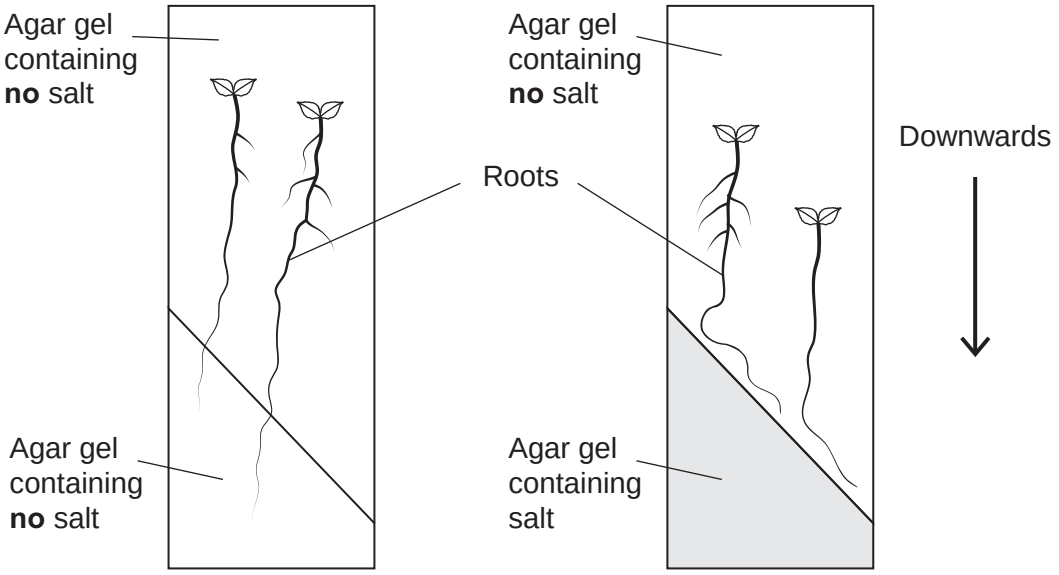
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Scientists investigated tropisms in the roots of tomato plants. They grew tomato plants from seeds on vertical agar plates, as shown in **Figure 4**. The top of each plate was made of agar gel containing **no** salt. The bottom of each plate was made of one of the following:

- agar gel containing **no** salt
- agar gel containing salt.

Typical results for growth of the roots are shown in **Figure 4**.

Figure 4



Do not write outside the box

7 (b) What do these results show about the responses of the roots of tomato plants to gravity and salt?

[3 marks]

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Question 7 continues on the next page

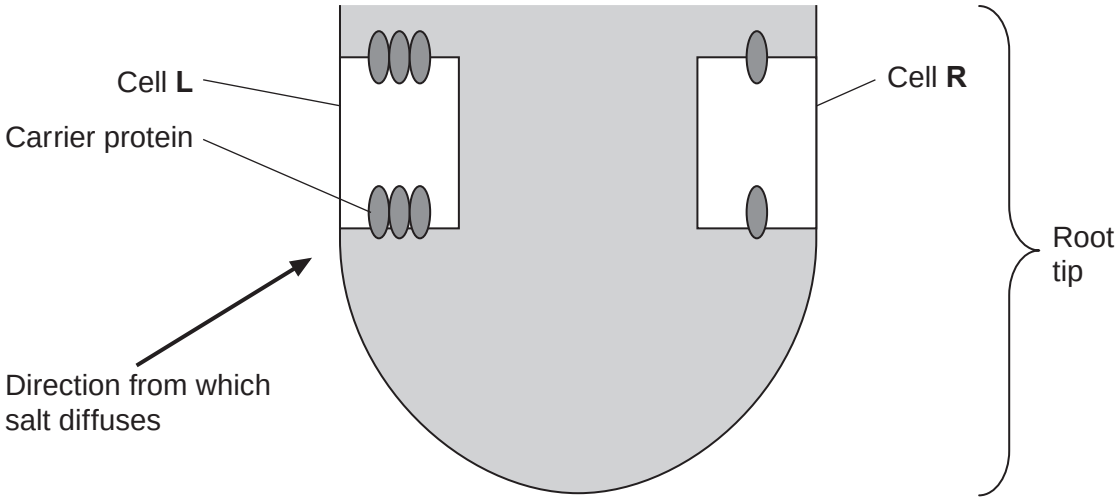
Do not write outside the box

7 (c) In root tips of tomatoes, IAA is transported **out** of the cells by a carrier protein. In roots of tomatoes, high concentrations of IAA inhibit cell elongation.

The scientists' hypothesis was that salt causes a change in the number of IAA carrier proteins in cells in different parts of the root tip.

Figure 5 shows two cells, **L** and **R**, in the root tip of a tomato plant.

Figure 5



Explain why this root tip would grow away from salt.

[3 marks]

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8 Scientists investigated the control of blood glucose concentration in mice. They kept a group of normal mice without food for 48 hours. After 48 hours, the blood glucose concentrations of the mice were the same as at the start of the experiment.

8 (a) Explain how the normal mice prevented their blood glucose concentration falling when they had **not** eaten for 48 hours.

[3 marks]

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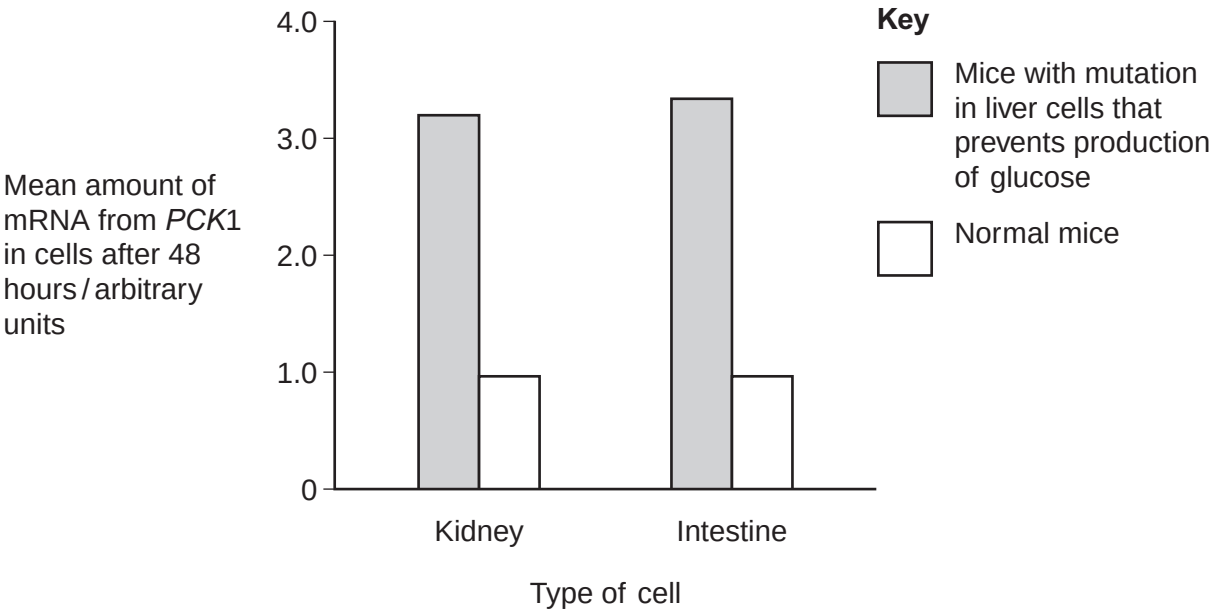
Question 8 continues on the next page

The scientists then investigated mice with a mutation that prevents their liver cells making glucose. They kept a group of these mice without food for 48 hours. After 48 hours, the mean blood glucose concentrations of the mutant mice and the normal mice were the same.

The scientists investigated how blood glucose concentration is controlled in these mutant mice. An enzyme required for synthesis of glucose is coded for by a gene called *PCK*1. The scientists measured the mean amount of mRNA produced from this gene in cells from the kidneys and intestines of normal mice and mutant mice.
They did this with mice that had previously been without food for 48 hours.

Figure 6 shows the scientists' results.

Figure 6



Do not write outside the box

8 (b) Use information from **Figure 6** to suggest how blood glucose concentration is controlled in the mutant mice, compared with the normal mice.

[3 marks]

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8 (c) The scientists performed statistical tests on the data shown in **Figure 6**, to see whether the differences in the amount of mRNA in cells from normal and mutant mice were significant. Both the probability values they obtained were $p<0.01$.

Explain what this means about the differences in the amounts of mRNA produced.

[2 marks]

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9 Some populations of flies are becoming resistant to insecticides intended to kill them.

Scientists developed a method for finding out whether a fly was carrying a recessive allele, **r**, that gives resistance to an insecticide. The dominant allele, **R**, of this gene does not give resistance.

The scientists:
- crossed flies with genotype **RR** with flies with genotype **rr**
- obtained DNA samples from the parents and offspring
- used the same restriction endonuclease enzymes on each sample, to obtain DNA fragments.

9 (a) Explain why the scientists used the same restriction endonuclease enzymes on each DNA sample.

[2 marks]

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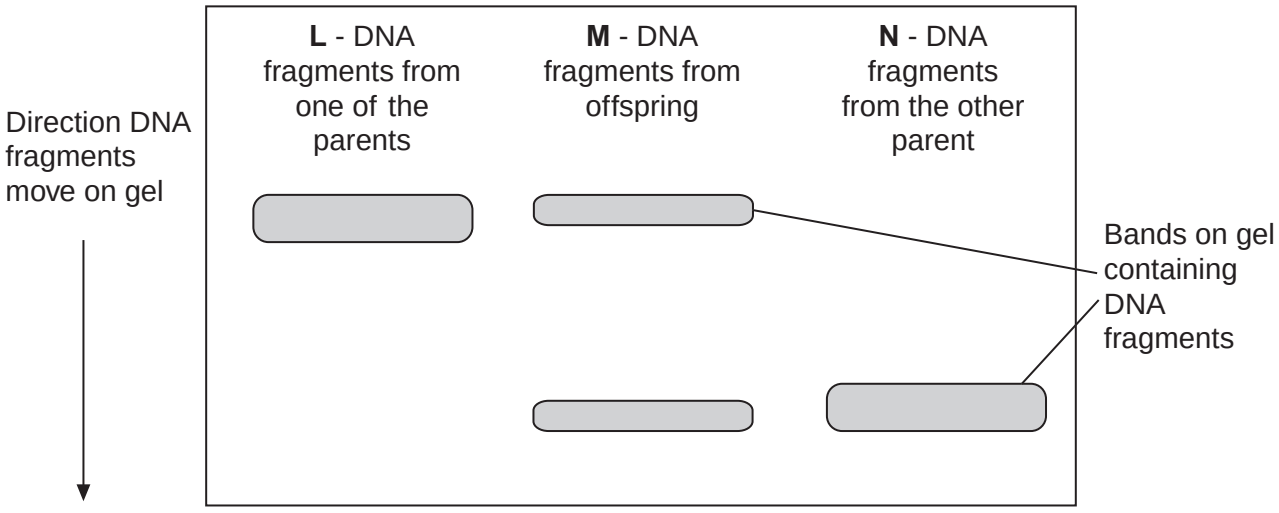
The scientists added two different primers to each sample of DNA fragments for the polymerase chain reaction (PCR).

- Primer A3 only binds to a 195 base-pair fragment from allele **r**.
- Primer A4 only binds to a 135 base-pair fragment from allele **R**.

The scientists separated the DNA fragments produced by the PCR on a gel where shorter fragments move further in a given time.

Their results are shown in **Figure 7**.

Figure 7



Do not write outside the box

9 (b) Explain why primer A3 and primer A4 only bind to specific DNA fragments.

[2 marks]

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9 (c) Use all the information given to explain the results in **Figure 7**.

[3 marks]

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9 (d) The scientists wanted to know on which chromosome the gene with alleles **R** and **r** was located. From the flies with genotype **RR**, they obtained cells that were in mitosis and added a labelled DNA probe specific for allele **R**. They then looked at the cells under an optical microscope.

Explain why they used cells that were in mitosis.

[2 marks]

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Question 9 continues on the next page

9 (e) Another group of scientists thought that pesticide resistance in some flies was related to increased activity of an enzyme called P450 monooxygenase (PM).
This enzyme breaks down insecticides.

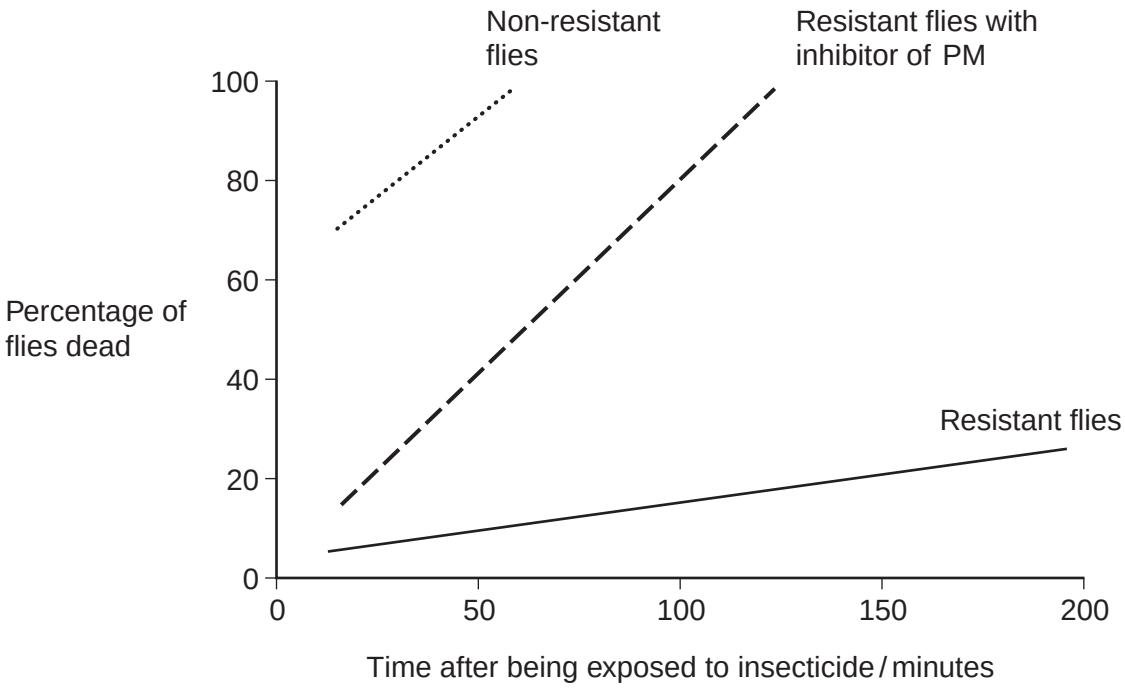
The scientists obtained large numbers of resistant and non-resistant flies. They then set up the following experiments.

- Non-resistant flies exposed to insecticide.
- Resistant flies exposed to insecticide.
- Resistant flies treated with an inhibitor of PM and then exposed to insecticide.

They then determined the percentage of flies that were dead at different times after being exposed to insecticide.

Figure 8 shows their results.

Figure 8



9 (e) (i) Explain why the scientists carried out the control experiment with the non-resistant flies.
[2 marks]

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Do not write outside the box

9 (e) (ii) The scientists concluded that the resistance of the flies to the insecticide is partly due to increased activity of PM but other factors are also involved.

Explain how these data support this conclusion.

[4 marks]

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Turn over for the next question

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Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) The importance of responses to changes in the internal and external environment of an organism.

[25 marks]

OR

10 (b) The importance to humans of the control of growth, reproduction and development of organisms, including themselves.

[25 marks]

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END OF QUESTIONS

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A- LEVEL

Biology

BIOL5R – Control in cells and in organisms
Mark scheme

2410
June 2015

Version: 1 Final Mark Scheme

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from aqa.org.uk

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<table>
<tr><th>Question</th><th>Marking Guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th>Function</th><th>Name</th></tr>
<tr><td>Attaches to Z line at the end of the sarcomere</td><td>1. Actin;</td></tr>
<tr><td>Breaks down ATP</td><td>2. ATPase / myosin (head);</td></tr>
<tr><td>Covers binding site on actin in relaxed myofibril</td><td>3. Tropomyosin;</td></tr>
</table>
</td><td>3</td><td>2. Accept water

3. Accept troponin</td></tr>
<tr><td>1(b)</td><td>1. Can’t form myosin/thick filaments;
2. Can’t pull/can’t move actin/slide actin past / (myosin) have to be joined/fixed to pull actin;
3. Myosin moves /if attached doesn’t move;
4. Can’t move actin towards each other/middle of sarcomere/between myosin/
can’t shorten sarcomere/can’t pull Z lines together;</td><td>3</td><td>Neutral: prevents actin and myosin sliding filament action
2. Accept: myosin can’t pull on each other

4. Accept: contract for shorten</td></tr>
</table>

Question	Marking Guidance	Mark	Comments
2(a)	1. Stimulates/causes ovulation/ /(secondary) oocyte(s); 2. Stimulates/causes formation of corpus luteum; 3. Stimulates/leads to production/release of oestrogen/progesterone;	2	1. Accept release of egg/ovum 1. Ignore references to follicle 3. Ignore: references to testosterone
2(b)	1. Inhibition of hypothalamus **so** less GnRH; 2. Inhibition of pituitary/less GnRH **so** less LH and FSH; 3. So no stimulation of testes to make testosterone;	3	Ignore references to negative feedback 1 and 2 must include all the statement 1 and 2 Accept none = less
2(c)	1. Keeps/makes/causes high testosterone; 2. So (keeps) inhibition of GnRH/LH/FSH;	2	1. Must have idea of high or higher 2. Accept: inhibits hypothalamus/pituitary gland 2. Accept less/no GnRH/LH/FSH

Question	Marking Guidance	Mark	Comments
3(a)(i)	1. (Tumour suppressor) gene inactivated/not able to control/slow down cell division; 2. Rate of cell division too fast/out of control ;	2	Ignore: references to growth 1 and 2 Accept: mitosis 1 and 2 Reject: meiosis
3(a)(ii)	1. (Genetic) code degenerate; 2. Mutation in intron;	1 max	1. Accept: codon for triplet 1. Accept description of degenerate code, e.g. another triplet codes for the same amino acid 2. Accept: mutation in non-coding DNA
3(b)	1. Antibody has specific tertiary structure/binding site/variable region; 2. Complementary (shape/fit) to receptor protein/GF/ binds to receptor protein/to GF; 3. Prevents GF binding (to receptor);	3	Do not accept explanations involving undefined antigen 2. Ignore: same shape as receptor protein/GF

Question	Marking Guidance	Mark	Comments
4(a)	Two suitable suggestions;; E.g. Parents/students might lie (about smoking)/don't know how much parents smoke / don't know what parents smoke / don't know strength of cigarettes parents smoke	2 max	Ignore: unqualified reference to bias / reference to sample size/ only one study/ not completing form correctly
4(b)	1. Children of parents who smoke likely to be/are exposed to more SHS/ have less expression of gene; 2. (Less expression of gene means) more likely to have allergic reaction; 3. Significant difference because SEs (or 2 × SE) do not overlap; 4. Large sample size, so data reliable;	3 max	1. Accept converse for parents who do not smoke Ignore: references to correlation and causation 3. Reject: results significant 3. Ignore: ref. to SDs
4(c)	1. Prevent binding of transcription factor; 2. Prevents RNA polymerase binding/working; 3. Prevents complementary/specific base-pairing; 4. (No transcription, so) no (pre)mRNA made; 5. No/less translation (of mRNA);	3 max	2. Ignore: references to polymerase bringing in complementary bases 3. Accept descriptions of base pairing – A with U or C with G 3. Accept complementary nucleotides 5. Accept description of translation/no protein synthesis

Question	Marking Guidance	Mark	Comments
5(a)	1. (Increased pressure) deforms/changes stretch-mediated sodium (ion) channel; 2. (Sodium channels open and) sodium ions flow in; 3. Depolarisation (leading to generator potential);	3	2. Accept Na^+ 3. Accept correct description of depolarisation
5(b)	Value between 2.17:1 and 2.29:1;; Values between 117 to 119 and between 52 to 54 found but ratio wrong way round = 1 mark	2	Accept rounding up to 2.2 or 2.3 Accept: number without : 1 Correct working showing answer but incorrect rounding in answer line = 1 Wrong way round gives answer between 0.35:1 and 0.46:1
5(c)	1. Parasympathetic greater effect than sympathetic; 2. Parasympathetic keeps heart rate down/lower/decreases heart rate (as blood pressure increases); 3. Sympathetic keeps heart rate up/higher/increases heart rate (as blood pressure increases); 4. Parasympathetic greatest/greater effect at high blood pressure/sympathetic greatest effect at low blood pressure;	3 max	Ignore: descriptions of graph 2. and 3. Accept converse for blood pressure decreases

Question	Marking Guidance	Mark	Comments
6(a)	One suitable suggestion; explained; Eg 1. Action potentials travel more slowly/don't travel; 2. So delay in muscle contraction/muscles don't contract/muscles contract slow(er); ***OR*** 3. Action potentials/depolarisation 'leaks' to adjacent neurones; 4. So wrong muscle (fibres) contract;	2 max	1. Accept: fewer/no saltatory movement of potentials 3. Accept: neurones not insulated
6(b)	Lipid-soluble / pass through phospholipid bilayer;	1	Not just 'pass through membranes'
6(c)	1. Prevents influx of calcium <u>ions</u> (into pre-synaptic membrane); 2. (Synaptic) vesicles don't fuse with membrane / vesicles don't release neurotransmitter; 3. Neurotransmitter does not diffuse across synapse/does not bind to receptors (on 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>;	4	1. Need idea of <u>moving into</u> pre-synaptic membrane/synaptic knob 1. Accept Ca^{++}/Ca^{2+} 2. Accept vesicles don't release acetylcholine 3. Accept: sarcolemma/muscle membrane for post-synaptic membrane 4. Accept Na^{+} 4. Accept prevents depolarisation of muscle cell Ignore: descriptions of events at post-synaptic membrane involving calcium ions and muscle contraction
6(d)	1. They won't affect synapses in brain; 2. They won't cause problems with the brain's function/won't damage brain; 3. (So only the) muscle/neuromuscular junctions treated/affected;	2 max	2. Accept: suitable named problem e.g. hallucination 2. Ignore: unqualified references to 'side effects' 2. Accept: reference to addiction/harm of smoking (cannabis)

Question	Marking Guidance	Mark	Comments
7(a)	1. Similarity – directional response (to a stimulus)/movement towards/away from a stimulus; 2. Difference – taxis (whole) organism moves and tropism a growth (response);	2	2. Must be clear which one, taxis or tropism, they are referring to 2. Taxis occurs in animals/motile organisms and tropism occurs in plants
7(b)	1. Grow in direction of/towards (pull of) gravity; 2. Grow away from salt; 3. Salt has more effect (than gravity);	3	Accept: tropism for growth Ignore: pulled by gravity 1. Accept: positively geotropic/gravitropic 2. Accept: negatively chemotropic/halotropic 1 and 2. Ignore: references to bends/moves 3. Accept: converse statement for gravity Note: all three points may appear in one sentence
7(c)	1. More carriers in (cell) **L**/lower in **R**; 2. (So) less IAA in (cell) **L**/more IAA in (cell) **R**; 3. (So) more (elongation) growth in **L**/less (elongation) growth in **R**;	3	Accept: left for **L** and right for **R**/side nearer salt for **L** 2. Accept: more IAA moves out of **L**/less IAA moves out of **R** 3. Accept: less inhibition of growth in **L**/more inhibition of growth in **R**;

Question	Marking Guidance	Mark	Comments
8(a)	1. Release of glucagon; 2. Leads to formation of glucose in liver (cells); 3. From non-carbohydrates/amino acids/fatty acids;	3	2. Reject: glucagon breaks down glycogen, or any other biological molecule 3. Accept: gluconeogenesis/references to glycogen as source of glucose
8(b)	1. Mutant mice (mRNA suggests) make a lot of (the) enzyme; 2. Mutant mice use kidney/intestine (cells) to make glucose; 3. Normal mice do this much less/normal mice use liver cells;	3	1. Accept: PCK1 made (for enzyme made) 2. Accept: use other organ (than liver)
8(c)	1. Differences significant; 2. Probability of difference being due to chance <u>less than</u> 0.01/1%/1 in 100 / probability of difference not being due to chance <u>more than</u> 0.99/99%/99 in 100;	2	Reject: references to results being significant once 2. Ignore: references to 0.05/5%/5 in 100

Question	Marking Guidance	Mark	Comments
9(a)	1. Cut (DNA) at same (base) sequence/(recognition) sequence; 2. (So) get (fragments with gene) **R**/required gene;	2	1. Accept: cut DNA at same place 2. Accept: 'allele' for 'gene'/same gene
9(b)	1. Each has/they have a specific base sequence; 2. That is complementary (to allele r or R);	2	2. Accept description of 'complementary'
9(c)	1. Fragments L from parent rr, because all longer fragments/195 base pair fragments; 2. Fragments N from parent RR, because all shorter fragments/135 base pair fragments; 3. (M from) offspring heterozygous/Rr/ have both 195 and 135 base pair fragments;	3	Ignore: references to fragments that move further/less, require identification of longer/shorter or 195/135 1 and 2 Accept: A3 for 195 and A4 for 135 1. Accept: (homozygous) recessive 2. Accept: (homozygous) dominant 3. Accept: have both bands/strips Reject: primer longer/shorter
9(d)	1. (Cells in mitosis) chromosomes visible; 2. (So) can see which chromosome DNA probe attached to;	2	

9(e)(i)	1. For comparison with resistant flies/other (two) experiments/groups; 2. To see death rate (in non-resistant)/ to see effect of insecticide in non-resistant/normal flies;	2	1. Ignore: compare results/data/no other factors Accept: 'pesticide' as 'insecticide' 2. Accept to see that insecticide worked/to see effect of enzyme

9(e)(ii)	(PM must be involved because) 1. Few resistant flies die (without inhibitor); 2. More inhibited flies die than resistant flies; 3. (PM) inhibited flies die faster (than resistant flies); (Other factors must be involved because) 4. Some resistant flies die; 5. But (with inhibitor) still have greater resistance/die slower than non-resistant flies;	4 max	5. Accept: (with inhibitor) die slower than non-resistant flies

Question	Marking Guidance	Mark	Comments
10(a)	10 (a) The importance of responses to changes in the internal and external environment of an organism. *Topic areas* **T -** 3.1.3 Transport in and out of cells (of specific substances) **I -** 3.1.6 Immune response **Hb -** 3.2.4 Haemoglobin **Tr -** 3.2.7 Transpiration – response to environmental factors – gas exchange in plants **B -** 3.2.9 Behaviour **A -** 3.2.10 Adaptation and selection **P -** 3.4.8 Changes in populations – selection pressures **R -** 3.5.1 Responses to stimuli – plants and tropisms – control of heart rate **Tk -** 3.5.1 Taxes and kineses **Rc -** 3.5.1 Receptors **H** – 3.5.2 Control of Heart Rate **Sn -** 3.5.1 and 2 Simple reflexes and neurones and synapses **Hr -** 3.5.2 and 5.4 Hormones and responses **C** – 3.5.2 Chemical mediators **Ho -** 3.5.4 Homeostasis – response to changes in internal environment **F -** 3.5.5 Feedback **G -** 3.5.7 Gene expression as part of response	25	

Question	Marking Guidance	Mark	Comments
10(b)	10 (b) The importance to humans of the control of growth, reproduction and development of organisms, including themselves. *Topic areas* **A -** 3.1.1 Pathogens (and invasion of human tissues) and 3.2.10 Antibiotic resistance – control of bacterial growth **Ch -** 3.1.3 Cholera **I -** 3.1.6 Immune response and vaccination (to control growth of pathogens) **B -** 3.2.11 Human influence on biodiversity **Hp -** 3.4.1 Human populations **Hf -** 3.4.5 Humans and farming practices – and 3.2.3 selective breeding **F -** 3.4.6 Use of fertilisers and pesticides **S -** 3.4.7 Succession – control of **G -** 3.4.8 Genetics – prediction of inherited conditions **Ge -** 3.5.7 Control of gene expression – stem cells **C -** 3.5.7 Regulation of gene expression – prevention, treatment and cure of cancer – and 3.2.5 Mitosis and cancer **Gc -** 3.5.8 Gene cloning and transfer **Gt -** 3.5.8 Gene therapy	25	

Centre Number						Candidate Number				
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Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
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TOTAL	

General Certificate of Education
Advanced Level Examination
June 2014

Biology BIOL5

Unit 5 Control in cells and in organisms

Friday 20 June 2014 9.00 am to 11.15 am

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Time allowed
- 2 hours 15 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the boxes or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Advice
- You are advised to spend no longer than 40 minutes on the essay.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 (a) (i) Why is the genetic code described as being universal?

[1 mark]

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1 (a) (ii) The genetic code uses four different DNA bases. What is the maximum number of different DNA triplets that can be made using these four bases?

[1 mark]

Transcription of a gene produces pre-mRNA.

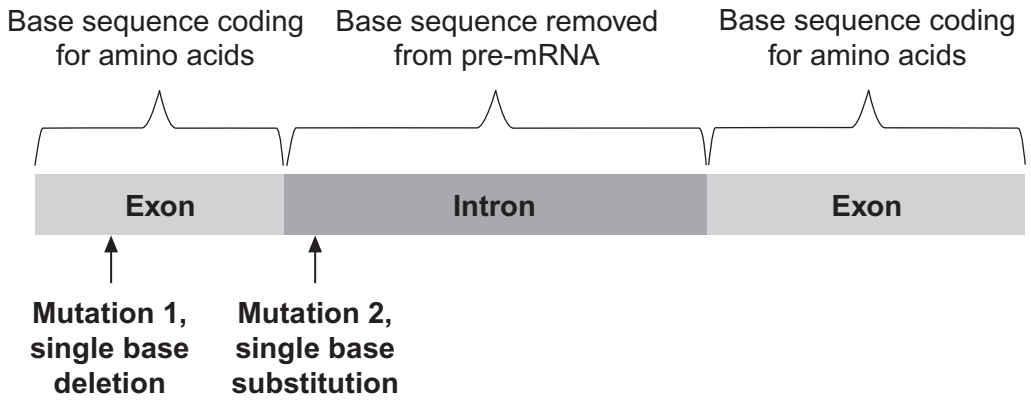
1 (b) Name the process that removes base sequences from pre-mRNA to form mRNA.

[1 mark]

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1 (c) **Figure 1** shows part of a pre-mRNA molecule. Geneticists identified two mutations that can affect this pre-mRNA, as shown in **Figure 1**.

Figure 1



Do not write outside the box

1 (c) (i) **Mutation 1** leads to the production of a non-functional protein.

Explain why.

[3 marks]

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[Extra space] .....

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1 (c) (ii) What effect might **mutation 2** have on the protein produced?

Explain your answer.

[2 marks]

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2 A biologist investigated the behaviour of a species of worm that lives in soil.

He cultured three samples of worms in three separate trays of soil for many days. Each culture:

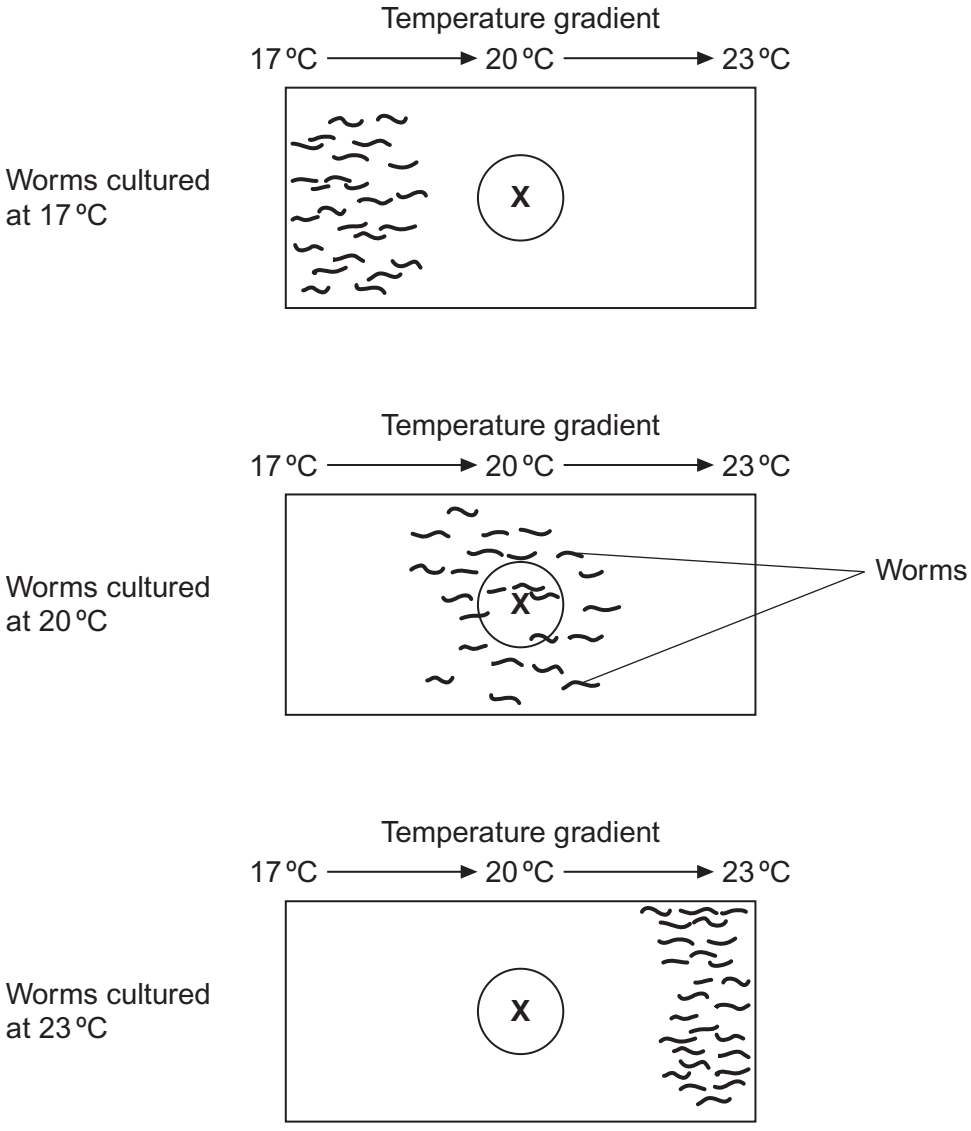
- contained a food supply
- was kept at a different temperature.

The temperatures of the cultures were 17 ºC, 20 ºC and 23 ºC.

The biologist then removed food from the trays for several hours. Then he transferred each sample of worms onto a glass surface where there was **no food**. Each surface had a temperature gradient across it. After 1 hour, the biologist recorded the position of each worm.

Figure 2 shows his results. On each diagram, (X) marks where he released the worms onto the glass surface.

Figure 2



Do not write outside the box

2 (a) The biologist concluded that the worms' behaviour demonstrated taxis.
How do these results support this conclusion?

[2 marks]

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2 (b) Using the information provided, suggest an explanation for the worms' behaviour on the glass surfaces in the absence of food.

[3 marks]

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[Extra space] .....

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2 (c) In each experiment, the biologist exposed the surfaces to light that was dim and even, so he could see where the worms went.

Apart from seeing where the worms went, suggest **two** reasons why it was important that the light was dim and even.

[2 marks]

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Do not write outside the box

3 (a) A myelinated axon conducts impulses faster than a non-myelinated axon. Explain this difference.

[3 marks]

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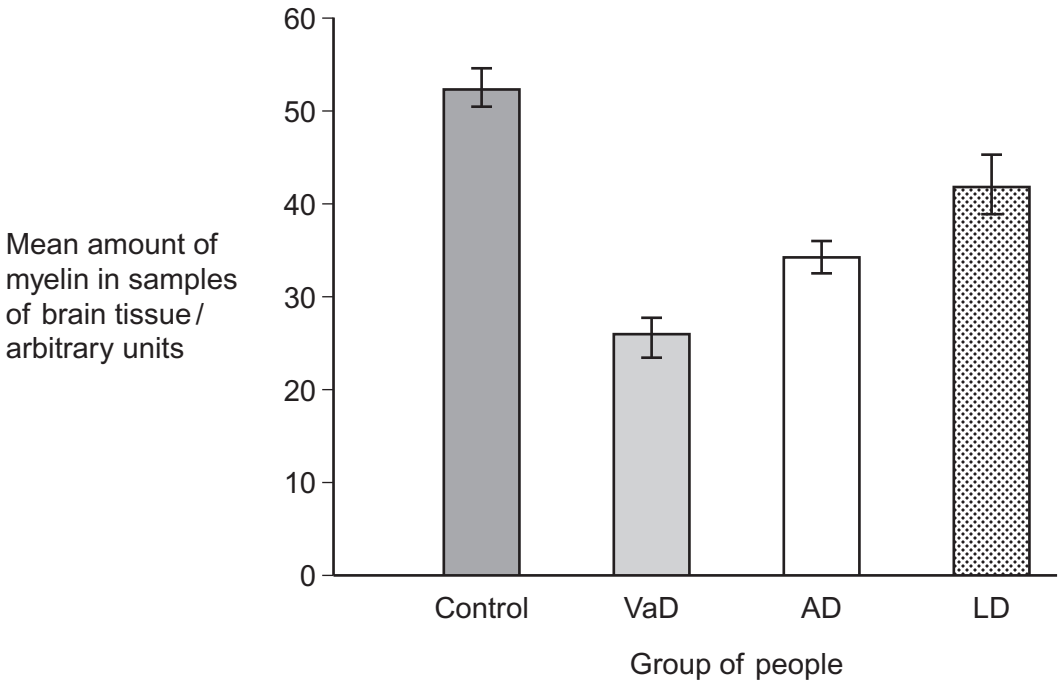
Doctors investigated the relationship between myelin in brain tissue and different types of dementia. All types of dementia involve loss of mental ability.

The doctors measured the mean amount of myelin in samples of brain tissue from:

- a control group of 12 people without dementia
- 20 people with vascular dementia (VaD)
- 19 people with Alzheimer's dementia (AD)
- 31 people with Lewy body dementia (LD).

The doctors' results are shown in **Figure 3**. The vertical bars show standard errors.

Figure 3



Do not write outside the box

3 (b) The doctors used a statistical test to compare the results for AD and LD. They obtained a value for P of 0.047.

What does this result show about the difference between the means for AD and LD?

Use the words **probability** and **chance** in your answer.

[2 marks]

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3 (c) A student who read this investigation concluded that there was a relationship between the amount of myelin in a person's brain and whether or not they had dementia.

Do these data support this conclusion? Give reasons for your answer.

[4 marks]

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9

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4 (a) When insulin binds to receptors on liver cells, it leads to the formation of glycogen from glucose. This lowers the concentration of glucose in liver cells.

Explain how the formation of glycogen in liver cells leads to a lowering of blood glucose concentration.

[2 marks]

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People with type II diabetes have cells with low sensitivity to insulin. About 80% of people with type II diabetes are overweight or obese. Some people who are obese have gastric bypass surgery (GBS) to help them to lose weight.

Doctors investigated whether GBS affected sensitivity to insulin. They measured patients' sensitivity to insulin before and after GBS. About half of the patients had type II diabetes. The other half did not but were considered at high risk of developing the condition.

Table 1 shows the doctors' results. The higher the number, the greater the sensitivity to insulin.

Table 1

Patients	**Mean sensitivity to insulin/ arbitrary units (± SD)**	
	Before gastric bypass surgery	**1 month after gastric bypass surgery**
Did not have diabetes	0.55 (± 0.32)	1.30 (± 0.88)
Had type II diabetes	0.40 (± 0.24)	1.10 (± 0.87)

Do not write outside the box

4 (b) The doctors concluded that many of the patients who did not have type II diabetes were at high risk of developing the condition.

Use the data in **Table 1** to suggest why they reached this conclusion.

[2 marks]

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4 (c) The doctors also concluded that GBS cured many patients' diabetes but that some were not helped very much.

Do these data support this conclusion? Give reasons for your answer.

[3 marks]

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5 Hodgkin's lymphoma (HL) is a type of cancer. It is usually treated using chemotherapy.

In young female patients with HL, chemotherapy can reduce their ability to have children in later life. This is because some of the drugs used in chemotherapy destroy developing follicles in their ovaries.

5 (a) Destruction of developing follicles during chemotherapy can lead to a much higher concentration of FSH in the young female patients' bodies than normal.

Use your knowledge of hormonal interactions to explain why.

[2 marks]

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5 (b) Some young female patients with HL are given an artificial hormone during chemotherapy. This artifical hormone **reduces** the release of FSH.

5 (b) (i) Suggest how the artificial hormone helps to prevent a reduction in their ability to have children in later life.

[3 marks]

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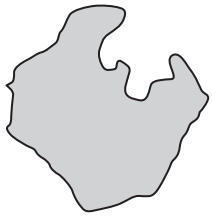
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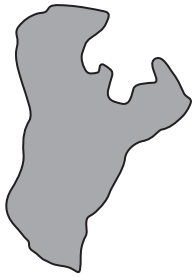
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5 (b) (ii) **Figure 4** shows the structures of the artificial hormone and the hormone that normally causes the release of FSH.

Figure 4



Artificial hormone



Hormone that normally causes the release of FSH

Suggest how the artificial hormone reduces the release of FSH.

[2 marks]

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Turn over for the next question

Do not write outside the box

6 (a) What is the role of phosphocreatine (PC) in providing energy during muscle contraction?

[2 marks]

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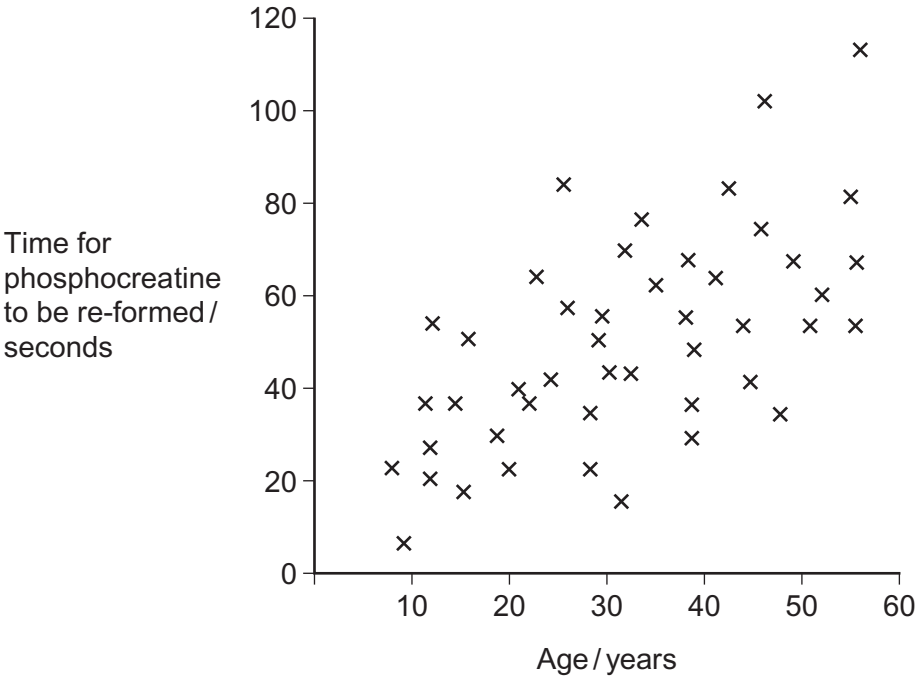
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Scientists investigated the time for phosphocreatine (PC) to be re-formed in arm muscles after the same exercise in healthy people of different ages. The exercise involved brief, rapid contractions of arm muscles.

Figure 5 shows the scientists' results. Each cross is the result for one person.

Figure 5



6 (b) There is a lot of variation in the time taken for PC to be re-formed in people of a very similar age.

Suggest **one** reason for this variation.

[1 mark]

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Do not write outside the box

6 (c) Use your knowledge of fast muscle fibres to explain the data in **Figure 5**.

[4 marks]

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Turn over for the next question

Do not write outside the box

7 CREB is a transcription factor in the mitochondria of neurones.

7 (a) What is a **transcription factor**?

[2 marks]

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7 (b) CREB leads to the formation of a protein that removes electrons and protons from reduced NAD in the mitochondrion.

Huntington's disease (HD) causes the death of neurones. People with HD produce a substance called huntingtin. Some scientists have suggested that binding of huntingtin to CREB may lead to the death of neurones.

Suggest how binding of huntingtin to CREB may lead to the death of neurones.

[3 marks]

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Do not write outside the box

7 (c) CREB is a protein synthesised in the cytoplasm of neurones. Transport of CREB from the cytoplasm into the matrix of a mitochondrion requires two carrier proteins.

Use your knowledge of the structure of a mitochondrion to explain why transport of CREB requires **two** carrier proteins.

[2 marks]

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Turn over for the next question

Do not write outside the box

8 Scientists wanted to measure how much mRNA was transcribed from allele **A** of a gene in a sample of cells. This gene exists in two forms, **A** and **a**.

The scientists isolated mRNA from the cells. They added an enzyme to mRNA to produce cDNA.

8 (a) Name the type of enzyme used to produce the cDNA.

[1 mark]

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The scientists used the polymerase chain reaction (PCR) to produce copies of the cDNA. They added a DNA probe for allele **A** to the cDNA copies. This DNA probe had a dye attached to it. This dye glows with a green light **only** when the DNA probe is attached to its target cDNA.

8 (b) Explain why this DNA probe will only detect allele **A**.

[2 marks]

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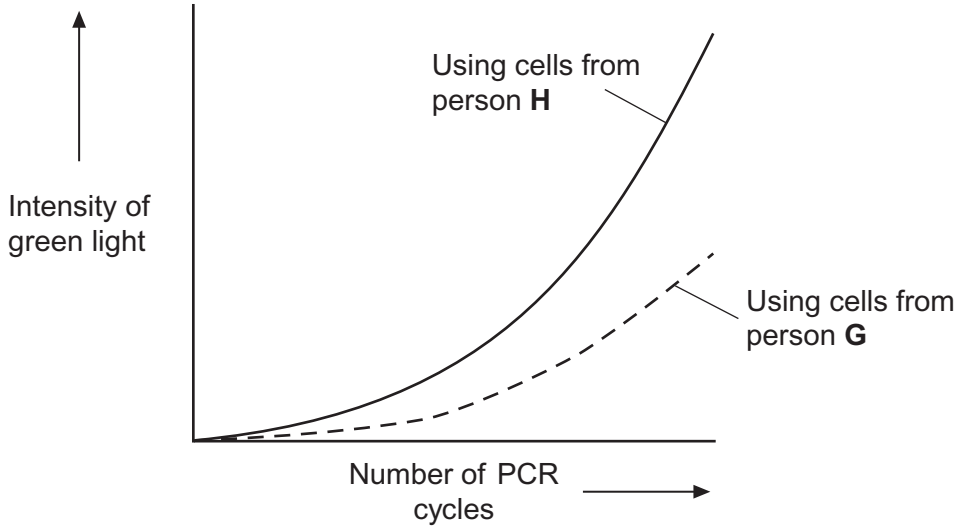
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8 (c) The scientists used this method with cells from two people, **H** and **G**.
One person was homozygous, **AA**, and the other was heterozygous, **Aa**.
The scientists used the PCR and the DNA probe specific for allele **A** on the cDNA from both people.

Figure 6 shows the scientists' results.

Figure 6



Do not write outside the box

8 (c) (i) Explain the curve for person **H**.

[3 marks]

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[Extra space] .....

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8 (c) (ii) Which person, **H** or **G**, was heterozygous, **Aa**? Explain your answer.

[2 marks]

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Turn over ▶

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9 Scientists measured the rate of respiration in **three** parts of an ecosystem.

They did this by measuring carbon dioxide released into the air by:

- leaves of plants
- stems and roots of plants
- non-photosynthetic soil organisms.

Table 2 shows the scientists' results for these three parts of the ecosystem.

Table 2

Part of ecosystem	**Mean rate of carbon dioxide production/ $cm^3\ m^{-2}\ s^{-1}$**	**Percentage of total carbon dioxide production measured by the scientists**
Leaves of plants	0.032	25.0
Stems and roots of plants	0.051	
Non-photosynthetic soil organisms	0.045	

9 (a) Complete **Table 2** to show the percentage of total carbon dioxide production by each part of the ecosystem.

Show your working.

[2 marks]

Do not write outside the box

9 (b) A student who looked at the data in **Table 2** concluded that plants carry out more respiration than non-photosynthetic organisms in the ecosystem.

Use the information provided to suggest why these data may **not** support the student's conclusion.

[2 marks]

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9 (c) What measurements would the scientists have made in order to calculate the rate of carbon dioxide production?

[2 marks]

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9 (d) The scientists calculated the mean rate of carbon dioxide production of the leaves using measurements of carbon dioxide release in the dark.

Explain why they did **not** use measurements taken in the light.

[2 marks]

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Question 9 continues on the next page

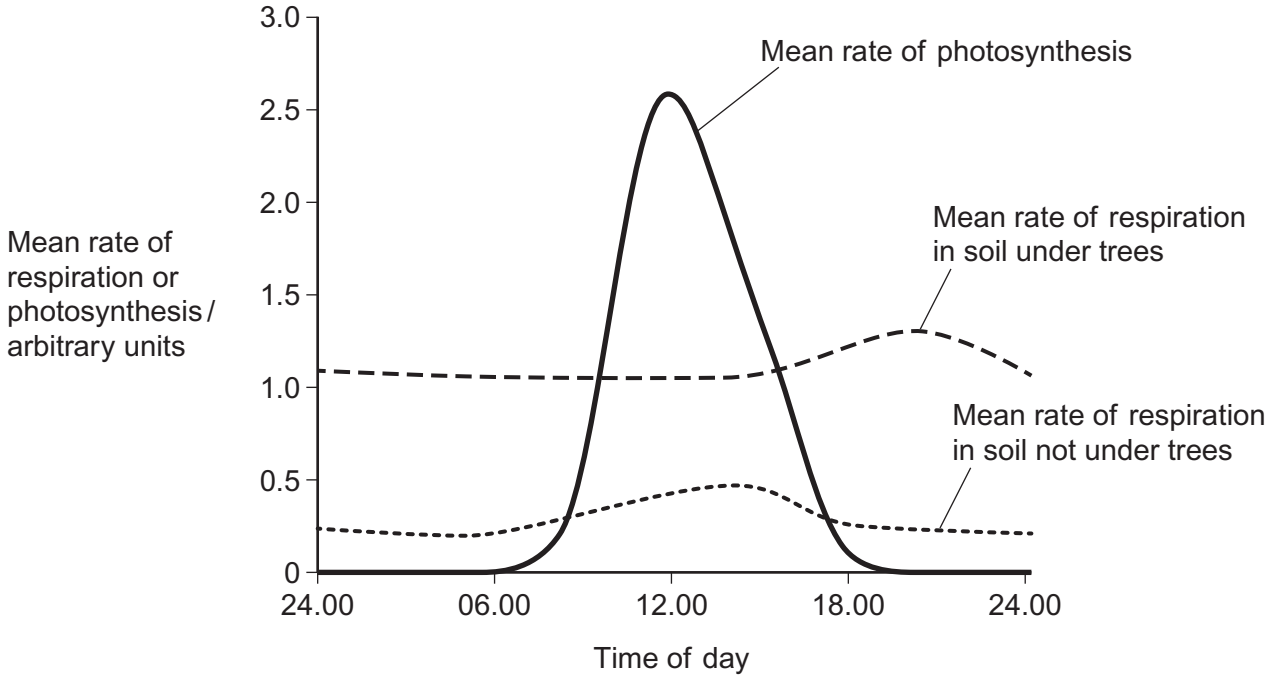
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Another group of scientists measured the mean rate of respiration in soil under trees and soil not under trees in the same wood. They also measured the mean rate of photosynthesis in the trees.

They took measurements at different times of day during the summer.

Figure 7 shows the scientists' results.

Figure 7



9 (e) (i) Describe **two** ways in which the mean rate of respiration in soil under trees is different from soil not under trees.

[2 marks]

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Do not write outside the box

9 (e) (ii) Suggest **one** explanation for the differences in the mean rate of respiration in soil under trees and soil not under trees between 06.00 and 12.00.

[2 marks]

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9 (f) The scientists suggested that the rise in the mean rate of photosynthesis was the cause of the rise in the mean rate of respiration in soil under trees.

9 (f) (i) Suggest how the rise in the mean rate of photosynthesis could lead to the rise in the mean rate of respiration in soil under trees.

[2 marks]

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9 (f) (ii) Suggest why there is a delay between the rise in the mean rate of photosynthesis and the rise in the mean rate of respiration.

[1 mark]

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Turn over for the next question

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Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) How cells and organisms carry out exchanges with their external environment to maintain their internal environment.

[25 marks]

OR

10 (b) How energy is transferred within and between organisms.

[25 marks]

If you want to make a plan write it here.

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END OF QUESTIONS

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A-LEVEL
BIOLOGY

BIOL5 - Control in cells and in organisms
Mark scheme

2410
June 2014

Version : 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question	Marking Guidance	Mark	Comments
1(a)(i)	(In all organisms/DNA,) the same triplet codes for the same amino acid;	1	Accept codon/same three bases/nucleotides Accept plurals if both triplets and amino acids Reject triplets code for an amino acid Reject reference to producing amino acid
1(a)(ii)	64;	1	
1(b)	Splicing;	1	Ignore deletion references Accept RNA splicing
1(c)(i)	1. (Mutation) changes triplets/codons after that point/causes frame shift; 2. Changes amino acid sequence (after this)/codes for different amino acids (after this); 3. Affects hydrogen/ionic/sulfur bond (not peptide bond); 4. Changes tertiary structure of protein (so non-functional);	3 max	Accept changes splicing site 1. Ignore changes in sequence of nucleotides/bases 2. Accept changes primary structure 2. Reject changes amino acid formed/one amino acid changed 4 Neutral 3-D structure
1(c)(ii)	1. Intron non-coding (DNA)/only exons coding; 2. (So) not translated / no change in mRNA produced / no effect (on protein) / no effect on amino acid sequence; ***OR*** 3. Prevents/changes splicing; 4. (So) faulty mRNA formed; 5. Get different amino acid sequence;	2 max	Context is the **intron** Do not mix and match from alternatives 1. Neutral references to introns removed during splicing 1.and 2. Ignore ref. to code degenerate and get same/different amino acid in

			sequence 2. Accept does not code for amino acids 4. Accept exons not joined together/introns not removed

Question	Marking Guidance	Mark	Comments
2(a)	1. (Taxis is) movement towards/away from a stimulus / a directional response/movement (to a stimulus); 2. (Move towards) temperature they were used to/cultured in;	2 max	Movement towards temperature they were used to = 2 marks
2(b)	1. Hungry, so seeking food / in absence of food respond to temperature; 2. Move towards temperature they were used to/cultured in; 3. Associate (this temperature) with food; 4. (Then) stay in this temperature;	3 max	Ignore references to temperature and enzymes 1. Must be stated not inferred from other statements 3. Accept they think food is here 3. Stated not inferred
2(c)	1. (Dim) worms live in soil/dark/ affected by bright light / dim light is like normal environment/what they are used to; 2. (Even) because worms might move towards/away from bright light / to avoid creating light gradient / prevent worms showing phototaxis/ all parts of surface exposed to same light; 3. (Dim light) ensures heat from light not a variable/ heat from lamp could kill/dry out worms;	2 max	2. Accept to avoid kinesis due to light 3. not just to control variables/factors

Question	Marking Guidance	Mark	Comments
3(a)	1. (In myelinated) action potential/depolarisation only at node(s); 2. (In myelinated, nerve impulse) jumps from node to node/saltatory; 3. (In myelinated) action potential/impulse does not travel along whole length;	3	The question is about speed of transmission, not repolarisation or related matters 3. Accept converse for non-myelinated
3(b)	1. Probability of obtaining this difference by chance; 2. Is less than 5%/less than 0.05/less than one in twenty; 3. Difference is significant;	2 max	1. and 3. Reject 'results' once only 1. This statement often split round 2. 2. Accept is 4.7%/0.047 but reject less than 4.7%/0.047 2. Accept correct greater than 95%/greater than 0.95 arguments
3(c)	1. (All) dementia results lower (than control group)/non-dementia result higher; 2. Error bars do not overlap so differences are (possibly) significant; 3. Dementia may be due to other factors / not only due to a lack of myelin; 4. (Because) big/significant differences in myelin in different dementia; 5. Only small sample sizes/only one study/ more data required;	4 max	2. Neutral results 2. Accept not due to chance/statistically significant 2. In this context, accept references to standard deviation 3. Accept suitable named factor e.g. genetic 4. Not just 'different'

Question	Marking Guidance	Mark	Comments
4(a)	(Formation of glycogen) 1. Glucose concentration in cell/liver falls; 2. Below that in blood (plasma)/ higher in blood; 3. Creates/maintains glucose concentration/diffusion gradient; 4. Glucose enters cell/leaves blood by facilitated diffusion/via carrier(protein)/channel (protein);	2 max	4. Not just diffusion
4(b)	1. Insulin sensitivity similar to/not (significantly) different from those with diabetes; 2. Overlap of SDs; 3. Their sensitivity (to insulin also) improved by GBS;	2 max	1. No values for non-obese, so comparisons with 'normal' not possible 2. Accept SE
4(c)	1. Sensitivity (to insulin) does increase; 2. But large SD/ large variation (after GBS); 3. (So) some showing no/little change/ get worse; 4. Do not know what sensitivity to insulin is of non-diabetics (who are not obese);	3 max	This part of the question concerns spread of data, not overlap of SDs 2. Accept use of figures/use of SD values to make this point. 2. Ignore ref to SE 4. Accept 'normal' as non-diabetic

Question	Marking Guidance	Mark	Comments
5(a)	1. No/less oestrogen produced (by follicles/ovaries); 2. No/less negative feedback (by oestrogen); 3. On pituitary (gland);	2 max	1. Ignore references to corpus luteum and progesterone 2. Ignore oestrogen inhibits FSH but accept oestrogen inhibits release/production of FSH
5(b)(i)	1. (Less FSH so) fewer/no follicles develop; 2. (So) fewer follicles (will be) destroyed (by chemotherapy); 3. (So) more follicles left for later in life/after treatment; 4. (So) more eggs;	3 max	1. Neutral fewer eggs develop Accept converse statements Ignore references to LH and ovulation Accept for one mark statement of set/limited number of follicles present (at birth)
5(b)(ii)	(Artificial hormone,) 1. Similar shape/structure/binding site to normal hormone; 2. So binds to (same) receptor and stops normal hormone binding;	2	1. Reject same shape 1. Accept part of shape same as hormone/similar tertiary structure Reject references to active sites, <u>enzyme</u> inhibitors and substrates. Accept references to binding sites and competitive inhibition of hormone binding sites

Question	Marking Guidance	Mark	Comments
6(a)	1. (Phosphocreatine) provides phosphate/phosphorylates; 2. To make ATP;	2	1. Accept P_i or P in circle 1. Reject phosphorus 2. Accept: ADP + CP → ATP + C Neutral – provides ATP
6(b)	One suitable suggestion; eg 1. Genetic differences; 2. Level of fitness/amount of regular exercise done/mass of muscle; 3. Sex; 4. Ethnicity 5. Metabolic rate; 6. Number of fast/slow muscle fibres	1 max	Neutral lifestyle/diet/illness
6(c)	1. (From graph, phosphocreatine) takes longer to remake as people get older; 2. Fast muscle fibres used for rapid/brief/powerful/strong contractions; 3. Phosphocreatine used up rapidly during contraction/to make ATP; 4. Anaerobic respiration involved; 5. (As people get older) slower metabolic rate/slower ATP production/slower respiration; 6. ATP used to reform phosphocreatine; 7. Lots of phosphocreatine in fast fibres;	4 max	1. Accept positive correlation between age and time to re-form phosphocreatine

Question	Marking Guidance	Mark	Comments
7(a)	1. (Protein/molecule) that moves from cytoplasm to DNA; 2. (TF) binds to specific gene/genes/ to specific part of/site on DNA/ binds to promoter/RNA polymerase; 3. Leads to/blocks (pre)mRNA production / allows/blocks binding of RNA polymerase (to DNA)/allows RNA polymerase to work;	2 max	1. Accept 'it' as TF. 1. Accept moves into nucleus 2. Accept regulator/enhancer region 3. Ignore translation unless context wrong Max 1 if refer to oestrogen as a transcription factor
7(b)	1. (Binding to CREB) prevents transcription/mRNA formation; 2. (Binding of huntingtin) prevents production/translation of protein (that removes electrons/protons from NAD); 3. Fewer electrons to electron transport chain/electron transport chain slows/stops/ stops/slower oxidative phosphorylation; 4. Fewer protons for proton gradient; 5. Not enough ATP produced/energy supplied to keep cells alive / anaerobic respiration not enough to keep cell alive;	3 max	1. Accept that lack of protein leaves NAD reduced 5. Accept neurones require ATP for active transport of ions 5. Ignore references to resting potential
7(c)	1. CREB/protein is too large/is water soluble so cannot cross membrane/phospholipid bilayer; 2. Mitochondrion has two membranes/inner and outer membranes; 3. For each (different) membrane a (different) carrier required;	2 max	2. Accept cristae for inner membrane 3. Ignore reference to channel proteins

Question	Marking Guidance	Mark	Comments
8(a)	Reverse transcriptase;	1	
8(b)	1. Probe (base sequence) complementary (to DNA of allele A/where A is); 2. (Probe) binds by forming base pairs/hydrogen bonds; 3. So (only) this DNA labelled/has green dye/gives out (green) light;	2max	1. Accept gene A 3. Accept glows for green light
8(c)(i)	1. More probe binding/more cDNA/mRNA/more allele/gene A means more light; 2. DNA (with **A)** doubles each (PCR) cycle; 3. So light (approximately) doubles/curve steepens more and more (each cycle) /curve goes up exponentially/ increases even faster;	3	
8(c)(ii)	(**G** because) 1. (Heterozygous) only has half the amount of probe for **A** attaching / only half the amount of DNA/allele A (to bind to); 2. (So,) only produced (about) half the light/glow/intensity (of **H**) (per cycle of PCR);	2	1. Accept only one A to bind to 2. If reference to 'half' for point 1, allow 'less light' in 2.

<table>
<tr><th>Question</th><th>Marking Guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>9(a)</td><td>
<table>
<tr><th>Part of ecosystem</th><th>Mean rate of carbon dioxide production/ cm^3m^{-2} s^{-1}</th><th>Percentage of total carbon dioxide production measured by the scientists</th></tr>
<tr><td>Leaves of plants</td><td>0.032</td><td>25.0</td></tr>
<tr><td>Stems and roots of plants</td><td>0.051</td><td><u>39.8</u></td></tr>
<tr><td>Non-photosynthetic soil organisms</td><td>0.045</td><td><u>35.2</u></td></tr>
</table>
2 correct = 2 marks;;
Adding rates to get 0.128 = 1;</td><td>2 max</td><td>If rounded to 40 and 35 in table;
• but working shows decimal points, then award 2 marks
• but no working shown, then 1 max.</td></tr>
<tr><td>9(b)</td><td>1. Data only include (heterotrophic) soil organisms;
2. Doesn’t include animals (above ground)/other (non-soil) organisms;
3. Doesn’t take into account anaerobic respiration;</td><td>2 max</td><td>Award points in any combination
Accept for 1 mark idea that CO_2 for leaves doesn’t take into account photosynthesis – not told in dark until 9(d)</td></tr>
<tr><td>9(c)</td><td>All three of following = 2 marks;;
Two of them = 1 mark;
Volume of carbon dioxide given off
(From known) area/ per m^2/m^{-2}
In a known/set time</td><td>2</td><td>Ignore ‘amount’/concentration of CO_2
Accept per second/per unit time</td></tr>
<tr><td>9(d)</td><td>1. (In the light) photosynthesis/in the dark no photosynthesis;
2. (In light,) carbon dioxide (from respiration) being used/taken up (by photosynthesis);</td><td>2</td><td></td></tr>
</table>

9(e)(i)	(Rate of respiration) 1. In soil under trees (always) higher; 2. In soil under trees does not rise between 06.00 and 12.00 /in the middle of the day/ peaks at 20:00-21.00/in the evening; 3. In soil **not** under trees, peaks at about 14:00-15:00/in middle of day;	2 max	Assume "it" means soil under trees 1. Accept converse for soil not under trees Accept 'in the shade' means under the trees 2. and 3. No mm grid, so accept 'between 18.00 and 24.00' or 'between 12.00 and 18.00'

9(e)(ii)	(Between 06.00 and 12.00, (No Mark)) Respiration higher in soil under tree, (No mark) 1. Tree roots carry out (a lot of) respiration; 2. More/there are roots under tree; ***OR*** 3. More food under trees; 4. So more active/greater mass of/more organisms (carrying out respiration); ***OR*** Soil not under trees respiration increases (No mark) 5. Soil in sunlight gets warmer; 6. Enzymes (of respiration) work faster;	2 max	Do not mix and match mark points. No list rule Accept converse for soil not under trees Accept converse for soil not under trees Accept converse for soil under trees

9(f)(i)	1. Photosynthesis produces sugars; 2. Sugars moved to roots; 3. (Sugars) are used/required for respiration;	2 max	2. Do not penalise named sugars other than sucrose

9(f)(ii)	Takes time to move sugars to roots;	1	Look for movement idea in (f)(i) – can carry forward to (ii)

Question	Marking Guidance	Mark	Comments
10(a)	**Cells and organisms carry out exchanges with their external environment <u>to maintain their internal environment</u>.** **Topic areas** **H -** Homeostasis (concept of) **D -** Digestion and absorption **C -** Cells **L -** Lung function **G -** Gas exchange **W -** Passage of water through plant **Nc -** Nutrient cycles **R -** Response to stimuli **N-** Neurones **T -** Temperature control **Tf** - tissue fluid and its formation **B -** Control of blood glucose concentration **Nf -** Negative feedback **Gn -** Gene expression		The topics listed contain material that could be made relevant to the title. Writing about these topics in a general sense may not address the question. Candidates may make correct use of material from other topics. A* includes where candidates use information about a topic in the specification but go beyond what is expected for our A level.

Question	Marking Guidance	Mark	Comments
10(b)	**<u>How energy is transferred</u> within and between organisms**. **Topic areas** **P -** Photosynthesis **Ec -** Energy transfer through ecosystems **F -** Food production **D –** Digestion (as in fuel) **Ab -** Absorption (by cells) **Mt -** Mass transport **R -** Respiration **A -** ATP **Sr -** Stimuli and responses **Mc -** Muscle contraction **N -** Nerve impulses		The topics listed contain material that could be made relevant to the title. Writing about these topics in a general sense may not address the question. Candidates may make correct use of material from other topics. A* includes where candidates use information about a topic in the specification but go beyond what is expected for our A level.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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10	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2013

Biology BIOL5

Unit 5 Control in cells and in organisms

Monday 17 June 2013 1.30 pm to 3.45 pm

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Time allowed
- 2 hours 15 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the boxes or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Advice
- You are advised to spend no longer than 40 minutes on the essay.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 (a) The genetic code is described as being degenerate. What does this mean?

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(1 mark)

1 (b) What is a codon?

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(2 marks)

1 (c) (i) What is the role of RNA polymerase during transcription?

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(1 mark)

1 (c) (ii) mRNA can be converted to cDNA.

Name the enzyme used in this process.

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(1 mark)

Do not write outside the box

1 (d) The diagram shows the base sequence on DNA where a restriction endonuclease cuts DNA.



Use evidence from the diagram to explain what is meant by a palindromic recognition sequence on DNA.

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(1 mark)

6

Turn over for the next question

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2 (a) Describe the part played by each of the following in myofibril contraction.

2 (a) (i) Tropomyosin

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(2 marks)

2 (a) (ii) Myosin

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(2 marks)

Do not write outside the box

2 (b) The table shows features of fast and slow muscle fibres.

Feature	Fast muscle fibre	Slow muscle fibre
Type of respiration	Mainly anaerobic	Mainly aerobic
Glycogen	High concentration	Low concentration
Capillaries	Few	Many

Use information from the table to suggest and explain **one** advantage of:

2 (b) (i) the high glycogen content of fast muscle fibres

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(2 marks)

2 (b) (ii) the number of capillaries supplying slow muscle fibres.

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(2 marks)

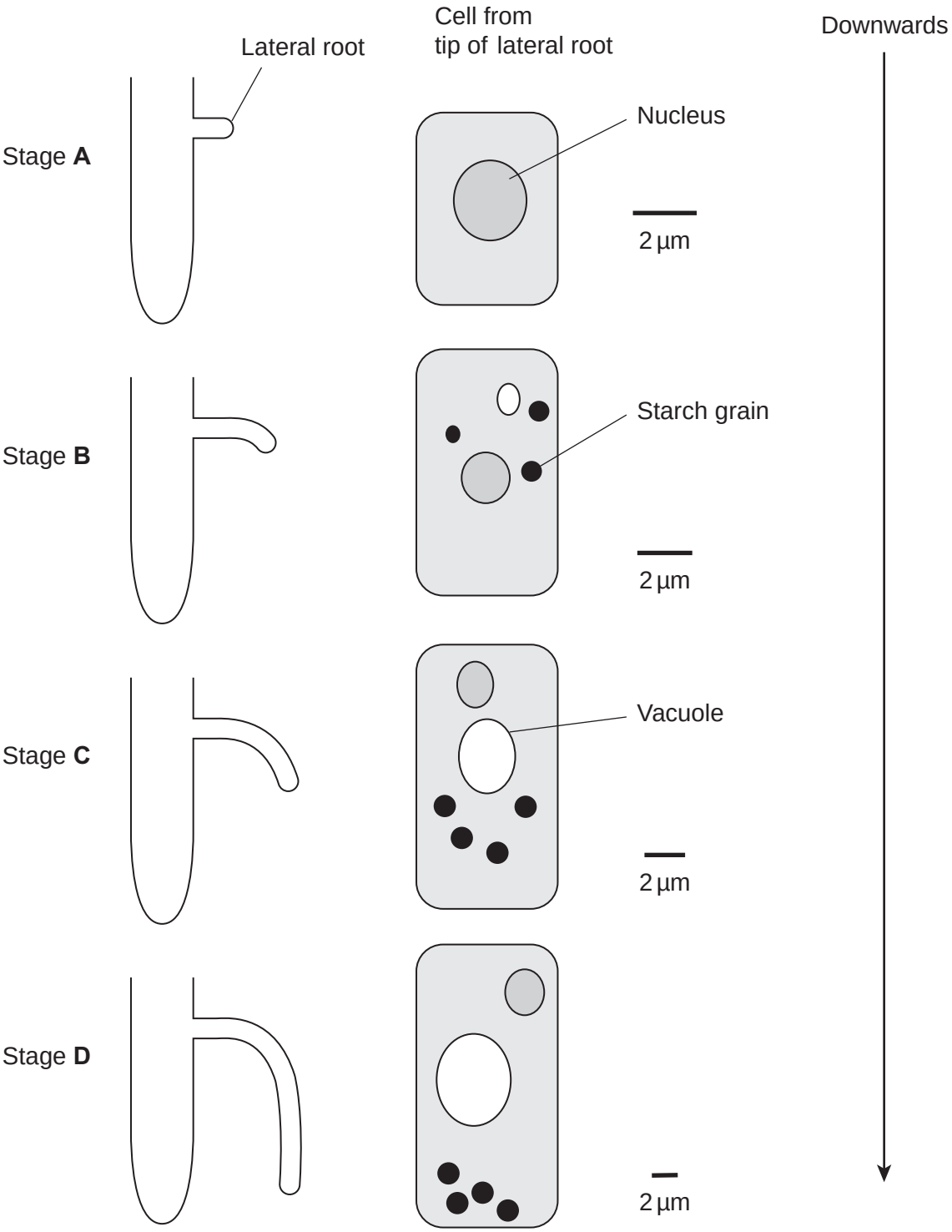
8

Turn over ▶

Do not write outside the box

3 Scientists investigated the response of lateral roots to gravity. Lateral roots grow from the side of main roots.

The diagrams show four stages, **A** to **D**, in the growth of a lateral root and typical cells from the tip of the lateral root in each stage. All of the cells are drawn with the bottom of the cell towards the bottom of the page.



Do not write outside the box

3 (a) Describe **three** changes in the root tip cells between stages **A** and **D**.

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3 .....

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(3 marks)

3 (b) The scientists' hypothesis was that there was a relationship between the starch grains in the root tip cells and the bending and direction of growth of lateral roots.

Does the information in the diagram support this hypothesis? Give reasons for your answer.

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(3 marks)

(Extra space) .....

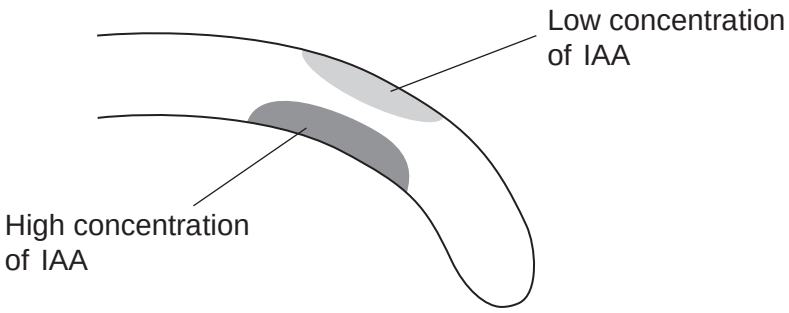
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Question 3 continues on the next page

Do not write outside the box

3 (c) The diagram shows the distribution of indoleacetic acid (IAA) in the lateral root at Stage **B**.



Explain how this distribution of IAA causes the root to bend.

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(2 marks)

8

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

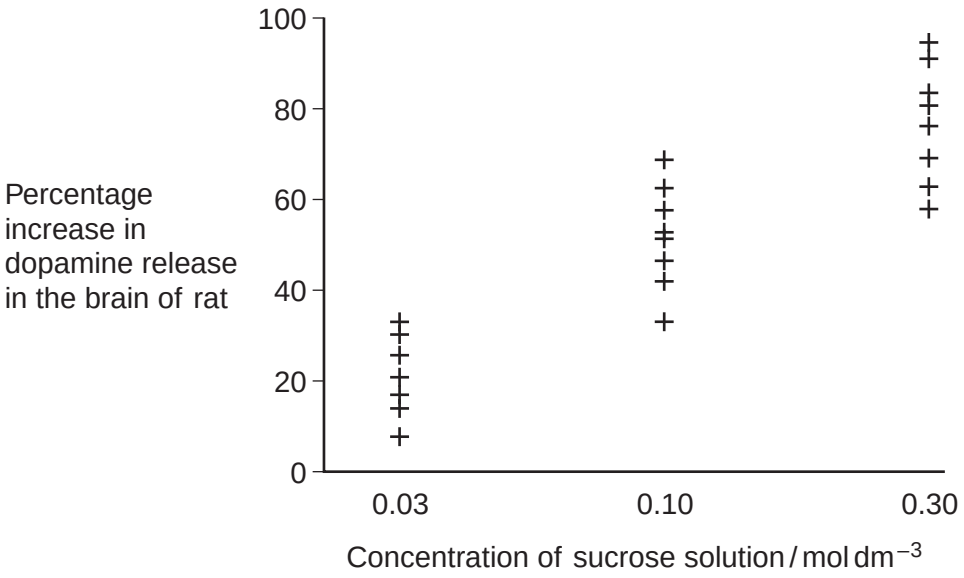
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4 The release of a substance called dopamine in some areas of the brain increases the desire to eat.

Scientists measured increases in the release of dopamine in the brains of rats given different concentrations of sucrose solution to drink.

Sucrose stimulates taste receptors on the tongue.

The graph shows their results. Each point is the result for one rat.



4 (a) The scientists concluded that drinking a sucrose solution had a positive feedback effect on the rats' desire to eat.

How do these data support this conclusion?

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(3 marks)

(Extra space) .....

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Do not write outside the box

4 (b) In this investigation, the higher the concentration of sucrose in a rat's mouth, the higher the frequency of nerve impulses from each taste receptor to the brain.

If rats are given very high concentrations of sucrose solution to drink, the refractory period makes it impossible for information about the differences in concentration to reach the brain.
Explain why.

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(2 marks)

4 (c) In humans, when the stomach starts to become full of food, receptors in the wall of the stomach are stimulated. This leads to negative feedback on the desire to eat.
Suggest why this negative feedback is important.

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(3 marks)

(Extra space) .....

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Do not write outside the box

5 Hyperthermia is a condition in which a person's body temperature is above 37.5 ºC. This happens when a person's body produces or absorbs more heat than it loses to the environment.

Doctors recruited healthy volunteers. At a room temperature of 20 ºC, the doctors measured each volunteer's:

- body temperature
- rate of oxygen consumption
- rate of carbon dioxide production.

Each volunteer then put on a suit that covered the whole body. Water at 38 ºC was circulated through pipes in the suit. This caused the volunteer to develop hyperthermia.

The doctors' results are shown in the table.

	At 20 ºC	**In suit at 38 ºC**	**P value**
Mean body temperature / ºC	36.82	38.62	< 0.001
Mean rate of oxygen consumption / $cm^3\ kg^{-1}\ minute^{-1}$	3.31	4.16	< 0.05
Mean rate of carbon dioxide production / $cm^3\ kg^{-1}\ minute^{-1}$	2.68	3.03	> 0.05

The doctors carried out statistical tests to see whether or not the differences in the results were significant. The P values from these tests are shown in the table.

5 (a) Calculate the percentage increase in mean body temperature.
Show your working.

Percentage increase .....

(2 marks)

Do not write outside the box

5 (b) Explain **one** way in which a suit with water circulating in it at 38 ºC causes hyperthermia.

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(2 marks)

5 (c) Were the changes produced by hyperthermia significant? Give reasons for your answer. You should use the P values in your answer.

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(2 marks)

5 (d) Using information from the table, explain the increase in mean rate of oxygen consumption.

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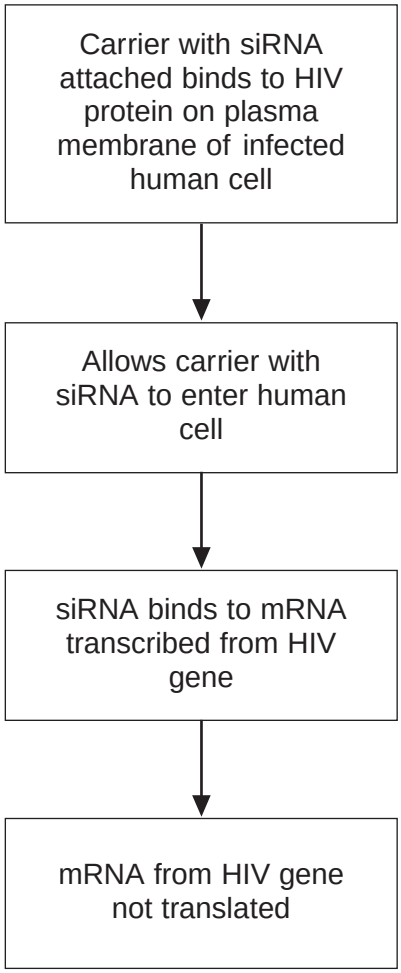
(2 marks)

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Do not write outside the box

6 Human immunodeficiency virus (HIV) particles have a specific protein on their surface. This protein binds to a receptor on the plasma membrane of a human cell and allows HIV to enter. This HIV protein is found on the surface of human cells after they have become infected with HIV.

Scientists made siRNA to inhibit expression of a specific HIV gene inside a human cell. They attached this siRNA to a carrier molecule. The flow chart shows what happens when this carrier molecule reaches a human cell infected with HIV.



Do not write outside the box

6 (a) When siRNA binds to mRNA, name the complementary base pairs holding the siRNA and mRNA together. One of the bases is named for you.

..... with .....

..... **Adenine** ..... with .....

(1 mark)

6 (b) This siRNA would **only** affect gene expression in cells infected with HIV.

Suggest **two** reasons why.

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2 .....

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(4 marks)

6 (c) The carrier molecule on its own may be able to prevent the infection of cells by HIV.

Explain how.

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(2 marks)

7

Do not write outside the box

7 Serotonin is a neurotransmitter released in some synapses in the brain. It is transported back out of the synaptic gap by a transport protein in the pre-synaptic membrane.

7 (a) Serotonin diffuses across the synaptic gap and binds to a receptor on the post-synaptic membrane.

Describe how this causes depolarisation of the post-synaptic membrane.

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(2 marks)

7 (b) It is important that a neurotransmitter such as serotonin is transported back out of synapses. Explain why.

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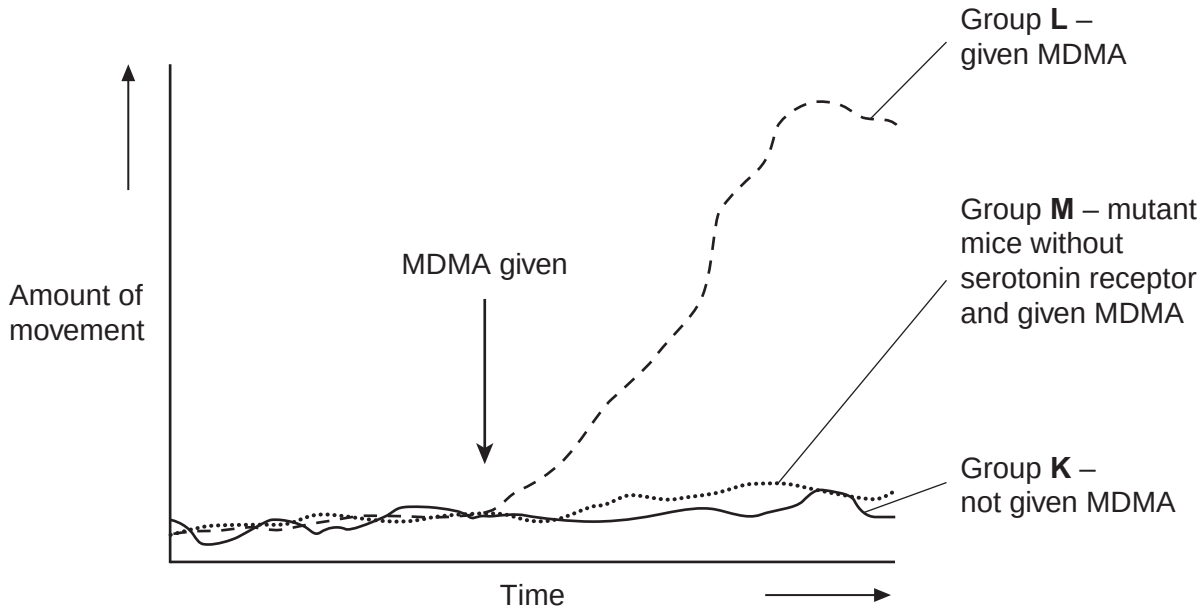
(2 marks)

Do not write outside the box

7 (c) Scientists investigated the effect of a drug called MDMA on movement of mice. They measured the amount of movement of three groups of mice, **K**, **L** and **M**.

- Group **K**, mice not given MDMA.
- Group **L**, mice given MDMA.
- Group **M**, mutant mice that did not produce a serotonin receptor on their post-synaptic membranes and were given MDMA.

The graph shows their results.



The scientists concluded that MDMA affects movement by binding to serotonin receptors.

How do these results support this conclusion?

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(3 marks)

(Extra space) .....

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7

Turn over ▶

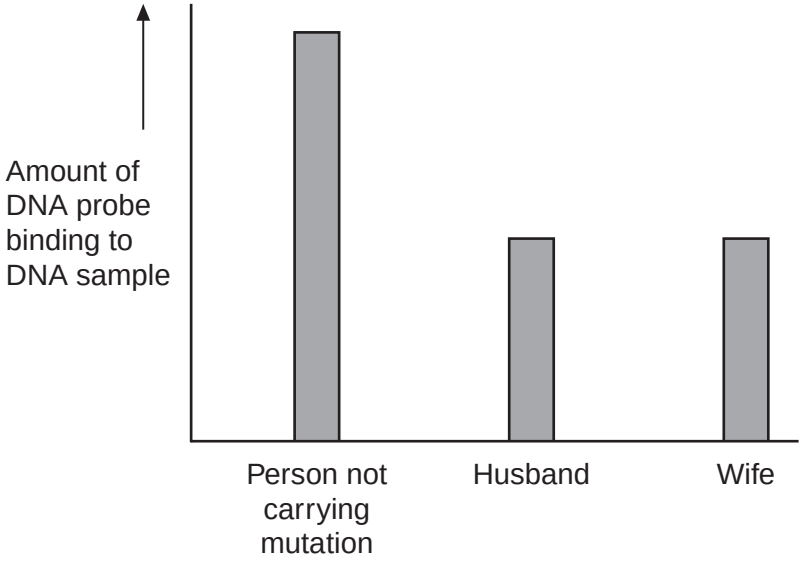
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8 A husband and wife wanted to know whether they were carriers of the mutated form of a gene. This mutation is a deletion that causes a serious inherited genetic disorder in people who are homozygous.

A geneticist took samples of DNA from the husband and the wife. He used a DNA probe to look for the deletion mutation. The DNA probe was specific to a particular base sequence in an exon in the gene. Exons are the coding sequences in a gene.

The geneticist compared the couple's DNA with that of a person known not to carry this mutation.

The chart shows the geneticist's results.



8 (a) The geneticist told the couple they were both carriers of the mutated gene. Explain how he reached this conclusion.

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(3 marks)

(Extra space) .....

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Do not write outside the box

8 (b) The DNA probe the geneticist used was for an exon in the DNA, **not** an intron. Explain why.

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(3 marks)

(Extra space) .....

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8 (c) To make the DNA probe, the geneticist had to find the base sequence of the normal gene. Once he had copies of the gene, what methods would he use to find the base sequence of the gene?

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(2 marks)

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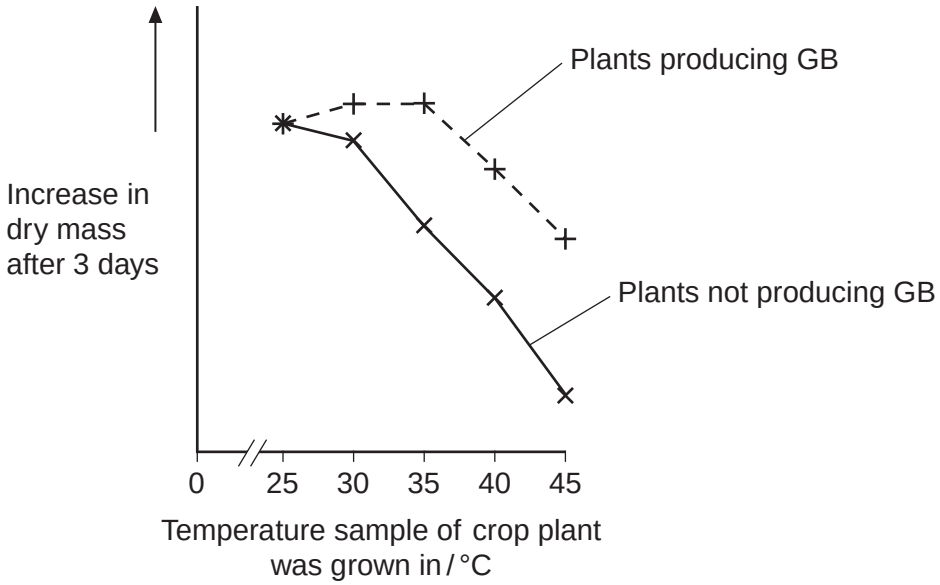
9 Some species of crop plant produce a substance called glycinebetaine (GB).

Scientists transferred the gene for GB into a species of crop plant that does not normally produce GB. These genetically modified plants then produced GB.

The scientists grew large numbers of the same crop plant with and without the gene at different temperatures. After 3 days, they found the increase in dry mass of the plants.

Figure 1 shows their results.

Figure 1



9 (a) Describe the effect on growth of transferring the gene for GB into this plant.

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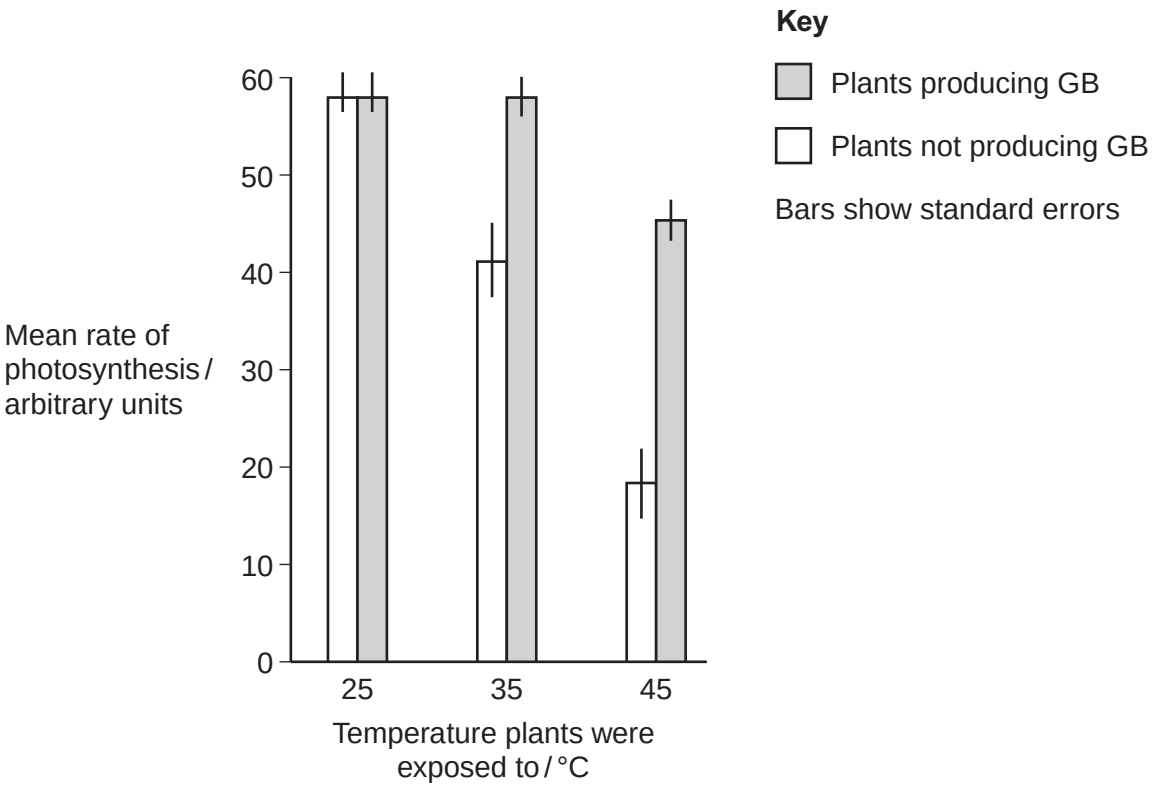
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(2 marks)

9 (b) The scientists measured the rate of photosynthesis in plants that produce GB and plants that do not produce GB at 25 ºC, 35 ºC and 45 ºC.

Figure 2 shows their results.

Figure 2



9 (b) (i) The scientists concluded that the production of GB protects photosynthesis from damage by high temperatures.

Use these data to support this conclusion.

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(1 mark)

Question 9 continues on the next page

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9 (b) (ii) Use the data from **Figure 2** for plants that do **not** produce GB to explain the effect of temperature on changes in dry mass of the plants shown in **Figure 1**.

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(4 marks)

(Extra space) .....

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Rubisco activase is an enzyme found in chloroplasts. It activates the light-independent reaction of photosynthesis.

The scientists discovered that, as temperature increased from 25 ºC to 45 ºC, rubisco activase began attaching to thylakoid membranes in chloroplasts and this stopped it working.

9 (c) Rubisco activase stops working when it attaches to a thylakoid.

Use your knowledge of protein structure to explain why.

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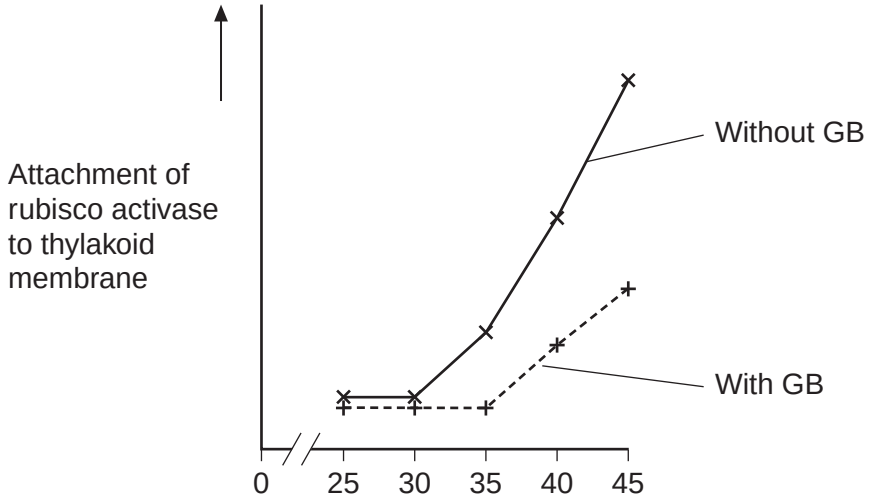
(2 marks)

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9 (d) The scientists investigated the effect of GB on attachment of rubisco activase to thylakoid membranes at different temperatures.

Figure 3 shows their results.

Figure 3



Use information from **Figure 2** and **Figure 3** to suggest how GB protects the crop plant from high temperatures.

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(4 marks)

(Extra space) .....

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Question 9 continues on the next page

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9 (e) The scientists' hypothesis at the start of the investigation was that crop plants genetically engineered to produce GB would become more resistant to high environmental temperatures.
The scientists developed this hypothesis on the basis of previous research on crops that are grown in hot climates.

Suggest how the scientists arrived at their hypothesis.

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(2 marks)

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Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) The membranes of different types of cells are involved in many different functions.

(25 marks)

OR

10 (b) There are many different types of relationships and interactions between organisms.

(25 marks)

If you want to make a plan write it here.

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END OF QUESTIONS

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Version 2.0



General Certificate of Education (A-level)
June 2013

Biology BIOL5

(Specification 2410)

Unit 5: Control in Cells and in Organisms

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from: aqa.org.uk

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Question	Marking Guidance	Mark	Comments
1(a)	One/an amino acid (can be) coded for by more than one triplet;	1	Accept codon for triplet Accept description of triplet – three bases/nucleotides
1(b)	1. Triplet/three bases on mRNA; 2. That code for an amino acid;	2	1. Accept nucleotide for base 1. Accept DNA for mRNA 1. Ignore references to RNA unqualified 2. Accept code for stop/start
1(c)(i)	To join nucleotides together to form mRNA/premRNA/RNA;	1	Reject forming base pairs Accept checking and correcting mismatched base pairs
1(c)(ii)	Reverse transcriptase;	1	If they give two enzymes, no mark
1(d)	GGATCC same as CCTAGG in opposite direction;	1	Accept reads same both ways/same forward and back Neutral bases are the opposite of each other/reference to base pairs

Question	Marking Guidance	Mark	Comments
2(a)(i)	1. Moves out of the way when calcium ions bind; 2. Allowing myosin to bind (to actin)/crossbridge formation;	2	1. Accept shape change with Ca^{2+} 1. Don't accept just "calcium" 1. Accept presence of calcium ions leads to movement instead of binds Accept references to troponin
2(a)(ii)	1. Head (of myosin) binds to actin and moves/pulls/slides actin past; 2. (Myosin) detaches from actin and re-sets/moves further along (actin) 3. This uses ATP;	2 max	**Q** 1. Accept myosin power stroke (to move actin) 1. Accept push 1. Accept crossbridges form instead of myosin head binds to actin 1. Must refer to myosin head or crossbridges
2(b)(i)	1. (Glycogen broken down) gives (lots of) glucose for glycolysis/anaerobic respiration; 2. Glycolysis/anaerobic respiration not very efficient/only yields 2 ATP per glucose;	2	1. Give if context of anaerobic respiration clear 2. Accept anaerobic respiration is a quick source of ATP for exercise 2. Accept very little ATP
2(b)(ii)	1. (Many capillaries) give high concentration/lots of oxygen/ shorter diffusion pathway for oxygen/large surface area for oxygen exchange/diffusion; 2. Good glucose supply with little glycogen present; 3. Allows high rate of/more aerobic respiration ***OR*** prevents build-up of lactic acid/(muscle) fatigue;	2 max	3. Accept idea of aerobic respiration during endurance events/long periods of exercise

Question	Marking Guidance	Mark	Comments
3(a)	Three changes described;;; Eg 1. Formation/growth of vacuole; 2. Formation of starch grains/amyloplasts; 3. Movement of grains/amyloplasts towards bottom of cell; 4. Cells get longer/wider/larger;	3 max	Neutral nucleus shrinks, since it doesn't 2. Accept starch grains get bigger Note – list rule applies
3(b)	1. Grows sideways before starch grains form; 2. Bending starts when/as grains form; 3. More bending as grains increase in number; 4. More elongation (of cells)/growth (of roots) downwards as starch grains increase/move; 5. Bending starts before grains move down; 6. Could be related to vacuole;	3 max	**Q** 3. Ignore starch grain growth references 6. Ignore references to nucleus
3(c)	1. Greater (elongation) growth on top of root/less growth on bottom of root; 2. (IAA) at bottom of root/where IAA concentration high inhibits expansion/elongation (of cells); 3. (IAA) at top of root/where IAA concentration low leads to expansion/elongation (of cells);	2 max	Ignore references to effects of IAA on cell division Reject references to cell shrinkage 2 and 3 need reference to expansion/elongation, not just growth 3. Accept less inhibition

Question	Marking Guidance	Mark	Comments
4(a)	1. Positive correlation between sucrose and dopamine concentrations/higher concentration of sucrose, more dopamine; 2. So (dopamine) makes them want to drink/eat more (sucrose); 3. Positive feedback because drinking/eating leads to wanting to drink/eat (even) more;	3	**Q** NB question is 'How <u>do</u> these ...', not 'Do these .... 1. Ignore simple statements of numbers from graph without description of trend 3. It must be a clear statement of why this example is positive feedback, not inferred from points 1 and 2
4(b)	1. (Refractory period) leads to discrete/separate nerve impulses/time when another nerve impulse can't happen; ***OR*** (Refractory period) limits number of impulses per second/frequency of nerve impulses; 2. When maximum frequency reached/exceeded, no further increase in information/all (higher) concentrations of sucrose seem the same;	2	
4(c)	1. (Negative feedback) stops desire/wish to eat/appetite; 2. (This) limits amount eaten/stops eating; 3. Prevents/reduces risk of obesity/too much energy intake;	3	1. Accept stops dopamine release (in this context) 1. Accept makes them feel full 2. Accept prevents constant eating 3. Accept prevents vomiting Accept descriptions based on what would happen in absence of the feedback mechanism – or if stomach empty for points 1 and 2

Question	Marking Guidance	Mark	Comments
5(a)	4.9/4.89;; 38.62 – 36.82; 36.82	2 max	Correct answer = 2 marks
5(b)	Suitable reason with explanation;; Eg Suit prevents loss of sweat; So heat of evaporation not lost; ***OR*** Water (initially) at higher temperature than skin/body/blood; (So) heat gained/less lost (by conduction/convection);	2 max	Accept idea of no heat gradient Ignore references to 'by radiation'
5(c)	1. Yes for temperature and oxygen consumption/no for carbon dioxide; 2. Because P value (equal to, or) less than 0.05 (other than carbon dioxide)/ P value greater than 0.05 (for carbon dioxide);	2	2. Here assume understanding that 0.001 is less than 0.05 2. Accept correct use of < and > for less than and more than 2. Accept valid responses based on greater or less than 95%
5(d)	1. Increased temperature leads to faster enzyme activity; 2. Faster rate of respiration (and oxygen consumption);	2	1. Accept faster metabolism 2. Accept more oxygen for respiration to mean more respiration

Question	Marking Guidance	Mark	Comments
6(a)	Cytosine with Guanine <u>and</u> (Adenine) with Uracil;	1	Ignore G, C and U
6(b)	Two reasons, with suitable amplification;; Only infected cells have HIV protein on surface; So carrier only attaches to/specific to these cells/siRNA can only enter these cells; ***OR*** siRNA (base sequence) complementary/specific to one mRNA; Only infected cells contain mRNA of HIV/this gene/ stops translation of this gene/only binds to this mRNA /destroys this mRNA;	4 max	**Q** Accept idea of specificity Accept could not inhibit other/non- HIV mRNA
6(c)	1. Carrier binds to (protein on) HIV; 2. Prevents HIV/it binding to (receptor on human) cell;	2	1. Accept references to HIV membrane Reject references to binding to HIV protein on human cell

Question	Marking Guidance	Mark	Comments
7(a)	1. Causes sodium ion channels to open; 2. Sodium ions enter (cell and cause depolarisation);	2	1. Reject if wrong sequence of events Reject sodium on its own only once
7(b)	1. (If not removed) keeps binding (to receptors); 2. Keeps causing action potentials/depolarisation (in post-synaptic membrane); 3. Prevents information being carried across synapse/described consequence;	2 max	Accept answers based on what happens if it is transported out – ie what should happen 2. Accept keeps Na^+ channels open(ing)
7(c)	1. Movement in all groups (about) same before MDMA; 2. MDMA increases movement in Group **L**; 3. Group **K** shows MDMA causes movement; 4. No/little increase in mice without receptor/Group **M**;	3 max	**Q** 2. Accept normal mice for **L** 3. Accept **K** is a control

Question	Marking Guidance	Mark	Comments
8(a)	1. Carriers are heterozygous/have one normal copy and one mutant copy of gene/have one recessive allele/don't have the condition; 2. Both have DNA that binds (about) half/50% amount of probe (that non-carrier does); 3. Probe binds to dominant/healthy allele; 4. So only one copy of exon in their DNA/ have one copy of gene without exon/base sequence for probe to bind to;	3 max	3. Accept normal and gene 4. Accept have <u>a</u> deletion mutation
8(b)	1. Introns not translated/not in mRNA; 2. (Exons) code for amino acids/introns do not code for amino acids; 3. Mutations of these (exons) affect amino acid sequences; 4. (That produce) faulty protein/change tertiary structure of protein; 5. So important to know if parents' exons affected, rather than any other part of DNA/introns;	3 max	1. Accept not expressed 2. Accept polypeptide/protein for amino acids 3. Accept deletion leads to frameshift 4. In this context, accept affects protein made Accept converse arguments involving – eg introns do not code for amino acids/proteins Reject references to making amino acids, once
8(c)	1. Restriction mapping/described; 2. DNA/base sequencing (of fragments)/ description/name of method;	2	

Question	Marking Guidance	Mark	Comments
9(a)	1. No effect at 25°C; 2. Keeps growing at 30°C and 35°C/up to 35°C (more than without GB); 3. Above 35°C, falls but grows more than plant without GB;	2 max	The question only refers to plants <u>with</u> GB 1. Reject same mass 3. Accept at all temperatures above 25°C more growth than without GB
9(b)(i)	<u>Significantly</u> different /SEs do not overlap ;	1	Accept converse without GB
9(b)(ii)	(As temperature increases,) 1. Enzyme activity reduced/(some) enzymes denatured; 2. Less photosynthesis, so fewer sugars formed; 3. Less (complex) biological molecules/organic substances made (that add to mass); 4. Less respiration; 5. Less energy/ATP for growth; 6. Less energy for named function associated with growth	4 max	3. Accept named (significant) substance – eg cellulose. Do not accept glucose/simple sugars 6. Eg mitosis, uptake of mineral ions
9(c)	1. (Rubisco activase attaches to thylakoid and) this changes shape/tertiary structure (of enzyme)/blocks active site/changes active site; 2. (This) prevents substrate/RuBP entering active site/binding;	2	Note – question states enzyme stops working when it attaches to thylakoid, not before 1. Accept rubisco in this context 2. Accept prevents ES complex forming 2. Accept no longer complementary to substrate/RuBP

9(d)	1. GB prevents/reduces binding of rubiscoactivase to (thylakoid membrane); 2. (Prevents it) up to 35°C; 3. (So) rubiscoactivase/enzyme remains active; 4. (So) photosynthesis/light-independent stage still happens; 5. Above 35°C, some binding still occurs but less than without GB, so less reduction in growth;	4 max	1. Accept enzyme instead of rubiscoactivase. Accept rubisco 4. Accept descriptions of light-independent stage

9(e)	1. Looked for information/journals, on crop plants that grow at high temperatures; 2. (Crop plants cited in this research) contain/make GB; 3. So assumed making plants produce GB makes them resistant to high temperatures;	2 max	1. "other research" is minimum accepted 1. Accept previous experiments research with temperature resistant crops Ignore simple references to looking at previous studies/other plants – need to relate to this context

Additional notes on marking Question 10

Care must be taken in using these notes. It is important to appreciate that the only criteria to be used in awarding marks to a particular essay are those corresponding to the appropriate descriptors. Candidates may gain credit for any information providing that it is biologically accurate, relevant and of a depth in keeping with an A-level course of study. Material used in the essay does not have to be taken from the specification, although it is likely that it will be. In fact, extra credit is given for those who show evidence of a greater breadth of study. These notes must therefore be seen merely as guidelines providing an indication of areas of the specification from which suitable factual material might be drawn.

In determining the mark awarded for breadth, content should ideally come from each of the areas specified if maximum credit is to be awarded. Where the content is drawn from two areas, two marks should be awarded and where it is taken only from a single area, one mark should be awarded. However, this should only serve as a guide. This list is not exhaustive and examiners should be prepared to offer credit for the incorporation of relevant material from other areas of study.

Question	Marking Guidance	Mark	Comments
10(a)	**1.M** Membrane function as selectively permeable barrier **1.T** Transport mechanisms across membranes **1.CT** Absorption and co-transport of sodium ions and glucose **2.P** Photosynthesis, chloroplast, thylakoids **2.R** Respiration, mitochondrion and cristae **2.Ps** Protein secretion, RER, SER and Golgi **3.A** Surface receptors/antigen and immune response **3.CD** Cell division **3.B** Vertical and horizontal transmission – membranes and bacteria **3.Pc** Pacinian corpuscle **4.Tr** Tropisms – movement of IAA **4.N** Nerve impulses/action potentials **4.S** Synaptic transmission **4.Mc** Muscle contraction, calcium ion movement/storage **4.H** Hormones - eg Blood glucose regulation – insulin and glucagon **4.O** Osmosis, including water movement in plants	25	Examiners are free to select other letters if they wish The emphasis in answers should be on the <u>involvement of membranes</u> in processes, not just the processes themselves Breadth, one mark for use of an example from each of the following approaches: 1. Membranes – basic functions 2. Organelle membranes 3. Cell surface membranes 4. Processes – eg protein secretion, synaptic transmission, cell division

Question	Marking Guidance	Mark	Comments
10(b)	**1.P** Pathogens and effects on host **1.CH** Cholera **1.TB** TB **2.T** Taxonomy **2.C** Classification and evolution **2.I** Inheritance and evolution **2.Gc** Genetic code, universal **2.B** Behaviour **2.Ev** Populations and evolution, variation between individuals within a species **3.BP** Relationships within ecosystems – eg predator/prey **3.E** Energy transfer in ecosystems **3.N** Nutrient cycles, the organisms involved **3.S** Succession, biodiversity, species and individuals in a community **4.H** Human impacts on the environment and its effect on relationships between organisms – including farming **4.Gt** Gene technology and GMO and selective breeding **4.Ar** Antibiotic resistance	25	Examiners are free to select other letters if they wish The emphasis in answers should be on the relationships and interactions between organisms not just the topics themselves Breadth, one mark for use of an example from each of the following approaches – 3 max: 1. Pathogen and host 2. Evolution (related topics) 3. Ecological 4. Human intervention in relationships

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
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TOTAL	

General Certificate of Education
Advanced Level Examination
June 2012

Biology BIOL5

Unit 5 Control in cells and in organisms

Friday 22 June 2012 9.00 am to 11.15 am

For this paper you must have:
- a ruler with millimetre measurements.
- a calculator.

Time allowed
- 2 hours 15 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the boxes or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Advice
- You are advised to spend no longer than 40 minutes on the essay.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 The black mamba is a poisonous snake. Its poison contains a toxin.

The table shows the base sequence of mRNA that codes for the first two amino acids of this toxin.

Base sequence of anticodon on tRNA						
Base sequence of mRNA	**A**	**C**	**G**	**A**	**U**	**G**
Base sequence of DNA						

Complete the table to show

1 (a) (i) the base sequence of the anticodon on the first tRNA molecule that would bind to this mRNA sequence *(1 mark)*

1 (a) (ii) the base sequence of the DNA from which this mRNA was transcribed. *(1 mark)*

1 (b) The length of the section of DNA that codes for the complete toxin is longer than the mRNA used for translation. Explain why.

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(1 mark)

1 (c) A mutation in the base sequence of the DNA that codes for the toxin would change the base sequence of the mRNA.

Explain how a change in the base sequence of the mRNA could lead to a change in the tertiary structure of the toxin.

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(1 mark)

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1 (d) The black mamba's toxin kills prey by preventing their breathing. It does this by inhibiting the enzyme acetylcholinesterase at neuromuscular junctions. Explain how this prevents breathing.

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(3 marks)

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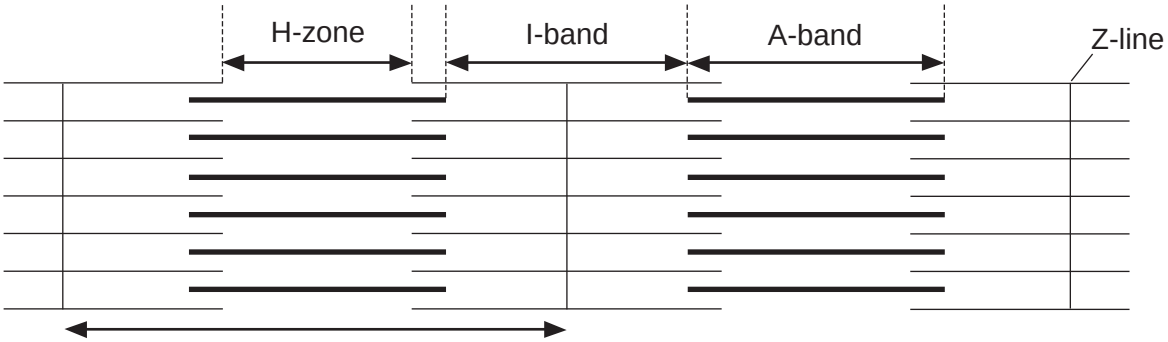
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Turn over for the next question

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2 The diagram shows two relaxed sarcomeres from skeletal muscle.



Length of sarcomere = 2.2 μm

2 (a) When the sarcomeres contract, what happens to the length of

2 (a) (i) the I-band

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(1 mark)

2 (a) (ii) the A-band?

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(1 mark)

2 (b) The length of each sarcomere in the diagram is 2.2 μm. Use this information to calculate the magnification of the diagram. Show your working.

Magnification .....

(2 marks)

Do not write outside the box

2 (c) People who have McArdle's disease produce less ATP than healthy people. As a result, they are not able to maintain strong muscle contraction during exercise. Use your knowledge of the sliding filament theory to suggest why.

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(3 marks)

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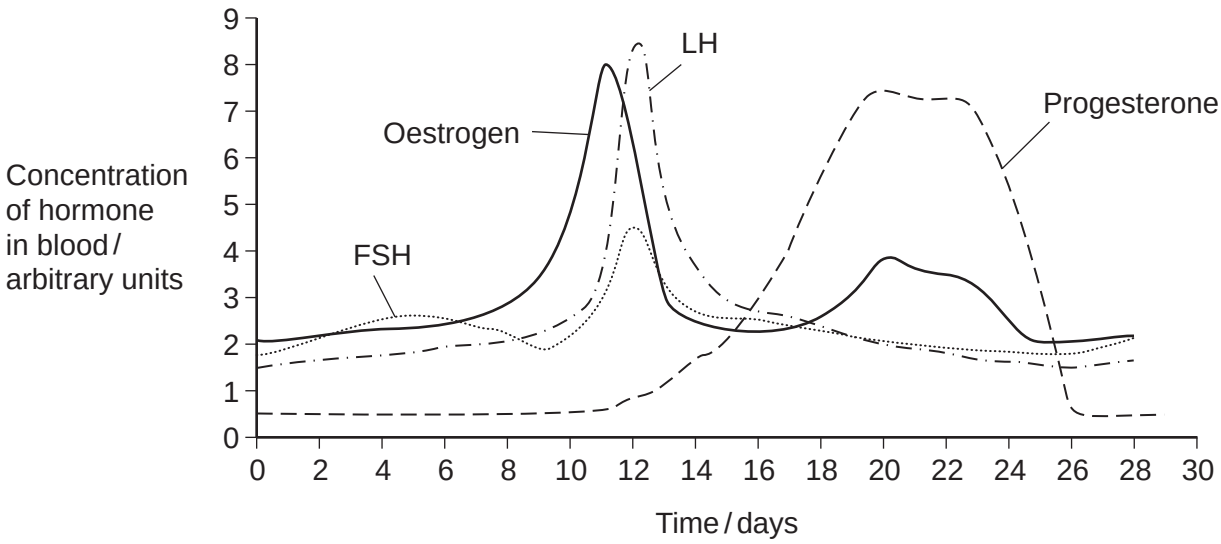
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Turn over for the next question

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3 The graph shows the concentration of four hormones in a woman's blood during one oestrous cycle.



3 (a) Explain how the graph supports the following statements.

3 (a) (i) Oestrogen causes the release of LH.

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(1 mark)

3 (a) (ii) The woman did **not** become pregnant during this cycle.

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(1 mark)

Do not write outside the box

3 (b) Implanon is a contraceptive device that is inserted under a woman's skin and prevents pregnancy for up to three years. It is a small rod that continuously releases progesterone into her blood. This progesterone prevents fertilisation from taking place.

3 (b) (i) Explain how Implanon prevents fertilisation from taking place.

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(4 marks)

(Extra space) .....

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3 (b) (ii) Suggest **one** advantage of using Implanon rather than an oral contraceptive.

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(1 mark)

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4 (a) Increased intensity of exercise leads to an increased heart rate. Explain how.

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(3 marks)

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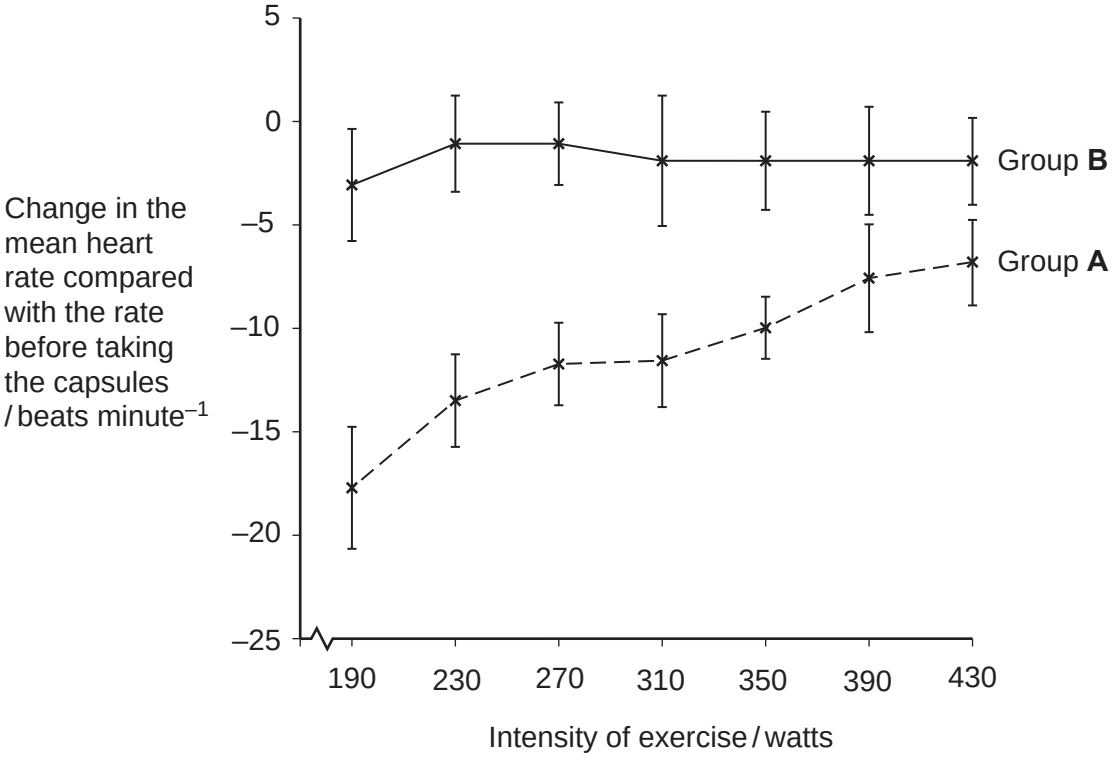
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4 (b) Scientists investigated the effect of taking omega-3 fatty acids in fish oil on heart rate during exercise. They recruited two large groups of volunteers, **A** and **B**. For each group, they measured the mean heart rates at different intensities of exercise. The volunteers were then given capsules to take for 8 weeks.

- Group **A** was given capsules containing omega-3 fatty acids in fish oil.
- Group **B** was given capsules containing olive oil.

After 8 weeks, they repeated the measurements of mean heart rates at different intensities of exercise. The graph shows their results. The bars represent the standard deviations.



Do not write outside the box

4 (b) (i) Group **B** was given capsules containing olive oil. Explain why.

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(1 mark)

4 (b) (ii) The scientists concluded that omega-3 fatty acids lower the heart rate during exercise. Explain how the information in the graph supports this conclusion.

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(3 marks)

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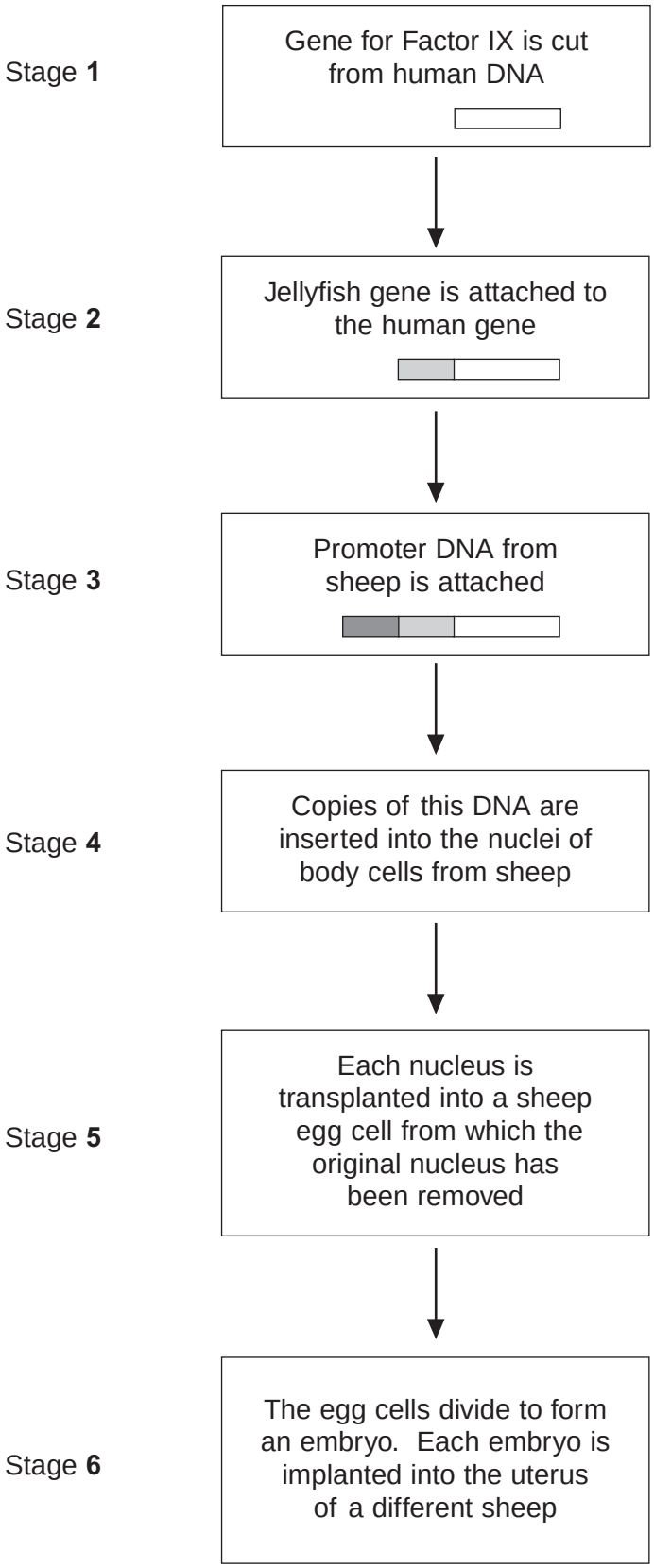
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Turn over for the next question

Do not write outside the box

5 Haemophilia is a genetic condition in which blood fails to clot. Factor IX is a protein used to treat haemophilia. Sheep can be genetically engineered to produce Factor IX in the milk produced by their mammary glands. The diagram shows the stages involved in this process.



Do not write outside the box

5 (a) Name the type of enzyme that is used to cut the gene for Factor IX from human DNA (Stage **1**) .

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(1 mark)

5 (b) (i) The jellyfish gene attached to the human Factor IX gene (Stage **2**) codes for a protein that glows green under fluorescent light. Explain the purpose of attaching this gene.

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(2 marks)

5 (b) (ii) The promoter DNA from sheep (Stage **3**) causes transcription of genes coding for proteins found in sheep milk.

Suggest the advantage of using this promoter DNA.

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(2 marks)

(Extra space) .....

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Question 5 continues on the next page

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5 (c) Many attempts to produce transgenic animals have failed. Very few live births result from the many embryos that are implanted.

5 (c) (i) Suggest **one** reason why very few live births result from the many embryos that are implanted.

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(2 marks)

(Extra space) .....

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5 (c) (ii) It is important that scientists still report the results from failed attempts to produce transgenic animals. Explain why.

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(2 marks)

9

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ANSWER IN THE SPACES PROVIDED

Turn over for Question 6

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6 (a) Adrenaline binds to receptors in the plasma membranes of liver cells. Explain how this causes the blood glucose concentration to increase.

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(2 marks)

(Extra space) .....

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6 (b) Scientists made an artificial gene which codes for insulin. They put the gene into a virus which was then injected into rats with type I diabetes. The virus was harmless to the rats but carried the gene into the cells of the rats.

The treated rats produced insulin for up to 8 months and showed no side-effects. The scientists measured the blood glucose concentrations of the rats at regular intervals. While the rats were producing the insulin, their blood glucose concentrations were normal.

6 (b) (i) The rats were not fed for at least 6 hours before their blood glucose concentration was measured. Explain why.

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(1 mark)

6 (b) (ii) The rats used in the investigation had type I diabetes. This form of gene therapy may be less effective in treating rats that have type II diabetes. Explain why.

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(1 mark)

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6 (b) (iii) Research workers have suggested that treating diabetes in humans by this method of gene therapy would be better than injecting insulin. Evaluate this suggestion.

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(4 marks)

(Extra space) .....

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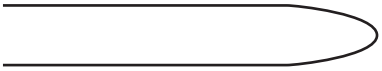
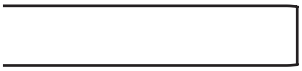
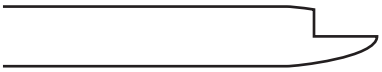
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Turn over for the next question

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7 Scientists investigated the response of the roots of pea seedlings to gravity.

They took three samples of seedlings, **A**, **B**, and **C**, and placed them so that their roots were growing horizontally. The root tips of each sample had been given different treatments. After a set time, the scientists recorded whether the roots of the seedlings had grown upwards or downwards and the amount of curvature. The table shows the treatment they gave to each sample and their results.

Treatment	Results	
	Direction of growth	**Mean amount of curvature / degrees**
A None 	Downwards	60
B Root tip removed 	Continues to grow horizontally	0
C Upper half of root tip removed 	Downwards	30

7 (a) The pea seedlings were kept in the dark after each treatment. Explain why this was necessary.

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(1 mark)

7 (b) What conclusion can be made from the results for treatment **B**?

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(1 mark)

Do not write outside the box

7 (c) Suggest how indoleacetic acid (IAA) could have caused the results for

7 (c) (i) treatment **A**

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(2 marks)

7 (c) (ii) treatment **C**.

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(2 marks)

6

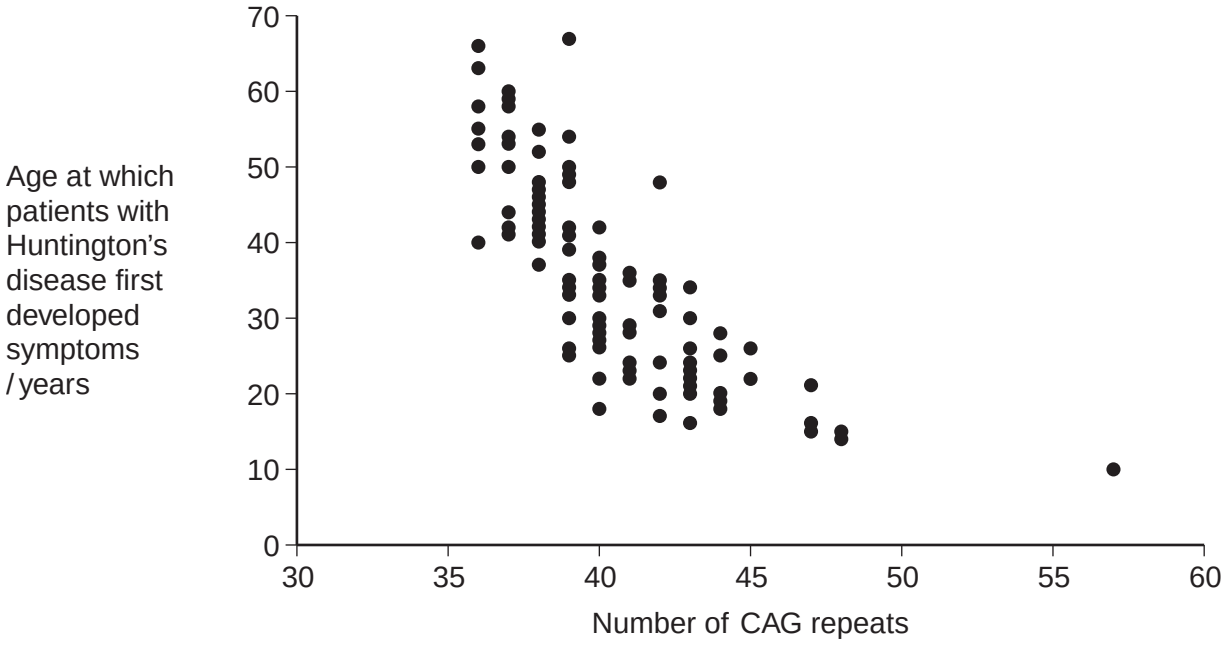
Turn over for the next question

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8 Huntington's disease is a genetic condition that leads to a loss in brain function. The gene involved contains a section of DNA with many repeats of the base sequence CAG. The number of these repeats determines whether or not an allele of this gene will cause Huntington's disease.

- An allele with 40 or more CAG repeats will cause Huntington's disease.
- An allele with 36 – 39 CAG repeats may cause Huntington's disease.
- An allele with fewer than 36 CAG repeats will not cause Huntington's disease.

The graph shows the age at which a sample of patients with Huntington's disease first developed symptoms and the number of CAG repeats in the allele causing Huntington's disease in each patient.



Do not write outside the box

8 (a) (i) People can be tested to see whether they have an allele for this gene with more than 36 CAG repeats. Some doctors suggest that the results can be used to predict the age at which someone will develop Huntington's disease.

Use information in the graph to evaluate this suggestion.

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(3 marks)

(Extra space) .....

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8 (a) (ii) Huntington's disease is always fatal. Despite this, the allele is passed on in human populations. Use information in the graph to suggest why.

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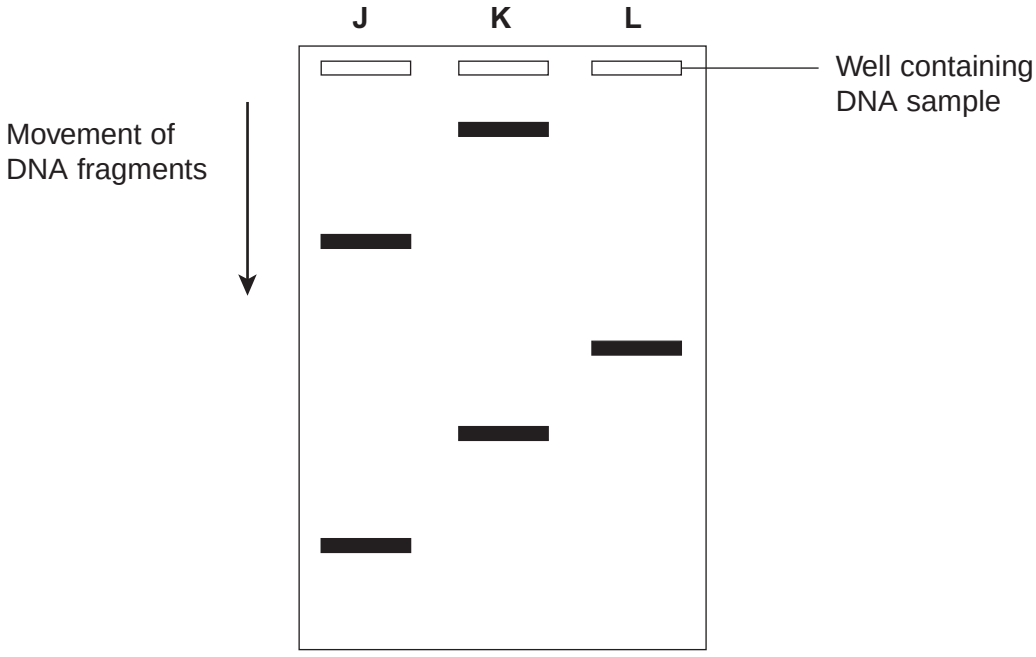
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(2 marks)

Question 8 continues on the next page

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8 (b) Scientists took DNA samples from three people, **J**, **K** and **L**. They used the polymerase chain reaction (PCR) to produce many copies of the piece of DNA containing the CAG repeats obtained from each person. They separated the DNA fragments by gel electrophoresis. A radioactively labelled probe was then used to detect the fragments. The diagram shows the appearance of part of the gel after an X-ray was taken. The bands show the DNA fragments that contain the CAG repeats.



8 (b) (i) Only one of these people tested positive for Huntington's disease. Which person was this? Explain your answer.

Person .....

Explanation .....

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(2 marks)

Do not write outside the box

8 (b) (ii) The diagram only shows part of the gel. Suggest how the scientists found the number of CAG repeats in the bands shown on the gel.

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(1 mark)

8 (b) (iii) Two bands are usually seen for each person tested. Suggest why only one band was seen for Person **L**.

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(1 mark)

9

Turn over for the next question

Do not write outside the box

9 Cows suffer from heat stress when the environmental temperature is too high. Heat stress occurs when their core body temperature rises above 39.4 °C. The table shows how environmental temperature affects the food intake, water intake and milk production of cows in a fixed period of time.

Environmental temperature / °C	Food intake / kg	Water intake / dm^3	Milk production / dm^3
20	18.2	81.8	27.0
25	17.7	88.6	25.0
30	17.0	95.0	22.9
35	16.7	144.1	18.0

9 (a) Calculate the percentage decrease in milk production between the temperatures of 30 °C and 35 °C. Show your working.

Answer ..... %

(2 marks)

9 (b) Suggest how each of the following responses helps to maintain core body temperature.

9 (b) (i) The change in water intake as environmental temperature increases.

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(1 mark)

9 (b) (ii) The change in food intake as environmental temperature decreases.

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(2 marks)

Do not write outside the box

9 (c) Explain the change in milk production as environmental temperature increases.

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(1 mark)

9 (d) The rectal temperatures of cows are recorded to monitor heat stress. This is a better measurement of core body temperature than measuring the temperature of the skin. Explain why.

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(2 marks)

9 (e) Selective breeding can be used to produce cows with desirable features. This involves mating cows with bulls. Suggest how a bull is selected to increase the probability of producing cows with a high milk yield.

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(1 mark)

Question 9 continues on the next page

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Milk contains lactose. Human babies produce the enzyme lactase, which digests lactose. Many human adults do not produce lactase and are lactose intolerant.

People who are lactose intolerant can become very ill if they drink milk or eat dairy products, such as butter and cheese.

9 (f) Scientists have recorded the percentage of adults who are lactose intolerant in different countries. Explain the advantage of using percentages in this type of study.

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(2 marks)

9 (g) The scientists found that the percentage of people who can tolerate lactose is much higher in populations that drink a lot of milk and eat a lot of dairy products.

Use your knowledge of natural selection to explain this finding.

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(4 marks)

(Extra space) .....

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Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy.

It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) The importance of shapes fitting together in cells and organisms.

(25 marks)

OR

10 (b) How bacteria can affect the lives of humans and other organisms.

(25 marks)

If you want to make a plan write it here.

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END OF QUESTIONS

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Version 1.1



General Certificate of Education (A-level)
June 2012

Biology BIOL5

(Specification 2410)

Unit 5: Control in Cells and in Organisms

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from: aqa.org.uk

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Although specific marks are not awarded in questions 1-7, marks will take into account the quality of written communication. Credit will only be awarded where candidates have presented information clearly and coherently and have used the specialist vocabulary indicated in the mark scheme for this unit. Specific references to the quality of written communications are marked **Q** in this mark scheme.

SECTION A

Question	Marking Guidance	Mark	Comments
1(a)(i)	UGC;	1	
1(a)(ii)	TGCTAC;	1	
1(b)	(DNA) contains introns/non-coding bases / mRNA only contains exons/coding bases;	1	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;	1	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;	3	3. 'Muscles contract' is not enough Accept: diaphragm stays contracted / cannot relax

Question	Marking Guidance	Mark	Comments
2(a)(i)	Decreases;	1	Accept any word that means a decrease e.g. shorter/narrower/ smaller etc
2(a)(ii)	Nothing / stays the same length / does not change;	1	
2(b)	1. Two marks for correct answer of 29545-30455; 2. One mark for incorrect answers in which candidate clearly divides measured width by actual width;	2	Correct answer = 2 marks outright. Range allows for a 1mm error in measuring Ignore rounding up
2(c)	(Idea ATP is needed for:) 1. Attachment/cross bridges between actin and myosin; 2. 'Power stroke' / movement of myosin heads / pulling of actin; 3. Detachment of myosin heads; 4. Myosin heads move back/to original position / 'recovery stroke';	3 max	1. Accept the role of ADP in attachment 2. Not just 'filaments slide' as given in the question stem

Question	Marking Guidance	Mark	Comments
3(a)(i)	1. LH increases/peaks after oestrogen increases/peaks; ***OR*** 2. Oestrogen increases/peaks before LH increases/peaks;	1	Need the idea of 'after' or 'before' Neutral: LH increases as oestrogen increases Neutral: oestrogen causes LH to be released as in stem of the question
3(a)(ii)	Progesterone falls / progesterone returns to start / progesterone not maintained;	1	Accept: FSH increases at end of the cycle
3(b)(i)	1. FSH inhibited; 2. Follicle not stimulated / ripened / does not grow; 3. LH inhibited; 4. Ovulation prevented / egg/ovum not released;	4	2. Accept: egg not ripened **Q** Neutral: egg/ovum not produced Only penalise if a <u>direct</u> incorrect statement is made e.g. LH inhibited so follicle not ripened = 1 mark FSH and LH inhibited so follicle not ripened and ovulation prevented = 4 marks
3(b)(ii)	Will not forget to take Implanon / may forget to take an oral contraceptive / does not have to be taken daily / not affected by illness/vomiting;	1	Neutral: ref. to lasting longer / acting quicker Neutral: 'constantly released' as given in the stem of the question Reject: oral contraceptives are digested Neutral: refs. to cost

Question	Marking Guidance	Mark	Comments
4(a)	1. (Oxygen/carbon dioxide) detected by chemoreceptors / (pressure) detected by baroreceptors; 2. Medulla/cardiac centre involved; 3. More impulses to SAN/along sympathetic nerve;	3	2. Accept a valid equivalent e.g. cardioacceleratory centre 3. Neutral: signals/messages Accept: acceleratory nerve Need idea of 'more impulses' directly, not by implication
4(b)(i)	1. To ensure results are due to omega-3/fatty acids (only) / not due to something else in the oil; 2. Placebo linked to mental/psychological effect;	1 max	Neutral: Idea of comparing groups/results Neutral: reference to a control group / placebo (unqualified)
4(b)(ii)	1. Lower/greater change of heart rate for Group **A**; 2. (Differences) are real / reliable / significant / not due to chance; 3. As bars do not overlap / values are not shared;	3	Ignore references to methodology

Question	Marking Guidance	Mark	Comments
5(a)	Restriction / endonuclease;	1	Ignore specific names of restriction enzymes e.g. EcoR1
5(b)(i)	1. (Acts as a) marker gene; 2. Shows that the (human) gene has been taken up/expressed; 3. (Only) implant cells/embryos that show fluorescence / contain the jellyfish gene;	2 max	1. Accept: gene marker
5(b)(ii)	1. Factor IX present in / extracted from milk; 2. Gene only expressed in mammary glands/udder / gene not expressed elsewhere; 3. Do not need to kill sheep (to obtain Factor IX);	2 max	2. Ignore references to milk The 'only' aspect is important here.
5(c)(i)	1. Mutation / nucleus/ chromosomes/DNA may be damaged / disrupts genes; 2. May interfere with proteins (produced)/gene expression/ translation; ***OR*** 3. Embryo/antigens foreign; 4. Embryo is rejected/attacked by immune system;	2 max	1. Neutral: cell may be damaged Ignore references to hormone levels or time of implantation 3. Neutral: antigens change 4. Need idea that the immune system is involved if mark point 3 has not been given 'Embryo foreign so rejected' = 2 marks 'Embryo rejected by immune system' = 1 mark 'Embryo is rejected' = 0 marks
5(c)(ii)	1. Saves time/money for others; 2. Same work is not repeated / methods can be compared/improved/ amended/ same errors are not made;	2	

Question	Marking Guidance	Mark	Comments
6(a)	1. Adenylate cyclase activated / cAMP produced / second messenger produced; 2. Activates enzyme(s) (in cell); 3. (So) glycogenolysis/ gluconeogenesis occurs / glycogenesis inhibited;	2 max	3. Neutral: 'glucose produced' as given in the question stem Accept: correct descriptions of these terms
6(b)(i)	1. Glucose/sugar in food would affect the results; 2. Food/eating would affect blood glucose (level); 3. (Allows time for) blood glucose (level) to return to normal;	1 max	1. Accept references to starch / carbohydrate 3. Neutral: allows time for insulin to act
6(b)(ii)	Type 2 diabetes is a failure to respond to insulin / still produces insulin / is not insulin-dependent;	1	
6(b)(iii)	(For) – 3 max 1. Avoids injections / pain of injections; 2. Long(er) lasting / permanent / (new) cells will contain/ express gene; 3. Less need to measure blood sugar / avoids the highs and lows in blood sugar; 4. Less restriction on diet; (Against) – 3 max 5. Rats are different to humans; 6. May have side effects on humans; 7. Long(er) term effects (of treatment) not known / may have caused effects after 8 months; 8. (Substitute) insulin may be rejected by the body;	4 max	A maximum of three marks can be awarded for each side of the argument Ignore references to methodology e.g. sample size not known 6. Accept: virus may be harmful / disrupt genes / cause cancer

Question	Marking Guidance	Mark	Comments
7(a)	1. (Seedlings) respond to light / are phototropic; ***OR*** 2. (Only) measuring the effect of gravity / response to gravity;	1	Reject: roots are positively phototropic / grow towards light Neutral: 'to control a variable' Neutral: light affects growth/results
7(b)	1. (Cells in) root tip detect gravity / respond to gravity; ***OR*** 2. IAA/auxin is produced in the root tip;	1	Must refer to root tip and not just the root
7(c)(i)	1. IAA/auxin moves to lower side / more IAA/auxin on lower side; 2. Lower side grows less/slower / upper side grows more /faster / inhibits growth on lower side;	2	Accept: references to 'cell elongation' instead of 'growth' Note: if auxin is placed at upper side, mark point 2 can still be awarded Need idea of 'less/slower' or 'more/faster' for mark point 2
7(c)(ii)	1. Less IAA/auxin (produced); 2. Lower side grows more/faster / less inhibition of growth on lower side;	2	2. Must refer to the lower side

Question	Marking Guidance	Mark	Comments
8(a)(i)	1. Negative correlation; 2. Wide range; 3. Overlap; 4. (Graph suggests that) other factors may be involved (in age of onset);	3 max	1. Accept: description for 'negative correlation' Neutral: 'correlation' Reject: positive correlation 2/3 Accept the use of figures from the graph 2/3 Can refer to age of onset or number of CAG repeats Ignore references to methodology
8(a)(ii)	1. Age of onset can be high / symptoms appear later in life; 2. (So) individuals have already had children / allele has been passed on; ***OR*** 3. Individuals have passed on the allele / already had children; 4. Before symptoms occur;	2 max	Accept: 'gene' for 'allele'
8(b)(i)	1. Person **K**; 2. (As has) high(est) band/band that travelled a short(est) distance/slow(er) <u>so</u> has large(st) fragment/number of CAG repeats;	2	2. Must correctly link distance moved and fragment size
8(b)(ii)	Run fragments of known length / CAG repeats (at the same time);	1	Accept: references to a DNA ladder / DNA markers Do not accept DNA sequencing
8(b)(iii)	Homozygous / (CAG) fragments are the same length/size/mass;	1	Accept: small fragment has run off gel / travelled further

Question	Marking Guidance	Mark	Comments
9(a)	1. 21 or 21.4; 2. One mark for the principle of difference/initial;	2	Correct answer = 2 marks outright Ignore number of decimal places
9(b)(i)	Water intake linked to sweating / panting;	1	Neutral: ref. to urine Neutral: dehydration
9(b)(ii)	1. Food intake linked to (increased) respiration; 2. Food intake linked to heat/energy release / maintaining body temperature;	2	1. Not 'increased metabolism' Reject: decreases respiration Neutral: references to environmental temperature increasing 2. This mark is independent of 1
9(c)	1. Increased sweating so less water available (for milk production); 2. Less food so less energy/nutrients available (for milk production); 3. Enzymes not working at optimum temperature;	1 max	2. Not just 'less energy available (for milk production)' 3. Reject: references to enzyme denaturation
9(d)	(Skin temperature) 1. Varies/fluctuates more / more heat lost/gained / (can be) further from core; 2. (As) more affected by environment / sweating / conduction / convection / radiation;	2	Accept: converse arguments for rectal temperature 2. Accept: 'not affected by' in relation to rectal temperature Accept: named environmental factors Accept: idea that skin is more exposed to the environment Accept refs. to vasoconstriction / vasodilation
9(e)	Select a bull whose mother/offspring produced a high milk yield;	1	

9(f)	1. Allows comparison; 2. (As) different countries have different population/ sample sizes;	2	
9(g)	1. (Selective) advantage producing lactase/ being lactose tolerant/able to digest milk/able to eat dairy foods; 2. People (producing lactase) reproduce; 3. (And) pass on gene/allele; 4. <u>Allele</u> frequency increases;	4	Accept: converse arguments for people who are lactose intolerant If mark point 2 has **not** already been given, then mark point 3 automatically gains 2 marks as reproduction must have occurred 4. Neutral: gene frequency increases / allele frequency changes Must be clearly stated and not implied

Additional notes on marking Question 10

Care must be taken in using these notes. It is important to appreciate that the only criteria to be used in awarding marks to a particular essay are those corresponding to the appropriate descriptors. Candidates may gain credit for any information providing that it is biologically accurate, relevant and of a depth in keeping with an A-level course of study. Material used in the essay does not have to be taken from the specification, although it is likely that it will be. In fact, extra credit is given for those who show evidence of a greater breadth of study. These notes must therefore be seen merely as guidelines providing an indication of areas of the specification from which suitable factual material might be drawn.

In determining the mark awarded for breadth, content should ideally come from each of the areas specified if maximum credit is to be awarded. Where the content is drawn from two areas, two marks should be awarded and where it is taken only from a single area, one mark should be awarded. However, this should only serve as a guide. This list is not exhaustive and examiners should be prepared to offer credit for the incorporation of relevant material from other areas of study.

Question 10

Essay A - The importance of shapes fitting together in cells and organisms

Section	Topic
	Proteins & Enzymes
3.1.2	Enzyme properties and digestion
3.1.2	Protein structure
3.1.3	Plasma membrane structure and cell transport
3.1.6	Antigens, antibodies, B cells & T cells
3.1.6	Vaccines
	Nucleic Acids
3.2.2	Structure of DNA
3.2.5	DNA Replication (not PCR)
3.5.7	Transcription & translation
3.5.8	Transcriptional factors, oestrogen, siRNA
3.5.8	Restriction enzymes
	Physiology
3.2.4	Haemoglobin
3.5.2	Action potentials & synaptic transmission
3.5.3	Muscle contraction
3.5.4	Control of blood glucose concentration
3.5.5	Control of mammalian oestrous cycle

Question 10

Essay B - How bacteria can affect the lives of humans and other organisms

Section	Topic
	Bacteria & Disease
3.1.1	Pathogens
3.1.2	Lactose intolerance
3.1.3	Cholera
3.1.4	Tuberculosis
3.2.10	Resistance to antibiotics
	Ecological Importance
3.4.6	Carbon cycle
3.4.6	Nitrogen cycle
3.4.6	Eutrophication
	Making Use of Bacteria
3.5.8	Use of bacterial enzymes e.g. restriction endonuclease, DNA polymerase for PCR
3.5.8	Use of bacterial plasmids e.g. *in vivo* gene cloning, genetically-modified crops, gene therapy
3.5.8	Use of bacteria to produce useful chemicals

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
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TOTAL	

General Certificate of Education
Advanced Level Examination
June 2011

Biology BIOL5

Unit 5 Control in cells and in organisms

Wednesday 22 June 2011 9.00 am to 11.15 am

For this paper you must have:
- a ruler with millimetre measurements.
- a calculator.

Time allowed
- 2 hours 15 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided.
- Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

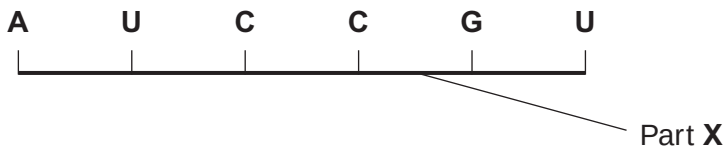
Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Advice
- You are advised to spend no longer than 40 minutes on the essay.

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Answer **all** questions in the spaces provided.

1 The diagram shows part of a pre-mRNA molecule.



1 (a) (i) Name the **two** substances that make up part **X**.

..... and .....

(1 mark)

1 (a) (ii) Give the sequence of bases on the DNA strand from which this pre-mRNA has been transcribed.

.....

(1 mark)

1 (b) (i) Give **one** way in which the structure of an mRNA molecule is different from the structure of a tRNA molecule.

.....

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(1 mark)

1 (b) (ii) Explain the difference between pre-mRNA and mRNA.

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(1 mark)

Do not write outside the box

1 (c) The table shows the percentage of different bases in two pre-mRNA molecules. The molecules were transcribed from the DNA in different parts of a chromosome.

Part of chromosome	Percentage of base			
	A	**G**	**C**	**U**
Middle	38	20	24	
End	31	22	26	

1 (c) (i) Complete the table by writing the percentage of uracil (U) in the appropriate boxes.

(1 mark)

1 (c) (ii) Explain why the percentages of bases from the middle part of the chromosome and the end part are different.

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(2 marks)

7

Turn over for the next question

Do not write outside the box

2 Different substances are involved in coordinating responses in animals.

2 (a) Hormones are different from local chemical mediators such as histamine in the cells they affect.

2 (a) (i) Describe how hormones are different in the cells they affect.

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(1 mark)

2 (a) (ii) Describe how hormones and local chemical mediators reach the cells they affect.

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(2 marks)

2 (b) Synapses are unidirectional. Explain how acetylcholine contributes to a synapse being unidirectional.

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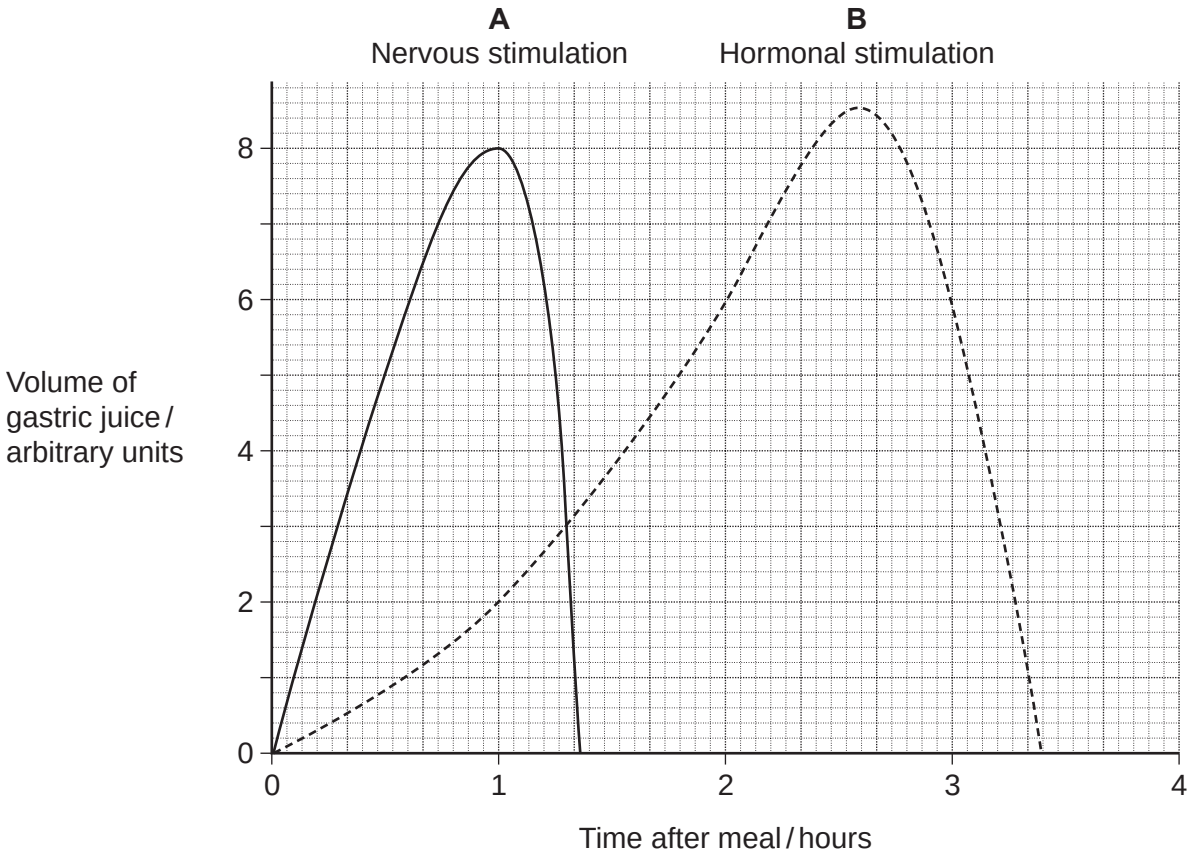
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(2 marks)

Do not write outside the box

2 (c) Cells in the stomach wall release gastric juice after a meal. The graph shows how the volumes of gastric juice produced by nervous stimulation and by hormonal stimulation change after a meal.



2 (c) (i) Describe the evidence from the graph that curve **A** represents the volume of gastric juice produced by nervous stimulation.

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(2 marks)

2 (c) (ii) Complete the table to show the percentage of gastric juice produced by nervous stimulation at the times shown.

	Time after meal / hours		
	1	**2**	**3**
Percentage of gastric juice produced by nervous stimulation			

(1 mark)

8

Do not write outside the box

3 IAA is a specific growth factor.

3 (a) Name the process by which IAA moves from the growing regions of a plant shoot to other tissues.

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(1 mark)

3 (b) When a young shoot is illuminated from one side, IAA stimulates growth on the shaded side. Explain why growth on the shaded side helps to maintain the leaves in a favourable environment.

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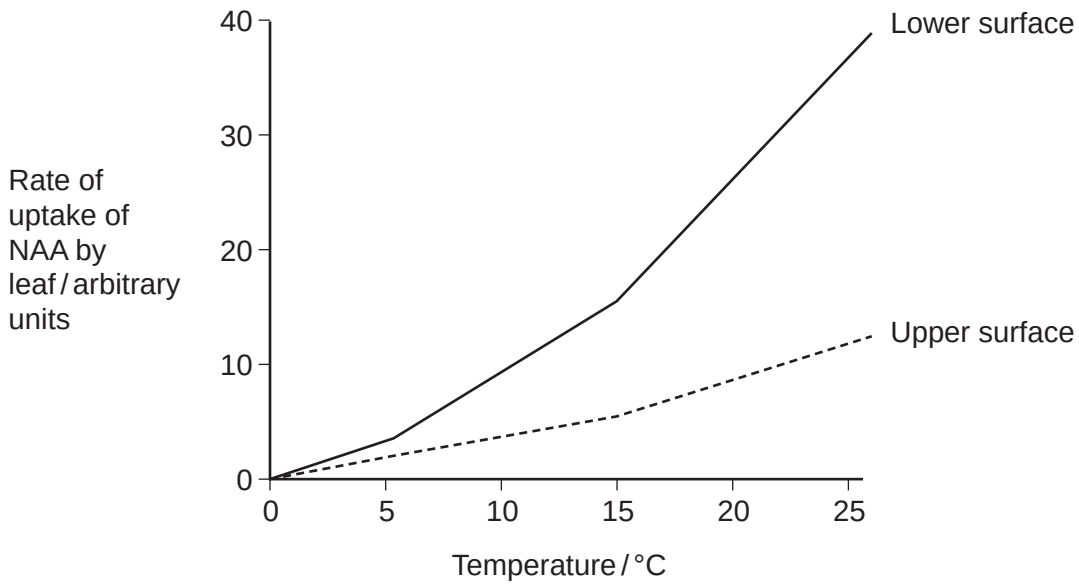
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(2 marks)

NAA is a similar substance to IAA. It is used to control the growth of cultivated plants. Plant physiologists investigated the effect of temperature on the uptake of NAA by leaves. They sprayed a solution containing NAA on the upper and lower surfaces of a leaf. The graph shows their results.



Do not write outside the box

3 (c) Explain the effect of temperature on the rate at which NAA is taken up by the lower surface of the leaf.

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(2 marks)

3 (d) There are differences in the properties of the cuticle on the upper and lower surfaces of leaves.

3 (d) (i) Suggest how these differences in the cuticle might explain the differences in rates of uptake of NAA by the two surfaces.

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(2 marks)

3 (d) (ii) In this investigation, the physiologists investigated the leaves of pear trees. Explain why the results might be different for other species.

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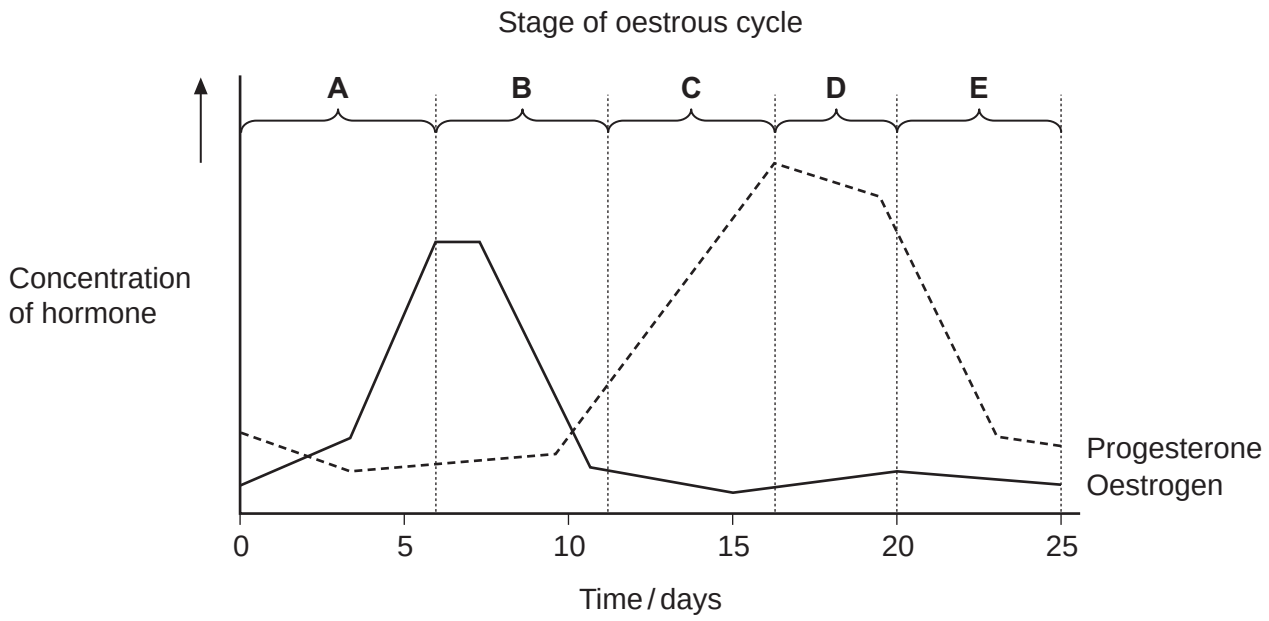
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(1 mark)

8

Do not write outside the box

4 The graph shows the concentrations of two hormones in the blood of an adult female pig over 25 days.



4 (a) (i) Use the graph to give the letter of the stage where ovulation occurred.

(1 mark)

4 (a) (ii) Give **one** piece of evidence from the graph that this pig was **not** pregnant at 25 days.

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(1 mark)

Do not write outside the box

4 (b) The relationship between oestrogen and LH is an example of positive feedback. Explain how.

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(2 marks)

4 (c) Farmers sometimes give progesterone to sheep to prevent ovulation. Explain how progesterone prevents ovulation.

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(2 marks)

6

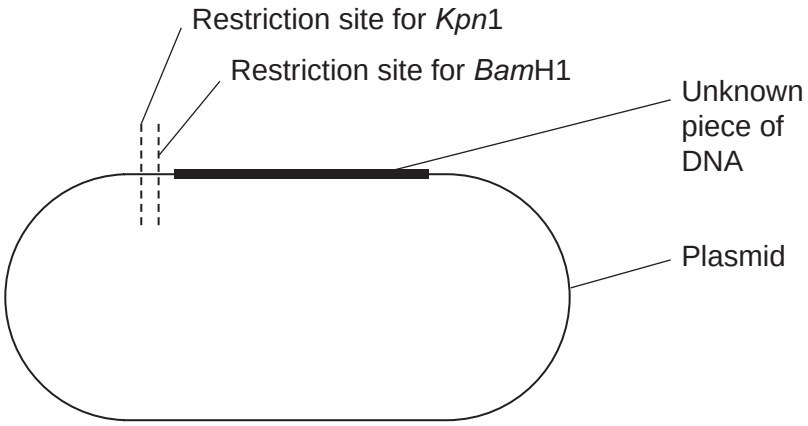
Turn over for the next question

Do not write outside the box

5 Scientists used restriction mapping to investigate some aspects of the base sequence of an unknown piece of DNA. This piece of DNA was 3 000 base pairs (bp) long.

The scientists took plasmids that had one restriction site for the enzyme *Kpn*1 and one restriction site for the enzyme *Bam*H1. They inserted copies of the unknown piece of DNA into the plasmids. This produced recombinant plasmids.

The diagram shows a recombinant plasmid.



5 (a) When the scientists digested one of the recombinant plasmids with *Kpn*1, they obtained two fragments. One fragment was measured as 1 000 bp.
The other fragment was described as "very large".

5 (a) (i) What does this show about the base sequence of the unknown piece of DNA?

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(2 marks)

5 (a) (ii) One of the fragments that the scientists obtained was described as "very large".
What is represented by this very large fragment?

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(1 mark)

Do not write outside the box

5 (b) When the scientists digested another of the recombinant plasmids with *Bam*H1, they obtained three fragments.

How many *Bam*H1 restriction sites are there in the unknown piece of DNA?

(1 mark)

5 (c) (i) Scientists can separate fragments of DNA using electrophoresis. Suggest how they can use electrophoresis to estimate the number of base pairs in the separated fragments.

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(2 marks)

5 (c) (ii) Scientists need to take precautions when they carry out restriction mapping. They need to make sure that the enzyme they have used has completely digested the DNA. One check they may carry out is to add the sizes of the fragments together. How could scientists use this information to show that the DNA has **not** been completely digested? Explain your answer.

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(2 marks)

8

Do not write outside the box

6 Plant physiologists attempted to produce papaya plants using tissue culture.
They investigated the effects of different concentrations of two plant growth factors on small pieces of the stem tip from a papaya plant. Their results are shown in the table.

Concentration of auxin / μmol dm^{-3}	**Concentration of cytokinin / μmol dm^{-3}**		
	5	25	50
0	No effect	No effect	Leaves produced
1	No effect	Leaves produced	Leaves produced
5	No effect	Leaves produced	Leaves and some plantlets produced
10	Callus produced	Leaves and some plantlets produced	Plantlets produced
15	Callus produced	Callus and some leaves produced	Callus and some leaves produced

Callus is a mass of undifferentiated plant cells.
Plantlets are small plants.

6 (a) Explain the evidence from the table that cells from the stem tip are totipotent.

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(2 marks)

6 (b) Calculate the ratio of cytokinin : auxin that you would recommend to grow papaya plants by this method.

Answer .....

(2 marks)

Do not write outside the box

6 (c) (i) Papaya plants reproduce sexually by means of seeds. Papaya plants grown from seeds are very variable in their yield. Explain why.

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(2 marks)

6 (c) (ii) Explain the advantage of growing papaya plants from tissue culture rather than from seeds.

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(1 mark)

7

Turn over for the next question

Do not write outside the box

7 (a) Desert iguanas are lizards that live in hot, dry conditions. Scientists measured the rate of oxygen consumption of desert iguanas at different body temperatures. Some of their results are shown in the table.

Body temperature / °C	Mean rate of oxygen consumption at rest / $cm^3 g^{-1} h^{-1}$
25	0.4
30	0.7
35	1.2
40	1.5

7 (a) (i) Explain how an increase in the iguana's body temperature affects its oxygen consumption when it is at rest.

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(3 marks)

(Extra space) .....

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7 (a) (ii) The units in the table allowed the scientists to compare the oxygen consumptions of different iguanas. Explain how.

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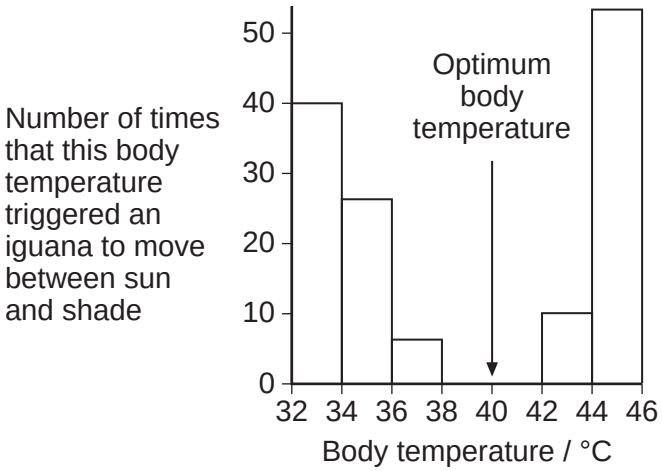
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(1 mark)

Do not write outside the box

7 (b) The scientists then investigated how body temperature affected the behaviour of desert iguanas. They kept the iguanas in cages. Half of each cage was in the sun and half was covered to provide shade. The scientists continuously measured the body temperature of each iguana. They also recorded the body temperature when the iguana moved between sun and shade. Their results are shown in the graph.



7 (b) (i) Describe how the movements of the iguanas between sun and shade are related to body temperature.

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(1 mark)

7 (b) (ii) The behaviour of the desert iguanas keeps their body temperatures within a narrow range. Explain how.

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(2 marks)

7 (c) At high temperatures, a desert iguana keeps its mouth wide open and breathes in and out rapidly. This is called panting. Explain how panting helps to reduce the body temperature of an iguana.

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(2 marks)

9

Do not write outside the box

8 (a) Transcriptional factors are important in the synthesis of particular proteins. Describe how.

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(2 marks)

8 (b) The flowchart shows how small interfering RNA (siRNA) affects the expression of a particular target gene.

1 A strand of siRNA combines with a protein to form an siRNA-protein complex.

↓

2 The siRNA-protein complex attaches to an mRNA molecule that codes for a particular protein.

↓

3 The siRNA-protein complex breaks the mRNA molecule down into smaller pieces.

8 (b) (i) The siRNA-protein complex attaches to an mRNA molecule coding for a particular protein (step **2**). Explain what causes the siRNA to attach only to one sort of mRNA molecule.

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(1 mark)

Do not write outside the box

8 (b) (ii) Describe and explain how expression of the target gene is affected by siRNA.

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(2 marks)

8 (b) (iii) Scientists have suggested that siRNA may be useful in treating some diseases. Suggest why siRNA may be useful in treating disease.

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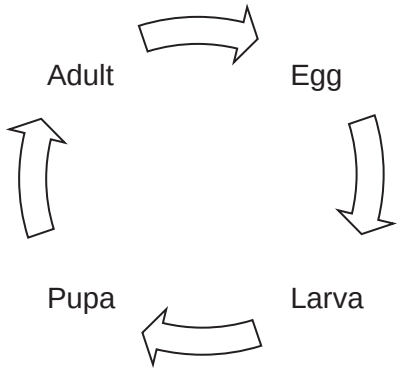
(2 marks)

7

Turn over for the next question

Do not write outside the box

9 The diagram shows the life cycle of a fly.



When the larva is fully grown, it changes into a pupa. The pupa does not feed. In the pupa, the tissues that made up the body of the larva are broken down. New adult tissues are formed from substances obtained from these broken-down tissues and from substances that were stored in the body of the larva.

9 (a) Hydrolysis and condensation are important in the formation of new adult proteins. Explain how.

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(2 marks)

9 (b) Most of the protein stored in the body of a fly larva is a protein called calliphorin. Explain why different adult proteins can be made using calliphorin.

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(1 mark)

The table shows the mean concentration of RNA in fly pupae at different ages.

Age of pupa as percentage of total time spent as a pupa	**Mean concentration of RNA / µg per pupa**
0	20
20	15
40	12
60	17
80	33
100	20

Do not write outside the box

9 (c) Describe how the concentration of RNA changes during the time spent as a pupa.

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(2 marks)

9 (d) (i) Describe how you would expect the number of lysosomes in a pupa to change with the age of the pupa. Give a reason for your answer.

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(2 marks)

9 (d) (ii) Suggest an explanation for the change in RNA concentration in the first 40 % of the time spent as a pupa.

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(2 marks)

9 (e) Suggest an explanation for the change in RNA concentration between 60 and 80 % of the time spent as a pupa.

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(2 marks)

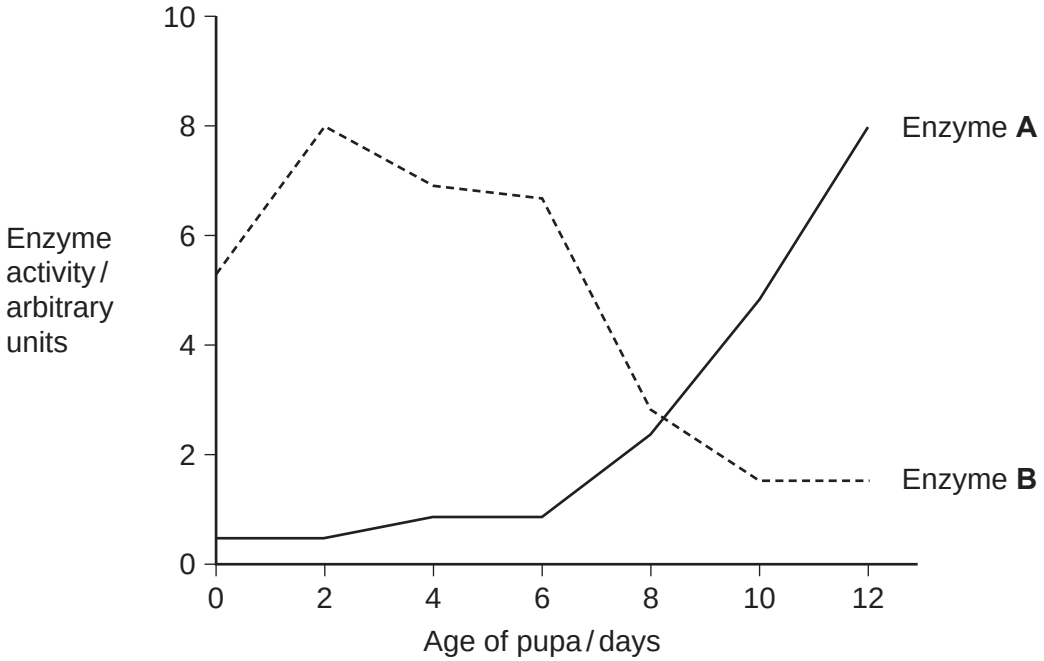
Question 9 continues on the next page

Turn over ▶

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9 (f) The graph shows changes in the activity of two respiratory enzymes in a fly pupa.

- Enzyme **A** catalyses a reaction in the Krebs cycle
- Enzyme **B** catalyses the formation of lactate from pyruvate



During the first 6 days as a pupa, the tracheae break down. New tracheae are formed after 6 days. Use this information to explain the change in activity of the two enzymes.

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(4 marks)

(Extra space) .....

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15

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Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) Using DNA in science and technology

(25 marks)

OR

10 (b) A cycle is a biological pathway or process in which the end product of one cycle becomes the starting point for the next cycle. Write an essay about cycles in biology.

(25 marks)

If you want to make a plan write it here.

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END OF QUESTIONS

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Version 1.0



General Certificate of Education (A-level)
June 2011

Biology BIOL5

(Specification 2410)

Unit 5: Control in Cells and in Organisms

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from: aqa.org.uk

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Although specific marks are not awarded in questions 1 – 9, marks awarded will take in to account the quality of written communication. Credit will only be awarded where candidates have presented information clearly and coherently and have used the specialist vocabulary indicated in the mark scheme for this unit. Specific references to quality of written communication are indicated in the guidance notes.

<table>
<tr><th>Question</th><th>Marking Guidelines</th><th>Mark</th><th>Comments</th></tr>
<tr><td>1(a)(i)</td><td>Phosphate and ribose;</td><td>1</td><td>Accept in either order. Both correct for one mark.
For phosphate accept PO_4 / Pi / (P) but not P.
Do not accept phosphorus.
Ignore references to pentose / sugar.</td></tr>
<tr><td>1(a)(ii)</td><td>TAGGCA;</td><td>1</td><td></td></tr>
<tr><td>1(b)(i)</td><td>Does not contain hydrogen bonds/base pairs /contains codons / does not contain anticodon / straight/not folded / no amino acid binding site/longer;</td><td>1</td><td>Assume that “it” refers to mRNA
Do not accept double stranded.</td></tr>
<tr><td>1(b)(ii)</td><td>(pre-mRNA) contains introns / mRNA contains only exons;</td><td>1</td><td>Assume that “it” refers to pre-mRNA
Accept non-coding as equivalent to intron.</td></tr>
<tr><td>1(c)(i)</td><td><table><tr><th>Part of chromosome</th><th>U</th></tr><tr><td>Middle</td><td>18</td></tr><tr><td>End</td><td>21</td></tr></table></td><td>1</td><td>One mark for both figures correct</td></tr>
</table>

1(c)(ii)	1. Different genes; 2. Have different (base) sequences / combinations of (bases); 3. (Pre-mRNA) transcribed from different DNA/codes for different proteins;	2 max	Note this question is not about the position of bases on genes. 1. Telomere on end is equivalent

<table>
<tr><th>Question</th><th>Marking Guidelines</th><th>Mark</th><th>Comments</th></tr>
<tr><td>2(a)(i)</td><td>Hormones have widespread effect / affect different organs / affect different parts of the body / affect distant organs / only affect cells with right receptor;</td><td>1</td><td>Assume “they” refers to hormones</td></tr>
<tr><td>2(a)(ii)</td><td>1. Hormones in blood;
2. Local chemical mediators spread by diffusion / spread directly;</td><td>2</td><td>1. May be awarded where candidates refer to both as “they”.</td></tr>
<tr><td>2(b)</td><td>1. (Acetylcholine) released from/in presynaptic side;
2. Diffusion from higher concentration/to lower concentration;
3. Receptors in postsynaptic (side) / binds on postsynaptic (side);</td><td>2 max</td><td>2. Mark for diffusion only awarded in context of unidirectional movement.</td></tr>
<tr><td>2(c)(i)</td><td>1. Rapid response;
2. Short duration;</td><td>2</td><td>Specific wording is not important. It is the principles that matter here.
Points may be made by referring to figures.</td></tr>
<tr><td>2(c)(ii)</td><td><table><tr><td></td><td>1</td><td>2</td><td>3</td></tr><tr><td>Percentage</td><td>80</td><td>0</td><td>0</td></tr></table></td><td>1</td><td>Ignore % sign</td></tr>
</table>

Question	Marking Guidelines	Mark	Comments
3(a)	Diffusion;	1	Ignore references to simple/facilitated Accept active transport
3(b)	1. Causes plant to bend/grow towards light / positive phototropism; 2. (Light) required for photosynthesis;	2	
3(c)	1. More kinetic energy; 2. Faster movement of molecules; 3. More diffusion;	2 max	Ignore references to opening stomata Answer should be in context of more but comparative statement only necessary once.
3(d)(i)	1. Thick cuticle on upper surface / thin cuticle on lower surface / few stomata on upper surface / no stomata on upper surface; 2. More diffusion / shorter diffusion pathway (on lower surface);	2	1. Ignore cuticle only on upper surface. Ignore references to more or less waxy. 2. If candidate writes about stomata accept ref to greater area for diffusion.
3(d)(ii)	Different species have different (qualified) properties;	1	Eg cuticle thickness Leaf size Number of stomata

Question	Marking Guidelines	Mark	Comments
4(a)(i)	B;	1	
4(a)(ii)	Fall in progesterone / progesterone same as at start / progesterone low at 25 days;	1	Ignore references to oestrogen
4(b)	Answer showing understanding of positive feedback i.e. more produces more / differs further; Answer showing understanding of positive feedback correctly linked to oestrogen and LH i.e. more oestrogen produces more LH;;	2	1 mark for basic idea 2 marks for idea illustrated correctly by example of oestrogen and LH Answer must relate to oestrogen increasing not just high oestrogen
4(c)	1. Progesterone has negative feedback effect / inhibits secretion of FSH/LH; 2. (FSH) stimulates follicle development / (LH) stimulates ovulation;	2	

Question	Marking Guidelines	Mark	Comments
5(a)(i)	1. Has the restriction site (cut by *Kpn*1); 2. Once; 3. 1000bp from *Kpn*1 on site of plasmid / ⅓ way along;	2	2. Must be explicit. Has a restriction site is point 1 only.
5(a)(ii)	(Most of) plasmid and rest of unknown DNA / rest of recombinant plasmid / rest of plasmid but not 1000 bp part;	1	Looking for idea rather than precise wording
5(b)	2;	1	
5(c)(i)	Give one mark for answer confined to smaller fragments move further/faster; Give two marks for comparing with distance/speed moved by fragments of known size/markers / DNA ladder;;	2	
5(c)(ii)	1. Large pieces of DNA present; 2. Add up to more than total length of original DNA / plasmid plus inserted DNA; 3. Because this would add undigested to total (original) length;	2	

Question	Marking Guidelines	Mark	Comments
6(a)	1. Gives rise to new plants/plantlets; 2. So must be able to develop into different tissues / other specialised cell types / differentiate;	2	1. Ignore references to leaves/callus
6(b)	Two marks for 5 : 1 / 50 :10 / 1 : 0.2;; One mark for ratio correctly identified but expressed incorrectly as 1 : 5 / 10 : 50 / 0.2 : 1;	2	
6(c)(i)	1. Meiosis; 2. Independent assortment / crossing over; 3. (Fusion of) genetically different gametes / random fertilisation;	2 max	
6(c)(ii)	Will be clones / produced by mitosis / will be genetically identical / less variation / all plants will have desired characteristics;	1	If the reference is to identical must be genetically identical, but allow less variation without the reference to genetical.

Question	Marking Guidelines	Mark	Comments
7(a)(i)	1. (Increased temperature) increases rate of reactions / increases kinetic energy / increases metabolism; 2. More energy/more ATP; 3. Oxygen consumption linked to respiration;	3	2 Needs reference to the idea of more.
7(a)(ii)	Units given per gram / per unit mass / mass is standardised / variation in mass taken into account;	1	Accept weight/size. Ignore references to other size-related parameters
7(b)(i)	Further away from the optimum, the greater the movement/least/no movement at optimum;	1	
7(b)(ii)	1. (Outside optimum temperature) moves (between sun and shade); 2. Warm up or cool down;	2	Accept converse of Does not move; At optimum temperature;
7(c)	1. Evaporation (of water from lining of mouth); 2. Heat transferred from blood;	2	

Question	Marking Guidelines	Mark	Comments
8(a)	1. Bind to DNA/gene; 2. At specific region/base sequence/promoter sequence; 3. Stimulate transcription / prevents transcription / turn on gene / turn off gene;	2 max	1. Generally attaching to DNA 2. At specific place 3. Accept description of transcription. Do not accept protein synthesis
8(b)(i)	Has complementary base sequence;	1	
8(b)(ii)	1. No longer able to make specific protein / cannot make whole protein / mRNA cannot be translated; 2. Because mRNA has been cut into pieces;	2	1. Reference to transcribes negates this point. 2. Do not accept mRNA destroyed / do not accept gene not expressed. Reference to target gene broken down negates this point.
8(b)(iii)	1. Some diseases are genetic / caused by mutations; 2. siRNA will stop product of this gene / the protein being produced / stops translation;	2	

Question	Marking Guidelines	Mark	Comments
9(a)	1. Hydrolysis breaks proteins / hydrolyses proteins / produces amino acids (from proteins); 2. Protein synthesis involves condensation; 3. Hydrolysis of polysaccharides/lipids linked to energy source (for synthesising proteins);	2 max	Do not award any credit if hydrolysis and condensation confused. 3. Accept hydrolysis of other molecules if related to protein synthesis
9(b)	Amino acids (from calliphorin) can be joined in different sequences/rearranged;	1	
9(c)	1. Fall, rise and fall; 2. Rise after 40 and fall after 80;	2	Ignore concentration values
9(d)(i)	Fall / increase then fall ; Lysosomes associated with tissue breakdown;	2	
9(d)(ii)	1. Tissues/cells are being broken down; 2. RNA is digested/hydrolysed/broken down; 3. By enzymes from lysosomes; 4. New proteins not made / no new RNA made;	2 max	
9(e)	1. (RNA) associated with making protein; 2. New / adult tissues are forming;	2	

9(f)	1. In the first 6 days no/little oxygen supplied / with breakdown of tracheae, no/little oxygen supplied; 2. (Without tracheae) respire anaerobically; 3. Anaerobic respiration involves reactions catalysed by enzyme **B** / conversion of pyruvate to lactate/involves lactate production; 4. Enzyme **A**/Krebs cycle is part of aerobic respiration;	4	Or, with emphasis on aerobic respiration: 1. Tracheae supply oxygen / after 6 days oxygen supplied; 2. (With tracheae) tissues can respire aerobically;

Additional notes on marking Question 10

Care must be taken in using these notes. It is important to appreciate that the only criteria to be used in awarding marks to a particular essay are those corresponding to the appropriate descriptors. Candidates may gain credit for any information providing that it is biologically accurate, relevant and of a depth in keeping with an A-level course of study. Material used in the essay does not have to be taken from the specification, although it is likely that it will be. In fact, extra credit is given for those who show evidence of a greater breadth of study.
These notes must therefore be seen merely as guidelines providing an indication of areas of the specification from which suitable factual material might be drawn.

In determining the mark awarded for breadth, content should ideally come from each of the areas specified if maximum credit is to be awarded. Where the content is drawn from two areas, two marks should be awarded and where it is taken only from a single area, one mark should be awarded. However, this should only serve as a guide. This list is not exhaustive and examiners should be prepared to offer credit for the incorporation of relevant material from other areas of study.

Essay A	**Using DNA in science and technology**
Section	
	DNA and classification
2.2	Structure of DNA
2.3	Differences in DNA lead to genetic diversity
2.9	Comparison of DNA base sequences
	DNA hybridisation
	Genetic engineering and making useful substances
1.3	Plasmids
5.8	The use of recombinant DNA to produce transformed organisms that benefit humans
	Other uses of DNA
2.5	Cell cycle and treatment of cancer
5.8	Gene therapy;
	Medical diagnosis and the treatment of human disease;
	The use of DNA probes to screen patients for clinically important genes;

Essay B	**A cycle is a biological pathway or process in which the end product of one cycle becomes the starting point for the next. Write an essay about cycles in biology.**
Section	
	Ecological cycles
4.6	Nutrient cycles
	Carbon cycle
	Nitrogen cycle
	Biochemical cycles
1.2	Enzyme action
4.2	Synthesis of ATP from ADP
4.3	Light-independent reaction
4.4	The Krebs cycle
	Physiological and genetic cycles
1.4	The mechanism of breathing
1.5	The cardiac cycle
2.5	The cell cycle
5.3	Muscle contraction
5.5	Oestrous cycle

UMS conversion calculator www.aqa.org.uk/umsconversion

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2010

Biology BIOL5

Unit 5 Control in cells and in organisms

Friday 25 June 2010 1.30 pm to 3.45 pm

For this paper you must have:
- a ruler with millimetre measurements.
- a calculator.

Time allowed
- 2 hour 15 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided.
- Do not write outside the boxes or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific vocabulary accurately.

Do not write outside the box

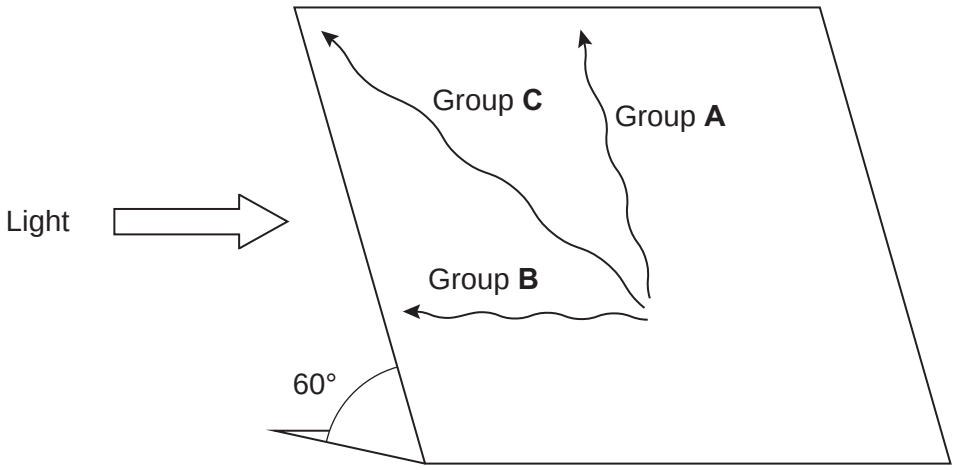
Answer **all** questions in the spaces provided.

1 Termites are insects. Some species live in colonies in the soil. Although most termites are wingless, winged termites are sometimes produced. The winged termites fly from the soil, mate and start new colonies.

A scientist studied the behaviour of winged termites. He divided these termites into three groups.

- Group **A** had their eyes covered.
- Group **B** had their antennae removed.
- Group **C** was the control group.

He put individual winged termites on a sloping board that was illuminated from one side. The diagram shows the direction of movement of a typical termite from each of the three groups.



1 (a) (i) What type of behaviour was shown by the termite from group **B**?

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(1 mark)

1 (a) (ii) Give the evidence for your answer.

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(1 mark)

Do not write outside the box

1 (b) Explain what the results from group **A** suggest about the factors controlling the behaviour of winged termites.

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(3 marks)

(Extra space).....

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1 (c) Suggest **one** advantage to the termites from group **C** of the behaviour shown in the investigation.

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(2 marks)

7

Turn over for the next question

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There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

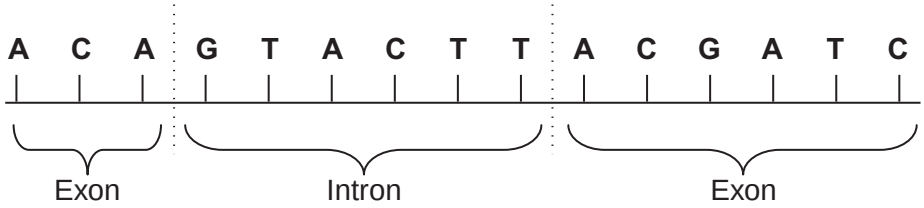
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2 (a) Complete the table to show the differences between DNA, mRNA and tRNA.

Type of nucleic acid	Hydrogen bonds present (✓) or not present (✗)	Number of polynucleotide strands in molecule
DNA		
mRNA		
tRNA		

(2 marks)

2 (b) The diagram shows the bases on one strand of a piece of DNA.



2 (b) (i) In the space below, give the sequence of bases on the pre-mRNA transcribed from this strand.

(2 marks)

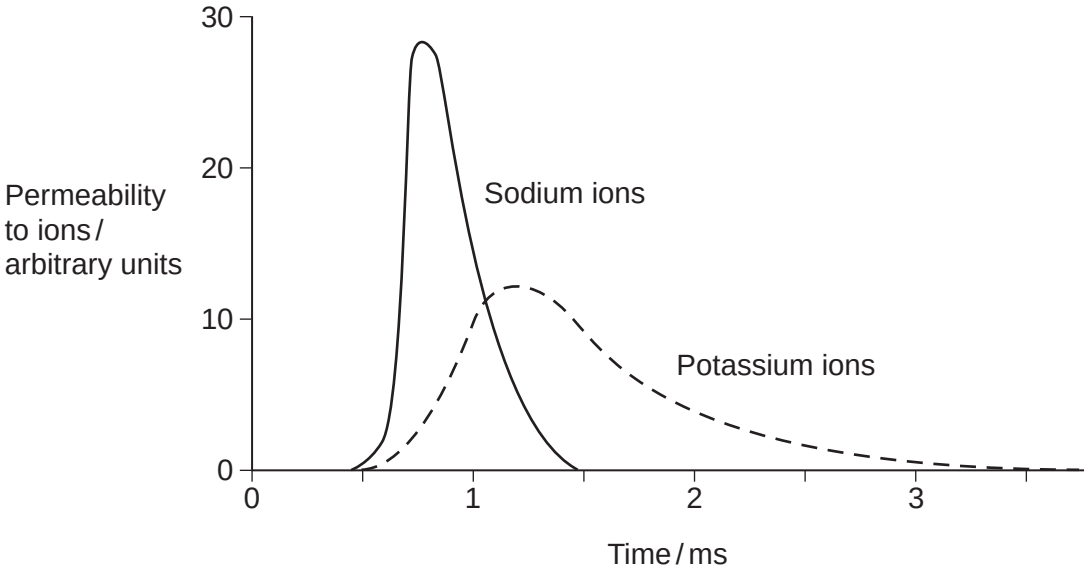
2 (b) (ii) In the space below, give the sequence of bases on the mRNA produced by splicing this piece of pre-mRNA.

(1 mark)

5

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3 During an action potential, the permeability of the cell-surface membrane of an axon changes. The graph shows changes in permeability of the membrane to sodium ions (Na^+) and to potassium ions (K^+) during a single action potential.



3 (a) Explain the shape of the curve for sodium ions between 0.5 ms and 0.7 ms.

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(3 marks)

(Extra space).....

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Do not write outside the box

3 (b) During an action potential, the membrane potential rises to +40 mV and then falls. Use information from the graph to explain the fall in membrane potential.

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(3 marks)

(Extra space).....

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3 (c) After exercise, some ATP is used to re-establish the resting potential in axons. Explain how the resting potential is re-established..

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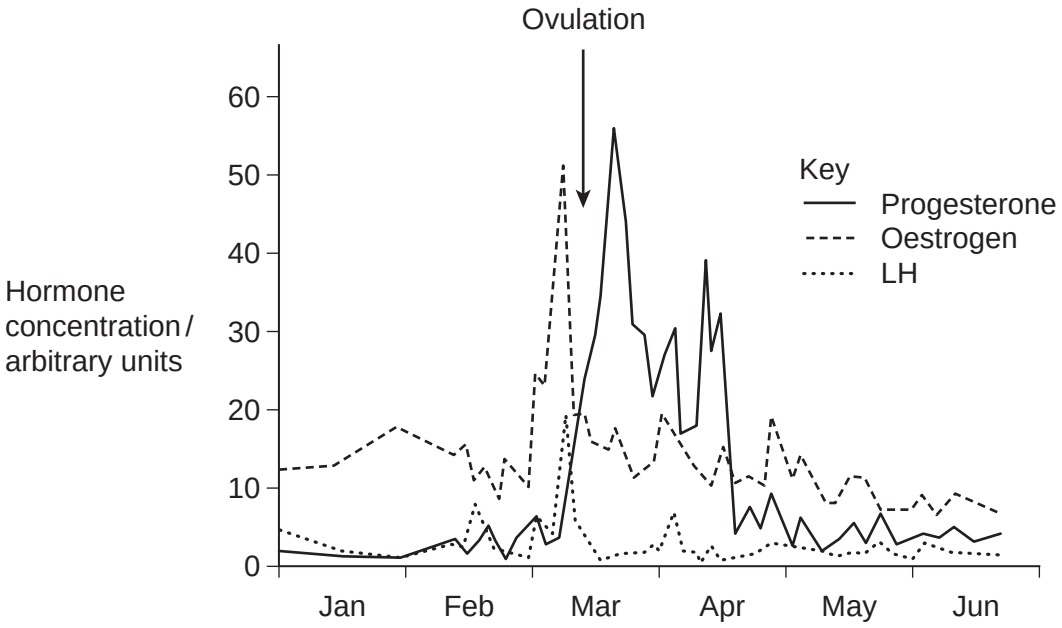
(2 marks)

8

Turn over for the next question

Do not write outside the box

4 Scientists investigated control of ovulation in a species of mammal. They measured the concentration of some hormones in the blood of females between January and June. The graph shows the results for one animal.



4 (a) The concentration of LH in the blood is controlled by negative feedback. Use the curves for progesterone and LH to explain how.

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(3 marks)

(Extra space) .....

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4 (b) (i) Explain how the change in progesterone concentration in March shows that ovulation took place at the time indicated.

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(2 marks)

4 (b) (ii) **Two** pieces of information from the graph, other than the change in progesterone concentration, show that ovulation took place at the time indicated. Explain how.

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(4 marks)

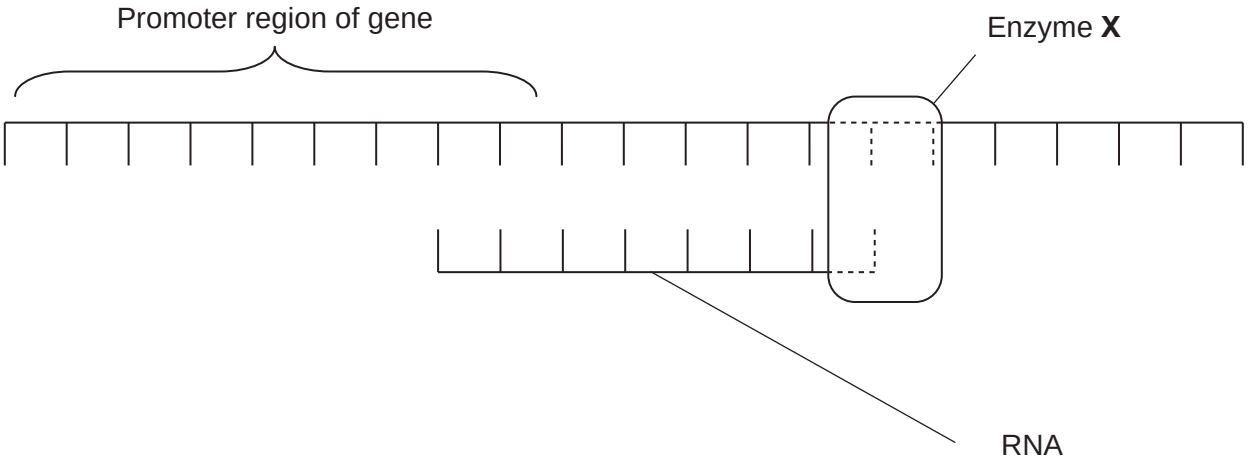
9

Turn over for the next question

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5 **Figure 1** shows part of a gene that is being transcribed.

Figure 1



5 (a) Name enzyme **X**.

.....

(1 mark)

5 (b) (i) Oestrogen is a hormone that affects transcription. It forms a complex with a receptor in the cytoplasm of target cells. Explain how an activated oestrogen receptor affects the target cell.

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(2 marks)

5 (b) (ii) Oestrogen only affects target cells. Explain why oestrogen does not affect other cells in the body.

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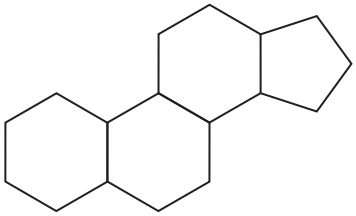
(1 mark)

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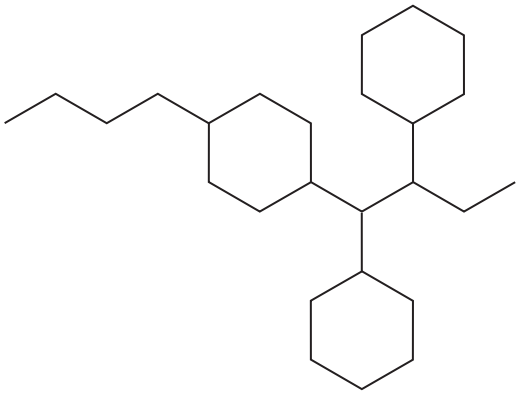
5 (c) Some breast tumours are stimulated to grow by oestrogen. Tamoxifen is used to treat these breast tumours. In the liver, tamoxifen is converted into an active substance called endoxifen.
Figure 2 shows a molecule of oestrogen and a molecule of endoxifen.

Figure 2

Oestrogen



Endoxifen



Use **Figure 2** to suggest how endoxifen reduces the growth rate of these breast tumours.

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(2 marks)

6

Turn over for the next question

Do not write outside the box

6 SCID is a severe inherited disease. People who are affected have no immunity. Doctors carried out a trial using gene therapy to treat children with SCID. The doctors who carried out the trial obtained stem cells from each child's umbilical cord.

6 (a) Give **two** characteristic features of stem cells.

1 .....

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2 .....

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(2 marks)

The doctors mixed the stem cells with viruses. The viruses had been genetically modified to contain alleles of a gene producing full immunity. The doctors then injected this mixture into the child's bone marrow.

The viruses that the doctors used had RNA as their genetic material. When these viruses infect cells, they pass their RNA and two viral enzymes into the host cells.

6 (b) One of the viral enzymes makes a DNA copy of the virus RNA. Name this enzyme.

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(1 mark)

Do not write outside the box

The other viral enzyme is called integrase. Integrase inserts the DNA copy anywhere in the DNA of the host cell. It may even insert the DNA copy in one of the host cell's genes.

6 (c) (i) The insertion of the DNA copy in one of the host cell's genes may cause the cell to make a non-functional protein. Explain how.

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(2 marks)

6 (c) (ii) Some of the children in the trial developed cancer. How might the insertion of the DNA have caused cancer?

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(2 marks)

6 (d) Five out of the 20 children in the trial developed cancer. Although the cancer was treated successfully, the doctors decided to stop the trial in its early stages. They then reviewed the situation and decided to continue. Do you agree with their decision to continue? Explain your answer.

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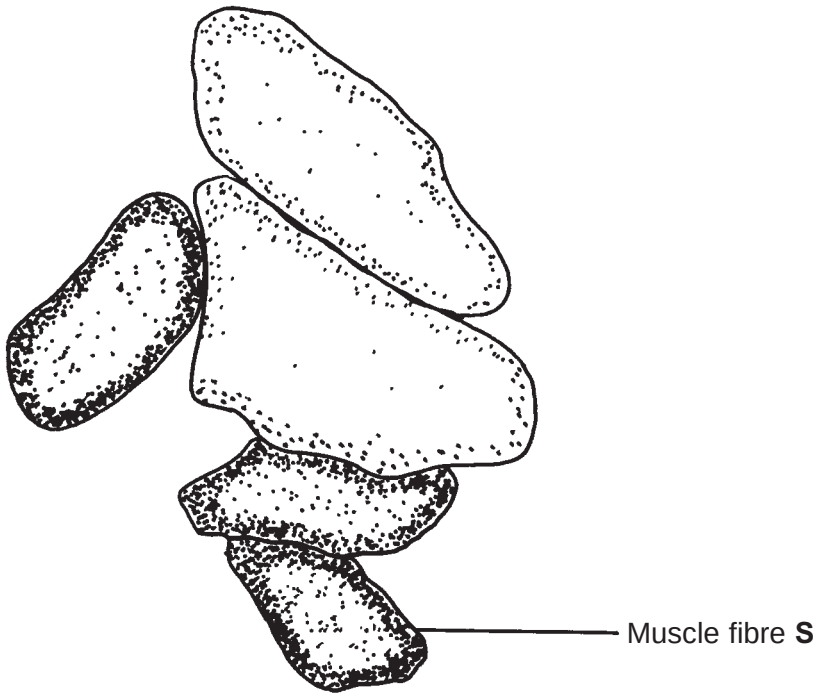
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(2 marks)

9

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7 The drawing is a tracing of a cross-section through skeletal muscle tissue. This muscle contains fast muscle fibres and slow muscle fibres. The section has been stained to show the distribution of the enzyme succinate dehydrogenase. This enzyme is found in mitochondria.



7 (a) (i) Succinate dehydrogenase catalyses one of the reactions in the Krebs cycle. What is the evidence from the drawing that muscle fibre **S** is a slow muscle fibre? Explain your answer.

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(2 marks)

Do not write outside the box

7 (a) (ii) Use evidence from the diagram to describe the distribution of mitochondria inside the slow muscle fibres. Explain the importance of this distribution.

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(3 marks)

(Extra space).....

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7 (b) (i) You could use an optical microscope and a slide of stained muscle tissue to find the diameter of one of the muscle fibres. Explain how.

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(2 marks)

7 (b) (ii) A student found the mean diameter for the slow muscle fibres in a section. Give **two** precautions that she should have taken when sampling the fibres. Give a reason for each precaution.

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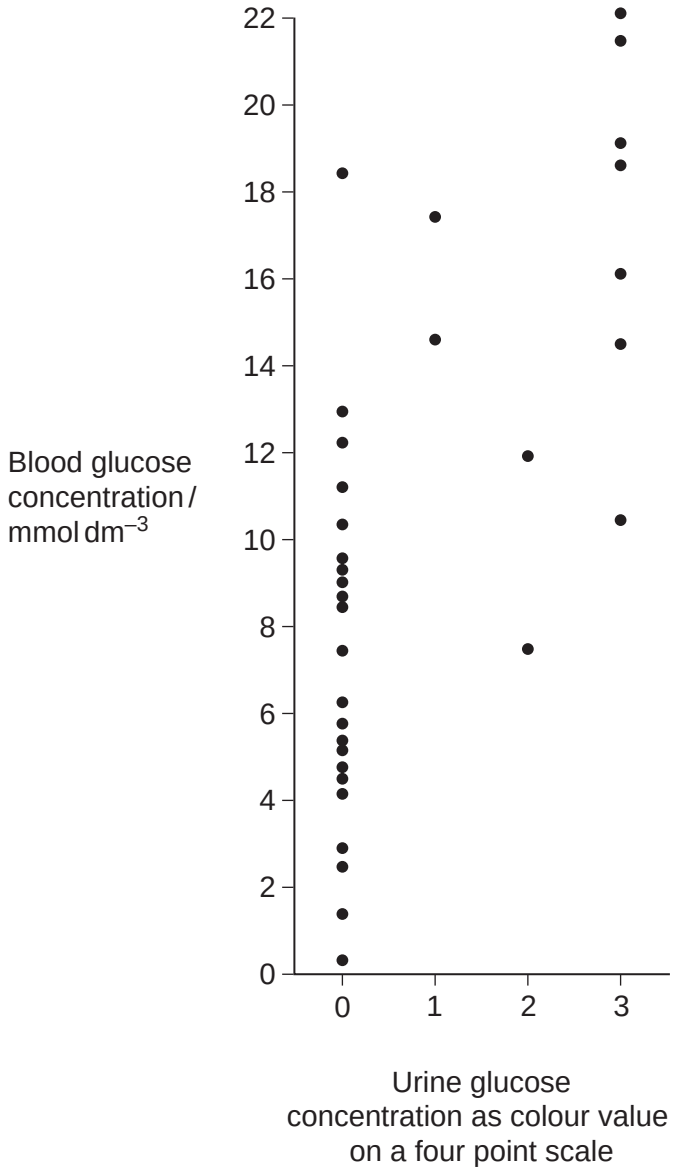
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(2 marks)

9

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8 (a) Technicians in a hospital laboratory tested urine and blood samples from a girl with diabetes at intervals over a one-year period. Each time the technicians tested her urine, they also measured her blood glucose concentration. Their results are shown in the graph.



Do not write outside the box

8 (a) (i) The girl who took part in this investigation was being successfully treated with insulin. The graph shows that on some occasions, the concentration of glucose in her blood was very high. Suggest why.

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(2 marks)

8 (a) (ii) Use the graph to evaluate the use of the urine test as a measure of blood glucose concentration.

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(3 marks)

(Extra space).....

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8 (b) Diabetic people who do not control their blood glucose concentration may become unconscious and go into a coma. A doctor may inject a diabetic person who is in a coma with glucagon. Explain how the glucagon would affect the person's blood glucose concentration.

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(2 marks)

7

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9 There are wolves in many European countries. Scientists investigated the genetic diversity of these wolves. They collected samples of DNA from the mitochondria of wolves from different countries. For each sample they identified which haplotypes were present in the DNA. A haplotype is a particular sequence of bases on DNA. Mutations can produce new haplotypes.

Country	Number of wolves sampled	Number of different haplotypes in mitochondrial DNA
Spain	84	3
Portugal	19	2
Italy	101	1
France	7	1
Bulgaria	29	6
Sweden	93	1

The scientists wanted to find out whether one of the haplotypes in the Portuguese wolves was the same as one of those in the Spanish wolves. They used a restriction endonuclease, electrophoresis and a labelled DNA probe.

9 (a) For what purpose did they use

9 (a) (i) the restriction endonuclease

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(1 mark)

9 (a) (ii) electrophoresis?

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(1 mark)

9 (b) Explain why the labelled DNA probe could be used to find out whether the haplotypes were the same.

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(2 marks)

Do not write outside the box

9 (c) Two hundred years ago there were many wolves in Italy. By the 1970s there were fewer than 100 wolves left. Since 1980, wolves have increased in number and have spread to France.

9 (c) (i) Use this information to explain the number of haplotypes in the Italian wolves.

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(2 marks)

9 (c) (ii) Suggest an explanation for the number of haplotypes in the wolves that have spread to France.

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(1 mark)

9 (d) The scientists analysed the DNA on the Y chromosome and the DNA in the mitochondria of the Swedish wolves. They concluded that the Swedish wolf population descended from one male wolf from Finland and one female wolf from Russia.

9 (d) (i) Explain why DNA on the Y chromosome helped them to reach this conclusion.

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(1 mark)

9 (d) (ii) Suggest why DNA in the mitochondria helped them to reach this conclusion.

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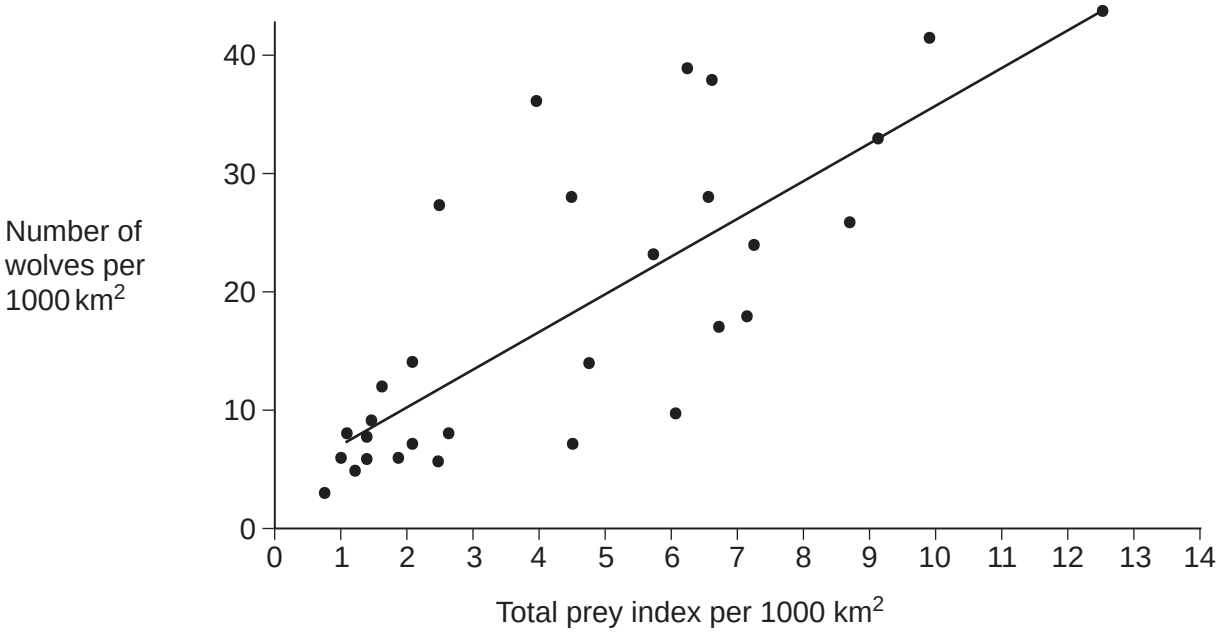
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(1 mark)

Question 9 continues on the next page

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Wolves eat different mammals. An ecologist investigated factors that affect wolf numbers in North America. He collected data from different field studies carried out in different places. The graph shows his results.



9 (e) (i) The wolf numbers are given per unit area. Explain why.

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(2 marks)

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9 (e) (ii) The ecologist calculated the total prey index for each of the places that had been studied. In order to do this, he gave each prey species a value based on how much food was available to wolves from the prey animal concerned. He called this value the prey index.

The ecologist considered that the prey index gave a better idea of the food available than the prey biomass in kg. Suggest why the prey index gives a better idea of food available.

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(2 marks)

9 (f) The ecologist calculated the total prey index by combining the prey indices and the total number of animals of each species present in 1000 km^2. He plotted this information on the graph.
What does the graph suggest about the factors that determine wolf numbers in North America? Explain your answer.

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(2 marks)

15

Turn over for the next question

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ESSAY

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and from the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) Carbon dioxide may affect organisms directly or indirectly. Describe and explain these effects. *(25 marks)*

OR

10 (b) The causes of disease in humans. *(25 marks)*

If you want to make a plan write it here.

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END OF QUESTIONS

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Version 1.0: 02/2010

General Certificate of Education
June 2010

Biology BIOL5

Control in cells and in organisms

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

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Although specific marks are not awarded in questions 1 – 7, marks awarded will take in to account the quality of written communication. Credit will only be awarded where candidates have presented information clearly and coherently and have used the specialist vocabulary indicated in the mark scheme for this unit. Specific references to quality of written communication are included in the Comments column in this mark scheme.

Question	Marking guidance	Mark	Comments
1(a)(i)	Taxis;	1	Ignore references to positive and negative, and prefixes such as photo- Accept taxes/tactic Allow phonetic spelling
1(a)(ii)	Moves towards stimulus/towards light;	1	Direction must be correct.
1(b)	Gravity; Antennae involved; Doesn't show light is involved/doesn't respond to light as they are unable to see/as eyes are covered;	3	Accept geotaxis
1(c)	Helps them to leave the soil/ground/reach the surface; Disperse/produce new colonies; Avoid competition;	2 max	

<table>
<tr><th>Question</th><th>Marking guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>2(a)</td><td><table>
<tr><td>DNA</td><td>✓</td><td>2</td></tr>
<tr><td>mRNA</td><td>x</td><td>1</td></tr>
<tr><td>tRNA</td><td>✓</td><td>1</td></tr>
</table></td><td>2</td><td>One mark for each correct column
Regard blank as incorrect in the context of this question
Accept numbers written out: two, one, one</td></tr>
<tr><td>2(b)(i)</td><td>Marking principles
1 mark for complete piece transcribed;

1 mark for complementary bases from sequence transcribed;</td><td>2</td><td>Correct answer
UGU CAU GAA UGC UAG

but allow 1 mark for complementary bases from section transcribed, providing all four bases are involved</td></tr>
<tr><td>2(b)(ii)</td><td>Marking principle
1 mark for bases corresponding to exons taken from 2(b)(i)</td><td>1</td><td>Correct answer
UGU UGC UAG
If sequence is incorrect in 2(b)(i), award mark if section is from exons. Ignore gaps.</td></tr>
</table>

Question	Marking guidance	Mark	Comments
3(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;	3 max	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;	3	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;	2	Do not penalise candidate who refers to sodium or potassium. Ions are mentioned in question

Question	Marking guidance	Mark	Comments
4(a)	LH rises; Increase in progesterone; Progesterone inhibits LH; (Then) LH falls;	3 max	The question requires explanation of control of LH Answer must relate to progesterone and LH. General answers should not gain credit here. Points 1 and 2 must relate to graph so reject secretes, makes etc
4(b)(i)	Corpus luteum; Progesterone produced;	2	Do not credit references to progesterone being needed.
4(b)(ii)	A lot of/ rise in oestrogen; Associated with follicle growth/development/ LH surge; ***OR*** Fall in oestrogen; Follice breaks down; Surge in LH (before ovulation); (LH) stimulates ovulation/release of egg; ***OR*** Fall in LH (after ovulation); Inhibited by progesterone;	4	

Question	Marking guidance	Mark	Comments
5(a)	RNA polymerase;	1	DNA polymerase is incorrect Ignore references to RNA dependent or DNA dependent Allow phonetic spelling
5(b)(i)	(Receptor/transcription factor) binds to promoter; Stimulates RNA polymerase/enzyme X; Transcribes gene/increase transcription;	2 max	
5(b)(ii)	Other cells do not have the/oestrogen/ ERα receptors;	1	But do not accept receptors in general.
5(c)	Similar shape to oestrogen; Binds receptor/prevents oestrogen binding; Receptor not activated/will not attach to promoter/no transcription;	2 max	Accept alternative Complementary to oestrogen; Binds to oestrogen; Will not fit receptor;

Question	Marking guidance	Mark	Comments
6 (a)	Will replace themselves/keep dividing/replicate; Undifferentiated/can differentiate/develop into other cells/totipotent/multipotent/pluripotent;	2	 Accept tissues
6 (b)	Reverse transcriptase;	1	Allow phonetic spelling
6(c) (i)	Alters base/nucleotide sequence/causes frame shift; Different sequence of amino acids in polypeptide/protein/primary structure; Alters tertiary structure;	2 max	Accept any reference, such as adding bases, to changing the base sequence of the gene. Reject deletion/substitution. Idea of sequence essential so not makes different amino acids. Accept answers involving stop/start codons and effect on protein.
6 (c) (ii)	Affects tumour suppressor gene; Inactivates (tumour suppressor) gene; Rate of cell division increased/tumour cells continue to divide;	2 max	Ignore answers relating to oncogenes.May gain third point.
6 (d)	Yes SCID patients unlikely to survive/quality of life poor unless treated; Cancer that develops is treatable/only affects 25%/five children; No Risk of developing cancer is high/25%; Cancer may recur/may not be treated successfully in future/only short time scale so more may develop cancer;	2 max	No mark for yes or no. Marks are for supporting argument based on biological reasoning. Accept any points

Question	Marking guidance	Mark	Comments
7 (a) (i)	Contains more/large amount of succinic dehydrogenase; (Slow fibres) have lots of mitochondria/ (slow fibres) respire aerobically;	2	Accept “the enzyme” since only one being discussed
7 (a) (ii)	Near edge/outside; Short distance for diffusion of oxygen/Allows rapid diffusion/more diffusion of oxygen; Oxygen used by mitochondria/electron transfer system in mitochondria;	3	 Ignore glucose Accept carbon dioxide Accept effect of carbon dioxide on cell e.g. carbon dioxide changes pH/carbon dioxide affects enzymes
7 (b) (i)	Measure with graticule/eyepiece scale; Calibrate against something of known size: ***OR*** Estimate/measure field diameter with a scale; Estimate number of fibres to cover diameter;	2	Q Last point could be a calibrated slide/haemocytometer/red blood cell or reasonable alternative Accept Mount on ruler/haemocytometer/graph paper; use this to measure size; Note position of ruler must be specified and correct
7 (b) (ii)	Equivalent measurements taken; At random to avoid bias/avoid choice of particular fibres; Large number to be representative/minimise effect of extremes/of anomalies;	2 max	As a stained slide is provided reject references to safety. Ignore reliable

Question	Marking guidance	Mark	Comments
8 (a) (i)	Eaten; Containing carbohydrate/sugar; Glucose absorbed from intestine/into blood; Long time after insulin injection/needs more insulin/has not taken insulin; Does not convert glucose to glycogen/glucose not taken up from blood;	2 max	
8 (a) (ii)	Shows positive correlation/directly proportional; A range of results for a particular value/values (for different colours) overlap; Urine test only an arbitrary scale/not directly related to concentration/colour is subjective/few colour values;	3	Accept description
8 (b)	Glycogen to glucose/glycogenolysis; By activating enzymes; Gluconeogenesis;	2 max	If name incorrect this disqualifies. Allow explanation in terms of glucose from a non-carbohydrate/named non-carbohydrate source.

Question	Marking guidance	Mark	Comments
9 (a) (i)	To cut the DNA;	1	Reject breakdown, cutting out
9 (a) (ii)	To separate the (pieces of) DNA;	1	
9 (b)	Complimentary base sequence/complementary DNA; Binds to both (haplotypes); Label would show up in both;	2 max	Idea of complimentarity required
9 (c) (i)	Bottleneck; Present population descended from small number/fewer than 100/1970 population; With small number few haplotypes/little genetic variation /little genetic diversity/few base sequences;	2 max	
9 (c) (ii)	All descended from Italian wolves/founder effect;	1	Reject same wolves. Must convey idea of descendents Accept there would be more if larger samples
9 (d) (i)	Y chromosome inherited/comes from male parents/only found in males;	1	
9 (d) (ii)	Mitochondria in egg/female gamete/no mitochondria come from sperm/male gamete;	1	
9 (e) (i)	Allows comparison; Different (sized) areas covered;	2	
9 (e) (ii)	Wolves do not eat all of prey animal/do not eat (large) bones/skin; Inedible parts make up different proportions/wolf eats different proportions;	2	

9 (f)	Limited by food/prey; As prey increases so do wolf numbers/positive correlation; Large range so other factors involved;	2 max	

Introduction

The essay is intended to assess a candidate's ability to bring together principles and concepts from different areas of biology, express ideas clearly and logically and use appropriate specialist vocabulary. It also provides an opportunity for candidates to demonstrate that they have met the ideals of stretch and challenge required to gain an A* grade. Because of this, essays are deliberately worded such that they allow candidates the freedom to respond in a variety of ways. Candidates are offered a choice of essay and it is important that the final mark reflects the quality of work, not the choice of essay.

The marking scheme considers four skill areas

S Scientific content
B Breadth of knowledge
R Relevance
Q Quality of written communication

In practice, this means that we are looking for

- evidence of knowledge and understanding in keeping with an A-level course of study
- selection of material relevant to the title, and drawn from different areas of the specification
- the ability to present an argument coherently and logically, using appropriate biological language.

Each of the skill areas is considered and matched against a series of descriptors to give the total mark. Notes are provided to assist in the application of the mark scheme to specific essay titles. Care must be taken in using these notes. It is important to appreciate that the only criteria to be used in awarding marks are those corresponding to the appropriate descriptors. Candidates may gain credit for any information providing that it is biologically accurate, relevant and of a depth in keeping with an A-level course of study. Material used in the essay does not have to be taken from the specification, although it is likely that it will. The notes must therefore be seen as no more than guidelines providing an indication of areas of the specification from which suitable factual material may be drawn.

Plans should be considered in awarding marks. Examiners are instructed to ignore the plan when reading the essay. They should then return to the plan. If further credit can be awarded because of material contained in the plan, this is done. Under no circumstances can a candidate lose credit for incorrect information contained in the plan.

Assessing scientific content

In assessing this area, note the following

- The maximum mark is 16
- Only even marks are awarded (16, 14, 12 etc). Intermediate marks (15, 13, 11 etc) cannot be used. This restricts examiners' choice and increases the reliability of the marking.
- Descriptors are given for 16, 12, 8, 4 and 0 marks. Work is matched to these descriptors. If a particular essay is considered to fall between the criteria for two descriptors an intermediate even mark (14, 10, 6 etc) is awarded.
- Candidates have approximately 40 minutes to plan and write their essays. It is important that candidates who allocate their time wisely should be able to gain maximum marks for what it is possible to write in this time. In practice, this amounts to between three and four sides of normal handwriting.
- Essays do not have to be perfect to gain higher marks. The amount of detail required by the specification should always be born in mind. Average A-grade candidates should be able to achieve 12 marks so it would not be unreasonable to expect around 15% of candidates to achieve such a mark.

Category	Mark	Descriptor
Exceptional	**16**	Material accurate and of a high standard throughout, reflecting a sound understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. In addition, there are some significant references to material that indicates greater depth or breadth of study.
	14	
Good	**12**	Most of the material is of a high standard reflecting a sound understanding of the principles involved and a knowledge of factual detail generally in keeping with an A-level course of study. Material accurate and free from fundamental errors, but there may be minor errors that detract from the overall accuracy.
	10	
Average	**8**	A significant amount of the content is of appropriate depth. Shows a sound understanding of most of the principles involved and knowledge of factual detail generally in keeping with a programme of A-level study. Most of the content is accurate with few fundamental errors.
	6	
Poor	**4**	Material presented is largely superficial with only occasional content of appropriate depth. Shows some understanding of some of the basic principles involved. If greater depth of knowledge is demonstrated, then there are fundamental errors.
	2	
Unacceptable	**0**	Such material as is relevant is both superficial and inaccurate. Fails to demonstrate evidence of knowledge in keeping with a programme of A-level study.

In marking scientific content, the first decision to be made is the category into which the essay falls. Examiners will discuss a range of specimen scripts at the standardising meeting that help them to make this decision. In general:

An exceptional essay

- reflects the detail that could be expected from a comprehensive knowledge and understanding of relevant parts of the specification
- is free from fundamental errors
- maintains appropriate depth and accuracy throughout
- includes two or more paragraphs of material that indicates greater depth or breadth of study

A good essay

- reflects the detail that could be expected from a comprehensive knowledge and understanding of relevant parts of the specification
- is free from fundamental errors
- maintains appropriate depth and accuracy throughout

An average essay

- contains a significant amount of material that reflects the detail that could be expected from a knowledge and understanding of relevant parts of the specification. In practice this will amount to about half the essay.
- is likely to reflect limited knowledge of some areas and to be patchy in quality
- demonstrates a good understanding of basic principles but will contain some errors and evidence of misunderstanding

A poor essay

- contains much material which is below the level expected of a candidate who has completed an A-level Biology course although there will be occasional valid points
- Contains fundamental errors reflecting a poor grasp of basic principles and concepts

Having decided on the basic category, examiners may award the mark above or below this according to whether the candidate has exceeded the requirements or just failed to meet them.

Assessing breadth

In assessing this area, note the following

- The maximum mark is 3
- The mark scheme will include notes which indicate how the marks for breadth should be awarded for individual essays. In determining the mark awarded for breadth, content should ideally be taken from each of the areas specified if maximum credit is to be awarded. Where the content is drawn from two areas, two marks should be awarded and where it is only taken from a single area, one mark should be awarded. However, this should only serve as a guide. The list is not exhaustive and examiners are prepared to offer credit for the incorporation of relevant material from other areas of study.
- Marks are awarded independently. Therefore it is possible for a candidate to gain full credit for breadth even though much of the essay is below the standard expected.

The general descriptors in the table below form the basis for awarding the mark for breadth.

Mark	Descriptor
3	A balanced account making reference to most of the areas that might realistically be covered in an A-level course of study
2	A number of aspects covered but a lack of balance. Some topics essential to an understanding at this level not covered.
1	Unbalanced account with almost all material based on a single aspect
0	Material entirely irrelevant

The descriptors should be interpreted using these guidelines.

Essay A **Carbon dioxide may affect organisms directly or indirectly. Describe and explain these effects**.

Section	
	Carbon dioxide affects the physiology of organisms
1.4	Pulmonary ventilation and the mechanism of breathing
4.3	Light-independent reaction of photosynthesis. Limiting factors
5.1	Role of chemoreceptors in controlling heart rate
	The direct effects of increasing carbon dioxide concentration
4.6	Respiration, photosynthesis and human activity giving rise to short-term fluctuations and long-term change. Yield of crop plants Carbon cycle
	Indirect effects of increasing carbon dioxide concentration
4.6	Role of carbon dioxide in producing global warming; Life cycles and number of insect pests; Distribution of animals and plants;
1.2	Effect of temperature on enzymes;

Essay B	**The causes of disease in humans**
Section	
	Pathogens
1.1	Pathogens include bacteria, viruses and fungi
	Pathogens cause disease by damaging cells and producing toxins
1.3	Cholera bacteria produce toxins resulting in diarrhoea
1.4	Symptoms and transmission of pulmonary tuberculosis
2.10	Horizontal gene transmission and MRSA
	Lifestyle
1.1	Risk factors associated with cancer and coronary heart disease
1.4	The effects of fibrosis, asthma and emphysema on lung function
1.5	The biological basis of heart disease
	Genetics
2.2	Differences in bases may lead to non-functional enzymes
2.5	Relationship between the cell cycle and cancer
5.6	Proto-oncogenes and tumour suppressor genes
	Gene mutations

Assessing relevance

In assessing this area, note the following

- The maximum mark is 3
- Marks are awarded independently. Therefore it is possible for a candidate to gain full credit for relevance even though much of the essay is below the standard expected.
- Be reasonable in considering material presented in the introduction to the essay. Many candidates will incorporate material of marginal relevance in the opening paragraph.
- Essays which are very short (under a page in length) should not be awarded 3 marks. Consideration should be give to awarding a maximum of 1 or 2 marks according to the amount written.

Mark	Descriptor
3	All material presented is clearly relevant to the title. Allowance should be made for use of marginally relevant introductory material
2	Material generally selected in support of title but some of the main content of the essay is only of marginal importance.
1	Some attempt made to relate material to the title but considerable amounts largely irrelevant.
0	Material entirely irrelevant or too limited in quantity to judge.

In essay (a) do not penalise references to respiration and carbon dioxide as irrelevant.
In essay (b) do not penalise references to antibiotic resistance as irrelevant.

Assessing quality of written communication

In assessing this area, note the following

- The maximum mark is 3
- Marks are awarded independently. However, it is unlikely that a candidate will gain full credit for the quality of written communication without a substantial proportion of the essay content being of the standard expected.
- Essays which are very short (under a page in length) should not be awarded 3 marks. Consideration should be give to awarding a maximum of 1 or 2 marks according to the amount written.
- Be reasonable in considering material presented at the end of the essay. Some candidates will be rushed and may incorporate information in note form.

Mark	Descriptor
3	Material is logically presented in clear English. Technical terminology has been used effectively and accurately throughout.
2	Account is logical and generally presented in clear scientific English. Technical terminology has been used effectively and is usually accurate.
1	The essay is generally constructed poorly and often fails to use an appropriate scientific style and terminology to express ideas.
0	Material entirely irrelevant or too limited in quantity to judge.

Definition of symbols to be used when marking the essay

Essay symbols

V Valid
X Wrong
+ Over and above A level
Q Poor QWC
N Irrelevant

Category	Mark	Scientific Content Descriptor
Exceptional	**16**	Material accurate and of a high standard throughout, reflecting a sound understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. In addition, there are some significant references to material that indicates greater depth or breadth of study.
	14	
Good	**12**	Most of the material is of a high standard reflecting a sound understanding of the principles involved and a knowledge of factual detail generally in keeping with an A-level course of study. Material accurate and free from fundamental errors, but there may be minor errors that detract from the overall accuracy.
	10	
Average	**8**	A significant amount of the content is of appropriate depth. Shows a sound understanding of most of the principles involved and knowledge of factual detail generally in keeping with a programme of A-level study. Most of the content is accurate with few fundamental errors.
	6	
Poor	**4**	Material presented is largely superficial with only occasional content of appropriate depth. Shows some understanding of some of the basic principles involved. If greater depth of knowledge is demonstrated, then there are fundamental errors.
	2	
Unacceptable	**0**	Such material as is relevant is both superficial and inaccurate. Fails to demonstrate evidence of knowledge in keeping with a programme of A-level study.

Mark	Beadth Descriptor
3	A balanced account making reference to most of the areas that might realistically be covered in an A-level course of study
2	A number of aspects covered but a lack of balance. Some topics essential to an understanding at this level not covered.
1	Unbalanced account with almost all material based on a single aspect
0	Material entirely irrelevant

Mark	Relevance Descriptor
3	All material presented is clearly relevant to the title. Allowance should be made for use of marginally relevant introductory material
2	Material generally selected in support of title but some of the main content of the essay is only of marginal importance.
1	Some attempt made to relate material to the title but considerable amounts largely irrelevant.
0	Material entirely irrelevant or too limited in quantity to judge.

Mark	Quality of written communication Descriptor
3	Material is logically presented in clear English. Technical terminology has been used effectively and accurately throughout.
2	Account is logical and generally presented in clear scientific English. Technical terminology has been used effectively and is usually accurate.
1	The essay is generally constructed poorly and often fails to use an appropriate scientific style and terminology to express ideas.
0	Material entirely irrelevant or too limited in quantity to judge.