EDEXCEL A-LEVEL BIOLOGY

BIOLOGY



EXAM QUESTION PACK

UNIT 5 OLD SPECIFICATION PAPERS

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Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number	Candidate Number

Biology

Advanced

Unit 5: Energy, Exercise and Coordination

Thursday 23 June 2016 – Morning
Time: 1 hour 45 minutes

Paper Reference
6BI05/01

You must have:
A copy of the scientific article from *Science News* (enclosed)

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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2/3/2/2/

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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Skeletal muscles contain muscle fibres and are arranged in antagonistic pairs.

(a) Place a cross ☒ in the box to complete the statement about skeletal muscles.

(1)

When a muscle fibre contracts, the number of myosin heads

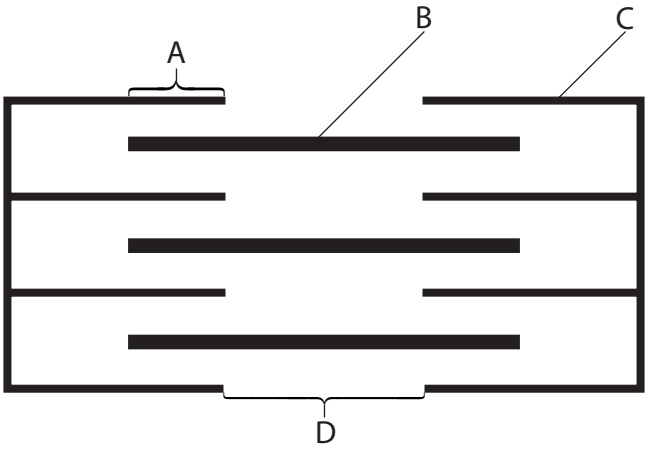
☒ **A** becomes zero

☒ **B** increases

☒ **C** reduces

☒ **D** stays the same

(b) The diagram below shows part of a muscle fibre.



Place a cross ☒ in the box to complete each statement about skeletal muscles.

(i) When a muscle fibre contracts, the labelled part that becomes shorter is

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

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(ii) The number of sarcomeres shown in the diagram is

(1)

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

(iii) The binding of calcium ions to troponin causes

(1)

☒ **A** depolarisation of the muscle membrane

☒ **B** myosin binding sites to be exposed

☒ **C** the sarcomere to widen

☒ **D** tropomyosin to be exposed

(iv) An enzyme that can break down ATP is found in

(1)

☒ **A** actin

☒ **B** myosin

☒ **C** tropomyosin

☒ **D** troponin

(v) Slow twitch muscle fibres contain

(1)

☒ **A** more mitochondria than fast twitch fibres

☒ **B** fewer mitochondria than fast twitch fibres

☒ **C** the same number of mitochondria as fast twitch fibres

☒ **D** no mitochondria

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(c) Suggest how tendons and antagonistic muscles cause the lower leg to move in the direction shown by the arrow in the diagram below.

(4)



(Total for Question 1 = 10 marks)

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2 Carrots are root vegetables that are eaten by many organisms.

An investigation was carried out to study the respiration rate of carrots.

100 g of carrot cubes were placed in a plastic bag containing air. The bag containing the carrot cubes was stored at 1 °C for three days.

All other variables were kept constant.

The percentages of oxygen and carbon dioxide in the bag were measured at the start of the investigation and at the end.

The results are shown in the table below.

Stage of the investigation	Percentage of each gas in the bag (%)	
	Oxygen	Carbon dioxide
Start	21.0	0.04
End	5.3	8.14

(a) (i) Suggest **two** variables, other than temperature, that need to be kept constant in this investigation so that valid results can be collected.

(2)

(ii) Explain the role of oxygen in the cells of the carrot cubes.

(3)

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(b) Explain how the carrots produce carbon dioxide at the start of this investigation.

(4)

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(c) The investigation was repeated at storage temperatures of 5 °C and 10 °C.

The table below shows the change in percentage of carbon dioxide in the bag at the end of the investigation compared with the start of the investigation for all three storage temperatures.

Storage temperature / °C	Change in percentage of carbon dioxide (%)
1	+ 8.1
5	+ 14.1
10	+ 16.2

Explain the effect of temperature on the change in the percentage of carbon dioxide in the bag.

(3)

(d) Suggest why the carrot tissue could survive when no oxygen was left in the bag.

(1)

(Total for Question 2 = 13 marks)

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3 Human hearts contain muscle that is myogenic. Exercise and other activities can affect heart rate.

(a) Explain what is meant by the term **myogenic**.

(2)

(b) Explain how an electrocardiogram (ECG) can be used to calculate a person's heart rate.

(3)

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*(c) Workers in the brewing industry may be at risk due to the carbon dioxide released by yeast fermentation.

Atmospheric air contains between 0.03% and 0.04% carbon dioxide.

A concentration of 5% carbon dioxide in the air causes a change in the heart rate of people exposed to this concentration.

Explain why a carbon dioxide concentration of 5% causes a change in heart rate.

(5)

(Total for Question 3 = 10 marks)

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4 A number of investigations have been carried out to study the effect of nature and nurture on human development.

(a) Explain how twin studies could be used to compare the effects of nature and nurture on human development.

(4)

(b) (i) Facial expressions can show different emotions.

Explain how a cross-cultural study could be used to investigate whether recognising different emotions through facial expression is due to nature or nurture.

(2)

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(ii) Suggest how this cross-cultural study could be carried out to make sure that the results are valid.

(2)

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(Total for Question 4 = 8 marks)

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5 Neurones are cells involved in coordination and control within an animal.

(a) The table below shows the concentration of sodium ions and potassium ions in the cytoplasm of a neurone and in the fluid outside the neurone.

Ion	Concentration of ion / mmol dm^{-3}	
	Cytoplasm	**Fluid outside the neurone**
Sodium	15	150
Potassium	150	5

(i) Using the information in the table, comment on the concentration gradients of these ions.

(2)

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(ii) During an action potential the distribution of sodium and potassium ions changes.

Explain how proteins in the cell surface membrane of this neurone enable the concentrations of these ions to **return** to those shown in the table.

(4)

(b) Describe how the arrival of a nerve impulse at a synapse causes the release of neurotransmitters.

(3)

(Total for Question 5 = 9 marks)

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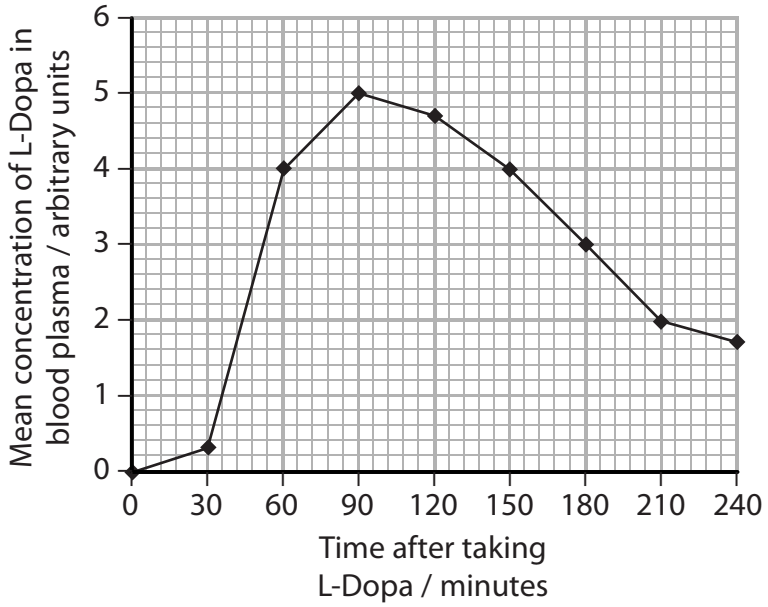
6 Humans and sea anemones have nervous systems with synapses.

(a) L-Dopa is a drug used to treat people with Parkinson's disease.

An investigation was carried out to study the uptake of L-Dopa from the gut into the blood plasma of people with Parkinson's disease.

A number of people with Parkinson's disease were each given a tablet containing 200 mg of L-Dopa. The concentration of L-Dopa in the blood plasma of each person was then recorded over a period of four hours.

The mean results are shown in the graph below.



(i) Using the information in the graph, calculate the mean rate of uptake of L-Dopa from 0 to 90 minutes.

Show your working.

(2)

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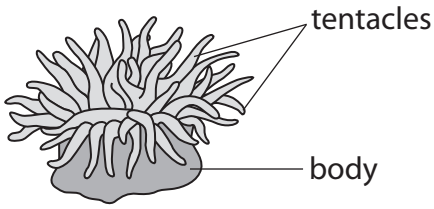
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(ii) Suggest an explanation for the decrease in the mean concentration of L-Dopa in the blood plasma after 90 minutes.

(4)

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(b) The sea anemone, shown in the diagram below, is a marine animal with tentacles.



A student investigated habituation in a sea anemone.

He gently touched a sea anemone, causing it to withdraw its tentacles into its body. He waited and recorded the time for the tentacles to fully re-emerge.

He repeated the process until the sea anemone was fully habituated.

(i) Suggest what the student would observe when the sea anemone was fully habituated.

(1)

(ii) The student investigated the length of time it took sea anemones to lose their habituation.

Suggest how the student carried out this investigation.

(3)

(Total for Question 6 = 10 marks)

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7 The scientific article you have studied is from *Science News*.

Use the information from the article and your own knowledge to answer the following questions.

(a) Ginkgo BioWorks could engineer a bacterium to 'suck carbon dioxide out of the atmosphere' (paragraph 5).

(i) Suggest why there may be a need to 'suck carbon dioxide out of the atmosphere'.

(2)

*(ii) Suggest how Ginkgo BioWorks could engineer such a bacterium.

(6)

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(b) The bacterium *Mycoplasma* has the 'shortest known genome' (paragraph 13). This bacterium contains only 525 genes.

Calculate the mean number of bases per *Mycoplasma* gene.

Show your working.

(2)

Answer = ... bases

(c) (i) Describe how 'building a stretch of DNA' would differ from 'building a stretch of RNA' (paragraph 21).

(3)

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(ii) Suggest why the scientists would 'insert the whole thing into a circular strand of DNA until they need it' (paragraph 21).

(1)

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(d) Suggest how 'three genes inhibited one another in sequence, their activity cycling regularly' (paragraph 26).

(3)

(e) A metabolic pathway is a many-stepped process.

Suggest the features of a metabolic pathway 'through which bacteria convert atmospheric nitrogen to ammonia' (paragraph 32).

(4)

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(f) Weiss and his team are 'working to harness a virus that could be used to test the idea in mice' (paragraph 40).

Suggest **two** features of the virus selected for this role.

(2)

(g) After 'testing the idea in mice', phase 1 testing must be carried out (paragraph 40).

Explain why phase 1 testing must be carried out before using this treatment on a patient with cancer.

(3)

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(h) 'Synthetic gene circuits could steer stem cells to develop into insulin-producing cells' (paragraph 41).

Describe **three** differences between a stem cell and an insulin-producing cell.

(3)

1. .....

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2. .....

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3. .....

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(i) Suggest why it is necessary to 'keep track of exposure to things like radiation within a cell' (paragraph 45).

(1)

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(Total for Question 7 = 30 marks)

TOTAL FOR PAPER = 90 MARKS

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Mark Scheme (Results)

Summer 2016

Pearson Edexcel GCE
in Biology (6BI05) Paper 01
Energy, Exercise and Coordination

ALWAYS LEARNING

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Summer 2016
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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the e boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question Number	Answer	Mark
1(a)	D - stays the same;	(1)

Question Number	Answer	Mark
1(b)(i)	D ;	(1)

Question Number	Answer	Mark
1(b)(ii)	A – 1 ;	(1)

Question Number	Answer	Mark
1(b)(iii)	B - myosin binding sites to be exposed ;	(1)

Question Number	Answer	Mark
1(b)(iv)	B - myosin ;	(1)

Question Number	Answer	Mark
1(b)(v)	A - more mitochondria than fast twitch fibres ;	(1)

Question Number	Answer	Additional Guidance	Mark
1(c)	1. {extensor muscles / eq} {contract / shorten / eq} ; 2. leg is straightened / eq ; 3. flexor muscle relaxes / eq ; 4. description of antagonistic action e.g. these muscles working in opposition, when one contracts the other relaxes ; 5. flexor is stretched / eq ; 6. tendons attach muscles to bones / eq ;	**1 ACCEPT** correctly named muscle e.g. quads/quadriceps **3 ACCEPT** correctly named muscle e.g. hamstrings **4 IGNORE** work together, in pairs	**(4)**

Question Number	Answer	Additional Guidance	Mark
2(a)(i)	Two from: 1. idea of size of cube ; 2. same {species / eq} of carrot ; 3. same {age / source / eq} of carrot ;	**1 ACCEPT** surface area / volume IGNORE mass	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(a)(ii)	1. (oxygen is) electron acceptor / eq ; 2. (also oxygen) binds with protons / H^+ /hydrogens ; 3. Idea of electrons from {electron transport chain / ETC} ; 4. to form (metabolic) water ;	**3 ACCEPT** from cytochromes	**(3)**

Question	Answer	Additional Guidance	Mark

Number			
2(b)	1. aerobic respiration ; 2. ref. to decarboxylation ; 3. (when) pyruvate broken down / eq ; 4. (decarboxylation occurs) in Krebs cycle ; 5. details of where in Krebs cycle e.g. removed from { C6 / C5 / eq} compound ;	**4 ACCEPT** link reaction **5 ACCEPT** C3 to C2 if refer to link reaction	**(4)**

Question Number	Answer	Additional Guidance	Mark
2(c)	1. as temperature increases, percentage of CO_2 in bag {increases / eq} ; 2. (as temperature increase) {reactants /named / eq} {gain more kinetic energy / collide more often} ; 3. increased enzyme activity / more E-S complexes form / eq ; 4. smaller increase between 5 and 10 because {more active sites occupied / some other factor is limiting / eq} ;	**1 ACCEPT** rises **IGNORE** change unqualified **4 ACCEPT e.g.** O_2 concentration could be limiting, high CO_2 levels inhibit enzymes	**(3)**

Question Number	Answer	Additional Guidance	Mark
2(d)	anaerobic respiration ;	**ACCEPT** fermentation but not lactic acid fermentation **IGNORE:** respiration unqualified	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(a)	1. idea that stimulation generated from within (muscle) ; 2. idea that this results in depolarisation ;		(2)

Question Number	Answer	Additional Guidance	Mark
3(b)	1. idea that it shows electrical activity of the heart ; 2. idea of how to identify {one heart beat / time for one heart beat} ; 3. count the number of { these / peaks / eq } in a {set time / stated time} or how long from one set of electrical activity to the next ; 4. description of how to obtain heart rate e.g. beats divided by time ;	**ACCEPT for 2:** from one {P wave / QRS complex / T wave } to the next	(3)

Question Number	Answer	Additional Guidance	Mark
3(c)	**QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence** 1. the concentration of carbon dioxide in the *alveoli* is higher / eq ; 2. the concentration of carbon dioxide in the blood is higher / pH of blood is lower / eq ; 3. detected by *chemoreceptors* in {*medulla* /*carotid* artery / *aorta* } ; 4. reference to {*cardiovascular / cardiac}* control centre in *medulla* ; 5. reference to *autonomic* nervous system / *sympathetic* nerve ; 6. more impulses to *SAN* / eq ; 7. { *noradrenalin(e)* / *norepinephrine* } released onto *SAN* ; 8. *SAN* (excitation) rate increased / eq ; 9. heart rate will increase / eq ;	**QWC Emphasis is on spelling of technical terms** **1 ACCEPT** {diffusion / concentration} gradient increased	**(5)**

Question	Answer	Additional Guidance	Mark

Number			
4(a)	1. { identical / monozygotic twins } are genetically identical / eq ; 2. derived from one egg and one sperm /one { zygote / embryo / eq } / eq ; 3. (so any phenotypic) difference is due to { nurture / environmental } / eq ; 4. {non-identical twins / dizygotic twins} are genetically different ; 5. (any phenotype) that is different when the environment is the same is likely to be { nature / genetic / eq } / eq ;	**ACCEPT** comments on monozygotic twins (MZ) raised apart as a context **1 ACCEPT** same alleles **IGNORE:** same DNA / genes **2 ACCEPT** one fertilised egg, ball of cells, blastula	**(4)**

Question Number	Answer	Additional Guidance	Mark
4(b)(i)	1. study groups from different cultures / eq ; 2. (if) outcome is the same then (likely to be) nature ; 3. (if) outcome is different in the groups then (likely to be) nurture ;	**1 IGNORE** different countries / environments	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(b)(ii)	1. idea of large sample size ; 2. idea of standardised sampling technique e.g. age, gender ; 3. same (range of) emotions used / eq OR standard methodology e.g. same photos ;		(2)

Question Number	Answer	Additional Guidance	Mark
5(a)(i)	1. idea that potassium (ion) gradient is greater than sodium (ion) gradient ; 2. Credit correct comparative manipulation of the data ; 3. idea of concentration gradients act in different directions / eq ;	**1 ACCEPT** steeper, higher for greater **2 ACCEPT** e.g (K^+ gradient is greater than gradient for Na^+) by 10 mmol dm^{-3}, ratio e.g. 1:10 and 30:1	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(a)(ii)	1. idea that proteins act as channels ; Repolarising: 2. (most voltage-dependent) { sodium / Na^+ } { channels / eq } closed ; 3. sodium ions cannot (continue to) enter { neurone / cytoplasm / eq } ; Resetting after hyperpolarisation: 4. (voltage-dependent) { potassium / K^+ } { channels / eq } close ; 5. sodium-potassium pump imports (two) potassium ions and exports (three) sodium ions / eq ;	**IGNORE:** descriptions of depolarisation/action potentials **1 ACCEPT** gates for channels	**(4)**

Question Number	Answer	Additional Guidance	Mark
5(b)	1. idea that Ca^{2+} enters synaptic bouton ; 2. vesicles containing neurotransmitter / eq ; 3. { move towards / fuse with presynaptic membrane / eq } / reference to exocytosis (of neurotransmitter) ;	**1 ACCEPT for 1:** knob, button, presynaptic neurone for bouton, through presynaptic membrane **3 ACCEPT** neurotransmitter released into synaptic {gap / cleft} **IGNORE:** vesicles being released	**(3)**

Question Number	Answer	Additional Guidance	Mark
6(a)(i)	correct answer with units gains full marks 1. 5 ÷ 90 ; 2. = { 0.056 / 0.06 } au min^{-1} ; OR 3 [(0.3÷ 30) + (3.7 ÷ 30) + (1 ÷ 30) ÷ 3] ; 4 = {0.054 / 0.05} au min^{-1} ;	**ACCEPT** answer expressed as e.g. 3.6 au per hour **2 ACCEPT** au/min, au per min	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(a)(ii)	1. idea that rate of use is greater than uptake from gut ; 2. idea that L-Dopa leaves the blood into tissues ; 3. L-Dopa crosses the blood-brain barrier / eq ; 4. converted to dopamine / eq ; 5. L-Dopa is broken down / eq ;	**1 IGNORE:** less being absorbed, running low in gut unqualified **4 ACCEPT** L-Dopa is a precursor to dopamine **5 ACCEPT** metabolised for broken down	**(4)**

Question	Answer	Additional Guidance	Mark

Number			
6(b)(i)	when{ touched / eq } the tentacles { not pulled into body / remain outside body / eq } ;	**ACCEPT:** no response when touched / no reaction to stimulus	**(1)**

Question Number	Answer	Additional Guidance	Mark
6(b)(ii)	1. use habituated sea anemone / eq ; 2. idea of stimulate after leaving for different lengths of time ; 3. idea of repetition at each different time ; 4. note time when anemone responds to being touched / eq ;	**2 ACCEPT** examples given **4 ACCEPT** note time when withdraws tentacles into body	**(3)**

Question Number	Answer	Additional Guidance	Mark

7(a)(i)	1. as it is a greenhouse gas / eq ; 2. idea of CO_2 leading to global warming ;	**2 ACCEPT** description of effect of global warming	**(2)**

Question Number	Answer	Additional Guidance	Mark
***7(a) (ii)**	***QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence**	**QWC Emphasis is on logical sequence**	
	1. idea of using gene involved / eq ;	**1 ACCEPT** allele	
	2. reference to {restriction enzyme / endonuclease} / eq ;		
	3. idea of same (restriction) enzyme used to cut open plasmid / eq ;		
	4. reference to sticky ends ;		
	5. detail of sticky ends e.g. complementary bases exposed ;		
	6. (DNA) ligase used to bind useful gene to plasmid / eq ;	**6 ACCEPT** join for bind	
	7. by forming phosphodiester bonds / eq ;	**7 ACCEPT** description of a phosphodiester bond	
	8. idea of uptake of plasmid by bacterium ;		**(6)**
Question Number	**Answer**	**Additional Guidance**	**Mark**

7(b)	Correct answer gains both marks 1. (one gene contains) 580 000÷525 / 1104.76 base pairs ; 2. this is { 2210 / 2209.5 } bases ; **OR** 3. (genome is 580 000 x 2) = 1160 000 bases ; 4. (one gene is 1160 000 ÷ 525) = { 2210 / 2209.5} bases ;	**Allow 1 mark:** 1105 bases	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(c)(i)	1. deoxyribose in DNA AND ribose in RNA ; 2. thymine in DNA AND uracil in RNA ; 3. idea of enzymes being used are different e.g. DNA polymerase v. RNA polymerase ; 4. 2 strands in DNA and 1 strand for RNA ;	**2 ACCEPT** T and U **3 ACCEPT** DNA formed by DNA replication and RNA by transcription **4 ACCEPT** double helix for 2 strands in DNA	**(3)**
Question Number	**Answer**	**Additional Guidance**	**Mark**
7(c)(ii)	so it can be inserted into a bacterium / idea of less likely to degrade ;	**ACCEPT:** less likely to {mutate / break down }	**(1)**

		IGNORE: for storage unqualified	

Question Number	Answer	Additional Guidance	Mark
7(d)	1. idea that product of a gene acts as an inhibitor ; 2. idea of inhibits next gene ; 3. (if) 1st gene active, it inhibits 2nd gene so 3rd gene is active ; 4. Idea of gene is transcribed for a limited time ;	**1 ACCEPT** protein/polypeptide for product, and repressor for inhibitor **3 ACCEPT** other logical sequence e.g. 2, 3 and then 1	**(3)**

Question Number	Answer	Additional Guidance	Mark
7(e)	1. each step requires its own enzyme / eq ;		

	2. to catalyse / control the step ; 3. idea of the product of one step being the {substrate / eq} for the next step ; 4. all steps must function for nitrogen to be converted to ammonia / eq ; 5. idea of involvement of { cofactors / coenzymes / eq } ;	**1 ACCEPT** appropriate ref to specificity e.g. enzyme 1 only acts on substrate 1 **3 ACCEPT** intermediates involved / reactant for substrate **4 ACCEPT** nitrogen gas {reduced to /H^+ added to form} ammonia **5 ACCEPT** ATP / FAD / NAD	**(4)**

Question Number	Answer	Additional Guidance	Mark
7(f)	1. idea of being non-pathogenic ; 2. virus will {identify / bind to / eq} cancer cells / eq ; 3. virus destroys cancer cells / eq ;	**1 ACCEPT** attenuated, harmless **3 ACCEPT** replicates in cancer cells	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(g)	1. (small number of) healthy people / eq ;		

	2. in case the treatment is dangerous / eq ; 3. idea of establishing dosage ;	**2 ACCEPT** ref to side effects, to make sure it is safe	**(3)**

Question Number	Answer	Additional Guidance	Mark
7(h)	<table><tr><th></th><th>Stem</th><th>Insulin</th><th></th></tr><tr><td>1.</td><td>{ any / eq } genes can be activated</td><td>most genes deactivated / eq</td><td>;</td></tr><tr><td>2.</td><td>{ un / less } differentiated</td><td>Differentiated</td><td>;</td></tr><tr><td>3.</td><td>cell can continue to divide / no Hayflick limit</td><td>{ limited / no } cell division / Hayflick limited</td><td>;</td></tr><tr><td>4.</td><td>can give rise to various different cell types</td><td>cannot give rise to other types of cell</td><td>;</td></tr><tr><td>5.</td><td>No insulin made / insulin gene not active</td><td>Insulin made / insulin gene active</td><td>;</td></tr><tr><td>6.</td><td>Found in various locations / named location (other than pancreas)</td><td>Found in pancreas</td><td>;</td></tr></table>	**1 ACCEPT** switched off **2 ACCEPT** specialised for differentiated	**(3)**

Question Number	Answer	Additional Guidance	Mark

7(i)	radiation could lead to { cancer / mutation / eq } ;	**ACCEPT:** named example e.g. deletion	**(1)**

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Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number	Candidate Number

Biology

Advanced

Unit 5: Energy, Exercise and Coordination

Wednesday 17 June 2015 – Morning
Time: 1 hour 45 minutes

Paper Reference
6BI05/01

You must have:
A copy of the scientific article taken from *Nature* and *Scientific American* (enclosed).

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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1/1/1/1/e2/

P 4 4 8 7 2 A 0 1 2 4

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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Humans have a nervous system that has a variety of neurones.

(a) The human brain is made up of a number of areas containing many millions of neurones.

Place a cross in the box ☒ that identifies the areas of the brain associated with riding a bicycle uphill.

(i) the decision to ride the bicycle

(1)

☒ **A** cerebrum

☒ **B** cerebellum

☒ **C** hypothalamus

☒ **D** medulla

(ii) initiating an increase in sweating during the ride

(1)

☒ **A** cerebrum

☒ **B** cerebellum

☒ **C** hypothalamus

☒ **D** medulla

P 4 4 8 7 2 A 0 2 2 4
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(b) Voltage-gated K^+ and Na^+ channels are involved in the transmission of impulses in sensory and motor neurones.

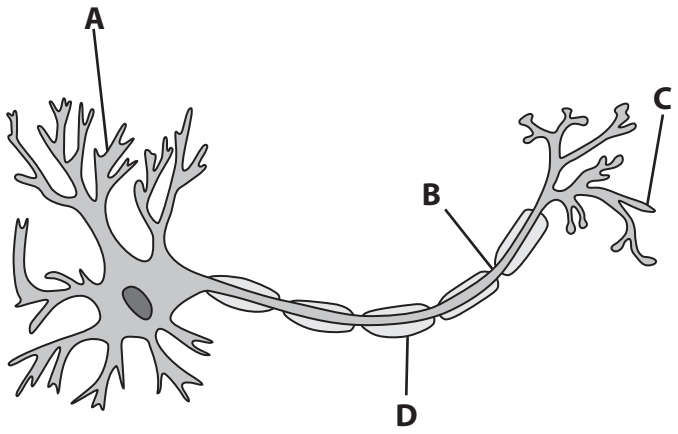
(i) The table below identifies two stages in the transmission of an impulse in a sensory neurone.

Place a tick (✓) in each box that correctly identifies whether the channels are open or closed during these two stages.

(2)

Stage	Voltage-gated K^+ channels open	Voltage-gated K^+ channels closed	Voltage-gated Na^+ channels closed
Depolarisation			
Repolarisation			

(ii) The diagram below shows a myelinated motor neurone.



Place a cross in the box ☒ that labels the site where neurotransmitters bind and initiate depolarisation.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

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(iii) Describe the differences in the structure of a myelinated sensory neurone and a myelinated motor neurone.

(3)

(Total for Question 1 = 8 marks)

P 4 4 8 7 2 A 0 4 2 4
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2 A human heart can work effectively for over a hundred years but many people throughout the world have heart problems.

(a) Explain how the sinoatrial node (SAN) ensures that oxygenated blood enters the aorta.

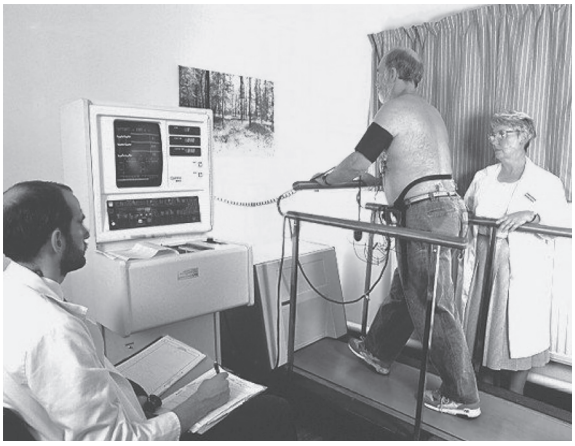
(4)

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*(b) The treadmill test can be used to diagnose heart problems.

This test requires a person to walk on a treadmill whilst an electrocardiogram (ECG) is recorded.

The angle of the treadmill is raised to increase the level of exercise. The photograph below shows a person carrying out the treadmill test.



Explain how the heart rate of this person is controlled as the level of exercise increases during this test.

(6)

P 4 4 8 7 2 A 0 6 2 4
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(c) The ECG below was recorded at rest.



(i) This person had a resting heart rate of 74 beats per minute.

Calculate the time taken for this ECG. Show your working.

(2)

Answer .....

(ii) Suggest suitable units for the vertical axis (*y*-axis) of this ECG.

(1)

.....

(Total for Question 2 = 13 marks)

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3 An investigation was carried out to study the effect of positive and negative physical and emotional experiences on humans.

The positive physical experience was a warm object placed on the arm of a person for five seconds.

The negative physical experience was a hot object placed on the arm of a person for five seconds.

All other variables were kept constant.

Two groups of people were used in this investigation. In the first group, the warm object was used before the hot object. In the second group, the hot object was used before the warm object.

After each experience, the individuals were asked to rate their feelings using the scoring system below.

Feelings	Score
Very bad	1
Bad	2
Neutral	3
Good	4
Very good	5

(a) Suggest why one group had the warm object placed on their arm before the hot object and the other group had the hot object placed on their arm first.

(2)

P 4 4 8 7 2 A 0 8 2 4
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(b) These two groups were then exposed to a positive emotional experience and a negative emotional experience.

The mean results for the investigation are shown in the table below.

Experience	Mean score for feelings and standard deviation	
	Physical	Emotional
Positive	4.5 ± 0.5	4.2 ± 0.4
Negative	1.9 ± 0.6	1.7 ± 0.4

A student concluded that the physical experiences and emotional experiences were similar.

Using information in the table, comment on the validity of this conclusion.

(4)

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(c) This investigation then used a scanning technique to study whether the same areas of the brain were involved in both physical experiences and emotional experiences.

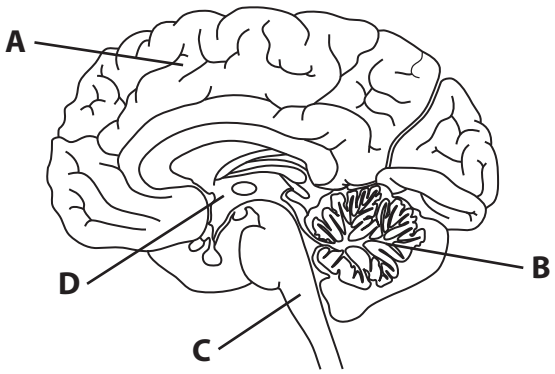
(i) Suggest the scanning technique required to study the brain in this investigation. Give reasons for your choice.

(3)

(ii) It was found that an area of the brain called the insula was involved in both physical experiences and emotional experiences. The insula is found just above the hypothalamus.

Using the diagram below, place a cross in the box ☒ that identifies the area of the insula.

(1)



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 3 = 10 marks)

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4 An investigation was carried out to study the effect of light on the mammalian retina.

Part of the retina of a young rat was removed and kept in the dark for two hours. This allowed the pigment in the rod cells to recover from bleaching caused by exposure to light.

(a) Suggest what happens in the rod cells during this two hours of darkness.

(5)

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(b) When the retina had recovered from bleaching, the resting potential of the bipolar neurones in the retina was found to be –43 mV.

The retina was then exposed to a range of light intensities. Each light intensity caused the bipolar neurones to depolarise. The peak voltage of the depolarisation for each light intensity was recorded.

All other variables were kept constant.

The investigation used retinas from an additional 14 rats.

The mean results are shown in the table below.

Light intensity / arbitrary units	**Mean peak voltage of depolarisation / mV**
1	11
3	18
6	19
9	20
12	20

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(i) Using the information in the table, describe the effect of light intensity on the mean peak voltage of depolarisation.

(2)

(ii) Suggest an explanation for the effect of light intensity on the mean peak voltage of depolarisation in these neurones.

(4)

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(c) Suggest **two** reasons why some people might have objections to the use of rats in this investigation.

(2)

.....

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.....

.....

.....

.....

(Total for Question 4 = 13 marks)

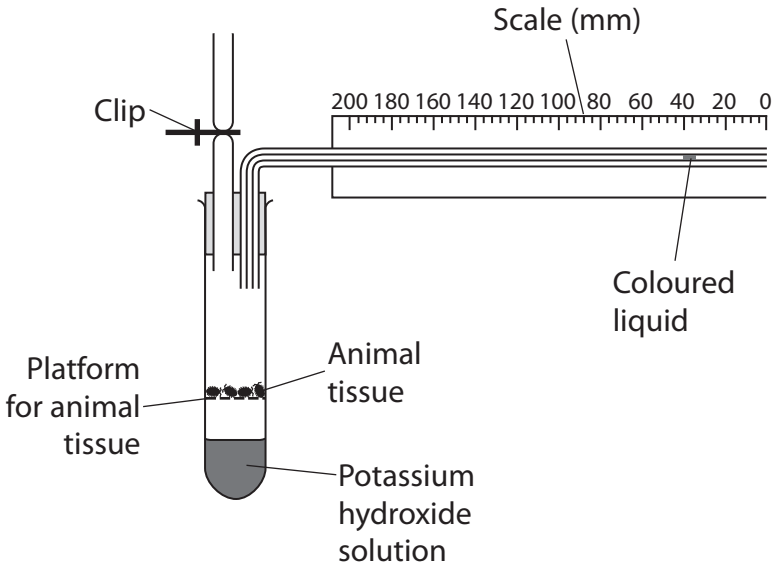
P 4 4 8 7 2 A 0 1 4 2 4
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5 The tissues of some animals can carry out anaerobic and aerobic respiration.

(a) Three investigations were carried out to study respiration in an animal tissue, using the apparatus shown below.

The tissue used glucose as the respiratory substrate.

All other variables were kept constant.



The table below shows the three investigations that were carried out and the result for investigation 1.

Investigation	Type of respiration	Potassium hydroxide solution absent or present	Coloured liquid moved to the left	Coloured liquid moved to the right	Coloured liquid did not move
1	Anaerobic	Absent	☒	☒	☒
2	Aerobic	Absent	☒	☒	☒
3	Aerobic	Present	☒	☒	☒

(i) Complete the table by placing a cross in one box ☒ for each of investigations 2 and 3 to show the response of the coloured liquid.

(2)

P 4 4 8 7 2 A 0 1 5 2 4
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(ii) Explain why the coloured liquid did not move in investigation 1.

(3)

(iii) Reduced NAD (NADH + H^+) would be formed in investigations 2 and 3.

Describe the fate of reduced NAD in aerobic respiration.

(4)

P 4 4 8 7 2 A 0 1 6 2 4
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(b) Explain how investigation 3, shown in the table, could be used to compare the rate of respiration of two different tissues.

(2)

.....

.....

.....

.....

.....

.....

(Total for Question 5 = 11 marks)

P 4 4 8 7 2 A 0 1 7 2 4
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6 A number of drugs, including EPO, have been used by athletes.

EPO is a drug that stimulates the formation of red blood cells. EPO has been used to enhance the performance of certain types of athlete.

(a) Sprinters usually have more fast twitch fibres in their leg muscles than long distance runners.

Suggest why EPO may have less of an effect on the performance of a sprinter than on a long distance runner.

(3)

(b) Suggest **two** ethical reasons why the use of drugs, such as EPO, should be banned from sport.

(2)

(Total for Question 6 = 5 marks)

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7 The scientific article you have studied is adapted from articles in *Nature* and *Scientific American*.

Use the information from the article and your own knowledge to answer the following questions.

(a) Rabies is a 'nasty infection' caused by a virus (paragraph 5).
Explain how scientists would be able to determine that the rabies pathogen is a virus.

(2)

*(b) Suggest how researchers had genetically modified the pathogen to 'provoke an effective immune response' (paragraph 12).

(6)

(c) Octopamine is a neurotransmitter (paragraph 24). Libersat and his team believe that wasp venom probably blocks octopamine receptors in the central nervous system of the cockroach.

Suggest **two** ways that the 'compound that reactivates octopamine receptors' (paragraph 25) could work.

(2)

(d) Suggest how scientists, such as Hughes, could have estimated that ants comprise 'half of all insect biomass worldwide' (paragraph 31).

(3)

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(e) 'While the manipulated individual may look like an ant, it represents a fungal genome expressing fungal behaviour through the body of an ant' (paragraph 33).

Suggest how fungal genes may be expressed and affect the behaviour of these ants.

(5)

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(f) Suggest what is meant by the term **clock genes** (paragraph 35).

(2)

(g) Suggest how a lack of 'signals' (paragraph 36) could lead to muscle atrophy.

(4)

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(h) 'Instead of one variable species' (paragraph 44), Evans, Hughes and Elliot have identified four new species of the fungus.

Suggest how these could have been identified as separate species.

(4)

(i) There is evidence showing that ants parasitised by the fungus bite the main veins of leaves (paragraphs 35 and 47).

Suggest the advantages to the zombie fungus of this ant behaviour.

(2)

(Total for Question 7 = 30 marks)

TOTAL FOR PAPER = 90 MARKS

P 4 4 8 7 2 A 0 2 3 2 4
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Mark Scheme (Results)

Summer 2015

Pearson Edexcel GCE
in Biology (6BI05) Paper 01
Energy, Exercise and Coordination

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question Number	Answer	Mark
1(a)(i)	A ; cerebrum	(1)

Question Number	Answer	Mark
1(a)(ii)	C ; hypothalamus	(1)

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	<table><tr><th>Stage</th><th>Voltage-gated K^+ channel open</th><th>Voltage-gated K^+ channel closed</th><th>Voltage-gated Na^+ channel closed</th></tr><tr><td>Depolarisation</td><td></td><td>✓</td><td></td></tr><tr><td>Repolarisation</td><td>✓</td><td></td><td>✓</td></tr></table>	3 columns correct = 2 marks 2 columns correct = 1 mark	(2)

Question Number	Answer	Mark
1(b)(ii)	A ;	(1)

Question Number	Answer	Additional Guidance	Mark
1(b)(iii)	In sensory neurone: 1. dendron longer; 2. dendron myelinated ; 3. axon shorter ; 4. {cell body / eq} {not at the end / towards the middle / to the side / eq } ; 5. reference to no {motor end plate / eq} ;	ALLOW converse for motor neurone 4. **ACCEPT** centron / nucleus for cell body	**(3)**

Question Number	Answer	Additional Guidance	Mark
2(a)	1. idea that initiates electrical activity over atria ;	1. **ACCEPT** initiates impulse / initiates depolarisaton	
	2. causes atria to contract / eq ;	2. **ACCEPT** systole for contract	
	3. {forcing / eq} the (oxygenated) blood into the left ventricle / eq ;		
	4. electrical activity from SAN {received by AVN / travels through {bundle of His / Purkyne fibres / eq }} ;	4. **ACCEPT** Purkinje for Purkyne	
	5. causing left ventricle to contract (forcing blood into aorta) / eq ;	5. **ACCEPT** systole for contract **NOT** left and right	**(4)**

Question Number	Answer	Additional Guidance	Mark
*2(b)	**(QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence)** 1. increase in *respiration* rate in *muscle* cells ; 2. more {CO_2/*carbonic* acid/eq} in blood ; 3. more {*lactate* / *lactic acid*} in blood / eq ; 4. idea that *chemoreceptors* in *medulla* stimulated ; 5. ref to *cardiovascular* control centre in *medulla* ; 6. ref to *autonomic nervous system* /*sympathetic nerve* ; 7. more *impulses* from {*medulla* / *cardiovascular* control centre} to SAN OR along neurones to SAN ; 8. More {*noradrenaline / norepinephrine*} released onto SAN ; 9. SAN (excitation) rate increased / eq ; 10. (causing an) increased {heart rate / eq} / eq ; 11. Comment on other mechanism e.g. presence of adrenaline, stretch receptor role ;	**QWC emphasis is on spelling** 2 OR 3 **ACCEPT** reduced blood pH 4. **ACCEPT** in *aorta, carotid* 6. **ACCEPT** *accelerator* nerve 10. **ACCEPT** beats per min for heart rate	**(6)**

Question Number	Answer	Additional Guidance	Mark
2(c) (i)	Correct answer with units gains 2 marks 1 beat = 0.81 sec / 60 ÷ 74 / eq ; 8.1 seconds ;	**ACCEPT** 8.11 seconds	**(2)**

Question Number	Answer	Mark
2(c) (ii)	mV / millivolts / eq ;	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(a)	1. idea that there was no bias ; 2. idea of contributes to validity ; 3. idea of hot object desensitises ; OR idea of thermoreceptors not harmed /overstimulated / habituated due to high temp ;	**1. ACCEPT** sequence of procedure has no effect/to see if positive then negative gives a different outcome to negative then positive	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(b)	1. conclusion is valid / eq ; 2. (because mean feelings) scores similar for both / eq ; 3. idea that difference between positive and negative (mean feelings) scores are similar ; 4. comment on SD as a measure of variation from the mean / eq ; 5. SD similar for physical and emotional when experience is positive / eq ; 6. Idea of overlap for {positive / negative} ; 7. figures used to support Mp6 e.g. for positive minimum is 4.0 for physical and maximum is 4.6 for emotional ;	**1 ACCEPT** conclusion is supported NB for negative the positive minimum for physical is 1.3 and maximum is 2.1 for emotional	**(4)**

Question Number	Answer	Additional Guidance	Mark
3(c)(i)	1. fMRI ; and any two from: 2. (fMRI) operates in real time / eq ; 3. as experience will be short lived / eq ; 4. Active areas will {light up / be coloured / eq} (on the image) / eq ; 5. high resolution (as areas involved may be small) / eq ; 6. Safer / eq ;	 **2 ACCEPT** live images, 4 images per second **4. ACCEPT** idea of active areas require more oxygen/oxygenated blood 5 **ACCEPT** more pixels, image is more detailed **6. ACCEPT** ref. to not using X rays, etc	**(3)**

Question Number	Answer	Mark
3(c)(ii)	D ;	**(1)**

Question Number	Answer	Additional Guidance	Mark
4 (a)	1. idea that opsin uncouples from the (rod cell) cell surface membrane ; 2. trans retinal {converts / eq} to cis retinal ; 3. rhodopsin is (re)formed / eq ; 4. from opsin and retinal ; 5. idea that this results in dark adaptation ; 6. permeability of the cell surface membrane to Na^+ increases / eq ; 7. hyperpolarisation of cell decreases / eq ; 8. (more) neurotransmitter is released / eq ;	**NB IGNORE *references to bipolar neurone responses*** **IGNORE** reference to retinol **6. ACCEPT** Na^+ {enters /channels unblocked / channels open} **7. ACCEPT** (partial) depolarisation / reduced potential difference **8. ACCEPT** glutamate for neurotransmitter	**(5)**

Question Number	Answer	Additional Guidance	Mark
4 (b)(i)	1. mean peak voltage increases as light intensity increases up to 9 AU / eq ; 2. idea of {non linear increase / increase decreases} ; 3. no further increase in change in mean peak voltage as light intensity increases from 9AU / eq ;	**IGNORE** speed references **2. ACCEPT** greatest change is mean peak voltage is when light intensity increases from 1 to 3	**(2)**

Question Number	Answer		Mark
4 (b)(ii)	*As light intensity increases up to 9AU* 1. idea that the greater the light intensity, the less {neurotransmitter/eq} there is binding to the neurone present ; 2. idea that inhibition removed e.g. (more) Na^+ channels open, (more) Na^+ diffuses into neurone ; 3. so peak voltage of depolarisation becomes more positive / eq ; *At high light intensities (from 9AU) :* 4. idea of no {neurotransmitter/eq} binding ; 5. sufficient Na^+ enters / eq ; 6. so action potential achieved ;	**NB ACCEPT** glutamate for neurotransmitter **ACCEPT** converse for decreasing light intensity **3 ACCEPT** increasing depolarisation **5 ACCEPT** threshold potential achieved	**(4)**

Question Number	Answer	Additional Guidance	Mark
4(c)	1. idea of rats have rights ; 2. rats made {blind/ eq } ; 3. 15 samples may not be sufficient for a reliable investigation / eq ; 4. idea that rat retina may not behave like human retina (so investigation has no (potential) medical application) ;	1. **ACCEPT** lack of consent given 2. **ACCEPT** harmed, causes pain, requires killing rats 4. **ACCEPT** tissue culture available	**(2)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>5(a) (i)</td><td>
<table>
<tr><th>Investigation</th><th>Type of respiration</th><th>Potassium hydroxide solution absent or present</th><th>Coloured liquid moved to the left</th><th>Coloured liquid moved to the right</th><th>Coloured liquid did not move</th></tr>
<tr><td>1</td><td>Anaerobic</td><td>Absent</td><td>☒</td><td>☒</td><td>☒</td></tr>
<tr><td>2</td><td>Aerobic</td><td>Absent</td><td>☒</td><td>☒</td><td>☒ ;</td></tr>
<tr><td>3</td><td>Aerobic</td><td>Present</td><td>☒ ;</td><td>☒</td><td>☒</td></tr>
</table>
</td><td></td><td>(2)</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
5(a)(ii)	1. (as anaerobic) no O_2 absorbed / eq ; 2. no CO_2 produced / eq ; 3. so no change in {volume/pressure} (so liquid does not move) ; 4. since for each 6C glucose respired, 2x3C lactate formed / eq ;	1. **ACCEPT** No oxygen used	(3)

Question Number	Answer	Additional Guidance	Mark
5(a)(iii)	1. (reduced NAD from glycolysis) enters mitochondria/ moves through outer mitochondrial membrane / eq ; 2. moves to inner membrane of mitochondrion / eq ; 3. becomes {oxidised /NAD / NAD^+} ; 4. as {electrons / eq} transferred to {electron transport chain / eq} / eq ; 5. fate of hydrogen ions described e.g. pumped into membrane space ; 6. (NAD) returns to {Krebs cycle/ matrix / eq} ;	**2. ACCEPT** crista for inner mitochondrial membrane **6. ACCEPT** cytoplasm, glycolysis	**(4)**

Question Number	Answer	Additional Guidance	Mark
5(b)	1. same mass of each tissue / eq ; 2. idea of time being recorded for {a set distance travelled by coloured liquid OR distance coloured liquid travelled in a set time} ;	**1. IGNORE** amount	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(a)	1. RBC will {carry/supply oxygen} ; 2. idea that low number of mitochondria present in fast twitch ; 3. so additional oxygen may have limited additional effect / eq ; 4. poor {blood supply / capillary network} in fast twitch muscle so little additional {oxygen / RBC / eq} received / eq ; 5. (in fast twitch) respiration is (primarily) anaerobic / eq ; 6. short {time duration of race/distance travelled} means minimal additional blood supplied to muscles in timeframe ;	ACCEPT converse for slow twitch muscle **4. ACCEPT** low numbers of RBC in fast twitch so extra will have minimal additional effect **6. ACCEPT** no need for oxygen because of short {time duration of race/distance travelled}	**(3)**

Question Number	Answer	Additional Guidance	Mark
6(b)	1. idea of not being fair ; 2. idea of being a poor role model for youngsters ; 3. health risk to athletes / eq ; 4. cost to {NHS / medical services / eq} of health implications / eq ;	**3. ACCEPT** raised blood clotting risk, harmful side effects	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(a)	1. protein coat / eq ; 2. no {cytoplasm / cell surface membrane present / eq } ; 3. contains { viral genetic material / eq } ; 4. very small / smaller than a bacterium / size stated ; 5. response to antivirals / eq ;	**1. ACCEPT** capsid **2. ACCEPT** no ribosomes, no organelles	**(2)**

Question Number	Answer	Additional Guidance	Mark
*7(b)	**(QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence)** 1. identify a gene that {provokes an effective immune response / codes for {antigen / eq} / inhibits *T. gondii* entering {brain/muscle} cells} ; 2. gene removed using a {restriction enzyme / endonuclease} ; 3. {same / this / eq} restriction enzyme used to open {*T. gondii* genome / eq} / eq ; 4. sticky ends {formed / eq } ; 5. ligase used to bind gene / eq ; 6. by forming phosphodiester bonds / eq ; 7. idea of method of introducing gene into pathogen ; 8. idea that gene needs to be expressed e.g. protein synthesised ; 9. idea of this protein in provoking an immune response ; 10. detail of immune response ;	QWC with emphasis on clarity of expression 3. **NOT** plasmid cut open 7. **IGNORE** plasmid 8. **ACCEPT** synthesises antigen	**(6)**

Question Number	Answer	Additional Guidance	Mark
7(c)	1. idea that it binds to wasp venom so it {is removed from / can no longer bind to} receptor ; 2. idea that breaks down wasp venom so it leaves receptor ; 3. idea that wasp venom binds more readily to it than to the receptor ; 4. idea of the nature of the compound e.g. enzyme ;		**(2)**

Question Number	Answer	Additional Guidance	Mark
7(d)	1. idea that mass of ants and mass other insects compared ; 2. in a measured area / reference to quadrat ; 3. samples taken from other habitats / eq ; 4. reference to extrapolate to world scale ;		**(3)**

Question Number	Answer	Additional guidance	Mark
7(e)	1. reference to transcription factors ; 2. bind to promoter region / form a transcription initiation complex / eq ; 3. RNA polymerase can bind /eq ; 4. mRNA made ; 5. idea of translation occurring ; 6. at ribosomes / on the RER / in the cytoplasm ; 7. idea of function of product e.g. inhibits normal ant behaviour / stimulates abnormal ant behaviour / description of abnormal behaviour given ; 8. idea of product affecting nervous system ;	2. **ACCEPT** gene switched on 5. **ACCEPT** protein/polypeptide produced	**(5)**

Question Number	Answer	Additional Guidance	Mark
7(f)	1. {sequence of bases / eq} on DNA that codes for a {polypeptide/protein/eq} ; 2. that regulates circadian rhythms / description given ;	2**. ACCEPT** idea that gene is activated at certain times of the day such as near noon	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(g)	1. (signals are) {calcium ions / Ca^{2+}} ; 2. less (Ca^{2+}) binding to troponin so less tropomyosin {displaced / eq} ; 3. so less myosin binding sites exposed (on actin) / less myosin binds (to actin) ; 4. so there is a lack of muscle use / eq ; 5. idea that muscle atrophy means muscle (mass) reduction	5. **ACCEPT** muscle wastage for muscle reduction	**(4)**

Question Number	Answer	Additional Guidance	Mark
7(h)	1. idea of unsuccessful breeding programme e.g.(fungi) unable to breed together / eq ; 2. could not produce sexually viable offspring / eq ; 3. they had {few (homologous) features in common / morphological differences / different chromosome number / eq} ; 4. { DNA / eq } compared ; 5. Use of electrophoresis ; 6. {banding / eq } did not match / eq;	1. **ACCEPT** cannot interbreed 4. **ACCEPT** DNA hybridisation, molecular phylogeny, proteomics 5. **ACCEPT** DNA profiling 6. **ACCEPT** converse	**(4)**

Question Number	Answer	Additional Guidance	Mark
7(i)	1. contains xylem / eq ; 2. idea that it is strong enough (to support the ant/fungus) ; 3. leaf supplies {a nutrient/named nutrient/water} to fungus ; 4. idea of enables effective spreading of fungal spores e.g. enables dispersal, effective reproduction ;		**(2)**

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Pearson Edexcel GCE

Biology

Advanced

Unit 5: Energy, Exercise and Coordination

June 2014

Scientific Article for use with Question 7

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Extracts from 'The Immortal Life of Henrietta Lacks'

Prologue
The Woman in the photograph

1. There's a photo on my wall of a woman I've never met, its left corner torn and patched together with tape. She looks straight into the camera and smiles, hands on hips, dress suit neatly pressed, lips painted deep red. It's the late 1940s and she hasn't yet reached the age of thirty. Her light brown skin is smooth, her eyes still young and playful, oblivious to the tumor growing inside her – a tumor that would leave her five children motherless and change the future of medicine. Beneath the photo, a caption says her name is "Henrietta Lacks, Helen Lane or Helen Larson."

2. No one knows who took that picture, but it's appeared hundreds of times in magazines and science textbooks, on blogs and laboratory walls. She's usually identified as Helen [illegible] but often she has no name at all. She's simply called HeLa, the code name given to the world's first immortal human cells – *her* cells, cut from her cervix just months before she died.

3. Her real name is Henrietta Lacks.

4. I've spent years staring at that photo, wondering what kind of woman she was, what happened to her children, and what she'd think about cells from her cervix [illegible] bought, sold, packaged and shipped by the trillions to laboratories around the world. I've tried to imagine how she'd feel knowing that her cells went up in the first space missions to see what would happen to human cells in zero gravity, or that they helped develop some of the most important advances in medicine: the polio vaccine, chemotherapy, cloning, gene mapping, in vitro fertilization. I'm pretty sure that she – like most of us – would be shocked that there are trillions more of her cells growing in laboratories now than there were in her body.

5. There's no way of knowing exactly how many of Henrietta's cells are alive today. One scientist estimates that if you could put all the cells ever grown onto a scale, they'd weigh more than 50 million metric tons, an unimaginable number, given that an individual cell weighs almost nothing. Another scientist figured that if you could lay all HeLa cells ever grown end-to-end, they'd wrap around the earth three times, spanning more than 350 million feet. In her prime, Henrietta herself stood only a bit over five feet tall.

6. I first learned about HeLa cells and the woman behind them in 1988, thirty-seven years after her death, when I was fifteen and sitting in a community college biology class. My instructor, Donald Defler, a blond Scottish balding man, paced at the front of the lecture hall and flipped on an overhead projector. He pointed to two diagrams that appeared on the wall behind him. They were schematics of the cell reproduction cycle, but to me they just looked like a neon-colored mess of arrows, squares, and circles with words I didn't understand, like "MPF Triggering a Chain Reaction of Protein Activations."

7. I was a kid who'd failed freshman year at the regular public high school because she never showed up. I'd transferred to an alternative school that offered dream studies instead of biology, so I was taking Defler's class for high-school credit, which meant that I was sitting in a college lecture hall at sixteen with words like *mitosis* and *kinase inhibitors* flying around. I was completely lost.

8. "Do we have to memorize everything on those diagrams?" one student yelled.

9. Yes, Defler said, we had to memorize the diagrams, and yes, they'd be on the test, but that didn't matter right then. What he wanted us to understand was that cells are amazing things: There are about one hundred trillion of them in our bodies, each so small that several thousand could fit on the period at the end of this sentence. They make up all our tissues – muscle, bone, blood – which in turn make up our organs.

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10. Under the microscope, a cell looks a lot like a fried egg: It has a white (the *cytoplasm*) that's full of water and proteins to keep it fed, and a yolk (the *nucleus*) that holds all the genetic information that makes you *you*. The cytoplasm buzzes like a New York City street. It's crammed full of molecules and vessels endlessly shuttling enzymes and sugars from one part of the cell to another, pumping water, nutrients, and oxygen in and out of the cell. All the while, little cytoplasmic factories work 24/7, cranking out sugars, fats, proteins, and energy to keep the whole thing running and feed the nucleus. The nucleus is the brains of the operation; inside every nucleus within each cell in your body, there's an identical copy of your entire genome. That genome tells cells when to grow and divide and makes sure they do their jobs, whether that's controlling your heartbeat or helping your brain understand the words on this page.

11. Defler paced the front of the classroom telling us how mitosis – the process of cell division – makes it possible for embryos to grow into babies, and for our bodies to create new cells for healing wounds or replenishing blood we've lost. It was beautiful, he said, like a perfectly choreographed dance.

12. All it takes is one small mistake anywhere in the division process for cells to start growing out of control, he told us. Just *one* enzyme misfiring, just one wrong protein activation, and you could have cancer. Mitosis goes haywire, which is how it spreads.

13. "We learned that by studying cancer cells in culture," Defler said. He spinned and spun to face the board, where he wrote two words in enormous print: HENRIETTA LACKS.

14. Henrietta died in 1951 from a vicious form of cervical cancer, he told us. But before she died, a surgeon took samples of her tumor and put them in a petri dish. Scientists had been trying to keep human cells alive in culture for decades, but they usually died. Henrietta's were different: they reproduced an entire generation every twenty-four hours, and they never stopped. They became the first immortal human cells ever grown in a laboratory.

15. "Henrietta's cells have now lived outside her body far longer than they ever lived inside it" Defler said. If we were to walk into every cell culture lab in the world and opened its freezers, he told us, we'd probably find trillions – trillions – of Henrietta's cells in small vials on ice.

16. Her cells were instrumental in research into the genes that cause cancer and those that suppress it; they helped develop the polio vaccine, herpes, leukemia, influenza, hemophilia, and Parkinson's disease; and they've been used to study lactose digestion, sexually transmitted diseases, appendicitis, human longevity, sperm penetration, mating, and the negative cellular effects of working in sewers. Their chromosomes and proteins have been studied with such detail and precision that scientists know their every quirk. Like guinea pigs and mice, Henrietta's cells have become the standard laboratory workhorse.

17. "HeLa cells were one of the most important things that happened to medicine in the last hundred years," Defler said.

The HeLa factory

18. Not long after Henrietta's death, planning began for a HeLa factory – a massive operation that would grow to produce trillions of HeLa cells each week. It was built for one reason: to help stop polio.

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19. By the end of 1951 the world was in the midst of the biggest polio epidemic in history. Schools closed, parents panicked, and the public grew desperate for a vaccine. In February 1952, Jonas Salk at the University of Pittsburgh announced that he'd developed the world's first polio vaccine, but he couldn't begin offering it to children until he'd tested it on a large scale to prove it was safe and effective. And doing that would require culturing cells on an enormous, industrial scale, which no one had done before.

20. The National Foundation for Infantile Paralysis (NFIP) – a charity created by President Franklin Delano Roosevelt, who'd himself been paralyzed by polio – began organizing the largest field trial ever conducted to test the polio vaccine. Salk would inoculate 2 million children and the NFIP would test their blood to see if they'd become immune. But doing this would require millions of neutralization tests, which involved mixing blood serum from newly vaccinated children with live poliovirus and cells in culture. If the vaccine worked, the serum from a vaccinated child's blood would block the poliovirus and protect the cells. If it didn't work, the virus would infect the cells, causing damage scientists could see using a microscope.

21. The trouble was, at that point, the cells used in neutralization tests came from monkeys, which were killed in the process. This was a problem, not because of concern for animal welfare – which wasn't the issue then that it is today – but because monkeys were expensive. Doing millions of neutralization tests using monkey cells would cost millions of dollars. So the NFIP went into overdrive looking for a cultured cell that could grow in mass scale and would be cheaper than using monkeys.

22. The NFIP turned to Gey and a few other tissue culturists for help, and Gey recognized the opportunity as a gold mine for the field. The March of Dimes was bringing in an average of $50 million in donations each year, and the NFIP intended to give much of that money to cell culturists so they could finally get a handle on human cancer cells, which they'd been wanting to do for years anyway.

23. The timing was perfect: by the time the NFIP contacted Gey for help, he realized that Henrietta's cells were unlike any human cells he'd seen.

24. Most cells in tissue culture grew only in a clot on a glass surface, which meant they ran out of space quickly. Increasing their numbers was labor-intensive: scientists had to repeatedly scrape the cells from one tube and transfer them into new ones to give them more space. HeLa cells, it turned out, weren't picky and didn't need a glass surface in order to grow. They could grow floating in a culture medium that was constantly stirred by a magnetic device, an important technique Gey developed, known as suspension growing in suspension. This meant that HeLa cells weren't limited by space in the same way that other cells were; they could simply divide until they ran out of culture medium. The bigger the vat of medium, the more the cells grew. This discovery meant that if HeLa was susceptible to poliovirus, which not all cells were, it would solve the mass-production problem and make it possible to test the vaccine without millions of monkey cells.

25. So in April 1952, Gey and one of his colleagues from the NFIP advisory committee – William Scherer, a young postdoctoral fellow at the University of Minnesota – tried infecting Henrietta's cells with poliovirus. Within days they found that HeLa was, in fact, *more* susceptible to the virus than any cultured cells had ever been. When they realized this, they knew they'd found exactly what the NFIP was looking for.

26. When the NFIP heard the news that HeLa was susceptible to poliovirus and could grow in large quantities for little money, it immediately contracted William Scherer to oversee development of a HeLa Distribution Centre at the Tuskegee Institute.

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27. At first the Tuskegee Center supplied HeLa cells only to polio-testing labs. But when it became clear that there was no risk of a HeLa shortage, they began sending the cells to any scientist interested in buying them, for ten dollars plus Air Express fees. If researchers wanted to figure out how cells behaved in a certain environment, or reacted to a specific chemical, or produced a certain protein, they turned to Henrietta's cells. They did that because, despite being cancerous, HeLa still shared many basic characteristics with normal cells: They produced proteins and communicated with one another like normal cells, they divided and generated energy, they expressed genes and regulated them, and they were susceptible to infections, which made them an optimal tool for synthesizing and studying any number of things in culture, including bacteria, hormones, proteins, and especially viruses.

28. Viruses reproduce by injecting bits of their genetic material into a liv[illegible] cell, essentially reprogramming the cell so it reproduces the virus instead of itself. When it c[illegible] to growing viruses – as with many other things – the fact that HeLa was malignant just made it *m[illegible]* useful. HeLa cells grew much faster than normal cells, and therefore produce[illegible] sults f[illegible] HeLa[illegible] a workhorse: it was hardy, it was inexpensive, and it was everywhere.

"Strangest hybrid"

29. By the 1960s, scientists joked that HeLa cells [illegible] so [illegible] that [illegible] could probably survive in sink drains or on door-knobs. They were everyw[illegible] e gen[illegible] public could grow HeLa at home using instructions from a *Scientific Amer[illegible]an* do-it-y[illegible] f art[illegible], and both Russian and American scientists had managed to grow HeL[illegible]

30. Henrietta's cells went up in the second [illegible] orbi[illegible] hich was launched by the Russian space program in 1960, and [illegible] st im[illegible] y arte[illegible] ward, NASA shot several vials of HeLa into space in the *Discoverer XV[illegible]* ate[illegible] new from simulated zero-gravity studies using animals that space travel[illegible] d ca[illegible] scular changes, degradation of bone and muscle, and a loss of red blood cells. Th[illegible] ion levels were higher beyond the ozone layer. But they didn't know w[illegible] effect[illegible] this would have on humans: Would it cause cellular changes, or even cell de[illegible]

31. When the firs[illegible] nans w[illegible] nto orbit, Henrietta's cells went with them so researchers could study the effects of sp[illegible] as the nutritional needs of cells in space, and how cancerous and noncancer[illegible] onded differently to zero gravity. What they found was disturbing: in mission after miss[illegible] ncerous cells grew normally in orbit, but HeLa became more powerful, dividing fast[illegible] ea[illegible] trip.

32. In 1960, Frenc[illegible] archers had discovered that when cells were infected with certain viruses in culture, the clumped together and sometimes fused. When they fused, the genetic material from the two cells combined, as with sperm meeting egg. The technical name for this was *somatic cell fusion*, but some researchers called it "cell sex". It was different from sperm-and-egg sex in several important ways: somatic cells were cells of the body, like skin cells, and their union produced offspring every few hours. Perhaps most important, cell sex was entirely controlled by researchers.

33. Genetically speaking, humans are terrible research subjects. We're genetically promiscuous – we mate with anyone we choose – and we don't take kindly to scientists telling us who to reproduce with. Plus, unlike plants and mice, it takes us decades to produce enough offspring to give scientists much meaningful data. Since the mid-1800s, scientists had studied genes by breeding plants and animals in specific ways – a smooth pea with a wrinkled one, a brown mouse with a white one – then breeding their offspring to see how genetic traits passed from one generation to the next. But they couldn't study human genetics the same way. Cell sex solved that problem, because it meant researchers could combine cells with any traits they wanted and study how those traits were passed along.

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34. In 1965 two British scientists, Henry Harris and John Watkins, took cell sex an important step further. They fused HeLa cells with mouse cells and created the first human-animal hybrids – cells that contained equal amounts of DNA from Henrietta and a mouse. By doing this, they helped make it possible to study what genes do, and how they work.

35. In addition to the HeLa-mouse hybrid, Harris fused HeLa with chicken cells that had lost their ability to reproduce. His hunch was that when those deactivated chicken cells fused with HeLa, something inside HeLa would essentially turn the chicken cell back on. He was right. He didn't know how it worked yet, but his discovery showed that something in cells regulated genes. And if scientists could figure out how to turn disease genes off, they might be able to create a form of gene therapy.

36. Soon after Harris's HeLa-chicken study, a pair of researchers at New York University discovered that human-mouse hybrids lost their human chromosomes over time, leaving only the mouse chromosomes. This allowed scientists to begin mapping human genes to specific chromosomes by tracking the order in which genetic traits vanished. If a chromosome disappeared and production of a certain enzyme stopped, researchers knew the gene for that enzyme must be on the most recently vanished chromosome.

37. Scientists in laboratories throughout North America and Europe [illegible] cells and using them to map genetic traits to specific chromosomes, creating a precursor to the human genome map we have today. They used hybrids to create the first monoclonal antibodies, special proteins later used to create cancer therapies like Herceptin, and to identify human blood groups that increased the safety of transfusions. They also used hybrids to study the problem of immunity in organ transplantation. Hybrids proved it was possible for DNA from two unrelated individuals, even of different species, to survive together *inside* cells without being attacked by the body's defenses, which meant the mechanism for rejecting transplanted organs had to be [illegible] cells.

38. Scientists were ecstatic about hybrids, but [illegible] about the United States and Britain, the public panicked as the media published sensational headline after the next:

[illegible] CELLS ARE BRED IN LAB…
[illegible] COULD BE TREE MEN…
[illegible] CREATE MONSTERS

39. *The Times* of London [illegible] HeLa-mouse cells the "strangest hybrid form of life ever seen in the lab – or out [illegible]." The *Washington Post* editorial said, "We cannot afford any artificially induced mouse-men," called the research "horrendous" and said the researchers should leave humans alone and "get back to their yeasts and fungi." One article ran with an image of a half-human, half-mouse creature with a long, scaly tail; another ran with a cartoon of a hippopotamus-woman reading the newspaper at a bus stop. The British press called the HeLa hybrids an "assault on life," and portrayed Harris as a mad scientist. And Harris didn't help the situation: he caused near-pandemonium when he appeared in a BBC documentary saying that the eggs of man and ape could now be joined to create a "mape."

40. Harris and Watkins wrote letters to editors complaining they'd been quoted out of context, their story sensationalized to "distort, misrepresent and terrify." They assured the public that they were just creating cells, not "trying to produce centaurs." But it didn't help. A public survey about their research was overwhelmingly negative, calling it pointless and dangerous, an example of "men trying to be gods." And the PR problem for cell culture was only going to get worse from there.

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The secret of immortality

41. More than thirty years after Henrietta's death, research on HeLa cells finally helped uncover how her cancer started and why her cells never died. In 1984 a German virologist named Harald zur Hausen discovered a new strain of a sexually transmitted virus called Human Papilloma Virus 18 (HPV-18). He believed it and HPV-16, which he'd discovered a year earlier, caused cervical cancer. HeLa cells in his lab tested positive for the HPV-18 strain, but zur Hausen requested a sample of Henrietta's original biopsy, so he could be sure her cells hadn't been contaminated with the virus in culture. The sample didn't just test positive; it showed that Henrietta had been infected with multiple copies of HPV-18, which turned out to be one of the most virulent strains of the virus.

42. There are more than one hundred strains of HPV in existence, thirteen of which cause cervical, anal, oral, and penile cancer – today, around 90 percent of all sexually active adults become infected with at least one strain during their lifetimes. Throughout the eighties, using HeLa and other cells, scientists studied HPV infection and how it causes cancer. They learned that HPV inserts its DNA into the DNA of the host cell, where it produces proteins that lead to cancer. They also found that when they blocked the HPV DNA, cervical cancer cells stopped being cancerous. These discoveries would help lead to an HPV vaccine, and eventually earn zur Hausen a Nobel Prize.

43. Research into HPV eventually uncovered how Henrietta's cancer started: HPV inserted its DNA into the long arm of her eleventh chromosome and disrupted, among other things, her p53 tumor suppressor gene. What scientists still haven't figured out is why HPV produced such monstrously virulent cells both in and out of Henrietta's body, especially since most cervical cancer cells are some of the hardest of all cells to culture.

44. When I talked to Howard Jones fifty years after he removed the tumor on Henrietta's cervix, he was in his early nineties and had seen thousands of cervical cancer cases. But when I asked if he remembered Henrietta, he laughed. "I'll never forget that tumor," he said, "because it was unlike anything I've ever seen."

45. I talked to many scientists about HeLa, and none could explain why Henrietta's cells grew so powerfully when many other cells don't survive. Today it's possible for scientists to immortalize cells by exposing them to certain viruses or chemicals, but very few cells have become immortal on their own as Henrietta's did.

46. Every decade has had landmark moments in HeLa research, and the connection between HPV and cervical cancer was only one of several in the eighties. At the beginning of the AIDS epidemic, a group of researchers, including a molecular biologist named Richard Axel, who would go on to win a Nobel Prize, infected HeLa cells with HIV. Normally, HIV can infect only blood cells, but Axel had inserted a specific DNA sequence from a blood cell into HeLa cells, which made it possible for HIV to infect them as well. This allowed scientists to determine what was required for HIV to infect a cell – an important step toward understanding the virus, and potentially stopping it.

47. Axel's research caught the attention of Jeremy Rifkin, an author and activist who was deeply involved in a growing public debate over whether scientists should alter DNA. Rifkin and many others believed that any manipulation of DNA, even in a controlled laboratory setting, was dangerous because it might lead to genetic mutations and make it possible to engineer "designer babies." Since there were no laws limiting genetic engineering, Rifkin regularly sued to stop it using any existing laws that might apply.

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48. In 1987 he filed a lawsuit in federal court to halt Axel's research on the grounds that it violated the 1975 National Environmental Policy Act, because it had never been proven environmentally safe. It was widely known, Rifkin pointed out, that HeLa was "an extraordinarily virulent and infectious line of cells" that could contaminate other cultures. Once Axel infected HeLa cells with HIV, Rifkin said, they could infect other cells and expose lab researchers around the world to HIV, "thus increasing the virus' host range and potentially leading to the further hazardous dissemination of the AIDS virus genome."

49. Axel responded to the suit by explaining that cells couldn't grow outside of tissue culture and that there was a world of difference between culture contamination and HIV infection. *Science* reported on the lawsuit, writing, "Even Rifkin admits that taken together these events sound more like the plot of a grade-B horror movie than the normal run of affairs in the country's [illegible] medical research laboratories." Eventually the suit was dismissed, Axel went on using HeLa [illegible] HIV research, and Rifkin's horror-film scenario didn't come true.

50. But in the meantime two scientists had developed a theory about H[illegible] sounded far more like science fiction than anything Rifkin had come up with. [illegible]ey said, was no longer human.

51. Cells change while growing in culture, just as they change in [illegible]. They're exposed to chemicals, sunlight, and different environments, all of which can cause DNA changes. Then they pass those changes on to each new generation [illegible] cell division, a random process that produces even more changes. Like humans, they [illegible].

52. All of this happened to Henrietta's cells [illegible] they were in culture. And they passed those changes on to their daughter cells, creating [illegible] HeLa cells that differed from one another in the same way that second, third, and fourth cousins differ, though they share a common ancestor.

53. By the early nineties, the [illegible] sample of Henrietta's cervix that Mary had put into culture in the Gey lab had given rise to many [illegible] all still known as HeLa, but all slightly different from one another, and [illegible]. Because of this, Leigh Van Valen, an evolutionary biologist at the University of Chicago, [illegible] suppose, in all seriousness, that [HeLa cells] have become a separate spe[illegible]."

54. Van Valen explain[illegible] later, saying, "HeLa cells are evolving separately from humans, and having a sepa[illegible]tion is really what a species is all about." Since the species name *Hela* was already t[illegible] of crab, the researchers proposed that the new HeLa cell species should be called *He[illegible]gartleri*, which combined *HeLa* with *cyton*, which is Greek for "cell," and *gartleri*, in honor of St[illegible]Gartler, who'd dropped the "HeLa Bomb" twenty-five years earlier.

55. No one challenged this idea, but no one acted on it either, so Henrietta's cells remained classified as human. But even today some scientists argue that it's factually incorrect to say that HeLa cells are related to Henrietta, since their DNA is no longer genetically identical to hers.

56. Robert Stevenson, one of the researchers who devoted much of his career to straightening out the HeLa contamination mess, laughed when he heard that argument. "It's just ridiculous," he told me. "Scientists don't like to think of HeLa cells as being little bits of Henrietta because it's much easier to do science when you disassociate your materials from the people they come from. But if you could get a sample from Henrietta's body today and do DNA fingerprinting on it, her DNA would match the DNA in HeLa cells."

57. Around the time Van Valen suggested HeLa was no longer human, researchers began exploring whether Henrietta's cells might hold the key to human life extension – perhaps even immortality – and headlines once again claimed that scientists had found the fountain of youth.

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58. In the early 1900s, Carrel's chicken-heart cells supposedly proved that all cells had the potential for immortality. But *normal* human cells – either in culture or in the human body – can't grow indefinitely like cancer cells. They divide only a finite number of times, then stop growing and begin to die. The number of times they can divide is a specific number called the Hayflick Limit, after Leonard Hayflick, who'd published a paper in 1961 showing that normal cells reach their limit when they've doubled about fifty times.

59. After years of disbelief and argument from other scientists, Hayflick's paper on cell limits became one of the most widely cited in his field. It was an epiphany: scientists had been trying for decades to grow immortal cell lines using normal cells instead of malignant ones, but it had never worked. They thought that their technique was the problem, when in fact it was simply that the lifespan of normal cells was preprogrammed. Only cells that had been transformed by a virus or a genetic mutation had the potential to become immortal.

60. Scientists knew from studying HeLa that cancer cells could di[illegible] indefi[illegible]ly, an[illegible]y'd speculated for years about whether cancer was caused by an error in [illegible] mechan[illegible]sm [illegible] mad[illegible] cells die when they reached their Hayflick Limit. They also knew that [illegible]s a str[illegible] of [illegible] at the end of each chromosome called a *telomere*, which shortened a tiny bit ea[illegible]me a[illegible]ded, like time ticking off a clock. As normal cells go through life, their [illegible]meres shor[illegible] with [illegible]ch division until they're almost gone. Then they stop dividing and be[illegible] to die[illegible] pro[illegible] correlates with the age of a person: the older we are, the shorter our telom[illegible] an[illegible] the f[illegible] times our cells have left to divide before they die.

61. By the early nineties, a scientist at [illegible] and [illegible] discover that human cancer cells contain an enzyme called *telomerase* [illegible] t r[illegible] their t[illegible]eres. The presence of telomerase meant cells could keep regenerating th[illegible]me[illegible] definitely. This explained the mechanics of HeLa's immortality: telom[illegible]or[illegible] found the ticking clock at the end of Henrietta's chromosomes so they ne[illegible] grew [illegible]d. It was this immortality, and the strength with which Henrietta's cells gr[illegible] ha[illegible]sible for HeLa to take over so many other cultures – they simply outlived and out[illegible]a[illegible] cells they encountered.

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Reference

The Immortal Life of [illegible]acks by Rebecca Skloot. Pan Books 2011 ISBN 978-0-330-53344-7

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Summer 2014
Publications Code UA038140
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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.

( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Answer	Mark
1(a)(i)	A ;	(1)

Question Number	Answer	Mark
1(a)(ii)	C ;	(1)

Question Number	Answer	Mark
1(a)(iii)	B ;	(1)

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	1. increased risk of obesity / eq ; 2. (coronary) heart disease / CHD / eq ; 3. diabetes / eq ; 4. high blood pressure / strokes ; 5. osteoporosis ;	1 ACCEPT overweight 2 ACCEPT build-up of cholesterol in {arteries / blood vessels}, CVD, atheroma 5 ACCEPT decrease in bone density	(2)

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	1. wear and tear on joints / eq ; 2. suppression of immune system / susceptibility to { respiratory tract infections / eq} / eq ;	1 ACCEPT damage to joints, ligaments, osteoarthritis, arthritis, wearing away of cartilage, stress fractures, named e.g. tennis elbow, RSI must be qualified 2 ACCEPT URT for upper respiratory tract, infections of the airways, reduced numbers of white blood cells IGNORE asthma	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(a)(i)	1. identical twins (agreement) is greater / eq ; 2. credit correct manipulation of the data e. g. {41% more / 2.4x as much / 141% higher / eq} agreement than non-identical twins ; 3. idea that alleles are involved ; 4. idea that non-identical have genetic differences ; 5. idea that because less than 100% then some other factor is involved ;	ACCEPT converse where appropriate 2. ACCEPT 41% difference 3. ACCEPT gene alternatives 3 and 4 IGNORE genes / DNA unqualified 4. ACCEPT identical twins are genetically the same	(4)

Question Number	Answer	Additional Guidance	Mark
2(a)(ii)	idea that there is less of a gap between the results ;	ACCEPT expressed as numbers, results similar (to each other), identical twin result is lower, non-identical higher	(1)

Question Number	Answer	Additional Guidance	Mark
2(b)	1. idea that active areas have more {oxygen / oxygenated blood} ; 2. active areas involved in face recognition will be identified / eq ; 3. idea of level of brain activity between identical twins and non identical twins is compared ; 4. to offer supportive evidence / improve validity of study ; 5. idea that fMRI shows brain activity in real time ; 6. idea of high resolution ; 7. comment on safety / eq ;	3. areas more active / more oxygenated blood flowing to areas in identical twins compared with non-identical twins 3. idea of {more / eq} areas showing activity in common in identical twins than non-identical 5. IGNORE 3D image 6. ACCEPT more detail 7. fMRI does not use X rays	**(4)**

Question Number	Answer	Additional Guidance	Mark
3(a)	1. idea that (some) have less myoglobin present ; 2. less blood / fewer red blood cells / less haemoglobin ; 3. as fewer capillaries present / eq ; 4. idea that respiration is (mainly) anaerobic ;		(2)

Question Number	Answer	Additional Guidance	Mark
3(b)(i)	negative feedback ;	ACCEPT -ve feedback, biofeedback is negative	(1)

Question Number	Answer	Additional Guidance	Mark
***3(b)(ii)**	(QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence) 1. idea that low pH is due to acid in the blood ; 2. *lactate* taken to *liver* / eq ; 3. reference to oxygen debt / EPOC ; 4. used to convert *lactate* back to *pyruvate* ; 5. with production of *reduced* NAD / eq ; 6. {*lactate* / *pyruvate*} converted to *glucose* / *glycogen* ; 7. *pyruvate* into *mitochondria* ; 8. idea of *chemoreceptors* detecting change in pH ; 9. idea of response e.g. increased { nerve impulse rate from *medulla* / breathing rate / heart rate} ; 10. (dissolved) CO_2 from blood (*diffuses*) into *alveoli* / eq ;	QWC emphasis is spelling ACCEPT *lactic* acid for *lactate* throughout and *pyruvic* acid for *pyruvate* 1. Accept for acid: *lactic acid*/*lactate*/(dissolved) CO_2 5. ACCEPT $NADH_2$ and $NADH + H^+$ 7. ACCEPT *lactate*, *matrix* as equivalent to mitochondria	**(5)**

Question Number	Answer	Additional Guidance	Mark
3(b)(iii)	1. reference to arterioles ; 2. muscles contracting to restrict diameter / eq (in shunts) ; 3. muscles relaxing to increase diameter / eq (of arterioles) ; 4. to redirect blood {away from deeper arterioles / into surface arterioles} / eq ; 5. to increase blood flow { into capillaries / towards surface } / eq ; 6. (so more heat lost) through radiation ;	IGNORE ref to relaxation of hair erector muscles 2. ACCEPT vasoconstriction 3. ACCEPT muscles relax to dilate arteriole ; 3. ACCEPT vasodilation 4. ACCEPT shunt vessels 5. More blood enters = to increase blood flow	**(4)**

Question Number	Answer	Additional Guidance	Mark
4(a)	1. mice of different mass / eq ; 2. idea of concentration is a controlled variable ; 3. idea of increases validity of investigation or conclusions ; 4. maybe harmful in high doses / eq ;	ACCEPT converse statement where appropriate 1. IGNORE ref to diff sizes unqualified 2. to overcome effect of {lighter mice receiving proportionately a higher dose / heavier mice receiving proportionately a lower dose} / to keep concentration per kg of mouse constant ; 3. ACCEPT so comparisons can be made 4. ACCEPT concentration for dose	(3)

Question Number	Answer	Additional Guidance	Mark
4(b)(i)	1. increases the ratio; 2. by { 0.3 / 17.6%} ; 3. inner membrane is larger / eq ;	1. ACCEPT ratio is higher 2. ACCEPT 18% 3. ACCEPT increases the surface area of inner membrane ACCEPT converse IGNORE it is smaller	(2)

Question Number	Answer	Additional Guidance	Mark
4(b)(ii)		ACCEPT converse where appropriate	
	1. idea that fatigue may be due to less ATP ;	1. ACCEPT running out, running short	
	2. inner membrane is the site of {electron transport chain / oxidative phosphorylation / eq} ;	2+3 ACCEPT crista for inner membrane	
	3. {more inner membrane / greater inner surface area} then more electron transport chain / eq ;	3. ACCEPT more aerobic respiration	
	4. more ATP made / eq ;	4. ACCEPT idea that more ATP present/available	
	5. detail of ATP synthesis e.g. ref to chemiosmosis, H^+ down electrochemical gradient through ATP synthase ;	5. This mp is independent of quantity	
	6. (so) delays onset of fatigue / eq ;	6. ACCEPT ref to muscles can contract for longer	
	7. by 34 seconds in {group A / those fed epicatechin} ;	7. gains Mp6 as well if states comparison e.g. 34s longer to fatigue	
			(5)

Question Number	Answer	Mark
5(a)(i)	B (between 12 and 15 hours) ;	(1)

Question Number	Answer	Mark
5(a)(ii)	D (phytochrome) ;	(1)

Question Number	Answer	Additional Guidance	Mark
5(a)(iii)	any two of the following standardised: water / eq mineral ion concentrations / eq light intensity / eq wavelength of light CO_2 concentration, temperature pH soil type ;	IGNORE seed ACCEPT named mineral ion	(2)

Question Number	Answer	Additional Guidance	Mark
5(a)(iv)	idea of using shorter time intervals e.g. 1 hour intervals ;	ACCEPT a description e.g. repeat with 12 hours of light, 13 hours, etc Ignore ref to more data collected unqualified	(1)

Question Number	Answer	Additional Guidance	Mark
5(b)	any one from: temperature water availability the {wavelength / quality} of light intensity of light {edaphic / named edaphic} factor ;	IGNORE ref to pollinators	(1)

Question Number	Answer	Additional Guidance	Mark
5(c)(i)	outer segment / internal membranes / inner membranes / vesicles ;	IGNORE ref to top, end, outer layer	(1)

Question Number	Answer	Additional Guidance	Mark
5(c)(ii)	<table><tr><th rowspan="2">Description</th><th colspan="3">Statement</th></tr><tr><th>Opsin binds to the rod cell membrane</th><th>Rhodopsin bleaches</th><th>ATP used</th></tr><tr><td>Rhodopsin responding to light</td><td>✓</td><td>✓</td><td>×</td></tr><tr><td>Rhodopsin being reset</td><td>×</td><td>×</td><td>✓</td></tr></table> Any two correct for 1 mark ;	IGNORE blank boxes IGNORE hybrid tick/crosses (✓)	(3)

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>6(a)</td><td>
<table>
<tr><th>Labelled structure</th><th>Name of structure</th><th>One function</th></tr>
<tr><td>A</td><td>Medulla (oblongata) ;</td><td>Controls {breathing / heart / eq} ;</td></tr>
<tr><td>C ;</td><td>Cerebral hemisphere/ cerebrum / frontal cortex ;</td><td>Feel emotions</td></tr>
</table>
</td><td>For A ACCEPT involuntary muscles or named e.g. swallowing, vomiting, sneezing
IGNORE brain stem

For cerebrum, reject cerebellum
For cerebrum, accept frontal lobe/prefrontal / cerebral cortex</td><td>(4)</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
6(b)(i)	1. idea that cuts at a specific sequence of bases ; 2. idea of (generates) sticky ends ; 3. so easier to join together / eq ;	1. ACCEPT DNA sequence 3. ACCEPT to produce {same / complementary / eq} sticky ends (in plasmid and (human) gene)	(2)

Question Number	Answer	Additional Guidance	Mark
6(b)(ii)	1. the chemical could be a {transcription factor / hormone} ; 2. idea of interaction at (bacterial) cell (surface) membrane ; 3. idea of transcription factor being activated ; (e.g. transcription initiation complex formed, binds to transcription factor) or counters inhibitor ; 4. ref to promoter region ; 5. idea of transcription occurs e.g. RNA polymerase binds, mRNA produced ;	2. ACCEPT binds to cell surface membrane/passes through 3. ACCEPT triggers secondary messenger to be released {into cytoplasm/from (inner side of) membrane} 5. NOT DNA polymerase	**(3)**

Question Number	Answer	Additional Guidance	Mark
6(b)(iii)	(ribosome has) larger and smaller subunit / (ribosomal) protein and rRNA ;	ACCEPT ref to 2 subunits ACCEPT 30S and 50S subunits	**(1)**

Question Number	Answer	Additional Guidance	Mark
6(b)(iv)	1. larger lumen so easier to put into blood / eq ; 2. (less muscle / thinner wall) so easier to penetrate / eq ; 3. (blood) pressure less so less damage to vein / eq ; 4. idea that vein is easier to find;	ACCEPT converse when appropriate IGNORE ref to 'going to the heart' 3. ACCEPT (blood) pressure less so less blood loss 4. ACCEPT nearer the skin surface/easier to access	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(a)	1. involves prophase, metaphase, anaphase and telophase ; 2. idea that produces two nuclei ; 3. idea that these are genetically identical to original ;	IGNORE ref to 46 chromosomes unqualified IGNORE ref to body cells/somatic cells unqualified 1. NOT if cytokinesis or interphase included as part of mitosis 2. ACCEPT produces two cells 3. ACCEPT parental ACCEPT clones (of parent) IGNORE repair, growth, asexual reproduction	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(b)	1. (SAN) is myogenic / description given ; 2. electrical activity from SAN causes atria to contract / eq ; 3. idea that activity of SAN can be changed by nerve impulses e.g controlled by medulla ; 4. credit detail of nervous control e.g. more impulses from accelerator increases heart rate ;	4. ACCEPT more { impulses from sympathetic / noradrenaline} increases heart rate more {impulses from vagus / more impulses from parasympathetic / acetylcholine} decreases heart rate	**(3)**

Question Number	Answer	Additional Guidance	Mark
7(c)	1. idea that lactase gene {activated / transcribed} ; 2. (synthesis of) lactase / eq ; 3. hydrolysis of lactose / glycosidic bonds broken ; 4. to produce glucose AND galactose ;		**(3)**

Question Number	Answer	Additional Guidance	Mark
7(d)	1. idea that a better model than guinea pigs or mice ; 2. idea of animal rights ; 3. easy to culture / eq ; 4. (HeLa cells) susceptible to disease / HPV / eq ;	1. ACCEPT ref to only HeLa {cells/DNA} are human 2. ACCEPT {fewer / no} ethical issues welfare of animals 3. ACCEPT cheaper (as continual supply)	**(2)**

Question Number	Answer	Additional Guidance	Mark
* 7(e)	(QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence) 1. idea that {motor neurone / cell body / nucleus} is destroyed ; 2. depolarisation does not occur in the neurone / (insufficient so) no action potential set up in the neurone ; 3. detail of (depolarisation / action potential) not occurring in neurone e.g. Idea Na^+ does not diffuse into neurone ; 4. {neurotransmitter / named neurotransmitter} not{released / produced / eq} at junction with muscle / eq ; 5. detail of lack of neurotransmitter release e.g. vesicles (containing neurotransmitter) do not {move / fuse} with {presynaptic membrane / eq} / eq ; 6. Ca^{2+} not released into muscle cytoplasm ; 7. Ca^{2+} not released from sarcoplasmic reticulum ; 8. no Ca^{2+} to {activate / eq} troponin ; 9. idea that muscle does not contract ;	QWC emphasis is clarity of expression 1. Accept idea of damage to myelin sheath/Schwann cells 3. ACCEPT Na^+ / cation channels {non-functional / eq} 4. ACCEPT {neurotransmitter / named neurotransmitter} not{released / produced / eq} at {motor neurone presynaptic membrane / motor end plate} 6. ACCEPT Ca^{2+} not released into sarcoplasm	**(6)**

Question Number	Answer	Additional Guidance	Mark
7(f)		NB If candidates consider viral genetic material in terms of DNA produced from RNA then still works	
	1. contains basis / eq ;	1. ACCEPT both have (4) bases / nucleotides	
	2. contain phosphate (groups) ;		
	3. have a pentose sugar ;	3. ACCEPT 5C sugar	
	4. reference to phosphodiester bonds ;	4. ACCEPT phosphoester	
	5. idea of discrete strands ;	5. ACCEPT linear	**(3)**

Question Number	Answer	Additional Guidance	Mark
7(g)	1. smooth shown as dominant / wrinkled shown as recessive e.g. use of upper and lower case ;	these could be gleaned from gametes	
	Parental generation:		
	2. both types shown as homozygous ;		
	F1:		
	3. all shown as heterozygous ;		
	F2:		
	4. genetic diagram to show that 75% are smooth / 25% are wrinkled ;	4. diagram should show genotypes	**(4)**

Question Number	Answer	Additional Guidance	Mark
7(h)	1. all the {DNA / eq} found in {a human / the human species / eq} ; 2. idea of genes {on different chromosomes / different positions on same chromosome} ;	1. ACCEPT all the bases / introns and exons for DNA eq ACCEPT population for species 2. ACCEPT locus/loci for position	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(i)	1. product (of p53 gene) {stops / eq} development of tumour cells / eq OR product {stops / regulates} progression {of cell cycle / towards mitosis} ; 2. acts as an inhibitor of {transcription / protein synthesis / eq} / eq ; 3. idea that {DNA / eq} repair ; 4. idea that leads to apoptosis ;	1. ACCEPT product stops tumour cells growing/ dividing 1. ACCEPT keeps it in interphase / named mitotic stage / interferes with mitosis progress 4. ACCEPT shortens telomeres	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(j)	1. protein / glycoprotein ; 2. reference to this being CD4 ; 3. found on cell (surface) membrane / eq ; 4. that acts as a {receptor / named receptor} for HIV / eq ;	1. IGNORE ref to haemoglobin 4. ACCEPT receptor for gp120	(2)

Question Number	Answer	Mark
7(k)	200 (nucleotides) ;	Clerical (1)







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Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Biology

Advanced

Unit 5: Energy, Exercise and Coordination

Monday 17 June 2013 – Afternoon
Time: 1 hour 45 minutes

Paper Reference
6BI05/01

You must have:
A copy of the scientific article adapted from several sources (enclosed)

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 3 9 8 8 7 A 0 1 2 4

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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Rod cells in the eye are linked to the brain by neurones.

(a) Place a cross in the box ☒ to identify the answer that correctly completes each statement.

(i) The pigment in a rod cell is made of opsin and

(1)

☒ **A** retina

☒ **B** retinal

☒ **C** retine

☒ **D** retinol

(ii) When light stimulates a rod cell the pigment changes. This pigment is

(1)

☒ **A** iodopsin

☒ **B** phytochrome far

☒ **C** phytochrome red

☒ **D** rhodopsin

(iii) Once the pigment has changed, the concentration of sodium ions inside the rod cell

(1)

☒ **A** decr

☒ **B** does not change

☒ **C** increase

☒ **D** reaches equilibrium with the outside of the cell

(iv) After changing, the pigment takes time to become functional again. This is because

(1)

☒ **A** it has to bleach

☒ **B** the membrane has to be polarised

☒ **C** the rod cell needs to reset

☒ **D** two components have to be rejoined

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(v) The cell that links a rod cell to a sensory neurone is

(1)

- ☒ **A** a bipolar neurone
- ☒ **B** a multipolar neurone
- ☒ **C** a unipolar neurone
- ☒ **D** an optic nerve

(b) Decreasing the intensity of light entering the eye causes pupil dilation.
Describe the roles of the circular and radial muscles in pupil dilation.

(2)

(Total for Question 1 = 7 marks)

Example

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2 There are various ways of investigating brain structure and function.

(a) Compare the use of computed tomography (CT) with magnetic resonance imaging (MRI) for studying brain structure.

(3)

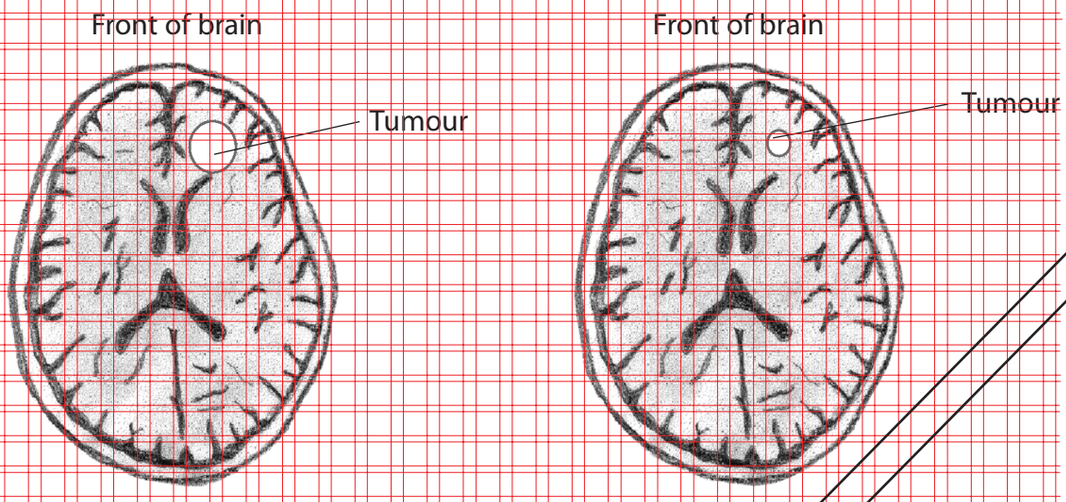
(b) Suggest why functional magnetic resonance imaging (fMRI) is considered better than CT for studying brain function.

(2)

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(c) The diagrams below show two MRI scans of the brain of a patient with a tumour. Scan 1 was taken before treatment was carried out, and scan 2 after treatment.



Scan 1 before treatment

Scan 2 after treatment

(i) Suggest why the tumour appeared white in the scans.

(2)

(ii) Using the information in the diagrams, describe the effect of the treatment on the tumour.

(2)

Exemplar

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(iii) Using the information in the diagrams, suggest **two** brain functions that may have improved after treatment. Give a reason for your answer.

(3)

(Total for Question 2 = 12 marks)

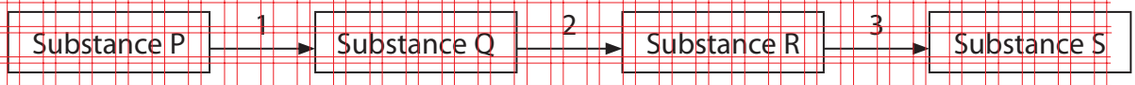
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3 Respiration is a metabolic process which consists of many steps.

(a) The diagram below shows a metabolic process consisting of three steps.

Each letter represents a different substance and each number a different enzyme.

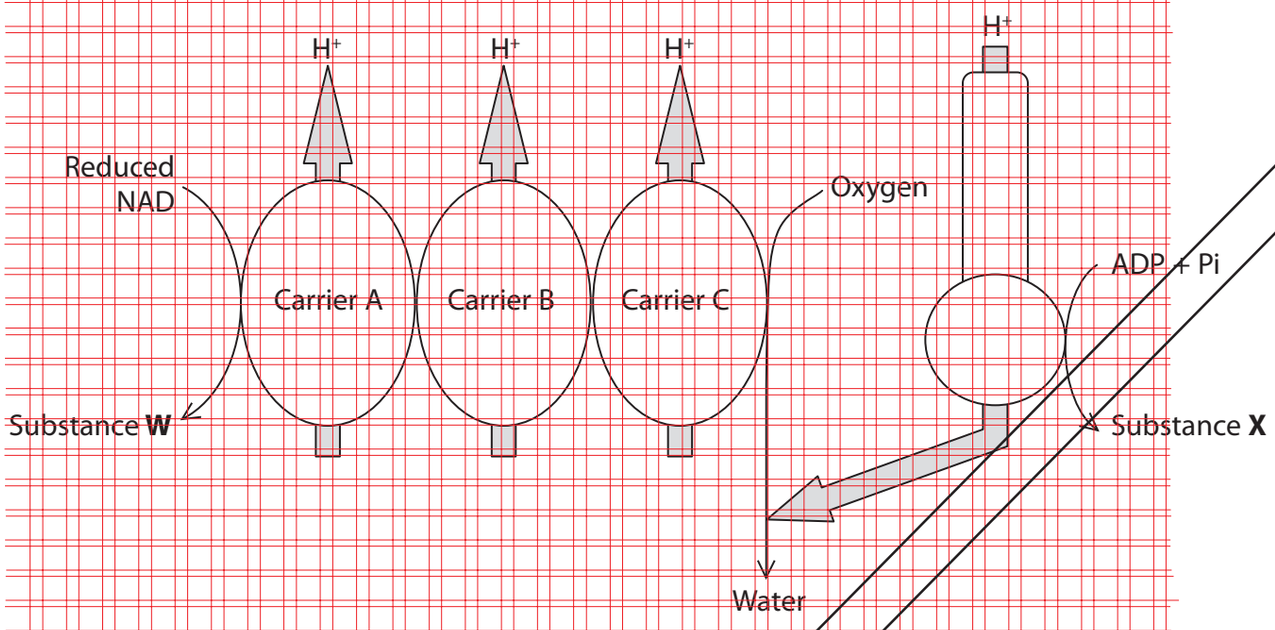


Describe and explain the functions of enzymes in this metabolic process.

(4)

Exemplar

(b) The diagram below shows the electron transport chain, which is part of aerobic respiration.



(i) Using the information in the diagram, name substance **W** and explain how it is formed.

(3)

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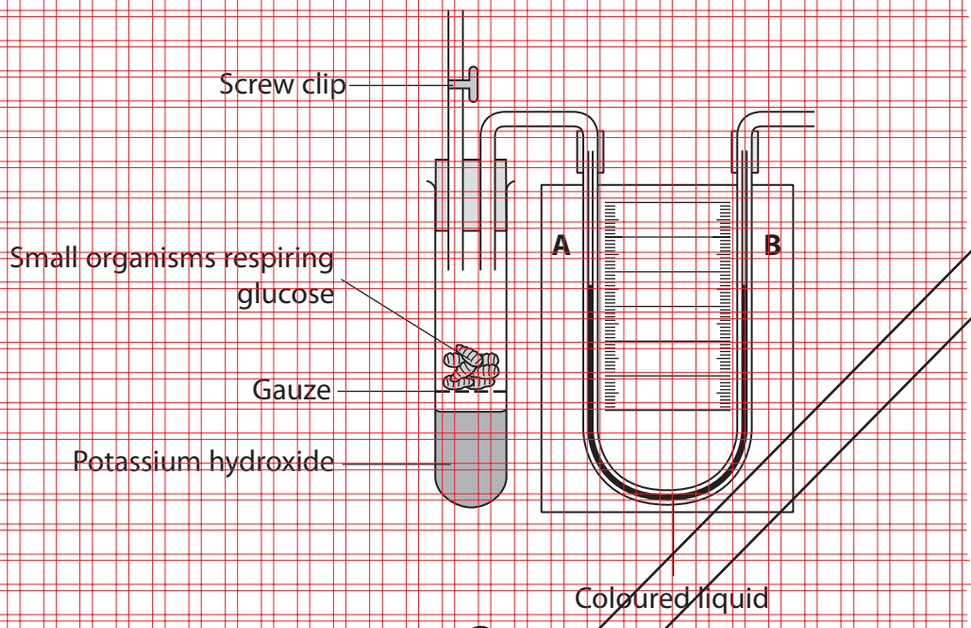
(ii) Name substance **X**.
Explain the link between the formation of substance **X** and the H^+ shown on the diagram.

(3)

Exemplar

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(c) The diagram below shows a respirometer used to measure the rate of aerobic respiration in small organisms.



Potassium hydroxide absorbs carbon dioxide.
The table below describes three different situations.
Place a cross in the box that correctly shows the movement of the coloured liquid in the U-shaped tube in each situation.

(3)

Situation	Movement of coloured liquid: towards A	towards B	does not move
Screw clip is open	☒	☒	☒
Screw clip is closed	☒	☒	☒
Potassium hydroxide is replaced with water and screw clip is closed	☒	☒	☒

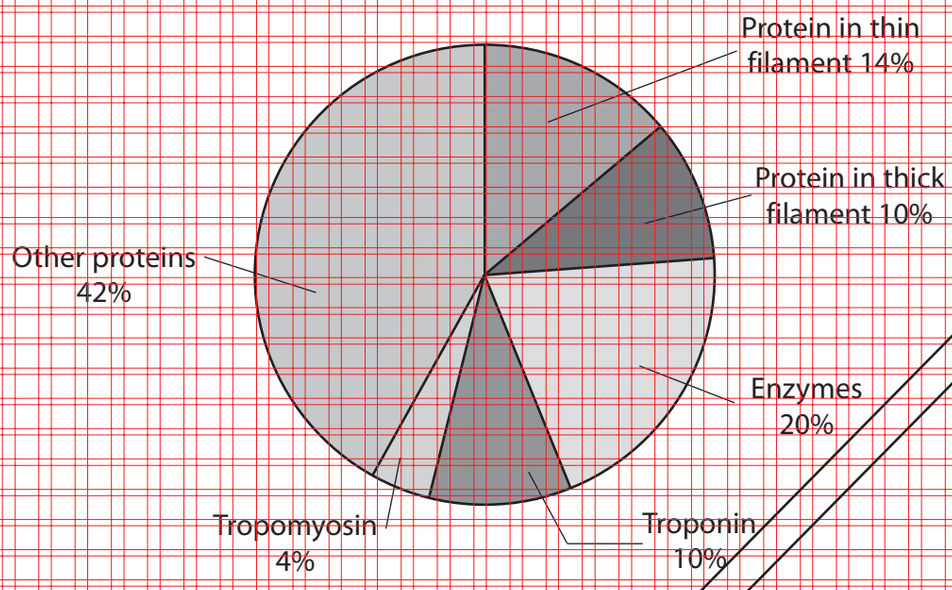
(Total for Question 3 = 13 marks)

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4 Skeletal muscle and cardiac muscle have some of the same proteins.

(a) Some of these proteins found in cardiac muscle are shown in the chart below.



(i) Using the chart, name the protein that makes up each of the two types of filament.

(2)

Protein in thin filament .....

Protein in thick filament .....

(ii) Describe the interaction between troponin and tropomyosin when a skeletal muscle fibre contracts.

(2)

.....

.....

.....

.....

.....

.....

(iii) In the chart, some of the other proteins are neurotransmitter receptors. These are found on the cell surface membrane of cardiac muscle cells in the sinoatrial node (SAN).

Suggest **one** neurotransmitter substance that might bind to these receptors.

(1)

.....

Exemplar

(b) Troponin T is found in cardiac muscle cells. It can leak into the blood if the heart is damaged as a result of cardiovascular disease.

Testing for troponin T in blood can be used to study patients with damaged hearts.

The table below shows the concentration of troponin T in the blood of patients. The table also shows the mean number of days in hospital and the range of stay.

Concentration of troponin T in the blood / arbitrary units	Mean number of days of stay in hospital and the range
6.0 +	9 ± 2.0
4.0 – 5.9	6 ± 1.0
1.0 – 3.9	3 ± 0.5

Using the information in the table suggest what prediction a doctor could make and comment on the reliability of this prediction for patients with damaged hearts.

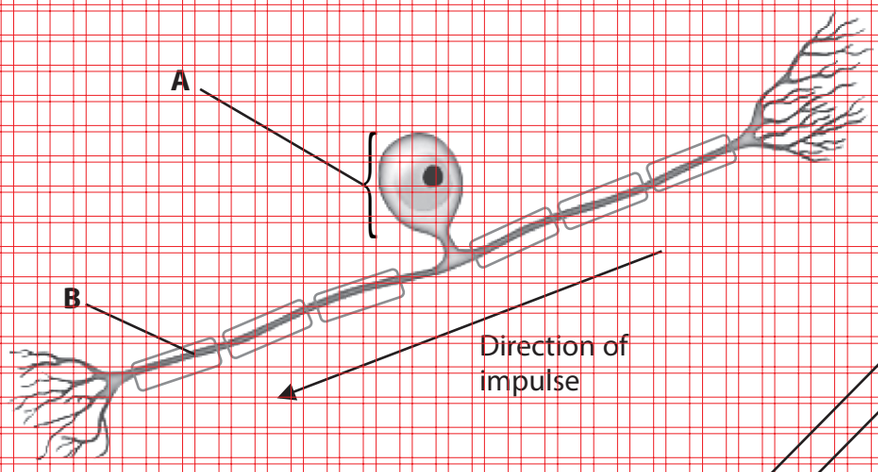
(3)

(Total for Question 4 = 8 marks)

Pearson Edexcel

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5 The diagram below shows a sensory neurone.



(a) Name the structures labelled **A** and **B**.

(2)

A .....

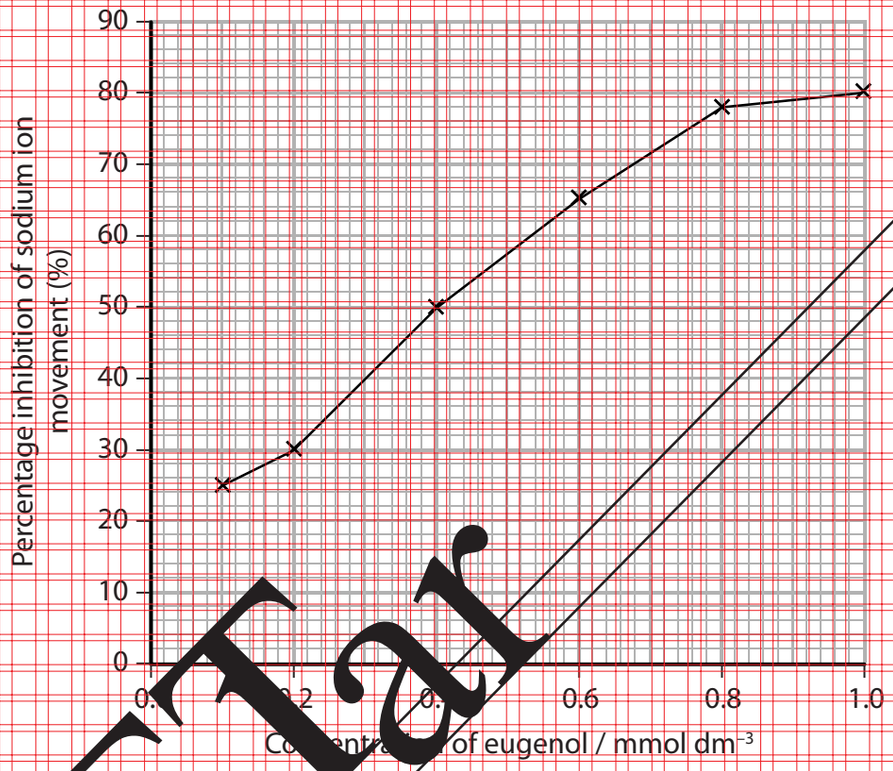
B .....

Exemplar

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(b) Eugenol is a drug that inhibits the movement of sodium ions and calcium ions through the cell surface membranes of sensory neurones.

The graph below shows the effect of eugenol concentration on the percentage inhibition of sodium ion movement.



(i) Describe the relationship between the concentration of eugenol and the percentage inhibition of sodium ion movement.

(2)

PreAmar

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*(ii) Eugenol can be used to reduce pain.

Suggest an explanation for how eugenol affects the movement of calcium ions and reduces pain.

(6)

(Total for Question 5 = 10 marks)

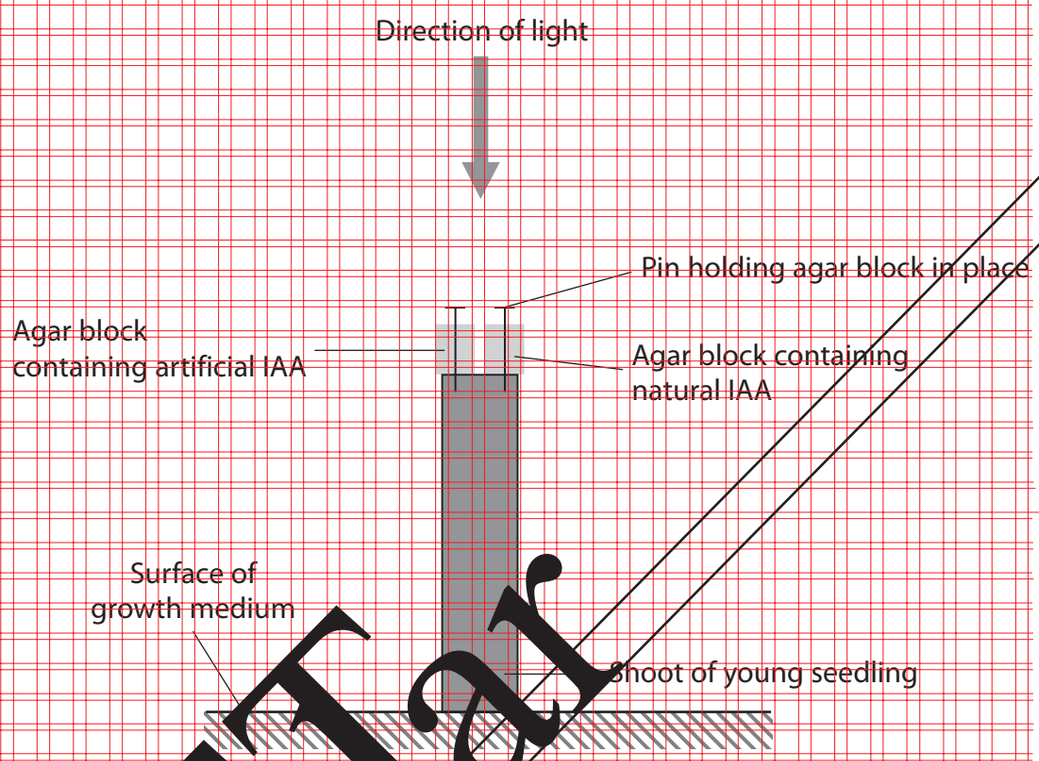
Exemplar

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6 IAA (auxin) is a plant growth substance.

(a) A student investigated the effect of natural IAA and artificial IAA on shoot growth.

The diagram below shows how she set up her investigation.



(i) The student also set up a control.

Describe a suitable control for this investigation.

(1)

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.....

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PreMar

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(ii) After 48 hours, the student recorded her observations of the growth of the shoots.
From her observations, she concluded that both natural and artificial IAA affected growth. She also concluded that the artificial IAA had a greater effect than the natural IAA.

Suggest what she recorded and explain how the IAA in the agar affected the growth of the shoot.

(5)

(b) IAA is known to [illegible] transcription factors.

Suggest how IAA [illegible] cells to synthesise proteins.

(4)

(Total for Question 6 = 10 marks)

Exemplar

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7 The scientific article you have studied is adapted from several sources.

Use the information from the article and your own knowledge to answer the following questions.

(a) The sweet potato eaten by naked mole rats (paragraph 3) is very rich in cellulose and starch.

Give **two** structural differences between cellulose and starch.

(2)

(b) Naked mole rats show evidence of poikilothermy (paragraph 5) whilst other mammals, such as humans, maintain a nearly constant body temperature.

(i) Describe the role of the human nervous system in returning a slightly raised body temperature to its normal level.

(4)

Pre Appeal

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(ii) Explain how shivering generates heat to return a slightly reduced body temperature to its normal level.

(2)

(c) Suggest how Buffenstein and Horsby introduced cancer-causing genes into cells from naked mole rats (paragraph 13).

(3)

Exemplar

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*(d) If we had to breathe the 'rank air' found in the tunnels of naked mole rats, it would leave us 'gasping for air' (paragraph 33).

Describe how the mechanism involved in the control of breathing rate in humans would respond to this 'rank air'.

(5)

(e) Suggest how a study of the naked mole rat could help in the design of prosthetic limbs (paragraph 47).

(2)

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(f) Using the information in paragraph 48, name **one** hormone and state its target organ.

(1)

Hormone .....

Target organ .....

(g) Suggest **two** reasons why the structure of the sperm may make it non-motile (paragraph 48).

(2)

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(h) The 'coefficient of band sharing' (paragraph 49) is a measure of the number of bands that different DNA samples have in common. The higher the coefficient the more bands the samples share. The maximum coefficient is 1.00.

Suggest why the coefficient of band sharing ranges from 0.93 to 0.99 within a colony of naked mole-rats.

(3)

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DxEdTar

(i) Suggest the importance of dispersers in naked mole rat colonies (paragraphs 50, 51 & 52).

(2)

(j) Describe and explain **two** ways in which naked mole rats are adapted to their environment.

(4)

(Total for Question 7 = 30 marks)

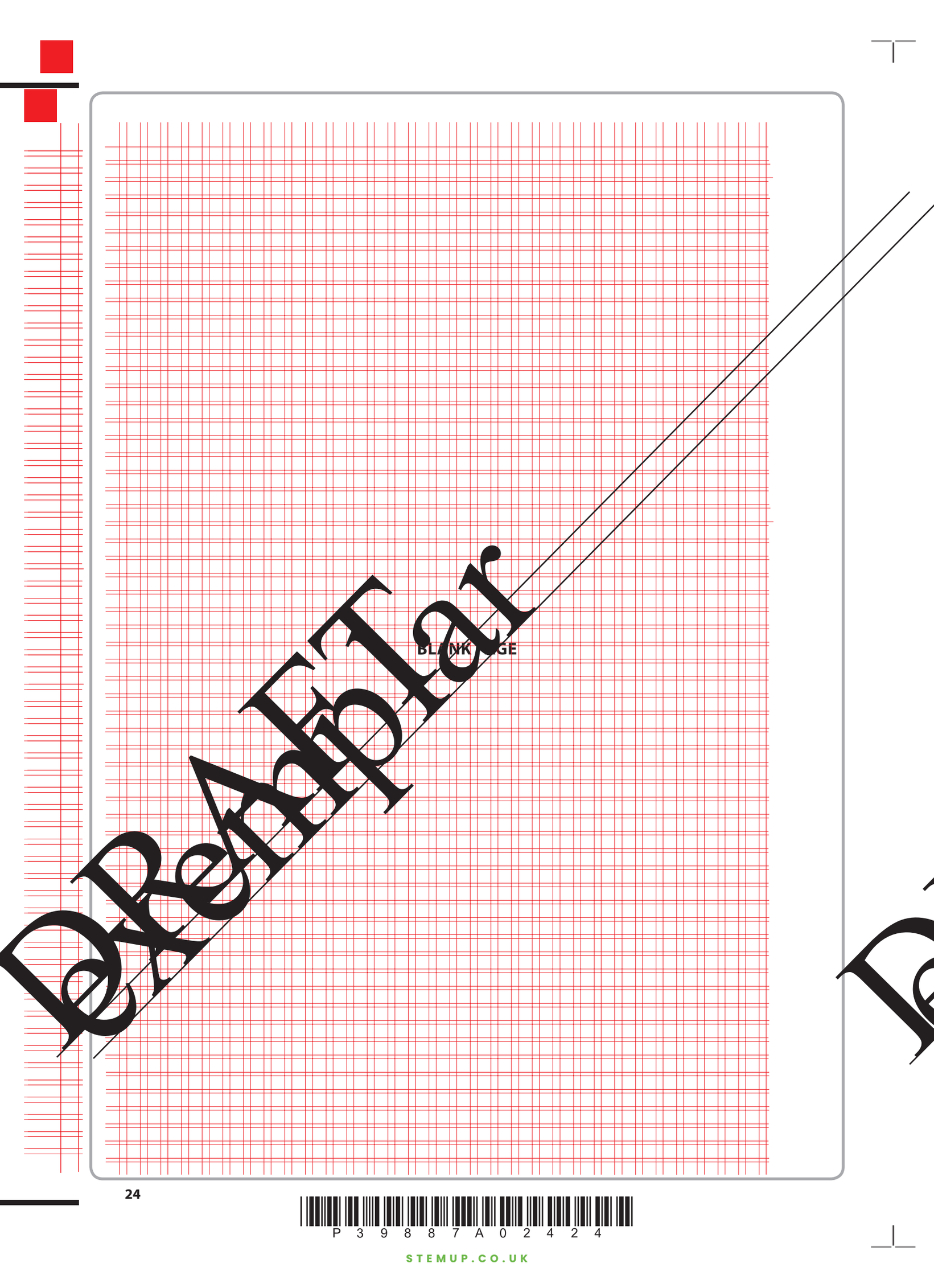
TOTAL FOR PAPER = 90 MARKS

Exemplar

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Example

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P 3 9 8 8 7 A 0 2 4 2 4

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Mark Scheme (Results)

Summer 2013

GCE Biology (6BI05)

Paper 01: Energy, Exercise and Coordination

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Summer 2013
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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question Number	Answer	Mark
1(a)(i)	B ;	**(1)**

Question Number	Answer	Mark
1(a)(ii)	D ;	**(1)**

Question Number	Answer	Mark
1(a)(iii)	A ;	**(1)**

Question Number	Answer	Mark
1(a)(iv)	D ;	**(1)**

Question Number	Answer	Mark
1(a)(v)	A ;	**(1)**

Question Number	Answer	Additional guidance	Mark
1(b)	1. Ideas of (muscles) work antagonistically ; 2. circular muscle relaxes ; 3. radial muscle contracts;	ACCEPT 2 stretched	**(2)**

Question Number	Answer	Additional guidance	Mark
2(a)	1. idea of comparative image clarity ; 2. CT therefore can only identify {larger / main} structures / MRI can identify smaller structures / eq ; 3. Reference to tissue identified / eq ; 4. MRI uses {radio waves / magnetic field}, CT uses X-rays / eq ; 5. Idea of both give {2D / 3D} images ; 6. limitation of MRI or CT ; 7. idea of images for both are at one point in time ; 8. ref to comparative cost of use ;	ACCEPT 1 - image resolution {higher in MRI / lower in CT} / MRI offers more detail ACCEPT 6 – MRI-noisy, need to keep still, not so good for people with metal implants, pacemakers CT ref to safety aspects of X-rays ACCEPT 8 - MRI more expensive than CT	**(3)**

Question Number	Answer	Additional guidance	Mark
2(b)	1. view brain activity directly / eq ; 2. idea of see brain activity over a period of time ; 3. safer as does not use X rays ; 4. no need to use special dyes ;	ACCEPT 1 – MRI identifies active areas by greater blood flow, greater oxygen uptake, presence of more oxyhaemoglobin in these areas ACCEPT 2 – see in real time, quotes figures such as fMRI takes up to 4 images a second or moving image, CT is still image	**(2)**

Question Number	Answer	Additional guidance	Mark
2(c)(i)	1. idea that tumour tissue differs from brain tissue ; 2. detail of effect on scan e.g. {energy source / magnetic field / radio waves / eq} {absorbed / blocked / eq}} ; 3. Ref to difference in blood supply ;	ACCEPT 1 - ref to relative densities, tumour growing / dividing / mutated cells	**(2)**

Question Number	Answer	Additional guidance	Mark
2(c)(ii)	1. Idea that (treatment) has been partially successful ; 2. tumour reduced / eq ; 3. reduction qualified e.g. in contact with less brain tissue or size reduction quoted ;	ACCEPT 3 - affecting less brain tissue Halved in size	**(2)**

Question Number	Answer	Additional guidance	Mark
2(c)(iii)	1&2. two appropriate functions given e.g. think, learn, show emotions, memory, personality, reasoning, eq ; ; 3. Because tumour is situated in the frontal lobe / cerebral hemispheres / cerebrum ;	ACCEPT 1&2 – decision making, problem solving, planning, intelligence, controls voluntary behaviour, forming associations (combining information from rest of cortex) ACCEPT 3 – frontal cortex	**(3)**

Question Number	Answer	Additional guidance	Mark
3(a)	1. Idea an enzyme converts a named substrate into named product e.g. enzyme 1 converts P to Q ; 2. idea that this product becomes the substrate of next step ; 3. idea of specificity ; 4. {controls / eq} the conversion / eq ; 5. speeds up the conversion / eq ; 6. by reducing activation energy / eq ; 7. credit reference to control of whole process ;	ACCEPT answers in context of respiration ACCEPT 1 - ref to an enzyme converting one named intermediate to the next e.g.{enzyme/ named enzyme} used to convert hexose to phosphorylated hexose ACCEPT 3 - description of specificity e.g. active site of enzyme 1 only accepts substance P or in context of named respiratory intermediate ACCEPT 4 – regulates ACCEPT 5 - catalysis / enzyme acts as a catalyst ACCEPT 7 - end product inhibition or description	**(4)**

Question Number	Answer	Additional guidance	Mark
3(b)(i)	1. W = {NAD / NAD^+ / NAD_{ox} / eq} ; Any two of the following: 2. (due to) reduced NAD {releasing/eq} {electrons / eq} ; 3. Idea of electrons go to {carrier A / ETC / eq} ; 4. idea of H^+ moved into inter-membranal space ;	ACCEPT 2 – being oxidized Releasing hydrogen (atoms), H^+/protons $^-$ ACCEPT 3 – 1st electron carrier/correctly named carrier	**(3)**

Question Number	Answer	Additional guidance	Mark
3(b)(ii)	1. substance **X** is ATP ; Any two of the following : 2. due to H^+ pass through {stalked particle / ATP synthase} ; 3. (H^+ passes) down an electrochemical gradient ; 4. (sufficient) energy is {released / eq} ; 5. to join ADP and {Pi / eq} ; 6. reference to chemiosmosis ;	ACCEPT 2 –ATPase ACCEPT 3 - description of electrochemical gradient ACCEPT 5 – phosphorylation of ADP	**(3)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>3(c)</td><td>
<table>
<tr><th rowspan="2">Situation</th><th colspan="3">Movement of coloured liquid</th></tr>
<tr><th>towards A</th><th>towards B</th><th>does not move</th></tr>
<tr><td>Screw clip is open</td><td></td><td></td><td>☒</td></tr>
<tr><td>Screw clip is closed</td><td>☒</td><td></td><td></td></tr>
<tr><td>Potassium hydroxide is replaced with water and screw clip is closed</td><td></td><td></td><td>☒</td></tr>
</table>
</td><td></td><td>(3)</td></tr>
</table>

Question Number	Answer	Additional guidance	Mark
4(a)(i)	1. (protein in thin filament) - actin / G actin ; 2. (protein in thick filament) - myosin ;		**(2)**

Question Number	Answer	Additional guidance	Mark
4(a)(ii)	1. {Ca^{2+} / calcium ions} bind to troponin ; 2. troponin {changes shape / moves / eq} ; 3. this displaces tropomyosin (away from myosin) / eq ;	ACCEPT 3 – pulls/shifts/moves tropomyosin	**(2)**

Question Number	Answer	Additional guidance	Mark
4(a)(iii)	acetylcholine / {noradrenaline / eq } ;	ACCEPT – ACh, noradrenalin, norepinephrine	**(1)**

Question Number	Answer	Additional guidance	Mark
4(b)	1. the higher troponin T, the longer the stay / eq ; 2. reliability of prediction decreases as troponin T concentration increases ; 3. because {range / eq} increases ; 4. least reliable for 6.0+ as range is largest ; 5. one range stated e.g. for 6.0+ it is 7 to 11 days ; 6. reference to range overlapping between 4.0-5.9 and 6.0+ ; 7. idea that 6.0+ is too wide a category for conc. of troponin T ; 8. idea that the higher the troponin T, the greater the damage to the heart ;	ACCEPT 1 - converse ACCEPT 2 - converse, less reliable at high troponin T ACCEPT 3 - range of the length of stay, range of data ACCEPT 4 - converse for 1.0-3.9 / 4.0-5.9	(3)

Question Number	Answer	Additional guidance	Mark
5(a)	**A** - cell body ; **B** - axon ;		**(2)**

Question Number	Answer	Additional guidance	Mark
5(b)(i)	1. increasing Eugenol concentration increases percentage inhibition / positive correlation ; 2. description of non linear correlation ; 3. credit correct manipulation of the data e.g. between 0.1 and 1.0 mmol dm^3 percentage inhibition to increase by 55% ;	ACCEPT 2 – e.g. greatest increase in inhibition is between eugenol concentration of 0.2 and 0.4 mmol dm^{-3}	**(2)**

Question Number	Answer	Additional guidance	Mark
***5(b)(ii)**	QWC – Spelling of technical terms (*shown in italics*) must be correct and the answer must be organised in a logical sequence) 1. {reduced / eq} Ca^{2+} enters { *presynaptic membrane* / into *sensory neurone*} ; 2. due to Ca^{2+} channel not opening / decreased sensitivity of *membrane* to Ca^{2+} ; 3. fewer *vesicles* {move towards / fuse} with *presynaptic membrane* ; 4. less *neurotransmitter* {released into / less diffuses across} {*synaptic* gap / eq} ; 5. less *neurotransmitter* binds to receptors on {*post-synaptic membrane* / adjacent neurone} ; 6. idea of reduced depolarisation / less Na^{+} or cation channels open ; 7. idea of { threshold intensity / *action potential* / *impulse*} less likely to occur ; 8. idea of pain not being sensed as impulse {stopped before entering CNS / leaving the *sensory neurone*} ;	ACCEPT 1 – into *synaptic* knob / pre-synaptic neurone ACCEPT 4 (& 5) - named neurotransmitter example ACCEPT 7 - not reached as alternative to less likely to be reached	**(6)**

Question Number	Answer	Additional guidance	Mark
6(a) (i)	(cut shoot) without IAA present / without agar blocks ;	ACCEPT - agar block with no IAA, empty agar block, agar block with water ACCEPT - auxin(s) as alternative to IAA	**(1)**

Question Number	Answer	Additional guidance	Mark
6(a) (ii)	1. (both sides of) shoot taller / eq ; 2. than the control / eq ; 3. both IAA's diffuse {down / out of agar / to zone of elongation} / eq ; 4. reference to cell elongation / eq ; 5. details of cell elongation / eq ; 6. shoot bends to the right / eq ; 7. (due to) more growth on {left side of shoot / side with artificial IAA} / eq ;	ACCEPT - auxin as alternative to IAA throughout ACCEPT 1 – grow {taller/higher/up/ towards the light} ACCEPT 3 – away from the light/agar block ACCEPT 6 - bends away from side with artificial IAA	**(5)**

Question Number	Answer	Additional guidance	Mark
6(b)	1. idea that IAA enters the cell ; 2. reference to movement within cell / IAA in cytoplasm to nucleus ; 3. effect when binds to transcription factor e.g. forms a transcription initiation complex or countering an inhibitor ; 4. reference to switching on gene ; 5. activity at promoter region / eq ; 6. allows formation of (m)RNA / eq ; 7. idea of translation produces protein ;	ACCEPT - auxin as alternative to IAA throughout ACCEPT 3 - joins to promoter region or activates transcription factor ACCEPT 5 – ref to RNA polymerase activity	**(4)**

Question Number	Answer	Additional guidance	Mark
7(a)	1. alpha glucose in starch and beta glucose in cellulose; 2. only {starch / amylopectin} can be branched / cellulose only a linear molecule ; 3. starch contains two types of molecule, cellulose only one ; 4. alternate monomers rotated through 180^0 in cellulose only ; 5. only {amylopectin / starch} can have 1-6 glycosidic bonds / cellulose has 1-4 glycosidic bonds only ;	ACCEPT 3 - the two named molecules of starch – amylose and amylopectin ACCEPT 5 – starch can have 1-6 & 1-4 glycosidic bonds but cellulose only 1-4	**(2)**

Question Number	Answer	Additional guidance	Mark
7(b)(i)	1. thermoreceptors in hypothalamus / eq ; 2. detect the increase in (core) blood temperature / eq ; 3. reference to heat loss centre activated ; 4. reference to autonomic nervous system ; 5. reference to impulses down motor neurones ; 6. to {effectors / named effector} / eq ; 7. detail of method of heat loss / eq ;	ACCEPT 5 - effector neurone for motor neurone ACCEPT 7 – vasodilation of blood vessels, sweat released, heat loss from blood through radiation	**(4)**

Question Number	Answer	Additional guidance	Mark
7(b)(ii)	1. (shivering) is muscle contraction ; 2. which uses {respiration / ATP / eq} ; 3. which release heat (to warm body) / eq ;	ACCEPT 2 - oxidative phosphorylation, ATP being converted to ADP and Pi	**(2)**

Question Number	Answer	Additional guidance	Mark
7(c)	1. (cancer causing) gene identified / eq ; 2. gene {cut / isolated / eq} from DNA / eq ; 3. using a {restriction / eq} enzyme / eq ; 4. gene in {vector / named vector} ; 5. mechanism for getting {gene / vector} into host cells (of naked mole rats) / eq ;	ACCEPT 4 – named examples including retrovirus, virus, liposome ACCEPT 5 - reference to (micro)injection, microprojectiles, electroporation, gene gun, inhaler	**(3)**

Question Number	Answer	Additional guidance	Mark
***7(d)**	QWC – Spelling of technical terms (*shown in italics*) must be correct and the answer must be organised in a logical sequence) 1. idea that this air has higher CO_2 content ; 2. {CO_2 level in blood increases / pH of blood falls / eq} ; 3. change detected by chemoreceptors in {carotid body / carotid artery / aortic body / aorta / medulla} ; 4. reference to {ventilation centre / eq} (in medulla) ; 5. sends more impulses along neurones / eq ; 6. to intercostal muscles / diaphragm / eq ; 7. causing an increased {ventilation rate / rate of breathing / depth of breathing} / eq ;	ACCEPT 2 - high, higher (for CO_2) ACCEPT 4 – respiratory centre, inspiratory centre for ventilation centre ACCEPT 5 – impulses sent more often	**(5)**

Question Number	Answer	Additional guidance	Mark
7(e)	1. naked mole rat's {incisors / eq} grow through {skin / lip} without {damage / eq} ; 2. lead to new {coatings / permanent seal /eq} at {skin / bone / metal} interface ; 3. so soft tissue is {not damaged / eq } (by the prosthetic) / eq ;		**(2)**
Question Number	Answer	Additional guidance	Mark
7(f)	gonadotrophin-releasing (hormone) and anterior pituitary / gonadotrophins and {ovaries / testes} ;	ACCEPT - testosterone and testes ACCEPT - gonads for testes or ovaries	**(1)**

Question Number	Answer	Additional guidance	Mark
7(g)	1. idea of irregularity of flagellum ; 2. Idea of irregularity associated with mid-region ;	ACCEPT 1 – no or more than one flagellum ACCEPT 2 – not enough mitochondria	**(2)**

Question Number	Answer	Additional guidance	Mark
7(h)	1. idea of high levels of inbreeding ; 2. low level of genetic diversity / eq ; 3. idea that there is some variation because more than one male is involved in ; 4. unfamiliar males used as mates (by queen) / eq ; 5. fusion of colonies / eq ; 6. arrival of a dispersal phenotype (from a different colony) ; 7. mutations / eq ;	ACCEPT 1 – accept idea in context of only one queen/female breeds ACCEPT 2 – restricted gene pool, low genetic variation	**(3)**

Question Number	Answer	Additional guidance	Mark
7(i)	1. reduces inbreeding (depression) / eq ; 2. increases outbreeding / outbreeding qualified ; 3. (leading to) increase in genetic diversity ; 4. idea of colony size regulation ; 5. idea of increase in fecundity ; 6. idea of increased chance of survival ;	ACCEPT 1 - less genetic drift ACCEPT 2 – disperser/new comer more likely to breed ACCEPT 3 – increased genetic variation, increase in variety of alleles ACCEPT 6 – appropriate ref to natural selection, due to environmental changes	**(2)**

Question Number	Answer	Additional guidance	Mark
7(j)	Paired responses: 1. reduced sensitivity to chemical pain / disconnection of 'pain nerves' ; 2. high CO_2 in air (of tunnels) ; 3. haemoglobin has higher affinity for oxygen / brain can tolerate eq ; 4. low O_2 levels (in tunnels) / eq ; 5. increased number of oxytocin receptors in brain ; 6. overcrowding / eq ; 7. non-pigmented ; 8. lack of UV light ; 9. outbreeding mechanisms such as disperser; 10. low genetic diversity ; 11. hairless/ naked/ reduction of sweat gland / loose skin / no insulating layer / poikilothermic ; 12. due to nature of its temperature environment / eq ; 13. teeth arrangement / eq ; 14. for digging underground ; 15. keen sense of smell/reduce eyesight / ref to circadian rhythms ; 16. dark conditions ; 17. division of labour ; 18. for the survival of the eusocial colony ;	ACCEPT1 - lack or receptor for chemical pain ACCEPT 3 – ref to brain's hypoxia response, neurones or brain resistance to hypoxia ACCEPT13 - forward of lips or long	**(4)**

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Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Biology

Advanced

Unit 5: Energy, Exercise and Coordination

Monday 21 January 2013 – Morning
Time: 1 hour 45 minutes

Paper Reference
6BI05/01

You must have:
A copy of the scientific article modified from New Scientist articles (enclosed)

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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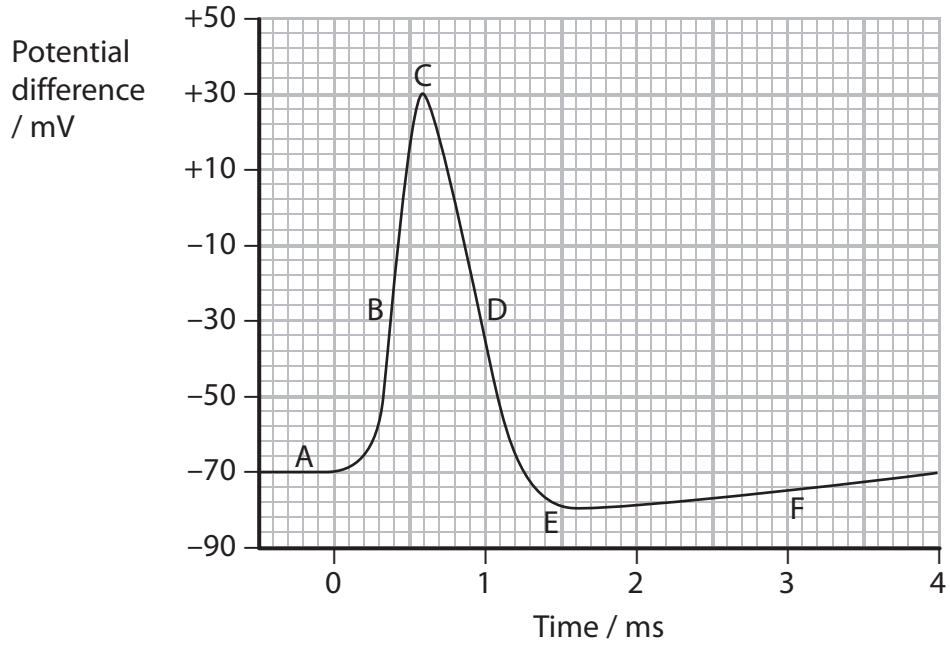
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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 (a) The graph below shows the changes in potential difference across the membrane of a neurone after stimulation.



(i) Using the information in the graph, state the maximum change in potential difference across the membrane of this neurone during depolarisation.

(1)

..... mV

(ii) The table below describes three of the stages shown in the graph.

Place a cross in the box (☒) below the letter that correctly links the description to one of the labels on the graph above.

(3)

Description	A	B	C	D	E	F
Stage when the concentration of positive ions is greatest inside the axon	☒	☒	☒	☒	☒	☒
Stage when hyperpolarisation first occurs	☒	☒	☒	☒	☒	☒
Stage showing the resting potential	☒	☒	☒	☒	☒	☒

P 3 9 8 8 1 A 0 0 2 2 8
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*(b) When a nerve impulse reaches a synapse, calcium ions enter the neurone through the pre-synaptic membrane. This causes a neurotransmitter, such as acetylcholine, to be released.

Describe and explain the sequence of events that occurs at the synapse, after a neurotransmitter has been released.

(5)

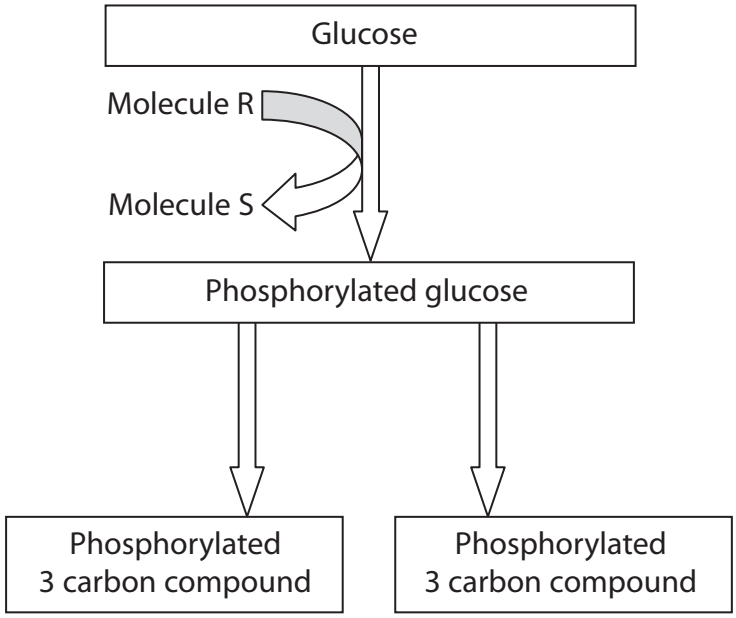
(Total for Question 1 = 9 marks)

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P 3 9 8 8 1 A 0 4 2 8
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2 Respiration is a vital process in living organisms.
All organisms carry out glycolysis. The Krebs cycle also occurs in some organisms.

(a) The diagram below shows some of the stages in glycolysis, using the hexose sugar glucose.



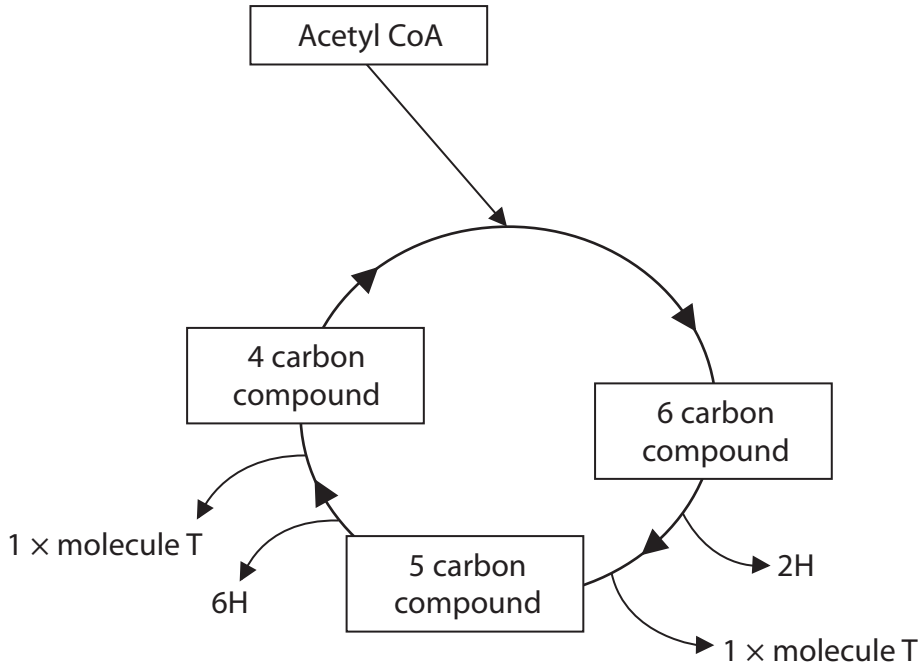
Name the molecules R and S shown in the diagram.

(2)

Molecule R .....

Molecule S .....

(b) The diagram below shows some of the stages in the Krebs cycle.



(i) Name molecule T and use the information in the Krebs cycle diagram to give a reason for your answer.

(2)

.....

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.....

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P 3 9 8 8 1 A 0 6 2 8
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(ii) Using information in the diagram, suggest what would happen in the Krebs cycle if acetyl CoA became unavailable.

(3)

(c) The hydrogen (H) from the Krebs cycle enters the electron transport chain and oxidative phosphorylation occurs.

Explain what is meant by the term **oxidative phosphorylation**.

(3)

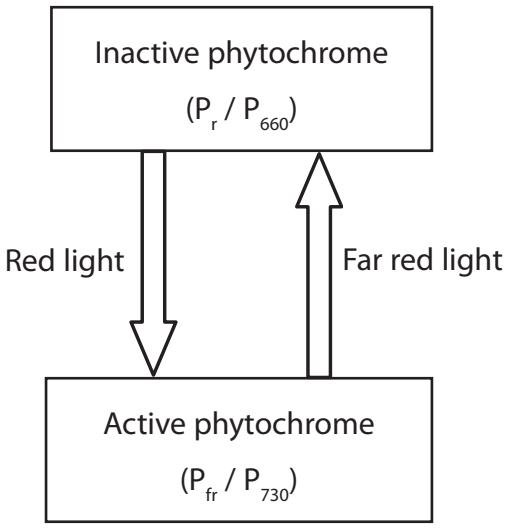
(Total for Question 2 = 10 marks)

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P 3 9 8 8 1 A 0 8 2 8
SEENUP.CO.UK

3 Phytochromes are photoreceptors found in many plants.

(a) The diagram below shows the interconversion of inactive phytochrome (P_r / P_{660}) and active phytochrome (P_{fr} / P_{730}).



State **one** way in which the active form of phytochrome can be converted back to the inactive form, other than by exposing it to far red light.

(1)

.....

.....

(b) A study was carried out to investigate the effect of red light and far red light on sunflower plants.



A sunflower

Magnification × 0.5

One group of sunflower seedlings, group A, was grown under a lamp that emitted red light and far red light of the same intensity.

Another group of sunflower seedlings, group B, was grown in the same way, except that the lamp emitted a lower intensity of red light. The intensity of far red light was unchanged.

When the plants were fully grown, the mean dry mass of the flowers produced and the mean length of the plant stems were recorded.

This study was repeated using new groups of sunflower seedlings.

The results are shown in the table below.

Study	Mean dry mass of the flowers / g		Mean stem length / cm	
	Group A	Group B	Group A	Group B
Original	58	45	125	148
Repeat	43	38	124	142

P 3 9 8 8 1 0 2 8
STEMUP.COUK

(i) Using the mean dry mass of the flowers shown in the table, compare the results of group A with group B for both the original and repeat studies.

(3)

(ii) The light conditions experienced by group B were similar to those found near ground level in woodland.

Using the mean stem lengths shown in the table, suggest the importance of these light conditions for a young seedling in the woodland.

(3)

P 3 9 8 1 8 A 0 1 2 8
STEMUP.CO.UK

(iii) A statistical analysis of the data for mean stem length was carried out.

The analysis showed that there was a significant difference between the mean stem length data for groups A and B.
However, there was no significant difference between the data from the original study and the repeat study.

Suggest a conclusion for the effect of light on mean stem length and use the results of this statistical analysis to comment on the reliability of the data.

(3)

(Total for Question 3 = 10 marks)

P 3 9 8 2 8 A 0 1 2 8
GTBMUP.COUK

4 Physiological changes occur when a person carries out a period of exercise, such as running 800 metres.

(a) One physiological change will be an increase in cardiac output.

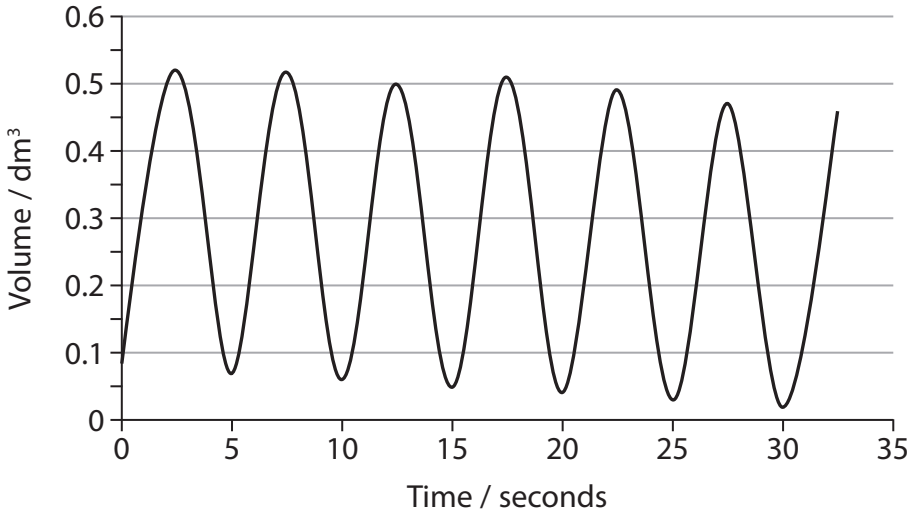
Describe the changes in the heart that bring about an increase in cardiac output.

(4)

P 3 9 8 1 8 A 0 1 3 2 8
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(b) The respiratory system will also undergo physiological changes during a period of exercise.

The spirometer trace shown below was recorded when an adult was at rest.
This trace can be used to calculate the resting breathing rate and tidal volume of the adult.



(i) Place a cross in the box (☒) that correctly identifies the approximate value for resting breathing rate and tidal volume for this adult.

(2)

Approximate value for	**0.1 dm^3**	**0.5 dm^3**	**6 dm^3 min^{-1}**	**6 breaths min^{-1}**	**12 breaths min^{-1}**
Resting breathing rate	☒	☒	☒	☒	☒
Resting tidal volume	☒	☒	☒	☒	☒

P 3 9 8 4 1 A 0 1 4 2 8
STEMUP.COUK

(ii) Describe how a spirometer trace recorded immediately after a short period of exercise would differ from this trace.

(2)

.....

.....

.....

.....

.....

.....

(c) A student used a spirometer to compare the resting breathing rate of musicians who play trumpets with musicians who play violins.

Suggest **two** variables the student should have considered when selecting the musicians, to make the study valid.

(2)

.....

.....

(Total for Question 4 = 10 marks)

P 3 9 8 5 2 8 A 0 0 5 2 8

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P 3 9 8 6 2 8 STEMUP.CO.UK

5 The photograph shows a female gymnast on a narrow beam.



(a) The table below refers to two regions of the brain.

Complete the table by describing **one** role of each region of the brain, while she is on the beam.

(2)

Region of the brain	One role while she is on the beam
Cerebellum	
Medulla oblongata	

P 3 9 8 7 8 A 0 1 2 8

(b) This gymnast will generate a lot of heat while she is on the beam.

Describe and explain how changes in blood flow in the skin will help her to control her body temperature.

(4)

(c) Gymnasts can damage their cruciate ligaments.
This is an injury that can be repaired using keyhole surgery.

(i) Explain what is meant by the term **cruciate ligament**.

(2)

P 3 9 8 2 8 STUDYUP.CO.UK 8 2 8

(ii) A gymnast was offered keyhole surgery to repair her damaged cruciate ligament.

Suggest and explain **two** reasons why she might choose this type of surgery.

(2)

.....

.....

.....

.....

.....

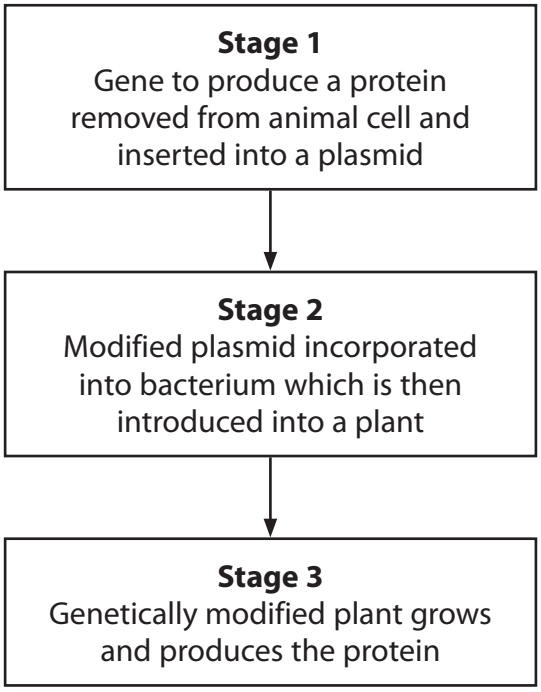
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(Total for Question 5 = 10 marks)

P 3 9 8 5 8 A 0 1 2 8

6 Some organisms have been genetically modified to produce proteins including hormones and vaccines.

The flow diagram below shows part of a process to produce a protein, using genetically modified plants.



(a) Describe and explain the role of the enzymes involved in stage 1.

(5)

P 3 9 8 3 1 A 0 2 0 2 8
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(b) Describe the structure of the modified plasmid used in stage 2.

(2)

(c) Suggest why plants rather than bacteria are used to produce the protein in stage 3.

(2)

(d) Describe **two** risks associated with the use of genetically modified organisms.

(2)

(Total for Question 6 = 11 marks)

P 3 9 8 1 8 A 0 1 2 8
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7 The scientific article you have studied is adapted from articles in New Scientist.

Use the information from the article and your own knowledge to answer the following questions.

(a) Suggest why 'incredibly efficient cellular mechanisms' can increase the chance of obesity (paragraphs 4 and 5).

(2)

(b) A larger VO_2max means more oxygen can enter a mitochondrion and therefore more energy can be released from fuel (paragraph 8).

Name **two** substances, other than oxygen, that need to enter the mitochondrion to enable energy to be released from fuel.

(2)

(c) Describe the structure of glycogen (paragraph 11).

(3)

P 3 9 8 7 8 A 0 2 2 8
STUDYMUP.COUK

(d) Using the information in paragraphs 12 to 14, explain how lowered testosterone levels may help a cyclist to race harder on successive days.

(3)

(e) Explain why Coyle suggests that greater muscle efficiency may be linked to an increase in the percentage of **slow twitch** muscle fibres (paragraph 20).

(2)

P 3 9 8 2 8 2 3 2 8
STUDYMUP.COUK

*(f) Suggest how 'the development of a leak in a specific class of calcium channel in muscle cells' can lead to muscle fatigue (paragraph 23).

(4)

(g) The ACE gene codes for the synthesis of angiotensin converting enzyme (ACE) (paragraph 25).

Complete the table by naming two nucleic acids involved in each of the processes described.

(2)

Process	Two nucleic acids involved in the process
Transcription of the ACE gene	1 ..... 2 .....
Synthesis of ACE at a ribosome	1 ..... 2 .....

P 3 9 8 4 2 8 A 0 2 4 2 8
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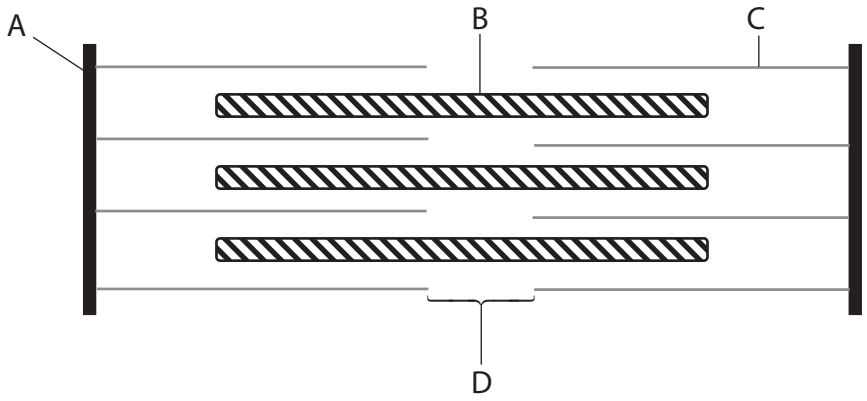
(h) A variant of the APOE gene could put individuals at increased risk in contact sports. DNA profiling is a technique that can be used in genetic screening.

Suggest how DNA profiling could be carried out to identify this variant of the APOE gene (paragraph 27).

(4)

P 3 9 8 5 2 8 A 0 2 5 2 8
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(i) The titin gene produces a protein that attaches to myosin in a sarcomere (paragraph 30).



Place a cross (☒) in the box that identifies myosin shown in the diagram.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(j) The colder the water Japanese Ama divers swim in, the higher their resting metabolic rate (paragraph 50).

Suggest and explain why this might be an advantage to these divers.

(3)

P 3 9 8 6 8 A 0 2 6 2 8
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(k) Pugh noticed the effects of climate change (paragraph 53).

Name **two** greenhouse gases that contribute to climate change.
Give **one** source of each of these gases.

(2)

.....

.....

.....

.....

(l) Using the information in paragraph 55, calculate the percentage increase in Pugh's core body temperature due to his "anticipatory thermogenesis".

Show your working.

(2)

Answer = ... %

(Total for Question 7 = 30 marks)

TOTAL FOR PAPER = 90 MARKS

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P 3 9 8 2 8 2 0 2 8 2 8
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Edexcel GCE

Biology

Advanced

Unit 5: Energy, Exercise and Coordination

January 2013

Scientific Article for use with Question 7

Paper Reference

6BI05/01

Do not return the Insert with the question paper.

IMPORTANT NOTICE

This article contains information that was published before recent events in the cycling world.

Question 7 is based on this article alone and not any other material or information that arises from media reports.

Candidates are advised to prepare for the examination using the information contained in this article and **NOT** from any other sources of information in the media.

Turn over ▶

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P 3 9 8 8 1 A

PEARSON

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Scientific article for use with Question 7

Superhuman: what gives elite athletes the edge?

1. Even if you're not a cycling fan, it's hard not to marvel at the amazing physical prowess of the Tour de France finalists. They will cross the finishing line having cycled 3553 kilometres in just 23 days. They will have climbed mountain passes more than 2000 metres high and averaged a speed of around 40 kilometres per hour.

2. Tour de France cyclists aren't the only people to have performed feats that seem superhuman to the rest of us. For example, Dean Karnazes, a 44-year-old ultramarathon runner from San Francisco, ran 50 marathons in 50 US states in 50 consecutive days, before running half the way home, from New York to St Louis, Missouri.

3. Some say many extreme endurance athletes are drugged up to their eyeballs. Tour de France winner, Floyd Landis was stripped of his title because he failed a drug test. His predecessor, Lance Armstrong, was also accused of drug abuse, though he has always denied the allegation and has never failed a drugs test. Armstrong famously won the title seven times in a row, and all this after being diagnosed with testicular cancer nine years earlier and having extensive chemotherapy and surgery. Yes, the spectre of performance-enhancing drugs looms large over extreme competitive sports, but could there be a more natural explanation for some athletes' incredible abilities?

Double-edged sword

4. One possibility is that some people are simply natural born superhumans. Sure, training and mental drive play major roles, but – all other things being equal – the key to gaining the ultimate competitive advantage might be hidden in our genes. It's not just a matter of long legs and large muscles: it seems the one thing many elite endurance athletes appear to share is incredibly efficient cellular mechanisms for producing energy.

5. That head start may come at a price. The genes that bless you with superhuman powers of endurance can also be a curse. Researchers have found that individuals with these genes who don't engage in regular exercise could be increasing their chances of suffering from obesity, diabetes and cancer. If you enjoy sports, on the other hand, but don't have the genes to be superhuman, all is not lost. Some researchers are developing supplements and gadgets (see "Cool it") that can enable you to temporarily become almost as good.

6. The Tour de France is one of the toughest physical endurance challenges in the world, so its cyclists are good subjects for studying the biology of extreme endurance athletes. At the top of the pack is Armstrong, one of the world's most successful extreme sportsmen. His innate physiology already sets him apart from the norm. Armstrong was born with a larger than average heart and lungs – a characteristic common among top competitive cyclists, marathon runners and freedivers. This means the rate at which oxygen is pumped around his body is greater than that of ordinary people.

7. To be an extreme endurance athlete, your body needs to be super-efficient at making energy, and blood oxygen levels are the key to that. Cells make energy in one of two ways. For quick bursts of power, they can burn carbohydrates without oxygen – known as anaerobic respiration. This is an inefficient process that generates lactic acid, which contributes to muscle tiredness but this respiration is a key source of energy for sprinters and weightlifters. Cells normally use aerobic respiration – a slower process using oxygen and glucose or fats. Endurance athletes generate most of their energy this way.

8. The maximum rate at which your body can transport oxygen to your muscles and then use it to convert fuel into energy is called the VO_2max, and is a measure of the volume of oxygen per kilogram of body weight per minute. The average healthy male has a VO_2max of between 40 and 50 ml/kg/min, which may climb to around 60 to 65 after prolonged training. When fully trained, Armstrong had a VO_2max of 83.8, and other top athletes have similar scores. Bjorn Daehlie, a Norwegian cross-country skier who holds the record for the most medals won at the Winter Olympics as well as the greatest number of golds, reportedly had a VO_2max of 96 – the highest ever recorded – and the earlier Tour de France record-holder, Miguel Indurain, came in at 88.

9. Edward Coyle of the Human Performance Laboratory at the University of Texas at Austin predicts that even if Armstrong was a couch potato, his VO_2max would not drop below 60. It's not just training, Coyle says. Armstrong is genetically predisposed to be above average.

10. So what other physiological advantages do these elite athletes have? Craig Atwood, an endocrinologist at the University of Wisconsin-Madison, thinks that in Armstrong's case there are some special circumstances. He has a controversial hypothesis: it's all down to the loss of his right testicle. "One of the interesting things about Lance Armstrong is that he went from being an exceptional one-day athlete before his surgery for cancer, to becoming a three-week endurance champion afterwards. The removal of his testicle may have produced changes in the levels of his hormones, which may have affected his metabolism."

11. Fat and glucose are what our bodies use for fuel. Small amounts of glucose are stored in the muscle in the form of glycogen, which is a more accessible fuel than the fat stored around the body and produces more energy per molecule of oxygen. However, it is in limited supply. This means that unless endurance athletes keep their nutrient intake up, they can use up their stores of glycogen during the race, resulting in extreme fatigue – known as "hitting the wall".

12. Atwood thinks the hormonal changes Armstrong underwent when he had a testicle removed may have enabled him to use more fats than he would otherwise have been able to. Studies of non-athletes who have had a testicle removed suggest that after surgery there is an increase in the levels of certain hormones called gonadotropins, which are known to boost fat metabolism. Levels of testosterone, a muscle-building hormone, remain about the same (*Medical Hypotheses*, vol 68, p 735).

13. A similar thing happens as men age: the rate at which their testicles produce hormones that would normally limit gonadotropin production, including testosterone, slows down. "In a sedentary individual, these changes will allow for the mobilisation and laying down of fat in different areas of the body, typically around the waist, as seen in older men and women," says Atwood. "However, if these changes occur in a young and active person, a lot of the free fatty acids can be taken up by the muscle and used as a source of energy."

14. Atwood thinks this may have helped Armstrong race harder on successive days, because his muscles would use the excess free fatty acids instead of the glycogen stores in his muscles, meaning he would have less glycogen to replenish at the end of each day. "Winning a Tour de France is all about recovery," says Atwood. "These guys have 18 hours in which to replenish their glycogen stores between stages. If you can't fully recover in that 18-hour window then you're obviously not going to do as well."

15. These hormone changes could also help explain why endurance capacity reaches its peak in most men at around 26 years old, when gonadotropin levels naturally start to increase, Atwood says. This peak is maintained for around five years. It may be no coincidence that the vast majority of Tour de France winners have been aged between 27 and 32.

16. Though direct evidence is lacking, Atwood's hypothesis does have a scientific basis. For example, a study in which an emulsion containing fatty acids was injected intravenously into athletes' bloodstreams before exercise showed an increased use of fatty acids and a decreased use of glycogen as a fuel, according to Trent Stellingwerff, formerly of the Department of Movement Sciences at Maastricht University in the Netherlands and now at Nestlé's Physical Performance and Mobility group in Lausanne, Switzerland. "However, despite strong evidence for glycogen sparing, there appears to be no consistent effect on exercise performance, with evidence actually showing a decrease in sprint performance," he says.

17. The biggest question is whether the hormone changes would affect how fast fat burns during exercise, says Lawrence Spriet at the University of Guelph in Ontario, Canada. It is possible that the loss of a testicle produces hormonal changes that alter metabolism at rest, but during exercise the "fight-or-flight" hormones – adrenalin and noradrenalin – become dominant in controlling the release of fatty acids, he says. "All other influences appear to be overridden."

18. There is also no guarantee, he adds, that increasing fat supply to the muscles would increase the uptake of fatty acids in the mitochondria – the cell's energy generators. Although some researchers are looking for other ways to increase the amounts and types of fuel that muscles can use (see "Energy bar"), for now the easiest way to improve your energy-producing capacity is to make more mitochondria and/or increase the size of the existing mitochondria, Spriet says. This is precisely what happens over the course of an intensive training regime.

19. Coyle agrees. Armstrong certainly has genetic potential, as his unusually high VO_2max shows, he says, but it's the years of training that have stimulated changes in his muscles, not the surgery. Between the ages of 21 and 28, when Armstrong won his first Tour de France, Coyle recorded an 8 per cent improvement in the power of his muscles. He also lost a relatively large amount of body fat, so his muscles had less weight to carry, resulting in even more effective power (*Journal of Applied Physiology*, vol 98, p 2191).

20. Coyle suggests greater muscle efficiency may also be linked to an increase in the percentage of "slow" muscle fibres, which tire less quickly than their "fast" counterparts and are therefore good for endurance activity. Such changes have been seen in rats during periods of extreme endurance training.

21. There is one other factor that singles Armstrong out from most of his contemporaries. When Coyle measured the level of lactic acid – a by-product of glycogen metabolism – in Armstrong's muscles after exercise, he found it was much lower than in any other competitive cyclists he had tested.

22. Until recently, it has been assumed that lactic acid, or lactate, is a bad thing, causing muscle fatigue and cramps. However, there is growing evidence that it can also act as an extra source of fuel – if your body has learned how to use it. Last year, George Brooks at the University of California, Berkeley, and his colleagues showed that muscle cells can reuse lactate by transporting it from the cytoplasm – the gelatinous fluid that fills cells – into the mitochondria, which use it to produce energy. Endurance training seems to increase the amount of lactate that is taken up by mitochondria, though it is probably also the case that some people's mitochondria are just naturally better at doing it, says Brooks. Efficient lactate use would be indicated by low levels of it in the muscles after exercise – as seen in Armstrong. "I would guess that Armstrong is a master of lactate clearance, both innate and acquired," says Brooks.

23. Lactic acid isn't the only cause of muscle fatigue. Andrew Marks at Columbia University in New York and his colleagues have discovered that a key factor in both muscle fatigue and how heart muscle responds after a heart attack is the development of a leak in a specific class of calcium channel in muscle cells. In both cardiac and skeletal muscle, contraction depends on the release of calcium stores from inside muscle cells. With muscle fatigue, one of the proteins that controls the channel gets used up, "so you end up getting a constant leak of calcium out of the channel, meaning the muscle no longer contracts properly", says Brett Giroir of the US Defense Advanced Research Projects Agency's Peak Soldier Performance programme, which part funds Marks's work. Marks has now developed a drug that stops this leakiness in heart muscle and is testing it to see if it can stop skeletal muscle from fatiguing so quickly.

The endurance gene

24. Researchers have yet to identify gene variants that predispose an individual to more efficient lactate use or less leaky muscles. However, the search for other genes that might influence athletic performance is well under way and there seem to be a number of likely candidates.

25. One of the best studied of these genes is *ACE*, which codes for the production of angiotensin converting enzyme, which helps to regulate blood pressure. It is also thought to influence how efficiently cells use oxygen, although exactly how is not fully understood. Nevertheless, there is evidence that one variant, labelled II, is more common in endurance athletes, while another variant, labelled DD, is associated with good performance in sports in which bursts of speed are needed, like football or sprinting.

26. The II variant also appears to be more prevalent in mountaineers, suggesting that it may help people adapt to low oxygen.

27. A better understanding of the factors that enable mountaineers to cope with low oxygen could help people in critical care. Clarifying the links between genetic disease and exercise could also enable genetic screening of individuals whose health may be put at risk by engaging in a particular sport. For example, one variant of the *APOE* gene, which is thought to be important for brain-cell repair, is associated with a neurological disorder called chronic traumatic encephalopathy – or "punch-drunk" syndrome – and Parkinson's syndrome, both of which can develop if you suffer repeated blows to the head (*The Journal of the American Medical Association*, vol 278, p 136). People with this variant should therefore avoid contact sports such as boxing and rugby, says Kathryn North of the University of Sydney, Australia.

28. Eventually drugs could be developed that would reduce these risks – a kind of tailored medicine for sportspeople, says Mike Grocott of the UCL "Extreme Everest" team. "If you were going to play rugby and you knew that you were at high risk of injury, you might take a medicine beforehand to compensate for your particular weakness."

29. Whether genetic screening could be used to identify children with the potential to become world-class athletes remains to be seen. Its success would depend on the relative importance of individual genes to elite athletic performance. "If there were a small number of genes with large effects, then tests could be quite valuable," says Claude Bouchard of Pennington Biomedical Research Center in Baton Rouge, Louisiana. "However, so far it seems that we are dealing with a large number of genes, each of which contributes 3 to 4 per cent, if that." North agrees: "Ultimately, there are likely to be around 50 genes that influence the elite athletic phenotype."

30. Genes may also influence factors such as how much your body responds to fitness training. Two genes in particular seem to influence a person's ability to increase the amount of blood they pump per minute through training – *titin*, which is involved in muscle contraction, and *kinesin 5B*, which transports large molecules around the cell.

31. So could coaches test for trainability and so tailor people's training programmes depending on their genetic make-up? "We just don't know at this stage," says Bouchard. North suspects it is possible. For example, erythropoietin (EPO) is a protein that increases the number of red blood cells in the body and therefore the amount of oxygen that can be carried in the blood. It can be increased artificially, which in professional sport is illegal, or naturally, through training at high altitude. If some individuals are genetically predisposed to produce more, or less, EPO than others they may respond differently to training in low oxygen – such as in a hypobaric oxygen chamber. Such simulated altitude training has been shown to improve speed, strength, endurance and recovery, and is practised by some athletes to improve their endurance ahead of competitions. How long the effects last is uncertain, however.

32. Unfortunately, having the right gene variants to be a superhuman endurance athlete is not necessarily all it's cracked up to be. Take energy efficiency. Some people's mitochondria are very efficient energy providers, while in other people they use more of the fuel to produce heat. Heat production is a natural function of these cell structures and is one of the main ways we keep warm in cold climates. Mitochondrial efficiency is very tightly linked to where in the world you come from: they are more efficient in people from warmer climates, and tend to produce more heat in people from cold climates, making them better able to tolerate the cold (see "Cool it"). That's not the case for everyone in cold countries, though. A study of elite Finnish athletes showed that all who excelled at endurance events had efficient mitochondria, (*European Journal of Human Genetics*, vol 13, p 965).

33. But these same highly efficient mitochondria may have a downside. They produce more reactive oxygen species – damaging free radicals – particularly if the energy they produce is not used up. So a person who eats a lot of chocolate and works at a desk, and yet has highly efficient mitochondria, is going to produce a lot of reactive oxygen species. This would make them more susceptible to a variety of degenerative diseases, cancer and premature ageing, says Douglas Wallace of the Center for Molecular and Mitochondrial Medicine and Genetics at the University of California, Irvine. It seems that if you're born with the genes for super-efficiency, you've got little choice but to exercise frequently to minimise the production of free radicals to stay healthy. Exercise hard, and you're more likely than the rest of us to reach the front of the pack.

34. "If Lance Armstrong never trained, an average young person would only be able to beat him if they trained as hard as they could," says Coyle. Even without practice, Armstrong could probably beat someone who had trained moderately. Of course, to train hard you obviously need the mental drive and a commitment to winning, something that is certainly true of Armstrong. "Again and again there are reports of Lance's incredible attention to every minute detail of his life leading towards getting himself ready for optimal performance," says Stellingwerff.

35. Whether the crowds at the Champs Elysées are about to see the next Lance Armstrong cross the finish line remains to be seen, because even if that person has the right physiology and is backed up by a crack team of coaches, nutritionists and sports scientists, it still might not be enough in the long run. "The best gene that you could find would be the mongrel gene that gives you the will to win," says North. "That is probably the most important factor of all."

Energy bar

The superfood that feeds both your muscles and your brain.

36. There are three main food groups: proteins, carbohydrates and fat. Now the US Defense Advanced Research Projects Agency (DARPA) is trying to create a fourth group. In doing so it hopes to provide soldiers, mountaineers and athletes with an extra source of energy and a means of maintaining their peak physical performance for longer.

37. During exercise, your muscles get most of their energy by burning a mixture of carbohydrates and fat. But if you are starving, the body begins to get extra energy from ketone bodies, acidic chemicals produced when the liver breaks down fatty acids. These are particularly important for the brain, as they can cross the blood-brain barrier and keep it supplied with energy.

38. Ketone bodies are not usually produced in large amounts, and they are not easy to get from food. But they are a more efficient source of fuel than fatty acids.

39. "The question we asked ourselves was 'can we fundamentally modify a person's diet to maintain their peak performance for longer?'" says Brett Giroir, manager of DARPA's Peak Soldier Performance programme. For the past few years, Kieran Clarke and her colleagues at the University of Oxford have been collaborating with DARPA to find forms of ketone bodies that could be taken up by the gut and used as a fuel.

40. "You can't give pure ketones, because they are too acid, and they would get used up very quickly," says Clarke. Instead, her team has created "ketone polymers" – chains of ketone bodies that can be broken down over time to create a sustained release of ketones.

41. Rats fed with ketone polymers ran 30 per cent faster and 30 per cent further on a treadmill on five consecutive days than those fed carbohydrates or fat. They also showed enhanced cognitive abilities. Human trials of the polymers are expected to start this year.

Cool it

Smart gloves keep exhaustion at bay

42. Working in the desert is tough. Temperatures can reach 50 °C in the daytime and drop to freezing at night. Troops deployed there often suffer from heatstroke, and sometimes even hypothermia. Craig Heller and his colleagues at Stanford University wanted to find a way of rapidly heating or cooling people to tackle bouts of both conditions. In doing so they discovered that cooling people down also increased their athletic endurance.

43. You can divide the human body into an inner core of the internal organs and an outer shell consisting of the skin and peripheral limbs. If you want to heat someone up by applying an external heat source, you usually have to heat up the entire shell. There is an exception, though. Specialised blood vessels exist in the palms of the hand that act as radiators, enabling the body to shed large amounts of heat very quickly. Using suction on the hand to open up these vessels seems to intensify the effect, while heating or cooling it at the same time provides a rapid way of directly controlling the body's core temperature. Heller's team has now developed a glove that does just that. Tests indicate that it could be useful for warming patients with hypothermia.

44. Conversely, cooling people's hands as they exercise increases their endurance. In treadmill tests, people who were exercised to exhaustion were able to last between 50 and 100 per cent longer if one hand was cooled at the same time. "We've done this time and time again and what it all points to is that the work capacity of an individual is limited by the heat of the muscle," he says.

45. Heller is now being funded by the US military to see if the glove could be used to improve the endurance of troops in the heat. He is also working on reducing its size, as at the moment it is about the size of a large coffee pot.

46. Heller's glove may also have important medical uses. "People with multiple sclerosis are incredibly sensitive to temperature," he says. "For them, walking down the block can be like climbing Mount Everest – if it's hot they just can't do it." In a recent study on 12 people with MS, Heller recorded a 35 per cent increase in their times on a treadmill test of endurance.

Superhuman: The secrets of the ice man

47. Perched on the edge of an Antarctic ice sheet, Lewis Gordon Pugh surveys the waves. At 0 °C, water does not get much colder than the sea beneath him. Undeterred, Pugh unzips his jacket, strips down to his swimming trunks and dives in.



48. Most of us would start to hyperventilate uncontrollably if we dived into such cold water. Pugh doesn't even gasp in pain but instead starts swimming. In December 2005, when Pugh took this plunge (pictured above), he went on to swim a kilometre in just over 18 minutes. Many ordinary people would drown after just a few minutes in such cold water. Pugh, however, not only survived but went on to make several more long-distance swims in extremely cold water. So what makes him able to keep swimming in such extreme cold?

49. A study of Pugh has confirmed that his response to cold water is anything but normal. Remarkably, though, while Pugh may have some innate advantages, it seems his near-superhuman ability is largely down to training – so perhaps it could be something we are all able to learn.

High metabolism

50. Pugh is far from the first to swim in icy water. There is a long tradition in Russia, China and many northern European countries of carving holes in frozen lakes, rivers or sea ice and diving in, often as part of a cultural or religious ritual. These are normally just quick dips, though: rarely do they involve distance swimming. Japanese and Korean pearl divers used to swim without wetsuits in temperatures of around 10 °C for up to 30 minutes. Part of their secret is their metabolism: the colder the water that Japanese Ama divers swim in during winter months, the higher their resting metabolic rate.

51. Even so, studies of Japanese Ama divers who have been diving for many years show that their response is not that different from the rest of us. Their core body temperature drops to 35 °C after 30 minutes in cold water – just above hypothermia, the point beyond which the body cannot warm up again without help. In contrast, Pugh can keep his core temperature as high as 36 °C even after swimming for 30 minutes in much colder water. How does he do it?

52. His background seems ordinary enough. Born in 1970 near Plymouth, in south-west England, he went to boarding school at the age of six. It wasn't until later, when he moved to South Africa, that he fell in love with swimming. At the age of 17, one month after his first proper swimming lesson, Pugh took part in an organised 7-kilometre swim from Robben Island – where Nelson Mandela was held for 18 years and the water is a chilly 12 °C. Back then he wore a wetsuit, but he says the swim planted the seeds of a passion for long-distance swimming and a desire to set new records.

Mental preparation

53. Over the past 20 years he has taken part in 17 long-distance swims, including across the English Channel, along the whole of the river Thames from Kemble to London, and a 204-kilometre, 21-day swim along Sognefjord in Norway. During his travels he began noticing the effects of climate change such as melting ice caps and retreating glaciers, and decided to use his ever more extreme swims to raise awareness of the state of the planet – culminating in two long swims in the Antarctic and the Arctic.

54. It takes more than ideological conviction to survive icy waters, though. Pugh attributes his success to intense mental preparation. In the weeks building up to a swim he will spend up to 4 hours a day with a coach, going through mental exercises to calm him and focus his mind on the task. These include concentrating on emotionally challenging periods of his life to build up a sense of determination that will help him succeed. "I think about every part of the swim, how it will occur from beginning to end. I hear the sound of my stroke in the water and I feel ice on my skin," he adds.

55. As the swim gets closer, he psychs himself up by listening to music by the likes of Eminem and P. Diddy. In the minutes before entering the water, Pugh recalls these emotions and is able to raise his core temperature, without doing any physical exercise, to 38.4 °C. That's an extraordinary 1.4 °C above his normal body temperature. Such "anticipatory thermogenesis" has been observed before, but not to such a high degree, says Timothy Noakes, a sports scientist at the University of Cape Town, South Africa, who has been studying Pugh as he swims.

Adrenalin

56. Other experiments found that injections of adrenalin (epinephrine) can induce this effect in Russian cold-water swimmers. Noakes speculates that Pugh may somehow be tapping into this mechanism during his pre-swim preparations.

57. Pugh has a number of other surprising skills. For example, instead of gradually lowering himself into the cold water, he dives straight in, which in most people would induce a cold shock response, the most common cause of death in icy waters, says Michael Tipton, a physiology researcher at the University of Portsmouth, UK.

58. Usually when nerves on the surface of the skin sense a sudden and massive drop in temperature, they trigger uncontrollable and involuntary hyperventilation. Swallow water during this stage and you can quickly drown. The blood vessels to extremities also narrow to reduce the flow of blood – and heat – away from vital organs. The sudden rise in blood pressure can trigger a heart attack.

Cold shock response

59. It is possible to become habituated to the cold so the initial cold shock response doesn't kick in quite so dramatically. But Pugh seems remarkably resistant, although even he does find breathing difficult for the first few minutes. "I certainly feel the cold," he says, "It's excruciatingly painful."

60. People who survive the initial shock of entering very cold water face another problem: as your limbs and muscles cool, the nerves are affected, which makes coordinated movements such as swimming harder and harder. Pugh, however, seems able to cut the supply of blood to superficial muscles while keeping the deeper ones warm, an ability also seen in the Ama divers.

61. Pugh does have one skill that has so far defied scientific explanation: when swimming he can stop himself shivering. Normally, shivering is an involuntary response to cold that kicks in once core body temperature drops below 36.6 °C or when skin temperature falls below 28 °C. This is usually beneficial, as the muscle contractions generate heat, but in cold water it only serves to increase the rate at which the body cools, Noakes says. That's because the increased blood flow transfers more heat from the core to the body's extremities. Somehow Pugh manages to avoid shivering even when his core temperature is below 36.6 °C and his skin temperature is around 5 °C.

Close to disaster

62. Even Pugh has his limits, though. He came close to disaster during a swim across Whaler's Bay off Deception Island in Antarctica. Thirty minutes into the swim, his core temperature started to drop rapidly. By the time he left the water a few minutes later it had plunged to a dangerous 33.6 °C. "If he swam for another 2 or 3 minutes his temperature would have dropped much further and he would have probably lost consciousness," Noakes says.

63. Undeterred Pugh went on to complete several more ice swims. In 2007 he swam 1 kilometre in the coldest water yet – a glacial -1.7 °C – at the geographic North Pole.

64. "When I went below 0 °C the cells in my fingers started to freeze. It took another four months before I could feel my hands again," he says. After reaching his goal of swimming both in the Arctic and in Antarctica, Pugh has for now hung up his towel.

Acknowledgements

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Mark Scheme (Results)

January 2013

GCE Biology (6BI05) Paper 01
Energy, Exercise and Coordination

ALWAYS LEARNING

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January 2013
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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question Number	Answer	Mark
1(a)(i)	100 (mV) ;	**(1)**

Question Number	Answer	Mark
1(a)(ii)		**(3)**

Description	**A**	**B**	**C**	**D**	**E**	**F**
Stage when the concentration of positive ions is greatest inside the axon			☒			
Stage when hyperpolarisation first occurs					☒	
Site showing the resting potential	☒					

Question Number	Answer	Mark
1*(b)	QWC – Spelling of technical terms (*shown in italics*) must be correct and the answer must be organised in a logical sequence 1. diffuses across {gap /eq} ; 2. binds to (receptors on) post-synaptic membrane / eq ; 3. idea of gated-channels opening or Na^+ travels through post-synaptic membrane ; 4. causing a depolarisation / eq ; 5. (if sufficient present) an action potential is set up in {post-synaptic membrane/adjacent cell / eq} ; 6. details such as temporal or spatial summation ; 7. idea that allows coordination / one way flow of information ; 8. idea that it allows integration in post-synaptic cell ; 9. neurotransmitter broken down (by enzyme) / eq ; 10. so that do not get {prolonged /eq} action potential in post-synaptic membrane / make receptors available again ; 11. credit reference to fate of products e.g. reabsorbed through pre-synaptic membrane OR to be re-synthesised into neurotransmitter substance ;	**(5)**

Question Number	Answer	Mark
2(a)	molecule R - ATP / adenosine triphosphate ; molecule S - ADP / adenosine diphosphate ;	**(2)**

Question Number	Answer	Mark
2(b)(i)	1. carbon dioxide / CO_2 ; 2. idea that the C has been removed from C_6 or C_5 ;	**(2)**

Question Number	Answer	Mark
2(b) (ii)	1. cycle would stop / eq ; 2. 4 carbon compound would accumulate / eq ; 3. 6 carbon compound would {run short / not be synthesised} / 5 carbon compound would run short / eq ; 4. idea that {molecule T / H} reduce ;	**(3)**

Question Number	Answer	Mark
2(c)	1. idea of electrons being {passed along / eq} the electron transport chain ; 2. idea of {losing / eq} energy ; 3. (used to) add a phosphate to ADP to make ATP / eq ; 4. reference to ATPase ; 5. idea of chemiosmosis ; 6. idea of oxygen as the final acceptor ;	**(3)**

Question Number	Answer	Mark
3(a)	(leave it) in the dark / eq ;	**(1)**

Question Number	Answer	Mark
3 (b)(i)	1. mass higher in A (compared with B) for both studies ; 2. the difference is less in repeat study ; 3. comparative manipulation of data e.g. 13g decrease for A to B for original and 5 g for repeat ; 4. mass lower in repeats (of both A and B) / eq ;	**(3)**

Question Number	Answer	Mark
3(b)(ii)	1. { increase / eq} in stem length ; 2. correct manipulation of the data e.g. by 23cm / 18.4% ; 3. reference to {taller / faster growing / eq} seedling ; 4. to receive {more light / higher red light / eq} / to maximize photosynthesis / eq ; 5. idea of allows {active phytochrome / eq} to be made ;	**(3)**

Question Number	Answer	Mark
3(b)(iii)	1. less red light {increases / eq} mean stem length / more far red light increases stem length / eq ; 2. the (significant) difference in mean stem length is not due to {chance / eq} / eq ; 3. the mean length for repeat was close to the original ; 4. suggesting it is likely to be reliable ;	**(3)**

Question Number	Answer	Mark
4(a)	1. heart rate increases / eq ; 2. {stroke volume / eq} increases / eq ; 3. {SAN /eq} activity increases / ; 4. AVN time delay decreases / eq ; 5. idea that more blood returning (to the heart) causes {heart / muscle} to stretch ; 6. idea that ventricles contract with greater force ;	**(4)**

Question Number	Answer	Mark
4(b) (i)		**(2)**

Approximate value for	**0.1 dm^3**	**0.5 dm^3**	**6 dm^3 min^{-1}**	**6 breaths min^{-1}**	**12 breaths min^{-1}**
Resting breathing rate					☒
Resting tidal volume		☒			

Question Number	Answer	Mark
4(b)(ii)	1. more {peaks / eq} in the same time / higher frequency / distance between (consecutive) peaks would decrease ; 2. idea of distance from peak to trough would increase ;	**(2)**

Question Number	Answer	Mark
4(c)	Any **two** from the following: 1. how often they play 2. age 3. body size / BMI / eq 4. gender / eq 5. fitness level / eq 6. health status / eq 7. lifestyle e.g. smoker or swimmer ; ;	**(2)**

Question Number	Answer	Mark
5(a)	<table><tr><th>**Region of the brain**</th><th>**One role while she is on the beam**</th></tr><tr><td>Cerebellum</td><td>maintaining balance / coordination of movement / muscle control / eq ;</td></tr><tr><td>Medulla oblongata</td><td>regulation of {breathing / heart beat} / eq ;</td></tr></table>	**(2)**

Question Number	Answer	Mark
5(b)	1. idea more blood flows near the skin surface / eq ; 2. due to {vasodilation / dilation of arterioles / eq} ; 3. {vasoconstriction / eq} of shunt vessels / eq ; 4. more blood to capillaries / eq ; 5. idea of more heat lost ; 6. via radiation ;	**(4)**

Question Number	Answer	Mark
5(c)(i)	1. {in the knee / behind the knee cap} /{cross- shaped / two ligaments} ; 2. (connective tissue that) connects bone to bone / eq ;	**(2)**

Question Number	Answer	Mark
5(c)(ii)	1. idea of smaller incision reduces chance of infection / eq ; 2. idea of smaller incision reduces recovery time ; 3. idea of smaller incision reduces likelihood of osteoarthritis / knee joint replacement later / eq ; 4. idea of smaller incision so less scar tissue / eq ; 5. idea of smaller incision so less blood loss / eq ; 6. idea of smaller incision so less pain / eq ; 7. use of local anaesthetic means less (associated) risk / eq ; 8. idea of cheaper related to fewer staff needed ;	**(2)**

Question Number	Answer	Mark
6(a)	1. reference to {restriction enzyme / endonuclease} ; 2. to cut gene out of animal DNA ; 3. idea of amplification using DNA polymerase (in PCR) ; 4. (enzymes) open plasmid ; 5. (same endonuclease) to produce 'sticky ends' /description / at selected base sequence ; 6. H bonds formed between bases at 'sticky ends' ; 7. ligase ; 8. to join gene to plasmid / eq ; 9. reference to {phosphodiester / eq} bond ;	**(5)**

Question Number	Answer	Mark
6(b)	1. (small) {circle /eq} of DNA ; 2. containing bacterial (survival) genes and {protein / animal} gene ; 3. marker gene / description given ;	**(2)**

Question Number	Answer	Mark
6(c)	1. idea of easier to manage growth e.g. do not need sterile conditions ; 2. idea that it is safer (than bacteria) ; 3. idea of more protein can be made /eq ; 4. bacteria may not have correct amino acids to make protein / eq ; 5. idea that it could produce edible drugs ; 6. idea that plants have introns/bacteria do not so gene does not need modifying ; 7. idea that it is cheaper ;	**(2)**

Question Number	Answer	Mark
6(d)	1. idea of gene transfer to other {species / eq} ; 2. idea of consequence of transfer e.g. resistance to pesticide / antibiotics, superweeds ; 3. idea of possible harmful effects from genes e.g. biochemical changes to substances that could act as allergens, long term effects of consuming ; 4. idea that benefit focused on developed countries / converse ; 5. idea of risk related to use of viral vectors ; 6. idea of effect on organic farmers ;	**(2)**

Question Number	Answer	Mark
7 (a)	1. idea that less {food /eq} required to deliver energy requirement ; 2. (so) more likely to have extra food not respired / {extra/surplus} energy ; 3. which could be laid down in body as fat / eq ;	**(2)**

Question Number	Answer	Mark
7 (b)	Any two from: 1. ADP 2. Pi / inorganic phosphate 3. pyruvate / pyruvic acid / lactate 4. fatty acids 5. NAD / eq 6. acetyl CoA / eq 7. water ; ;	**(2)**

Question Number	Answer	Mark
7 (c)	1. many {alpha / eq} glucose monomers ; 2. joined by glycosidic bonds ; 3. detail of glycosidic bonds e.g. 1-4 ; 4. reference to side branches present / 1-6 glycosidic bonds ;	**(3)**

Question Number	Answer	Mark
7 (d)	1. more gonadotropins ; 2. {use / muscle uptake} of (excess) fatty acids ; 3. respired to release (much) energy / increased fat metabolism ; 4. idea of reduced requirement to replenish glycogen stores ;	**(3)**

Question Number	Answer	Mark
7 (e)	1. (slow twitch muscles) carry out aerobic respiration / full oxidation / eq ; 2. which produces more ATP (than anaerobic) / eq ; 3. 'energy' not locked up in lactate / eq ; 4. idea that it takes longer for lactate levels to build up ;	**(2)**

Question Number	Answer	Mark
7 *(f)	QWC – Spelling of technical terms (*shown in italics*) must be correct and the answer must be organised in a logical sequence) 1. Ca^{2+} leaks out of {cell / *cytoplasm* / *sarcoplasmic reticulum*} ; 2. idea of change in Ca^{2+} binding to *troponin* ; 3. causes displacement of *tropomyosin* / eq ; 4. idea of change in number of *myosin* binding sites exposed ; 5. comment on *myosin* binding to *actin* ; 6. (loss of Ca^{2+} from cell / cytoplasm) therefore force exerted by muscle is lower than expected OR (more Ca^{2+} in cytoplasm) results in less ATP so less muscle contraction ;	**(4)**

Question Number	Answer	Mark
7 (g)		**(2)**

Process	**Two nucleic acids involved in the process**
Transcription of the ACE gene	DNA & mRNA ;
Production of ACE at a ribosome	Any **two** from: mRNA, tRNA, rRNA ;

Question Number	Answer	Mark
7 (h)	1. obtain a sample of cells / extract DNA (from cells) ; 2. reference to named enzyme ; 3. idea of how to increase amount of DNA ; 4. reference to electrophoresis ; 5. details of electrophoresis ; 6. use a {DNA / gene} probe ; 7. with a base sequence complementary to that on the {variant / eq} ; 8. idea of matching with known variant profile ;	**(4)**

Question Number	Answer	Mark
7 (i)	B ;	**(1)**

Question Number	Answer	Mark
7 (j)	1. (higher metabolic rate) means more chemical reactions / eq ; 2. more {energy released / ATP used} / eq ; 3. (which) releases heat / eq ; 4. keeps divers warmer / warm for longer / able to swim without a wetsuit / eq ;	**(3)**

Question Number	Answer	Mark
7 (k)	1. carbon dioxide due to {deforestation / land cleaning / burning fossil fuels / correct ref to respiration / eq} ; 2. methane from {rice fields / anaerobic bacterial action / ruminant fermentation / named ruminant} ;	**(2)**

Question Number	Answer	Mark
7 (l)	1. 1.4 ÷ 37 = ; 2. 3.8 (%) ; Correct answer gains both 2 marks	**(2)**

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Edexcel GCE

Biology

Advanced

Unit 5: Energy, Exercise and Coordination

Friday 22 June 2012 – Morning
Time: 1 hour 45 minutes

Paper Reference
6BI05/01

You must have:
A copy of the scientific article taken from The Biologist articles (enclosed)

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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1/1/1/1/1/

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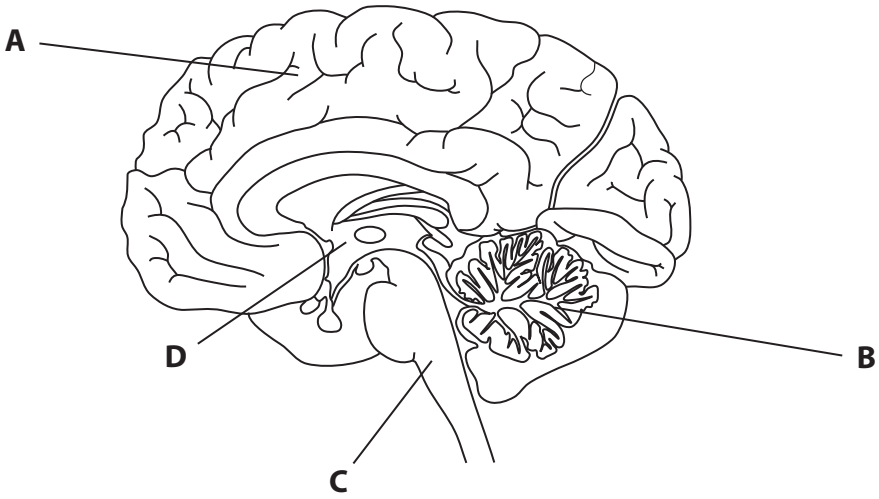
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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 (a) The brain acts as the main coordinating centre for nervous activity. It receives information, interprets it and responds accordingly.



(i) Coordination of movement is controlled by the part of the brain labelled

(1)

☒ **A** Cerebral hemisphere

☒ **B** Cerebellum

☒ **C** Medulla oblongata

☒ **D** Hypothalamus

(ii) During exercise, chemoreceptors in the carotid artery detect a decrease in pH due to increased carbon dioxide.
This results in nerve impulses being sent to the

(1)

☒ **A** Cerebral hemisphere

☒ **B** Cerebellum

☒ **C** Medulla oblongata

☒ **D** Hypothalamus

P 3 9 5 7 1 2 A 0 1 2 2 8
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(b) At the start of depolarisation, the ions that move into the axon causing the action potential are

(1)

- ☒ **A** Calcium
- ☒ **B** Chloride
- ☒ **C** Potassium
- ☒ **D** Sodium

(c) When an impulse arrives at a synapse, the ions that enter the pre-synaptic membrane are

(1)

- ☒ **A** Calcium
- ☒ **B** Chloride
- ☒ **C** Potassium
- ☒ **D** Sodium

(d) Acetylcholine is a chemical which acts as

(1)

- ☒ **A** an enzyme
- ☒ **B** a hormone
- ☒ **C** a neurotransmitter
- ☒ **D** a receptor

(e) The drug MDMA (ecstasy) changes behaviour by

(1)

- ☒ **A** decreasing the concentration of adrenaline in brain synapses
- ☒ **B** decreasing the concentration of serotonin in brain synapses
- ☒ **C** increasing the concentration of adrenaline in brain synapses
- ☒ **D** increasing the concentration of serotonin in brain synapses

(Total for Question 1 = 6 marks)

2 The Human Genome Project is helping in the design of new drugs to treat a variety of human diseases and in the development of synthetic tissues.

(a) (i) Explain the meaning of the term **Human Genome**.

(1)

(ii) Describe **one** ethical implication associated with the use of information obtained from the analysis of the human genome.

(1)

P 3 9 5 7 2 A 0 4 2 8
SEMUR.CO.UK

(b) Melanoma is an aggressive form of skin cancer.

Very few patients with this cancer survive for more than five years. Some melanomas are associated with a genetic mutation identified by the Human Genome Project.

Drug R (R05185426) has been developed to treat patients with these melanomas. In clinical trials, drug R has been shown to cause a 50% shrinkage of melanomas in only a few months.

(i) Suggest how work on the Human Genome Project helped in the development of drug R.

(3)

(ii) Suggest how drug R may have caused the melanoma to shrink in only a **few months**.

(4)

(iii) Drug R needs one more round of testing, in a phase III trial, before it can be approved for use.

Explain what is meant by a **phase III trial**.

(2)

P 3 9 5 2 8 A 0 6 2 8
SAMUEL.CAD.UK

(c) Yeast cells were genetically modified, using human DNA, to produce collagen. This collagen can be used to make synthetic corneas.

Ten patients who were blind were each given a synthetic cornea. They were all able to see with no reported complications due to tissue rejection.

Suggest why these synthetic corneas were not rejected.

(2)

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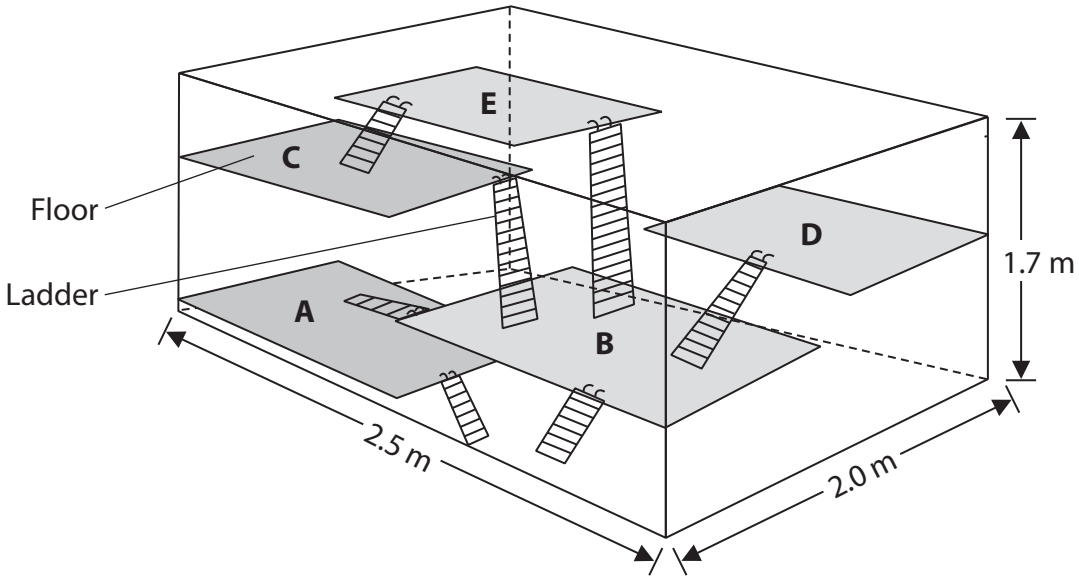
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(Total for Question 2 = 13 marks)

3 (a) An investigation was carried out to study the ability of rats to learn. A number of rats were divided into two groups, P and Q.

The rats in group P were deprived of food for twenty hours and then released into a cage. The cage contained hidden food and the rats were left in this cage for four hours each day.
This was repeated each day for fourteen days.

The diagram below shows the cage.
In the cage, the floors A, B, C, D and E had hidden food, water, wooden blocks, freshly cut wood chips, branches, fresh leaves, plastic containers and paper bags.



(i) The rats in group Q were used as a control.
Describe how the rats in control group Q would have been treated.

(2)

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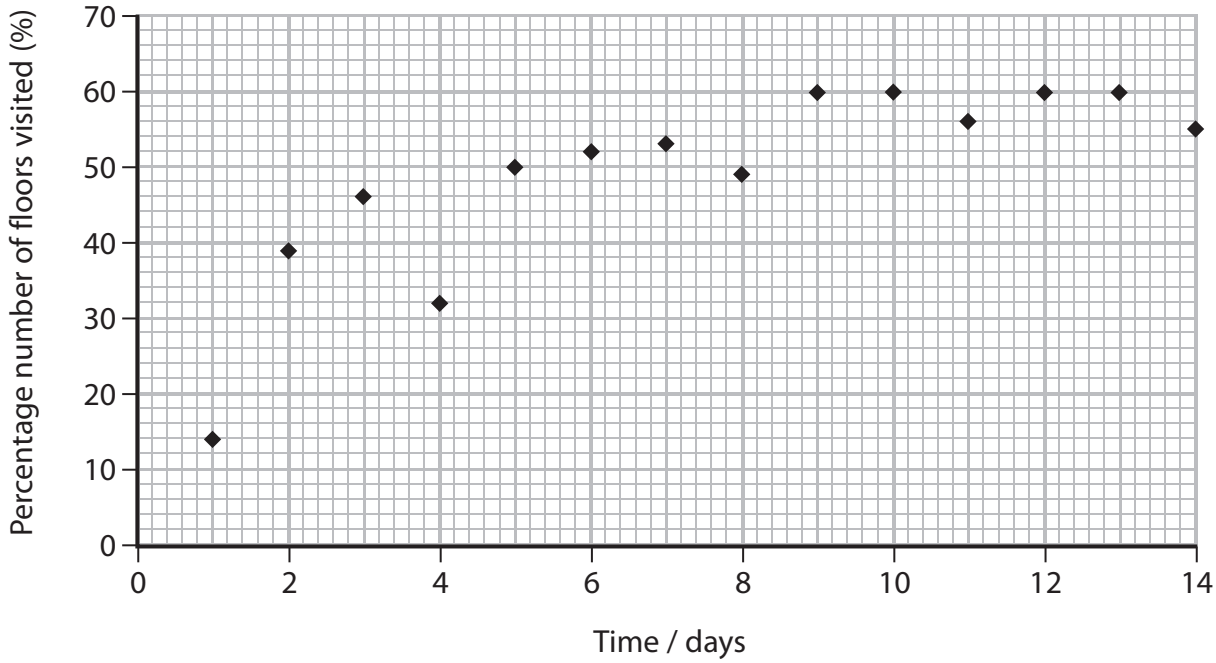
P 3 9 5 7 2 A 0 8 2 8
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(ii) Explain why the rats were not fed for twenty hours each day.

(1)

(b) During each four-hour period in the cage, the number of floors visited by the rats in group P was recorded as a percentage of the total number of floors.

The graph below shows the results of this experiment.



Using the information in the graph, describe the behaviour of the rats in group P over the fourteen-day period during this investigation.

(3)

(c) In a second experiment, the two groups of rats were placed in a maze containing hidden food.
The percentage of rats from each group that found the food in a short period of time was recorded.

The results are shown in the table below.

Group	Percentage of rats finding food (%)
P	85
Q	0

Explain the effect of the first experiment on the ability of rats to find food in a short period of time.

(2)

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P 3 9 5 1 2 A 0 1 0 2 8
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(d) The brains of both groups of rats were examined.
The mean spine density per neurone for each group was calculated.

Spine density represents a measure of the number of synapses per neurone.

The results are shown in the table below.

Group	Mean spine density / arbitrary units
P	1.96
Q	1.78

Suggest how these results explain the effect of the first experiment on the ability of rats to find food using the cage.

(2)

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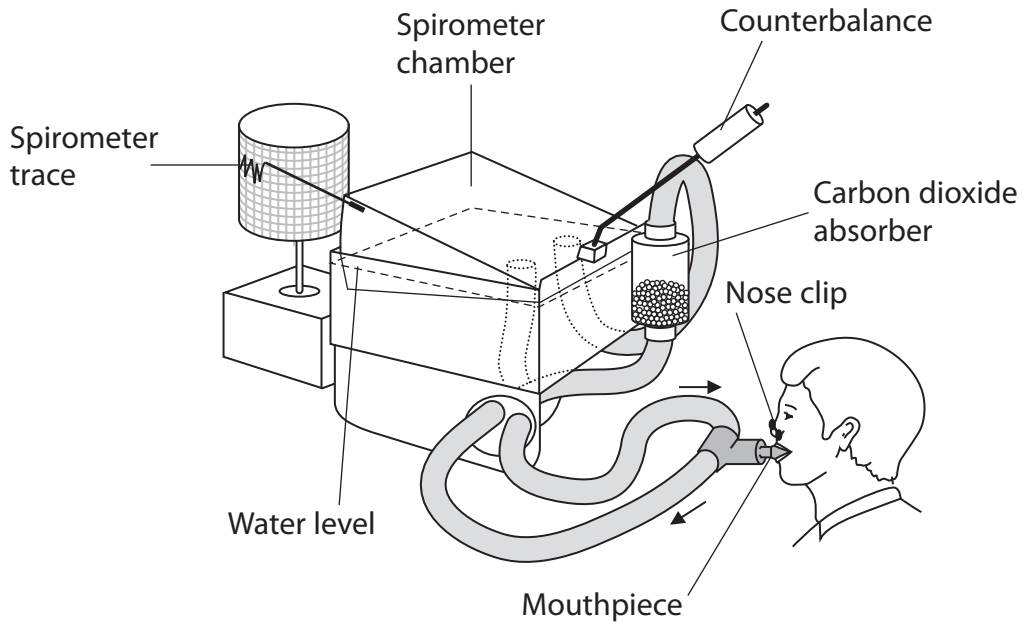
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(Total for Question 3 = 10 marks)

P 3 9 5 1 2 A 0 1 2 8
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4 *(a) A spirometer can be used to measure tidal volumes and breathing rates.

The diagram below shows a spirometer.



Explain how you would use the traces from this spirometer to compare the tidal volumes and breathing rates of male and female human subjects.

(6)

P 3 9 5 1 2 A 0 1 2 8
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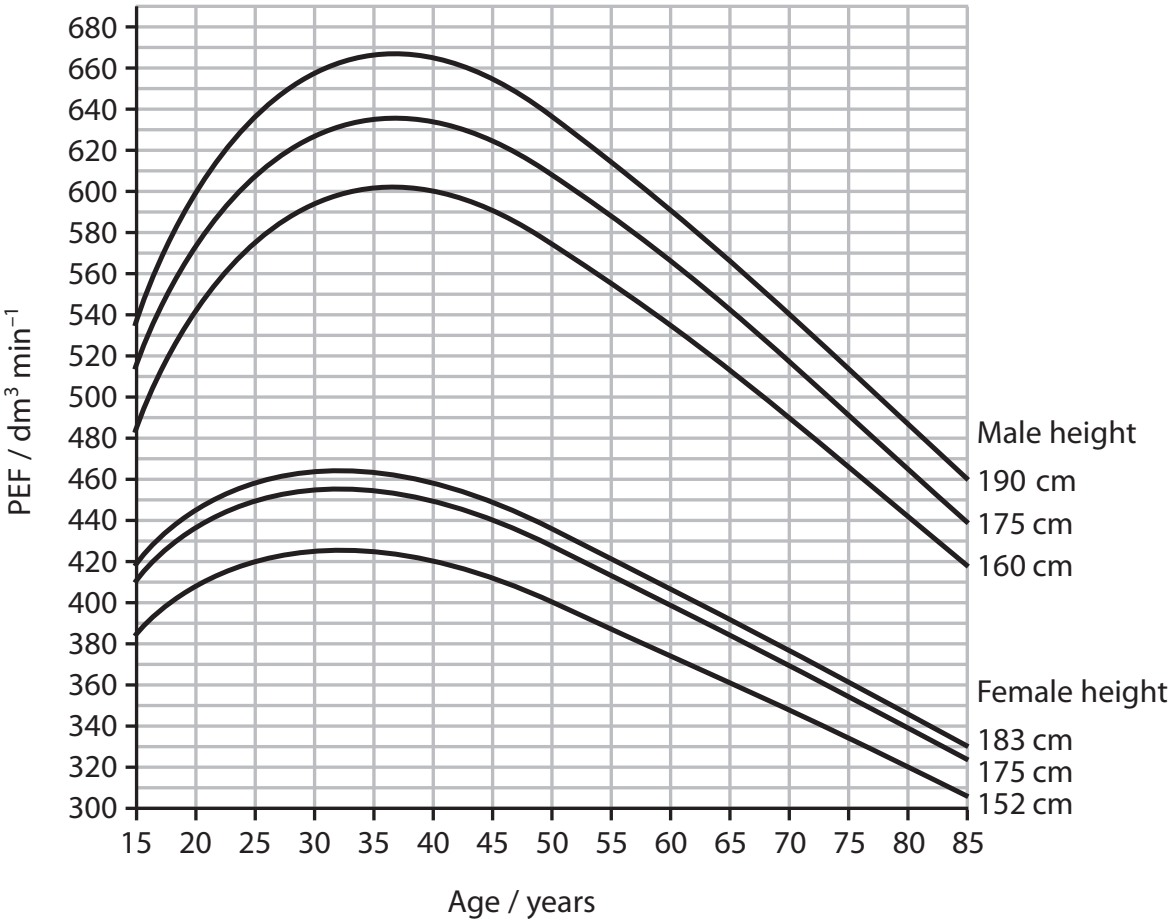
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Question 4 continues on the next page

P 3 9 5 3 2 8 A 0 0 1 2
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(b) The peak expiratory flow (PEF) is a measure of how fast a person can breathe out. This can indicate any obstruction in the airways of the lungs. It is measured using a peak flow meter.

The graph below shows the expected PEF values for people aged 15 to 85 years of various heights.



(i) Using the information in the graph, describe the effect of age on PEF.

(4)

P 3 9 5 1 2 A 0 1 4 2 8
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(ii) Using the information in the graph, give one reason for the difference in PEF values between ages 35 years and 85 years.

(1)

.....

.....

(iii) If a person with asthma has a PEF 30% below the expected value, it may indicate that their asthma is not under control.
A 52-year old man with asthma has a PEF reading of 350 $dm^3\ min^{-1}$.

Using the information in the graph, state whether or not his asthma is being kept under control. Give a reason for your answer.

(2)

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(iv) Give one other piece of information that is needed before an accurate diagnosis of his asthma can be made.

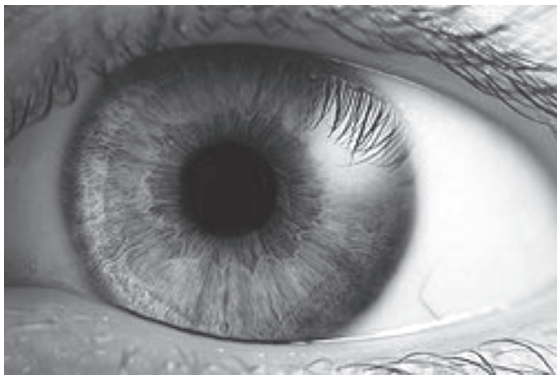
(1)

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(Total for Question 4 = 14 marks)

5 (a) The picture below shows the human eye with the black pupil in the centre.
The pupil can change size to allow either more or less light into the eye.
Its size is controlled by the iris muscles surrounding it.



Magnification ×2

(i) Suggest why the pupil appears black.

(1)

(ii) There are two sets of iris muscles, the radial muscles and the circular muscles.
They work antagonistically to alter the size of the pupil.

Explain why these two sets of muscles need to be antagonistic.

(3)

P 3 9 5 1 2 A 0 1 6 2 8
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(iii) The pupil increases in diameter in dim light.
Explain how neurones enable this response to occur.

(3)

(b) Tropicamide is a drug used in eye drops.
Tropicamide has an effect on the diameter of the pupil in the eye.
This makes it easier for the doctor to examine the retina or lens in the eye of a patient.

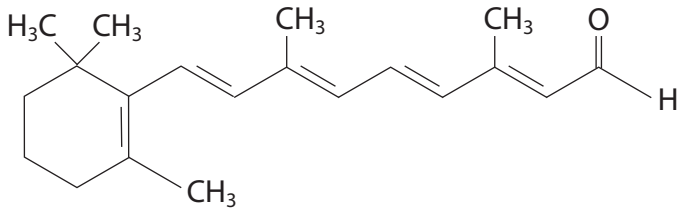
Suggest how tropicamide in the eye drops makes it easier to examine the retina.

(3)

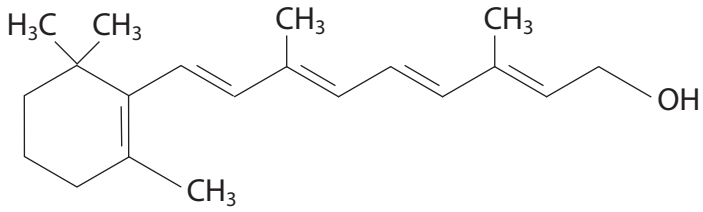
P 3 9 5 7 2 A 0 0 1 7 2 8
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(c) The diagrams below show the structure of two molecules, retinal and retinol.

Retinal



Retinol



Retinol is the most common form of dietary vitamin A and retinal is part of the structure of rhodopsin.

Suggest how a deficiency of vitamin A would adversely affect a person's vision.

(3)

(Total for Question 5 = 13 marks)

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6 The table below shows some statements relating to photoreceptors (phytochromes) in plants.

Complete the table with a tick (✓) if the statement is correct or a cross (×) if the statement is not correct.

(4)

Statement	Tick (✓) or cross (×)
Cause cell depolarisation	
Affected by all wavelengths of light	
Involved in plant growth and development	
Affected by darkness	

(Total for Question 6 = 4 marks)

P 3 9 5 2 8 A 0 2 0 2 8
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7 The scientific article you have studied is adapted from articles in The Biologist. Use the information from the article and your own knowledge to answer the following questions.

(a) Explain why obesity is 'a big problem' for society (paragraph 2).

(2)

.....

.....

.....

.....

(b) Describe the structure of triglyceride fat found in white adipose tissue (WAT).

(2)

.....

.....

.....

.....

(c) Calculate the percentage increase in deaths for young girls with anorexia (paragraph 6).

(2)

Answer = ... %

(d) State the evidence supporting the idea that specific parts of the brain are responsible for the gender differences in the processing of information related to body image (paragraphs 8 to 14).

(4)

(e) Explain why the raised cortisol levels due to dieting in females, may be a long term risk factor (paragraph 18).

(2)

P 3 9 5 1 2 A 0 1 2 2 8
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(f) Suggest why it may be an advantage to have lipids stored in 'many small droplets rather than in a large mass' in brown adipose tissue (BAT) (paragraph 28).

(2)

(g) Suggest how the uncoupling agent UCP-1 might affect the production of ATP and heat (paragraph 28).

(3)

(h) Suggest why 18F-fluorodeoxyglucose (18FFDG) becomes 'trapped' in the cells, unlike glucose which is rapidly metabolised (paragraph 32).

(3)

(i) Explain why the seaweed pigment fucoxanthin caused a reduction in abdominal fat in rats (paragraph 38).

(3)

*(j) Give the scientific evidence for the protein PRDM16 being responsible for potential weight loss (paragraphs 40 and 41).

(5)

P 3 9 5 4 2 A 0 2 4 2 8
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(k) Give **two** pieces of evidence showing that environmental factors can alter gene expression (paragraphs 45 to 47).

(2)

.....

.....

.....

.....

(Total for Question 7 = 30 marks)

TOTAL FOR PAPER = 90 MARKS

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Mark Scheme (Results)

Summer 2012

GCE Biology (6BI05) Paper 01
Energy, Exercise and Coordination

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Summer 2012
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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- Write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- Select and use a form and style of writing appropriate to purpose and to complex subject matter
- Organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

GENERAL INFORMATION

The following symbols are used in the mark schemes for all questions:

Symbol	Meaning of symbol
; semi colon	Indicates the end of a marking point
Eq	Indicates that credit should be given for other correct alternatives to a word or statement, as discussed in the Standardisation meeting
/ oblique	Words or phrases separated by an oblique are alternatives to each other
{ } curly brackets	Indicate the beginning and end of a list of alternatives (separated by obliques) where necessary to avoid confusion
() round brackets	Words inside round brackets are to aid understanding of the marking point but are not required to award the point
[] square brackets	Words inside square brackets are instructions or guidance for examiners
[CE] or [TE]	Consecutive error / transferred error

Crossed out work

If a candidate has crossed out an answer and written new text, the crossed out work can be ignored. If the candidate has crossed out work but written no new text, the crossed out work for that question or part question should be marked, as far as it is possible to do so.

Spelling and clarity

In general, an error made in an early part of a question is penalised when it occurs but not subsequently. The candidate is penalised once only and can gain credit in later parts of the question by correct reasoning from the earlier incorrect answer.

No marks are awarded specifically for quality of language in the written papers, except for the essays in the synoptic paper. Use of English is however taken into account as follows:

- the spelling of technical terms must be sufficiently correct for the answer to be unambiguous
  e.g. for amylase, ‘ammalase’ is acceptable whereas ‘amylose’ is not
  e.g. for glycogen, ‘glicojen’ is acceptable whereas ‘glucagen’ is not
  e.g. for ileum, ‘illeum’ is acceptable whereas ‘ilium’ is not
  e.g. for mitosis, ‘mytosis’ is acceptable whereas ‘meitosis’ is not

- candidates must make their meaning clear to the examiner to gain the mark.

- a correct statement that is contradicted by an incorrect statement in the same part of an answer gains no mark – irrelevant material should be ignored

Question Number	Answer	Mark
1(a)(i)	B ;	**(1)**

Question Number	Answer	Mark
1(a)(ii)	C ;	**(1)**

Question Number	Answer	Mark
1(b)	D ;	**(1)**

Question Number	Answer	Mark
1(c)	A ;	**(1)**

Question Number	Answer	Mark
1(d)	C ;	**(1)**

Question Number	Answer	Mark
1(e)	D ;	**(1)**

Question Number	Answer	Mark
2 (a)(i)	all the {DNA / genes / eq} of (the human species) ;	**(1)**

Question Number	Answer	Mark
2 (a)(ii)	Any **one** from: 1. idea of discrimination e.g. insurers might have access to a person's DNA / 2. idea of who decides whether a person is tested / 3. idea of need for confidentiality / 4. expensive medical treatments might be restricted / eq ;	**(1)**

Question Number	Answer	Mark
2 (b)(i)	1. idea that (Human Genome Project) identifies allele related to melanoma e.g. mutant allele, aberrant allele ; 2. idea that drug targets this allele ; 3. (mutant) allele can no longer express itself / eq ; 4. idea of drug preventing translation ; 5. idea that such a drug is more effective ;	**(3)**

Question Number	Answer	Mark
2 (b)(ii)	1. idea that drug affects expression of the allele ; 2. idea that protein not produced ; 3. idea that (melanoma) cells killed ; 4. idea that (melanoma) cells do not divide ; 5. idea that they are replaced with normal body cells ; 6. through mitosis / eq ; 7. description of specific part of mitosis affected e.g. no spindle fibres ;	**(4)**

Question Number	Answer	Mark
2 (b)(iii)	1. randomised trial / eq ; 2. {large number / eq} of patients ; 3. double blind / eq ; 4. idea of {use of placebo / use of current treatment} ; 5. testing how effective the drug is on patients / eq ;	**(2)**

Question Number	Answer	Mark
2 (c)	1. yeast cells have human collagen {gene / allele / DNA / eq} ; 2. idea that new collagen is recognised as 'self' e.g. has no non-self antigens ; 3. does not trigger immune response / eq ;	**(2)**

Question Number	Answer	Mark
3 (a)(i)	1. cage with no enrichment / eq ; 2. idea of same regime e.g. starvation time, feeding time, time in cage ;	**(2)**

Question Number	Answer	Mark
3 (a)(ii)	idea of motivation e.g. to encourage them to look for food ;	**(1)**

Question Number	Answer	Mark
3 (b)	1. overall trend increases / eq ; 2. idea of rapid increase in visiting over first {2 / 3 / 5} days / eq ; 3. after this the increase in visiting slows down / eq ; 4. comment on lower percentage on day 4 ; 5. comment on levels off from day {5 / 9} ; 6. idea that the rats did not visit all the floors (on each day) e.g. 100% of the floors never achieved ; 7. manipulation of figures / eq ;	**(3)**

Question Number	Answer	Mark
3 (c)	1. idea that exploration encouraged in group P ; 2. due to {enrichment / hidden food / eq} ; 3. idea that they are more intrepid e.g. they visit more of the maze ; 4. {better / more adept / eq} at looking for food / learnt to look for food ;	**(2)**

Question Number	Answer	Mark
3 (d)	1. more synapses /eq ; 2. idea that more {connections between neurones / neurones connected together} ; 3. idea of better learning capacity ;	**(2)**

Question Number	Answer	Mark
***4 (a)**	**Take into account quality of written communication when awarding the following points.** 1. idea of calibration for volume ; 2. idea of calibration for time ; 3. description of how to calculate tidal volume (from trace) / eq ; 4. idea that one peak = one breath ; 5. reference to breathing rate is number of peaks per minute ; 6. idea of standardised group of males and females e.g. same age, non-smokers ; 7. idea that traces taken at rest ; 8. reference to replicates ; 9. description of how to calculate the mean from the trace ;	**(6)**

Question Number	Answer	Mark
4 (b)(i)	1. PEF increases (from 15) to when they are in their 30s and then decreases ; 2. reaches a peak at age {30 to 34} for women / eq ; 3. reaches a peak at age {36 to 39} for men / eq ; 4. idea that PEF falls below value at 15 (later on in life) ; 5. manipulation of figures to illustrate the points above ;	**(4)**

Question Number	Answer	Mark
4 (b)(ii)	weakening of muscles / loss of elasticity of lungs ;	**(1)**

Question Number	Answer	Mark
4 (b)(iii)	1. he is more than 30% below / must be less than 400 dm^3 min^{-1}/ he is {37 to 39 %} below / eq ; 2. therefore his asthma is not under control ;	**(2)**

Question Number	Answer	Mark
4 (b)(iv)	height ;	**(1)**

Question Number	Answer	Mark
5 (a)(i)	{pigment / eq} at back of eye absorbs light / no light is reflected out (from the choroid) ;	**(1)**

Question Number	Answer	Mark
5 (a)(ii)	1. circular muscles contract (and radial muscles relax) to {constrict / eq} pupil ; 2. radial muscles contract (and circular muscles relax) to {dilate / eq} pupil ; 3. need for fine control of aperture to allow pupil to be reset to a different size / allow changing to take account of varying light intensity ; 4. (these) muscles can only shorten / eq ; 5. antagonistic muscles have opposite effects / eq ; 6. idea that contraction of one muscle set stretches the other ;	**(3)**

Question Number	Answer	Mark
5 (a)(iii)	1. details of impulse e.g. depolarisation / eq ; 2. reference to bipolar {neurone / cell / eq} ; 3. reference to sensory neurone / eq ; 4. reference to optic nerve ; 5. reference to {motor / eq} neurone connected to (radial) muscles ; 6. reference to contraction of radial muscle ;	**(3)**

Question Number	Answer	Mark
5 (b)	1. has an effect on nervous system of iris / eq ; 2. radial muscles contract / eq ; 3. idea of prevention of pupil constriction ; 4. larger aperture / pupil dilates / eq ; 5. letting more light in / eq ; 6. (so) can see {more / all / eq} retina ;	**(3)**

Question Number	Answer	Mark
5 (c)	1. retinol and retinal are very similar in structure / eq ; 2. idea of retinol is needed to make retinal / eq ; 3. idea that shortage of retinol in diet leads to less retinal ; 4. in rods ; 5. idea that this leads to reduced vision in {low light / at night / eq} ;	**(3)**

Question Number	Answer	Mark
6		**(4)**

Statement	Tick (✓) or cross (×)
Cause cell depolarisation	×
Affected by all wavelengths of light	×
Involved in plant growth and development	✓
Affected by darkness	✓

1 for each correct row.

Question Number	Answer	Mark
7 (a)	1. high numbers of obese people / eq ; 2. this is linked to increased risk of diseases such as {diabetes / CVD / eq} ; 3. idea that this puts an economic burden on society ;	**(2)**

Question Number	Answer	Mark
7 (b)	1. three fatty acids ; 2. contains a glycerol (molecule) / ref. to ester bonds ;	**(2)**

Question Number	Answer	Mark
7 (c)	1. 80% × {10 / 15 / 20} % OR 0.8 × 0.1 OR 0.8 x 0.15 OR 0.8 x 0.2 OR idea that percentage mortality has not changed ; 2. 0% / 8% / 12% / 16% / (range) 8 to 16% ;	**(2)**

Question Number	Answer	Mark
7 (d)	1. (serious) self reflection is associated with increased activity in the mPFC (in both) / eq ; Body image: 2. there is a link between overweight body image in females and activation of mPFC / eq ; 3. there is no (significant) mPFC activation in men when presented with equivalent male images /eq ; Words: 4. {words / eq} associated with increased activation in the amygdala in females / eq ; 5. (and) deactivation of the left mPFC in females / eq ; 6. in men this response was reversed / eq ;	**(4)**

Question Number	Answer	Mark
7 (e)	1. idea that cortisol levels need to be high for a long time ; 2. this leads to {high blood pressure / suppressed thyroid function / impaired immunity / increased intra-abdominal fat / CVD / diabetes / cancer} ;	**(2)**

Question Number	Answer	Mark
7 (f)	1. greater surface area / eq ; 2. idea of more quickly hydrolysed (by enzymes) / eq ; 3. to release energy / for use in respiration / eq ;	**(2)**

Question Number	Answer	Mark
7 (g)	1. UCP-1 is in the mitochondria / eq ; 2. idea that electron transport chain is disrupted ; 3. (therefore) less ATP is produced by the electron transport chain / eq ; 4. UCP-1 might inhibit {ATP synthase / ATPase / eq } OR alter the proton gradient / eq ; 5. more energy as heat / eq ;	**(3)**

Question Number	Answer	Mark
7 (h)	1. it only undergoes the first stage of metabolism / eq ; 2. glucose is completely metabolised / eq ; 3. idea that products of 18F-FDG breakdown cannot be metabolised ; 4. idea that this is due to wrong shape for next enzyme ; 5. (so) cannot bind to active site / binds permanently / eq ; 6. idea that (altered shape means) cannot exit through the same glucose / eq channels they entered by ;	**(3)**

Question Number	Answer	Mark
7 (i)	1. fucoxanthin increases the production of UCP-1 / eq ; 2. UCP-1 {uncouples / disrupts / eq} the electron transport chain / oxidative phosphorylation / eq ; 3. less ATP available for use / eq ; 4. more energy lost as heat / eq ; 5. extra fat is used in {respiration / eq} ;	**(3)**

Question Number	Answer	Mark
***7 (j)**	**Take into account quality of written communication when awarding the following points.** 1. PRDM16 levels higher in BAT than WAT / eq ; 2. loss of PRDM16 causes a loss in heat production / eq ; 3. more energy stored as fat in WAT / eq ; 4. (artificial) excess of PRDM16 causes white fat cells to become brown fat cells / eq ; 5. this influences UCP-1 levels / eq ; 6. genetically engineered mice had high levels of UCP-1 during BAT formation / eq ; 7. increasing PRDM16 in muscle cells causes them to differentiate into brown fat cells / eq ; 8. increased BAT as a result associated with increased {heat production / weight loss / fat loss / eq} / eq ;	**(5)**

Question Number	Answer	Mark
7 (k)	1. anorexia associated with a reduction in {CD68 expression / mRNA coding for fat synthesis / certain proteins / eq} / eq ; 2. anorexia associated with an increase in resistin mRNA expression / eq ; 3. {psychological distress / eq} leads to changes in DNA structure / methylation of DNA / eq ;	**(2)**

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Edexcel GCE

Biology

Advanced

Unit 5: Energy, Exercise and Coordination

Tuesday 31 January 2012 – Afternoon
Time: 1 hour 45 minutes

Paper Reference
6BI05/01

You must have:
A copy of the scientific article taken from The Biologist articles (enclosed)

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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1/1/1/1/1/

P 3 9 5 0 6 A 0 1 2 4

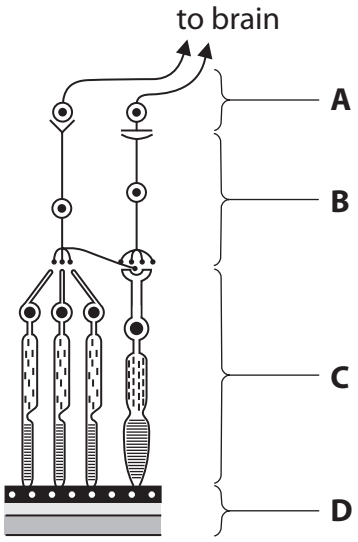
PEARSON

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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The diagram below shows the position of some of the cells in the retina of the eye.



(a) Place a cross in the box ☒ next to the correct letter to complete each of the following statements.

(i) Rod cells are found in the layer labelled

(1)

☒ **A** ☒ **B** ☒ **C** ☒ **D**

(ii) The neurones of the optic nerve begin in the layer labelled

(1)

☒ **A** ☒ **B** ☒ **C** ☒ **D**

(iii) In this diagram of the retina, the light would pass through from

(1)

☒ **A** bottom to top

☒ **B** left to right

☒ **C** right to left

☒ **D** top to bottom

P 3 9 5 0 6 A 0 2 2 4
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(b) The macula is the central part of the retina in the eye.
Macular degeneration is a common cause of blindness.

Recent research has shown that macular degeneration in adult mice can be successfully treated. This involves injecting embryonic stem cell-derived photoreceptors into their retinas.

(i) Suggest why this sort of treatment might not restore vision in people with macular problems who have been blind from an early age.

(3)

(ii) Suggest why this type of treatment for blindness in humans could be regarded as controversial.

(2)

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(c) A group of scientists proposed to investigate a treatment for people who have been blind from an early age.

This investigation involves kittens having their eyes kept shut immediately after birth. After 12 weeks, their eyes will be opened and stem cells injected into the cerebral hemispheres of their brains.

These kittens will then be raised for two years in a constant environment and the development of their retinas will be compared with a control group.

(i) Suggest why the stem cells will be injected into the cerebral hemispheres.

(2)

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(ii) Suggest why the environment should be kept constant in this investigation.

(2)

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(Total for Question 1 = 12 marks)

P 3 9 5 0 6 A 0 4 2 4
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2 Florence (Flo-Jo) Griffith-Joyner's world record of 10.49 seconds for the 100 m women's sprint in 1988 is unbeaten.



In this short time, a sprinter such as Flo-Jo could not deliver enough oxygen to her muscles to maintain aerobic respiration.

* (a) Describe how a sprinter is able to release sufficient energy for the 100 m sprint without having enough oxygen available for her muscles.

(6)

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(b) (i) Lactate (lactic acid) can build up in the muscles of a sprinter.
Suggest why the build-up of lactate may prevent any further increase in speed.

(2)

(ii) Explain the fate of lactate following a sprint.

(4)

(Total for Question 2 = 12 marks)

P 3 9 5 0 6 A 0 6 2 4
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3 The table below shows information about the top ten fastest men and women in both the 100 m sprint and the marathon race of 42.2 km.

Race	Mean speed / m s^{-1}	Standard deviation
Men's 100 m sprint	10.22	0.10
Women's 100 m sprint	9.35	0.08
Men's marathon	5.65	0.02
Women's marathon	5.06	0.05

(a) (i) Give reasons why the data in the table may be considered to be reliable.

(2)

.....

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.....

.....

(ii) For the marathon, the women's mean speed is 89.6% of the men's mean speed.

For the 100 m sprint, calculate the women's mean speed as a percentage of the men's mean speed.
Show your working.

(2)

Answer = ... %

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(iii) Using the information in the table, describe the difference between the mean speeds for men and women for the 100 m sprint.
Suggest a reason for the difference.

(2)

(b) Suggest why the mean speeds for the marathon are less than the 100 m sprint for both men and women.

(3)

(Total for Question 3 = 9 marks)

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QUESTION 4 STARTS ON THE NEXT PAGE

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4 A study examined the risk of developing a mental disorder.
This study determined the risk for both the population as a whole and for those who had a close relative (parent, brother, sister or child) with the same disorder.

The results are shown in the table below.

Mental disorder	Risk of developing mental disorder (%)		
	Population as a whole		Those with a close relative with the same disorder
	Males	Females	
Alcoholism	7.0	2.0	15
Anxiety	3.0	6.0	15
Manic depression	2.0	3.0	15
Neurotic depression	6.0	12.0	11
Obsessive compulsive	0.1	0.1	10
Schizophrenia	1.0	1.0	10

(a) (i) People with obsessive compulsive disorder (OCD) have symptoms such as repeated washing, checking, touching, counting or arranging.

Using the data in this table, give the evidence that OCD is an inherited condition.

(2)

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(ii) Using the data in the table, explain the validity of the statement that 'OCD is an inherited condition'.

(2)

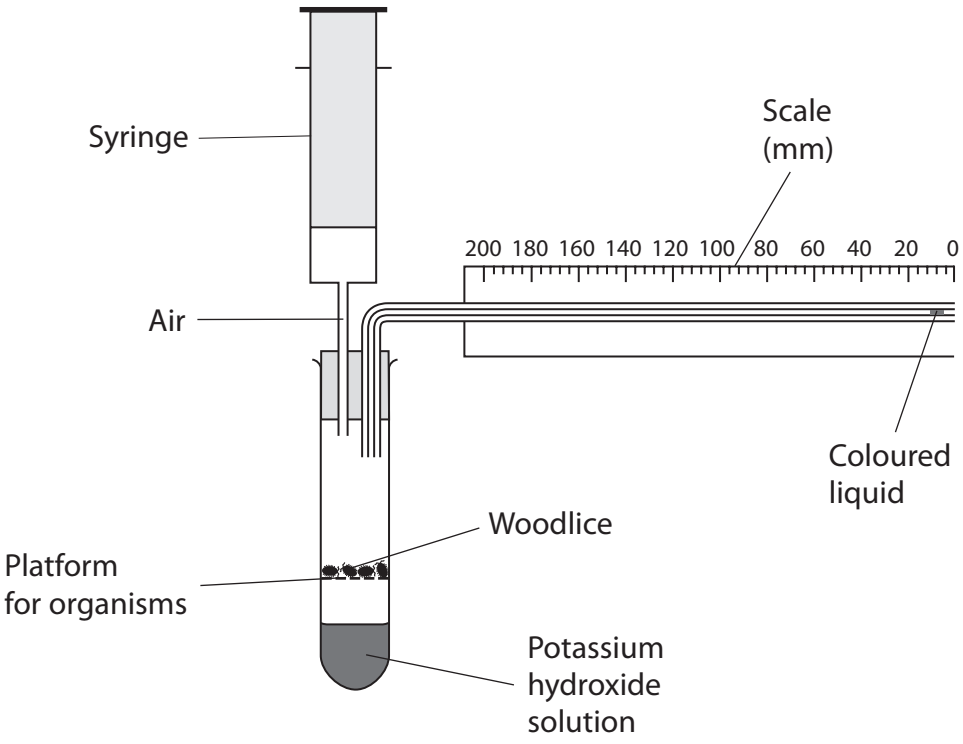
(iii) Using the data in the table, state which disorder is least likely to be an inherited condition.
Give a reason for your answer.

(2)

(Total for Question 4 = 6 marks)

P 3 9 5 0 6 A 0 1 1 2 4
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5 The apparatus shown in the diagram below can be used to measure the rate of respiration of small animals such as woodlice.



(a) (i) Potassium hydroxide solution absorbs carbon dioxide.
Suggest a reason for absorbing carbon dioxide in this apparatus.

(1)

.....

.....

.....

(ii) Suggest what the syringe is used for in this apparatus.

(2)

.....

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P 3 9 5 0 6 A 0 0 1 2 2 4
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*(b) Describe how this apparatus could be used to find the mean rate of respiration of woodlice.

(6)

(Total for Question 5 = 9 marks)

P 3 9 5 0 6 A 0 1 3 2 4
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6 Muscles, bones and joints allow movement of the skeleton.

(a) Place a cross in the box ☒ next to the correct word to complete each of the following statements.

(i) Muscles are attached to bones by

(1)

☒ **A** cartilage

☒ **B** ligaments

☒ **C** synapses

☒ **D** tendons

(ii) In a joint, bones are joined to each other by

(1)

☒ **A** cartilage

☒ **B** ligaments

☒ **C** synapses

☒ **D** tendons

(iii) Muscles that work in pairs across a joint are known as

(1)

☒ **A** agonists

☒ **B** antagonists

☒ **C** extensors

☒ **D** flexors

(iv) In key-hole surgery, cruciate ligaments are repaired using tissue from

(1)

☒ **A** bones

☒ **B** cartilage

☒ **C** ligaments

☒ **D** tendons

(v) Fast twitch muscle fibres have

(1)

☒ **A** few capillaries

☒ **B** high myoglobin content

☒ **C** low glycogen content

☒ **D** many mitochondria

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(vi) Slow twitch muscle fibres

(1)

☒ **A** fatigue quickly

☒ **B** have no myoglobin

☒ **C** have low glycogen content

☒ **D** have few mitochondria

(Total for Question 6 = 6 marks)

7 In an investigation into dieting and obesity, mice were fed a restricted quantity of food. It has been found that the stress of having less food causes the release of the hormone noradrenaline. This causes the mice to hunt for food.
These food-restricted mice will tolerate electric shocks in order to eat.

(a) Suggest why this investigation might be regarded as unacceptable.

(2)

(b) Noradrenaline acts by increasing blood flow to the muscles.

(i) Suggest how this increase in blood flow is brought about.

(2)

(ii) Suggest why this increase in blood flow would be of advantage to the food-restricted mice.

(2)

(Total for Question 7 = 6 marks)

P 3 9 5 0 6 A 0 0 1 6 2 4
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8 The scientific document you have studied is adapted from an article in 'The Biologist'.

Use the information from the scientific article and your own knowledge to answer the following questions.

(a) Describe **two** symptoms of Parkinson's disease.

(2)

(b) Patients with Parkinson's disease have little of the neurotransmitter dopamine in the motor cortex of their brains.

Explain how 'dopamine agonists' might be a useful treatment for Parkinson's disease (paragraph 10).

(2)

(c) Dopamine is not given to the patients as it is not effective.
However, the precursor L-Dopa (levadopa) can be given to patients.

Suggest why L-Dopa might be a useful treatment for patients with Parkinson's disease.

(3)

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(d) Describe the advantages of deep brain stimulation (DBS) to patients with Parkinson's disease who do not respond to treatment with drugs.

(3)

(e) Suggest why the 'stereotactic frame' has proved to be so useful in DBS (paragraph 22).

(2)

(f) Suggest how DBS affects the cell membranes of brain cells (paragraph 22).

(3)

P 3 9 5 0 6 A 0 0 8 2 4
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(g) Explain why Jamie is able to stay awake during the operation without feeling any associated pain (paragraph 22).

(2)

(h) Suggest the advantage of Jamie being conscious during the operation.

(1)

(i) Explain how the experimental model for Parkinson's disease in monkeys was created (paragraphs 54 to 56).

(2)

(j) The subthalamic nucleus and the external segment of the globus pallidus (Table 1, paragraph 62) are connected to each other.

Suggest why this might be relevant for the DBS treatment of Parkinson's disease.

(2)

(k) Describe how fMRI can be used to monitor the activity of different areas of the brain (paragraph 62).

(3)

(l) fMRI can produce four images per second.
Explain why this is unlikely to monitor the effects of DBS (paragraph 62).

(2)

(m) Explain what is meant by the phrase 'placebo responders' (paragraph 64).

(2)

P 3 9 5 6 A 0 2 0 2 4
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(n) Explain what is meant by the 'causal' nature of DBS (paragraph 73).

(1)

.....

.....

.....

(Total for Question 8 = 30 marks)

TOTAL FOR PAPER = 90 MARKS

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Mark Scheme (Results)

January 2012

GCE Biology (6BI05) Paper 01
Energy, Exercise and Coordination

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Question number	Answer	Mark
1(a)(i)	C	(1)

Question number	Answer	Mark
1(a)(ii)	A	(1)

Question number	Answer	Mark
1(a)(iii)	D	(1)

Question number	Answer	Mark
1(b)(i)	1. Idea that lack of (visual) stimulation limits brain development ; 2. Idea that this due to of lack of connections ; 3. within the {visual cortex / eq} / eq ; 4. Idea that the brain cannot interpret this visual information correctly / eq ; 5. reference to critical {period / window} ; 6. idea that mice are different from humans ;	(3)

Question number	Answer	Mark
1(b)(ii)	1. Idea that embryo supplies cells ; 2. Idea that some people have {ethical / eq} objections to the use of embryonic cells / eq ; 3. Idea of objections to the use of animals ; 4. Idea of risk of stem cells becoming cancerous ;	(2)

Question number	Answer	Mark
1(c)(i)	1. Idea that (cerebral hemisphere) is the site of vision perception ; 2. reference to visual cortex / eq ; 3. idea that stem cells differentiate ; 4. this treatment will help to establish (neurone) connections / eq ; 5. Idea that can not get stem cells to this location any other way (than injection) ;	(2)

Question number	Answer	Mark
1(c)(ii)	1. reduce number of variables / to keep all variables constant / eq ; 2. so that only the effect of the {treatment / eq} is measured / eq ;	(2)

Question number	Answer	Mark
2 (a)* QWC	**(QWC – Spelling of technical terms** *(shown in italics)* **must be correct and the answer must be organised in a logical sequence)** 1. idea that energy obtained from ATP ; 2. idea that ATP already in muscle cells e.g. ATP store ; 3. ATP from {*glycolysis*/ substrate level *phosphorylation*/ eq} ; 4. idea that *glycolysis* produces ATP {rapidly / eq} ; 5. idea that some {*aerobic respiration* / eq} due to some oxygen present ; 6. *glycolysis* occurs in *cytoplasm* / eq ; 7. idea of need to recycle NAD^+ ; 8. idea that *pyruvate* is converted to *lactate* ; 9. reference to *anaerobic respiration* ; 10. idea of *lactate* tolerance ; 11. reference to fast *twitch* {muscle / fibres} ; 12. reference to {*creatine phosphate* / eq} ;	(6)

Question number	Answer	Mark
2 (b)(i)	1. (lactate build up) causes {drop in pH / more acidic / increase H^+ /eq} ; 2. idea of this affects enzyme {activity / shape / eq} ; 3. this slows down {glycolysis / ATP production / anaerobic respiration / eq} ; 4. reference to muscle contractions being affected ;	(2)

Question number	Answer	Mark
2 (b)(ii)	1. reference to lactate in the blood / eq ; 2. {transported to / broken down in / eq} liver ; 3. lactate is {converted to pyruvate / eq} ; 4. this involves {oxidation / production of reduced NAD / eq} ; 5. pyruvate is then {oxidised / eq} ; 6. reference to Krebs cycle ; 7. {this requires extra oxygen / reference oxygen debt} / eq ; 8. idea that carbon dioxide and water are produced ;	(4)

Question number	Answer	Mark
3(a)(i)	1. idea that sample size is enough ; 2. comment on the accuracy of measurement / eq ; 3. standard deviations are small / eq ;	(2)

Question number	Answer	Mark
3(a)(ii)	1. (9.35 ÷10.22) ; 2. (0.91487) × 100 = 91.5 (%) ;	(2)

Question number	Answer	Mark
3(a)(iii)	1. men are faster than women / eq ; Any **one** from: 2. idea of differences in body structure e.g. men have more muscle, longer legs, more fast twitch fibres ; 3. idea of differences in physiology e.g. testosterone ;	(2)

Question number	Answer	Mark
3(b)	1. marathon distance greater / eq ; 2. Idea that more aerobic respiration is needed ; 3. to {reduce / eq} production of lactate ; 4. anaerobic respiration not efficient enough / eq ; 5. {oxygen debt / lactate levels} cannot be sustained over this distance / eq ; 6. idea that marathon runners use slow twitch fibres ;	(3)

Question number	Answer	Mark
4(a)(i)	1. idea that people are more likely to have obsessive compulsive disorder if they have a close relative with the condition ; 2. credit manipulation of figures i.e. 100 times more likely ; 3. therefore they may also have the {genes / alleles / genotype / eq} for this condition / eq ;	(2)

Question number	Answer	Mark
4(a)(ii)	1. idea that if they have a close relative with this illness, the risk {ought to be higher than / is only} 10% ; 2. therefore other factors must be involved as well / eq ; 3. named example of environmental influence e.g. learnt behaviour ;	(2)

Question number	Answer	Mark
4(a)(iii)	1. neurotic depression ; 2. {little / eq} difference between {population as a whole / females} and close relative data / eq ;	(2)

Question number	Answer	Mark
5(a) (i)	Any **one** from: 1. reduces {volume / pressure of gas} / eq ; 2. allows {measurement of oxygen used / movement of liquid / eq} ;	(1)

Question number	Answer	Mark
5(a) (ii)	1. returning the coloured liquid back to zero / eq ; 2. idea of calibration ; 3. repetition / eq ;	(2)

Question number	Answer	Mark
5(b)* QWC	**(QWC – Spelling of technical terms** *(shown in italics)* **must be correct and the answer must be organised in a logical sequence)** 1. reference to constant temperature ; 2. use of water bath / eq ; 3. reference to {suitable / stated / fixed time / eq} ; 4. Reference to measuring {volume / distance} ; 5. description of how to obtain volume ; 6. calculation of rate described / eq ; 7. reference to replicates ; 8. description of control e.g. no woodlice ; 9. idea of welfare of animals important ; 10. reference to {mass / eq} of woodlice ;	(6)

Question number	Answer	Mark
6(a)(i)	D	(1)

Question number	Answer	Mark
6(a)(ii)	B	(1)

Question number	Answer	Mark
6(a)(iii)	B	(1)

Question number	Answer	Mark
6(a)(iv)	D	(1)

Question number	Answer	Mark
6(a)(v)	A	(1)

Question number	Answer	Mark
6(a)(vi)	C	(1)

Question number	Answer	Mark
7 (a)	1. Idea that animals are being mistreated e.g. caused stress, pain ; 2. idea that it is not ethical ; 3. research topic might not be regarded as essential / eq ;	(2)

Question number	Answer	Mark
7 (b)(i)	1. effect on heart described e.g. increase heart rate / increased cardiac output ; 2. idea of acts as neurotransmitter/ effect on sites of control e.g. increased SAN activity, excitatory centre, sympathetic nerves ; 3. idea of vasodilation ; 4. increase in blood pressure / eq ;	(2)

Question number	Answer	Mark
7 (b)(ii)	1. (increased blood flow) provides more {glucose / oxygen} / enables more {respiration/ energy release} ; 2. for muscle used in “food hunt”/ eq ;	(2)

Question number	Answer	Mark
8 (a)	1. {stiffness / rigidity} (of muscles) / eq ; 2. tremor (of muscles) / eq ; 3. slowness of movement / bradykinesia / eq ; 4. poor balance / postural instability / eq ; 5. walking problems / akinesia / eq ; 6. depression / eq ; 7. speech problems / eq ; 8. swallowing difficulty / dysphagia / eq ;	(2)

Question number	Answer	Mark
8 (b)	1. dopamine agonists {mimic/ eq} dopamine / eq ; 2. they bind to dopamine receptors at {synapses / eq} / eq ; 3. they trigger action potentials / eq ;	(2)

Question number	Answer	Mark
8 (c)	1. L-Dopa can pass into the brain / eq ; 2. L-Dopa is converted into dopamine / eq ; 3. dopamine triggers action potentials at synapses / eq ; 4. {alleviates / eq} symptoms / eq ;	(3)

Question number	Answer	Mark
8 (d)	1. can help to {reduce / manage / eq} symptoms / eq ; 2. idea of no side effects ; 3. prevention of {decline / eq} ; 4. idea of effects immediate ; 5. economic benefits qualified e.g. return to work ; 6. social benefit qualified e.g. better quality of life ;	(3)

Question number	Answer	Mark
8 (e)	1. stereotactic frame allows {more accuracy / less damage / eq} / eq ; 2. almost any area of the brain can now be {stimulated / eq} ; 3. {more / stated} disorders can be treated e.g. cluster headaches, phantom pains ;	(2)

Question number	Answer	Mark
8 (f)	1. brain cells have a potential difference across their membrane / eq ; 2. electrical stimulation above a threshold level / eq ; 3. causes {depolarisation / action potentials} / eq ; 4. the membrane is then repolarised / eq ;	(3)

Question number	Answer	Mark
8 (g)	1. brain has no pain receptors / eq ; 2. {local anaesthetic / eq} used / pain receptors de-sensitised ; 3. sense organs are elsewhere e.g. skin, scalp ;	(2)

Question number	Answer	Mark
8 (h)	(Jamie) can give feedback during the operation / eq ;	(1)

Question number	Answer	Mark
8 (i)	1. {neurotoxin / MPTP} destroys the dopaminergic cells / eq ; 2. in the {basal ganglia / substantia nigra} ; 3. creating Parkinsonian symptoms (in monkeys) / eq ;	(2)

Question number	Answer	Mark
8 (j)	1. connection means that {both / globus pallidus external segment} could be related to Parkinson's / eq ; 2. stimulation of either could be beneficial / eq ; 3. idea of larger target area ; 4. greater chance of success of treatment / eq ;	(2)

Question number	Answer	Mark
8 (k)	1. haemoglobin (without oxygen) absorbs the signal / oxyhaemoglobin does not / eq ; 2. fMRI measures oxygen {uptake / change / eq} ; 3. More brain activity /eq ; 4. lower signal means higher brain activity / eq ;	(3)

Question number	Answer	Mark
8 (l)	1. fMRI can only measure events every 0.25 seconds (250ms) ; 2. DBS involves (transient) {events / effects / changes / neural activity / eq} that last a few milliseconds / eq ; 3. idea that fMRI is not fast enough to pick up changes due to DBS ;	

Question number	Answer	Mark
8 (m)	1. person taking the placebo does respond / eq ; 2. idea that placebo should produce no effect ;	(2)

Question number	Answer	Mark
8 (n)	DBS produces an immediate observable effect / no other cause of the effect / eq ;	(1)

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Edexcel GCE

Biology

Advanced

Unit 5: Energy, Exercise and Coordination

Wednesday 22 June 2011 – Morning
Time: 1 hour 45 minutes

Paper Reference
6BI05/01

You must have:
A copy of the scientific article taken from New Scientist articles (enclosed)

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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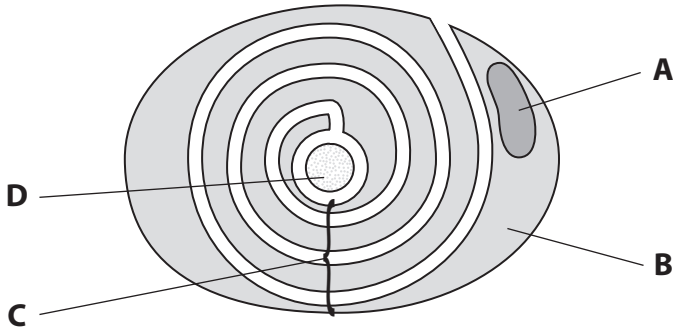
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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The diagram below shows a section through a motor neurone.



(a) Identify structures A, B, C and D by placing a cross ☒ in the correct box in the table below.

(4)

Structure	A	B	C	D
Axon	☒	☒	☒	☒
Cytoplasm of Schwann cell	☒	☒	☒	☒
Myelin sheath	☒	☒	☒	☒
Nucleus of Schwann cell	☒	☒	☒	☒

P 3 6 3 6 5 A 0 2 2 4
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(b) Describe the role of the structure labelled **C** in the conduction of nerve impulses.

(4)

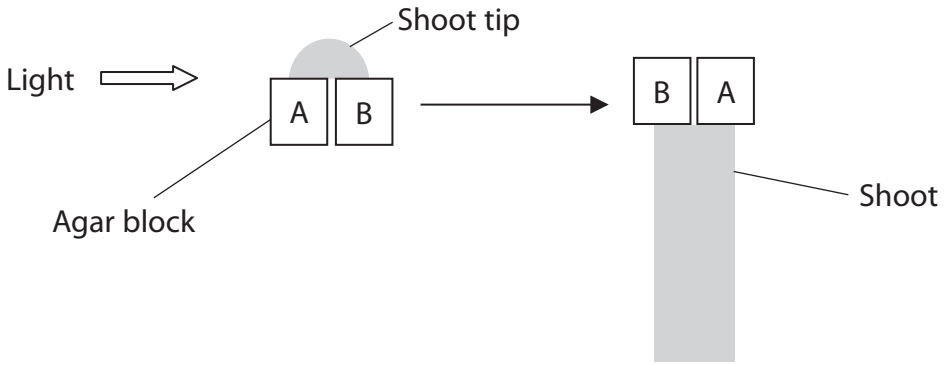
(c) Explain how the structure of the axon cell membrane is related to the conduction of nerve impulses.

(3)

(Total for Question 1 = 11 marks)

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2 The tip of a plant shoot was placed on two agar blocks and light was shone from one side. The tip was removed and the agar blocks were then placed on a shoot without a tip, as shown in the diagram below.



(a) In the space below, draw a diagram to show the shoot as it would appear several hours later.

(1)

*(b) Describe the mechanism that causes the change you have drawn.

(4)

P 3 6 3 6 5 A 0 4 2 4
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(c) Compare this response of a shoot to light with hormonal coordination in animals.

(4)

(Total for Question 2 = 9 marks)

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3 When exercise begins, both ventilation rate and heart rate increase. This supplies more oxygen to muscles.

(a) (i) Describe how breathing rate and tidal volume can be determined from a spirometer trace.

(3)

(ii) Explain how you would use breathing rate and tidal volume to calculate ventilation rate.

(1)

P 3 6 3 6 5 A 0 6 2 4
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(b) An investigation was carried out to study the changes in oxygen uptake by the blood in the lungs after the first ten seconds of exercise.

Men with artificial pacemakers agreed to exercise with their heart rate controlled at 50 beats per minute. The ventilation rate and the oxygen uptake at rest were measured. These were also measured, after the first ten seconds of exercise and the differences recorded.

This was repeated with the heart rate controlled at 100 beats per minute.

The results are shown in the table below.

Heart rate / beats per minute	**Increase in ventilation rate / $dm^3\ min^{-1}$**	**Increase in oxygen uptake by the blood / $cm^3\ min^{-1}$**
50	4.3	87
100	3.9	190

(i) State **one** factor, other than heart rate, that could have affected the rate at which blood passed through the heart.

(1)

.....

.....

(ii) Using the information in the table, describe the effect of an increase in heart rate on both the ventilation rate and oxygen uptake by the blood, after the first ten seconds of exercise.

(3)

.....

.....

.....

.....

.....

.....

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(iii) Explain how an increased heart rate results in increased uptake of oxygen by the blood in the lungs.

(3)

(iv) What conclusions could be drawn from the results of this investigation?

(2)

(Total for Question 3 = 13 marks)

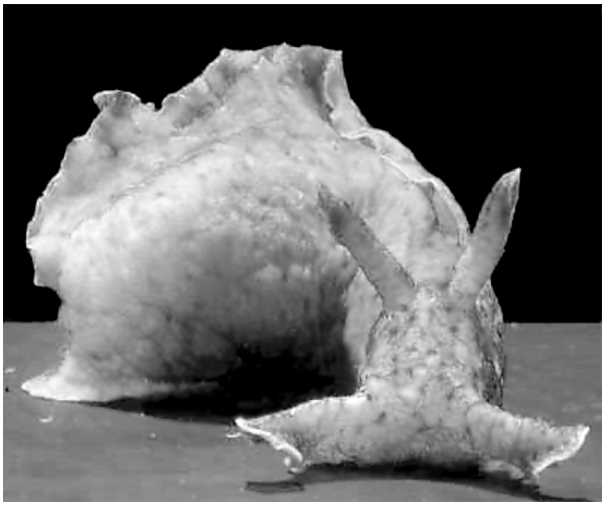
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4 In some organisms, the nervous response to a stimulus can reduce as a result of repetition. This is known as habituation.

Sea slugs are marine animals which have gills for the uptake of oxygen from seawater.

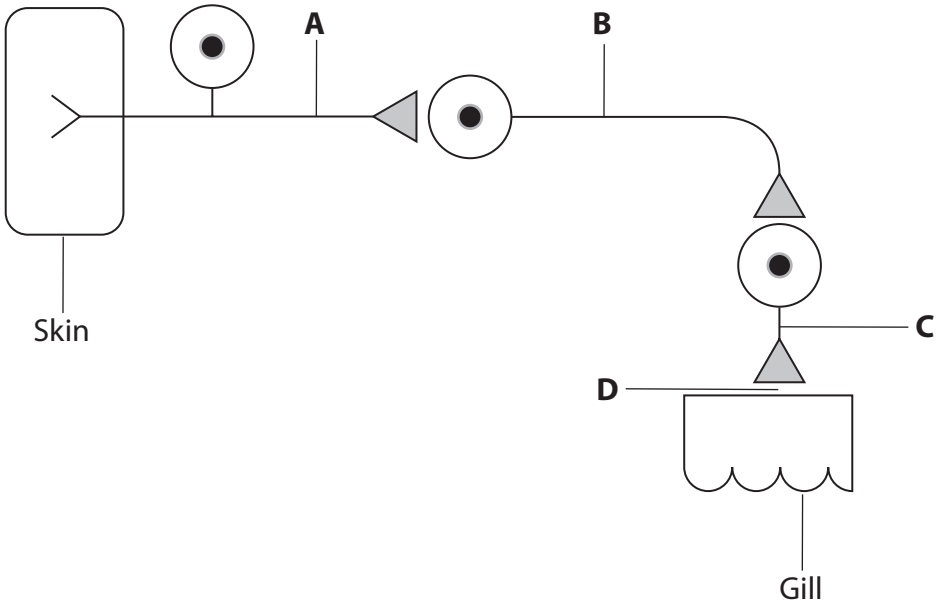


Sea slug

Magnification × 1

A sea slug withdraws its gill when its skin is touched. After some time, the gill is exposed again. With repeated touches, the time taken for it to expose the gill decreases. When the skin is touched frequently, the gill is not withdrawn.

The diagram below shows some of the neurones (nerve cells) involved in this response.



P 3 6 3 6 5 A 0 0 1 0 2 4
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(a) Place a cross ☒ in the correct box in the table below to identify where structures **A**, **B**, **C** and **D**, listed in the table, are shown on the diagram.

(3)

Structure	A	B	C	D
Motor neurone	☒	☒	☒	☒
Sensory neurone	☒	☒	☒	☒
Synapse	☒	☒	☒	☒

(b) (i) Suggest how a repeated stimulus could result in less response from the gill.

(3)

(ii) Suggest how this habituation may be of benefit to a sea slug.

(2)

(Total for Question 4 = 8 marks)

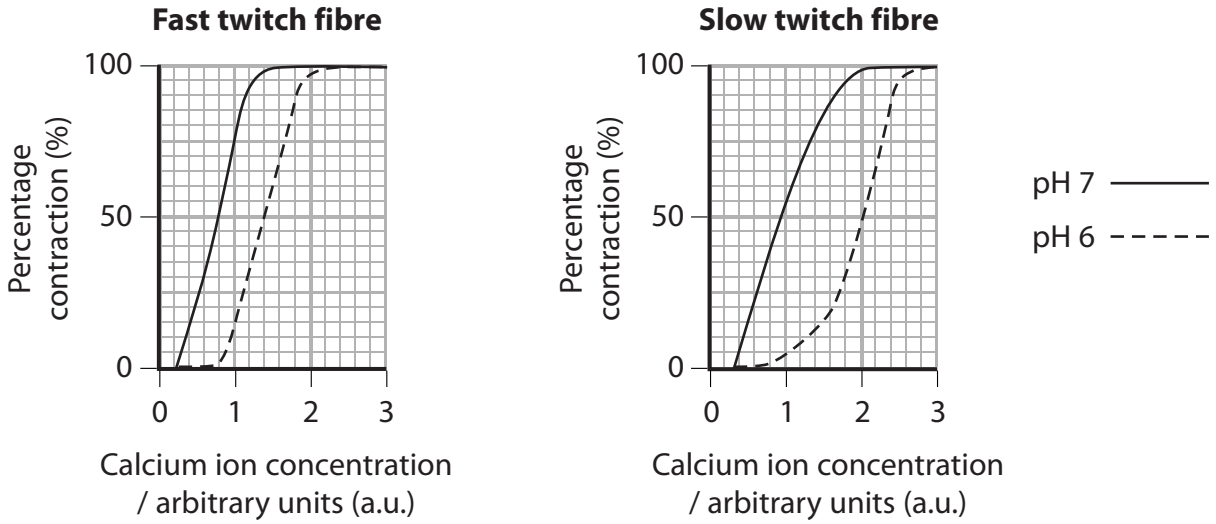
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5 An investigation was carried out into the effect of pH on the contraction of muscle fibres.

Single muscle fibres were used with their surrounding membranes removed. These fibres will contract when exposed to calcium ions in solution.

Isolated slow twitch and fast twitch fibres were tested at pH 7 and pH 6, in a range of calcium ion concentrations.

Results for both types of fibre are shown in the graphs below.



(a) The sensitivity of a muscle fibre is defined as the concentration of calcium ions required to cause 50% of full contraction.

Using the information in the graphs, complete the table below.

(2)

Type of fibre	Sensitivity		Change in sensitivity / a.u.
	Calcium ion concentration at pH 7 / a.u.	Calcium ion concentration at pH 6 / a.u.	
Fast twitch	0.8	1.4	
Slow twitch			

(b) Using the information in the graphs, compare the effect of pH on slow twitch and fast twitch fibres.

(2)

.....

.....

.....

.....

P 3 6 3 6 5 A 0 1 2 2 4
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(c) (i) Describe a circumstance that could cause a fall in pH in living muscle.

(1)

(ii) Suggest how the different responses of these two types of fibre to pH may be related to their different functions in muscle.

(2)

(d) It is possible to replace the troponin in fast twitch fibres with troponin from slow twitch fibres. Fast twitch fibres that have been treated in this way have the same sensitivity as slow twitch fibres.

Use your knowledge of the sliding filament theory of muscle contraction to explain why this might have been predicted.

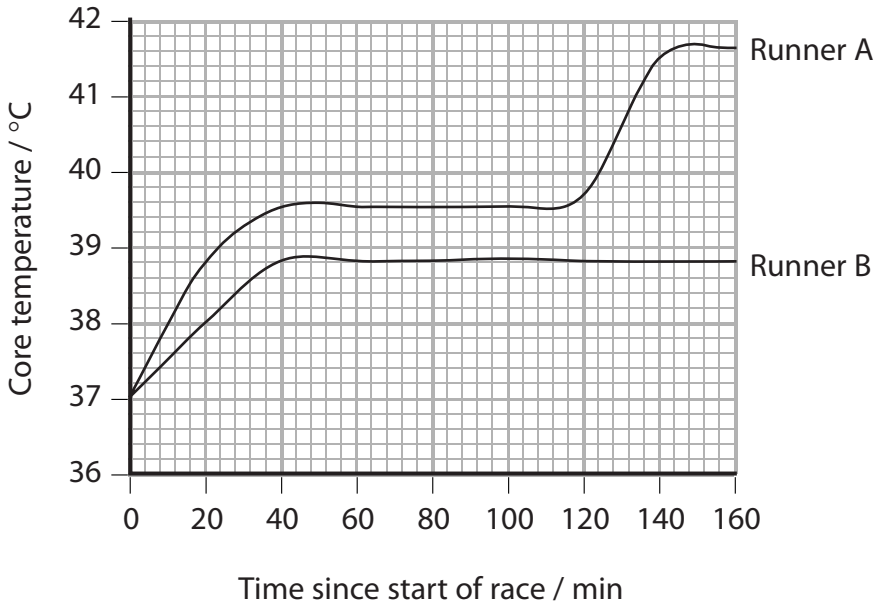
(3)

(Total for Question 5 = 10 marks)

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6 Marathon runners can have difficulty with thermoregulation over the course of a 26 mile race, particularly on a hot day. Two marathon runners, A and B, had their core temperatures recorded during a race.

The graph below shows the core temperatures recorded during the race.



(a) Suggest an explanation for the change in core temperatures of both runners in the first 30 minutes of the race.

(2)

.....

.....

.....

.....

.....

P 3 6 3 5 6 5 A 0 1 4 2 4
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(b) Suggest an explanation for the constant core temperatures of both runners between 60 and 100 minutes of this race.

(5)

(c) During this race, runner A lost 3.02 kg of water and runner B lost 2.43 kg of water.

Using the information in the question and your own knowledge, suggest reasons for the change in core temperature of runner A after 120 minutes.

(2)

(Total for Question 6 = 9 marks)

P 3 6 3 6 5 A 0 1 5 2 4
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7 The scientific article you have studied is adapted from articles in New Scientist. Use information from the article and your own knowledge to answer the following questions.

(a) Suggest how erythropoietin (epo) production might be shut down when oxygen levels in the blood are normal (page 2, paragraph 6).

(3)

P 3 6 3 1 6 5 A 0 1 6 2 4
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*(b) Describe how adenoviruses in the blood 'are recognised and destroyed by the immune system' (page 3, paragraph 4).

(5)

P 3 6 3 6 5 A 0 1 7 2 4
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(c) 'A single injection elevated hematocrits for over a year in the mice and for 12 weeks in the monkeys.' (page 3, paragraph 5)

Suggest why the injection of genes into body cells does not have a permanent effect.

(2)

(d) 'Sludge blood' (page 4, paragraph 1) can lead to high blood pressure and atherosclerosis.

Explain the connection between high blood pressure and atherosclerosis.

(3)

(e) Name the 'small vessels' (page 4, paragraph 1) that have the greatest effect in producing high blood pressure.

(1)

(f) Suggest **one** way in which one gene could result in the production of several different proteins.

(1)

P 3 6 3 6 5 A 0 1 8 2 4
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(g) Use information in the article to describe **three** ways in which athletes might artificially enhance their performance.

(3)

(h) Explain why the governing bodies of sports ban the artificial enhancement of performance.

(2)

(i) A proteasome is 'a barrel-shaped multi-protein complex that chops proteins down into their component amino acids for reuse'.

Explain how muscle protein can be chopped into amino acids inside a cell.

(2)

P 3 6 3 6 5 A 0 1 9 2 4
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(j) Explain what is meant by repolarisation of a cardiac muscle cell or a nerve cell.

(2)

(k) Suggest why large numbers of mitochondria are found in muscle cells.

(2)

P 3 6 3 7 6 5 A 0 1 2 0 2 4
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(l) 'Schuelke discovered that the boy had a mutation in both copies of the gene coding for the muscle growth inhibitor myostatin.' (page 10, paragraph 1)

Suggest how this boy could have inherited this condition. Use a genetic diagram to illustrate your answer.

(4)

(Total for Question 7 = 30 marks)

TOTAL FOR PAPER = 90 MARKS

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Mark Scheme (Results)

June 2011

GCE Biology (6BI05) Paper 01
Energy, Exercise and Coordination

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Alternatively, you can contact our GCE Science Advisor directly by sending an email to ScienceSubjectAdvisor@EdexcelExperts.co.uk.
You can also telephone 0844 576 0037 to speak to a member of our subject advisor team.

June 2011
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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Quality of Written Communication

- Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

GENERAL INFORMATION

The following symbols are used in the mark schemes for all questions:

Symbol	Meaning of symbol
; semi colon	Indicates the end of a marking point
Eq	Indicates that credit should be given for other correct alternatives to a word or statement, as discussed in the Standardisation meeting
/ oblique	Words or phrases separated by an oblique are alternatives to each other
{} curly brackets	Indicate the beginning and end of a list of alternatives (separated by obliques) where necessary to avoid confusion
() round brackets	Words inside round brackets are to aid understanding of the marking point but are not required to award the point
[] square brackets	Words inside square brackets are instructions or guidance for examiners
[CE] or [TE]	Consecutive error / transferred error

Crossed out work

If a candidate has crossed out an answer and written new text, the crossed out work can be ignored. If the candidate has crossed out work but written no new text, the crossed out work for that question or part question should be marked, as far as it is possible to do so.

Spelling and clarity

In general, an error made in an early part of a question is penalised when it occurs but not subsequently. The candidate is penalised once only and can gain credit in later parts of the question by correct reasoning from the earlier incorrect answer.

No marks are awarded specifically for quality of language in the written papers, except for the essays in the synoptic paper. Use of English is however taken into account as follows:

- the spelling of technical terms must be sufficiently correct for the answer to be unambiguous
  e.g. for amylase, 'ammalase' is acceptable whereas 'amylose' is not
  e.g. for glycogen, 'glicojen' is acceptable whereas 'glucagen' is not
  e.g. for ileum, 'illeum' is acceptable whereas 'ilium' is not
  e.g. for mitosis, 'mytosis' is acceptable whereas 'meitosis' is not

- candidates must make their meaning clear to the examiner to gain the mark.

- a correct statement that is contradicted by an incorrect statement in the same part of an answer gains no mark – irrelevant material should be ignored

Question Number	Answer	Mark
1(a)	D ;	**(1)**

Question Number	Answer	Mark
1(a)	B ;	**(1)**

Question Number	Answer	Mark
1(a)	C ;	**(1)**

Question Number	Answer	Mark
1(a)	A ;	**(1)**

Question Number	Answer	Mark
1(b)	1. reference to (electrical) insulation / eq ; 2. reference to depolarisation at nodes ; 3. impulse jumps from node to node / eq ; 4. saltatory conduction ; 5. reference to faster conduction ;	**(4)**

Question Number	Answer	Mark
1(c)	1. idea that phospholipid restricts ion movement / eq ; 2. proteins span the membrane / eq ; 3. idea that sodium potassium pump moves ions / eq ; 4. (protein) {gates / channels} allow {diffusion / movement} of ions / eq ;	**(3)**

Question Number	Answer	Mark
2(a)	shoot bends to right /eq ;	**(1)**

Question Number	Answer	Mark
*** 2(b) QWC**	(QWC – Spelling of technical terms *(shown in italics)* must be correct and the answer must be organised in a logical sequence) 1. reference (photo)tropism ; 2. light causes {redistribution / eq} of {auxin / IAA / eq} ; 3. high concentration {away from light / in block B} / eq ; 4. (auxin / eq) diffuses (down) into shoot ; 5. stimulates cell elongation / eq ; 6. description of change in cell e.g. fewer cross links in cellulose, cell wall more plastic, acidification, stimulation of enzyme production, vacuolation ; 7. {side away from / eq} light longer / eq ;	**(4)**

Question Number	Answer	Mark
2(c)	1. both chemical / eq ; 2. both transported away from production site / eq ; 3. comparison of mechanism of transport described e.g. diffusion in plants, blood system in animals ; 4. speed of action compared e.g. slower in plants, some animal hormones are faster ; 5. duration of effect compared e.g. some animal hormones have a shorter term effect ; 6. idea that this plant response involves {growth / cell elongation} only e.g. animal hormones do not just affect growth ; 7. comparison of stimuli ;	**(4)**

Question Number	Answer	Mark
3(a)(i)	1. breath identified ; 2. reference to time (for one / several peaks) ; 3. ref method for tidal volume e.g. height from peak to trough on trace ; 4. reference to calibration for volume ;	**(3)**

Question Number	Answer	Mark
3(a)(ii)	breathing rate x tidal volume / eq ;	**(1)**

Question Number	Answer	Mark
3(b)(i)	stroke volume / strength of (cardiac) muscle contraction / blood viscosity / size {atria/ventricles/chambers} / adrenaline / eq ;	**(1)**

Question Number	Answer	Mark
3(b)(ii)	1. there is little difference in ventilation rate / does not increase as much / eq ; 2. oxygen uptake increases / eq ; 3. credit use of manipulated figures ;	**(3)**

Question Number	Answer	Mark
3(b)(iii)	1. idea that there is more blood passing through (lungs) / eq ; 2. oxygen diffuses into blood / eq ; 3. {diffusion/eq} gradient being maintained / eq ; 4. oxygen (diffuses) in faster / eq ;	**(3)**

Question Number	Answer	Mark
3(b)(iv)	1. increased heart rate (from 50-100) {increases oxygen uptake / increases ventilation rate less} / eq ; 2. idea that heart rate has a greater effect on oxygen uptake than on ventilation rate ;	**(2)**

Question Number	Answer	Mark
4(a)	C ; A ; D ;	**(3)**

Question Number	Answer	Mark
4(b)(i)	1. high frequency of impulses / eq ; 2. {depletes /eq} neurotransmitter / eq ; 3. calcium ion channels do not open / are less responsive / eq ; 4. reference to synapse / synaptic {membrane / knob / eq } ; 5. (post synaptic) membrane not depolarised / eq ; 6. impulses do not reach gill / eq ;	**(3)**

Question Number	Answer	Mark
4(b)(ii)	1. avoids wasted {effort / time / resources / eq} / eq ; 2. to {non-threatening / unimportant / eq} stimulus / eq ; 3. reference to natural frequent stimuli e.g. wave action ;	**(2)**

Question Number	Answer	Mark
5(a)	1. change for fast twitch = 0.6 ; 2. reading at pH 7 = 0.9 to 1.0, reading at pH 6 = 1.95-2.05, to give answer within the range 0.95 - 1.15 ;	**(2)**

Question Number	Answer	Mark
5(b)	1. lower pH, both {less / eq} sensitive to calcium ions / lower pH more calcium ions needed for (50%) contraction / eq ; 2. effect on slow twitch is greater / eq ; 3. lower pH decreases contraction (in both) / eq ; 4. lower pH has no effect at high calcium ion concentration (in both) / eq ;	**(2)**

Question Number	Answer	Mark
5(c)(i)	Anaerobic {conditions/respiration} / lack of oxygen / process that reduces pH / eq ;	**(1)**

Question Number	Answer	Mark
5(c)(ii)	1. fast twitch anaerobic / slow twitch aerobic ; 2. fast twitch more likely to experience low pH / eq ; 3. low pH due to lactate / eq ; 4. (fast twitch) is less affected by change in pH / eq ; 5. can continue to respond to stimulus at lower pH / eq ;	**(2)**

Question Number	Answer	Mark
5(d)	1. troponin binds calcium ions / eq ; 2. tropomyosin {moved / eq }; 3. (causing) myosin binding sites exposed / eq ; 4. on actin ; 5. calcium binding site sensitive to pH / eq ; 6. idea that troponin is different in each fibre ;	**(3)**

Question Number	Answer	Mark
6(a)	1. more {muscle contraction / respiration} / eq ; 2. idea that heat energy released ; 3. idea that more heat produced than lost ;	**(2)**

Question Number	Answer	Mark
6(b)	1. ref to {detection of temperature change / temperature receptors} ; 2. reference hypothalamus ; 3. more sweating / eq ; 4. loss of heat due to evaporation (of water) / eq ; 5. vasodilation (of arterioles) / eq ; 6. loss of radiant heat / eq ; 7. heat gained equal heat lost / eq ; 8. reference negative feedback ; 9. behavioural heat loss mechanism described / eq ;	**(5)**

Question Number	Answer	Mark
6(c)	1. idea of dehydration ; 2. no longer sweating / eq ; 3. cooling mechanisms failing / eq ; 4. heat production greater than heat loss / eq ; 5. increase of pace / eq ;	**(2)**

Question Number	Answer	Mark
7(a)	1. reference to epo receptor ; 2. (gene) transcription stops / eq ; 3. reference to role of {transcription factors / repressors} ; 4. no mRNA produced / eq ; 5. no translation (of mRNA) / eq ;	**(3)**

Question Number	Answer	Mark
***7(b) QWC**	(QWC – Spelling of technical terms *(shown in italics)* must be correct and the answer must be organised in a logical sequence) General: 1. reference *antigens* (on the virus) ; 2. reference to *antigen* presentation ; 3. {stimulation / activation / eq} of {*lymphocytes* / T cell / B cell} / eq ; 4. proliferation (of l*ymphocytes*) qualified / eq ; 5. leads to {*cell mediated* / *humoral*} response ; Cell mediated: 6. reference T killer cells ; 7. causes virus-infected cell lysis / eq ; Humoral : 8. reference to {*plasma* cells / B *effector* cells}; 9. {produce / release / eq} (*antigen* specific) *antibodies* ; 10. description of *antibody* action ; 11. reference to {*phagocytosis* / *macrophage* action} ; 12. Reference to *interferon* action ;	**(5)**

Question Number	Answer	Mark
7(c)	1. {DNA / eq} degrades / eq ; 2. (modified) cells die / eq ; 3. reference to (modified) cells removed by immune response ; 4. reference to {DNA / eq} lost from cells ;	**(2)**

Question Number	Answer	Mark
7(d)	1. reference to effect on artery walls / eq ; 2. damages endothelium / eq ; 3. triggers inflammation / eq ; 4. starts formation of atheroma / eq ; 5. idea that artery narrows leading to (further) increase in blood pressure ;	**(3)**

Question Number	Answer	Mark
7(e)	arterioles / arteries ;	**(1)**

Question Number	Answer	Mark
7(f)	post transcription modification of RNA / mutation / eq ;	**(1)**

Question Number	Answer	Mark
7(g)	Any 3 from the following: Drugs: epo, steroids, IGF, insulin, velcade, astemizole, other growth factors, antibodies to myostatin, to block atrogin 1 protein Gene therapy: {epo, IGF, MGF} gene Atrophy treatment to block out any of the following: Foxo, Atrogens,{Atrogin 1/MAFbx}, muRF1, Ubiquitin ligase, UPP pathway, erg1(a) ; ; ;	**(3)**

Question Number	Answer	Mark
7(h)	1. prevent unfair advantage / eq ; 2. prevent risk to their health / eq ;	**(2)**

Question Number	Answer	Mark
7(i)	1. enzymes ; 2. break peptide bonds / eq ; 3. ref hydrolysis ;	**(2)**

Question Number	Answer	Mark
7(j)	1. redistribution of ions / eq ; 2. across the cell membrane /eq ; 3. causes {change in / different} potential difference / return to resting potential ;	**(2)**

Question Number	Answer	Mark
7(k)	1. {provide / eq} ATP ; 2. reference to aerobic respiration / eq ; 3. for contraction / (pumping) Ca^{2+} back into sarcoplasmic reticulum / eq ;	**(2)**

Question Number	Answer	Mark
7(l)	1. mother has heterozygous genotype / eq ; 2. father has heterozygous genotype / eq ; 3. correct gametes ; 4. genotype of boy identified as homozygous / eq ; 5. reference to mutation arising in sperm / fathers germ cell ;	**(4)**

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Biology

Advanced

Unit 5: Energy, Exercise and Coordination

Thursday 27 January 2011 – Morning **Time: 1 hour 45 minutes**	Paper Reference **6BI05/01**

You must have:
A copy of the scientific article taken from New Scientist articles (enclosed)

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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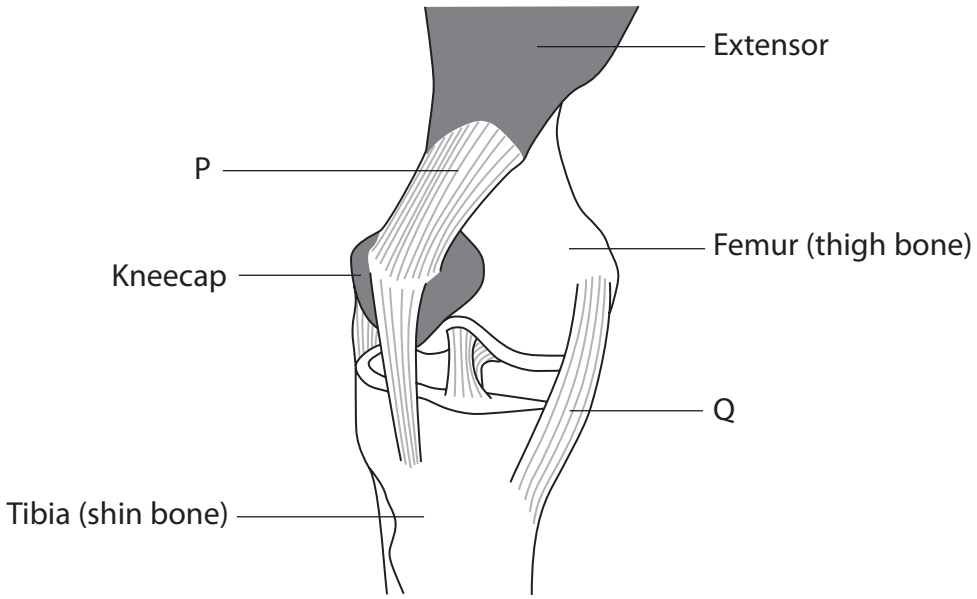
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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Sports injuries can result in damaged human knee joints. The damaged joint can be repaired using keyhole surgery.

The diagram below shows a human knee joint.



(a) Place a cross ☒ in the box to identify each of the following structures.

(i) Structure P

(1)

☒ **A** Cartilage

☒ **B** Ligament

☒ **C** Muscle

☒ **D** Tendon

(ii) Structure Q

(1)

☒ **A** Cartilage

☒ **B** Ligament

☒ **C** Muscle

☒ **D** Tendon

P 3 7 4 9 1 A 0 2 2 0
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(b) Describe the function of structure Q.

(2)

(c) Structure Q may become torn during some sporting activities. It may not be possible to join the torn parts together. Material can be removed from structure P without causing any damage. This material can be used to join the damaged pieces of Q together.

Suggest why the use of material from structure P will mean that recovery will be quite slow and require careful physiotherapy.

(2)

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(d) The operation to repair the damage can be done using keyhole surgery.
Suggest the benefits of this technique.

(3)

(Total for Question 1 = 9 marks)

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2 Plants can detect and respond to environmental cues.

Cocklebur is a plant that flowers after it has been exposed to a sufficiently long period of darkness. The minimum length of time in darkness needed to stimulate flowering is called the critical period.

An investigation was carried out into the effect of light and dark periods on cocklebur flowering. Four plants, A, B, C and D, were exposed to light and dark periods of different length. The presence or absence of flowers was recorded after several weeks.

The diagram below shows the pattern of light and dark periods for these plants and the effect on flowering.

Plant	Time / hours						Flowers present
	0	4	8	12	16	20	
A							Yes
B							No
C							No
D							No

key

Light

Dark

(a) (i) Using the information in the diagram, give the critical period for flowering of cocklebur plants.

(1)

.....

(ii) Using the information in the diagram and your own knowledge of photoreceptors, explain why plant B has not flowered.

(2)

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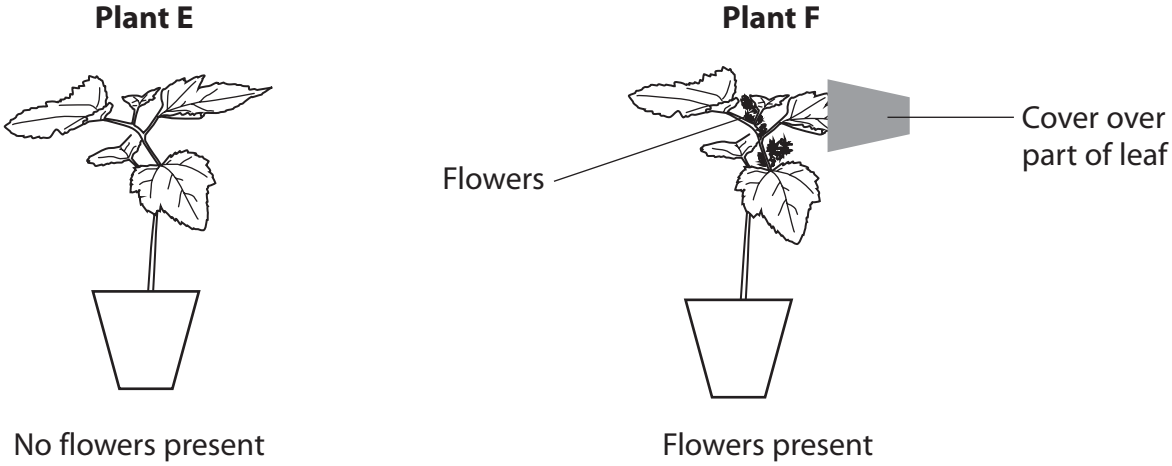
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(b) In a further investigation, plants E and F were exposed to six hours of darkness each day. Part of a leaf on plant F was covered so that the leaf experienced eight hours of darkness each day.

The diagram below summarises the results of this investigation.



Explain the purpose of plant E in this investigation.

(2)

.....

.....

.....

.....

.....

.....

P 3 7 4 9 1 A 0 6 2 0
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(c) Using your own knowledge of photoreceptors, explain the results of these investigations. What do they suggest about the control of flowering in cocklebur plants?

(4)

(d) Suggest benefits to plants of being able to respond to changes in day length.

(3)

(Total for Question 2 = 12 marks)

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3 L-Dopa can be used to treat people with Parkinson's disease. Using L-Dopa for a long period of time can have side effects that include uncontrolled movement of limbs.

It is possible that increasing the levels of serotonin in the brain could be an effective treatment for these side effects. It has been suggested that MDMA (ecstasy) could be used to increase levels of serotonin.

(a) Explain why L-Dopa is used to treat people with Parkinson's disease.

(2)

(b) Explain how MDMA could affect levels of serotonin in the brain.

(3)

P 3 7 4 9 1 A 0 8 2 0
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(c) In trials of this treatment, marmosets (small monkeys) were given a drug to reduce dopamine production. They were then treated with L-Dopa until they showed the side effects observed in the treatment of people with Parkinson's disease.

(i) Suggest a reason why the marmosets were treated with a drug to reduce dopamine production.

(1)

(ii) Describe the ethical issues involved in the use of animals in a trial of this kind.

(3)

(d) The results of the study showed that MDMA did reduce the side effects in the marmosets.

Describe the steps that would need to be taken before a similar treatment could be used in humans.

(3)

(Total for Question 3 = 12 marks)

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4 According to the sliding filament theory of muscular contraction, force is produced when myosin molecules change shape.

Myosin molecules can generate a force of 1.7×10^{-6} N per million molecules when they change shape.

Measurements of a single muscle fibre showed that a force of 3.5×10^{-3} N was produced when it contracted.

(a) Use this information to calculate the number of myosin molecules changing shape during the contraction of this muscle fibre. Show your working.

(2)

Answer .....

(b) Examination of this muscle fibre found that there were only a few mitochondria present.

(i) Name this type of muscle fibre.

(1)

.....

P 3 7 4 9 0 1 A 0 0 1 0 2 0
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(ii) The energy required for contraction of muscle fibres is provided by ATP. Describe how enough ATP is made available for contraction of this muscle fibre, despite there being only a few mitochondria.

(5)

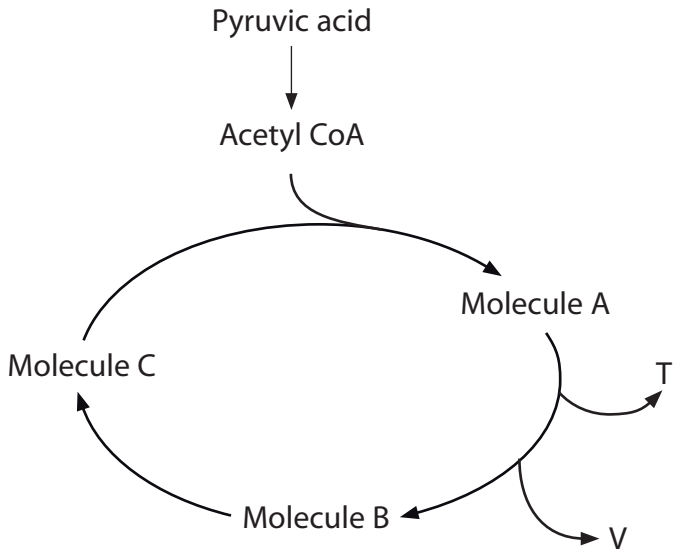
(iii) Explain why you would expect this type of muscle fibre to fatigue quickly.

(2)

(Total for Question 4 = 10 marks)

P 3 7 4 9 1 A 0 1 1 2 0
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5 The diagram below summarises some of the reactions in aerobic respiration.



(a) Name the process that produces pyruvic acid.

(1)

.....

(b) Place a cross ☒ in the box that correctly identifies each of the following.

(i) The waste product V

(1)

☒ **A** ATP

☒ **B** Carbon dioxide

☒ **C** Lactic acid

☒ **D** Water

(ii) The molecule T that becomes reduced during the process

(1)

☒ **A** ADP

☒ **B** Oxygen

☒ **C** NAD

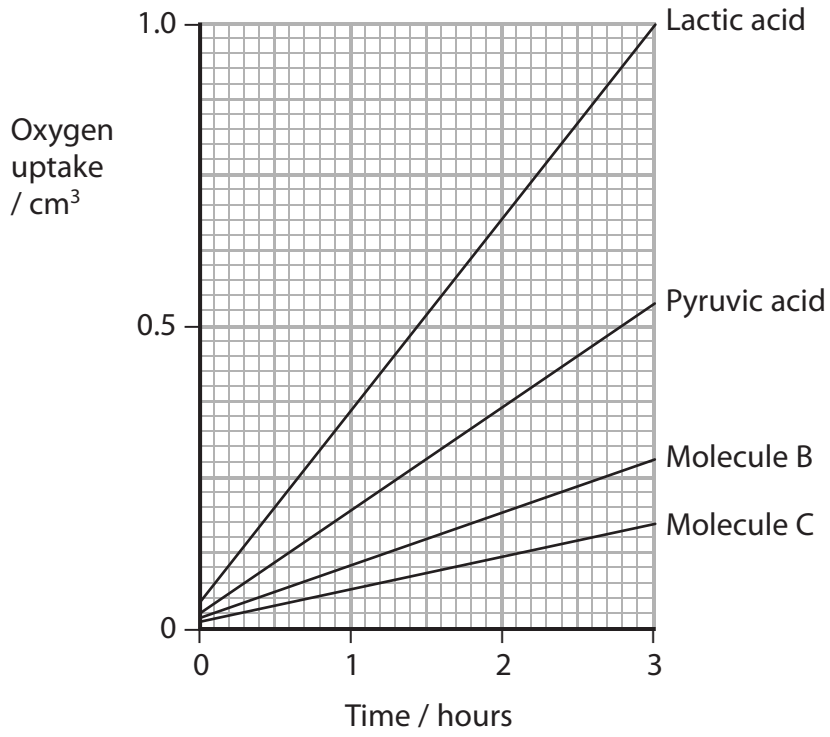
☒ **D** Water

P 3 7 4 9 1 A 0 0 1 2 2 0
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(c) An investigation was carried out into the ability of bacteria to use different substances as substrates for aerobic respiration.

Cultures of bacteria were grown separately in media containing lactic acid or one of the substances shown in the diagram (pyruvic acid, molecule B or molecule C). The initial concentration of each of these substances in the media was the same. The oxygen uptake of each culture was measured over a period of time.

The results are shown in the graph below.



P 3 7 4 9 1 A 0 1 3 2 0
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(i) Using the information in the diagram and the graph, suggest an explanation for the differences in oxygen uptake between bacteria using pyruvic acid, molecule B and molecule C as a substrate.

(4)

(ii) Suggest **one** reason for the rapid oxygen uptake by bacteria in a medium containing lactic acid. Give an explanation for your answer.

(2)

(Total for Question 5 = 9 marks)

P 3 7 4 9 A 0 1 4 2 0
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6 Cardiac muscle is myogenic.
The rhythmic contraction of the heart, in a particular sequence, is a feature of the cardiac cycle.

(a) Explain what is meant by the term **myogenic**.

(2)

*(b) Describe how the sequence of muscular contraction in the heart is coordinated and how the movement of blood through the heart is controlled.

(6)

(Total for Question 6 = 8 marks)

P 3 7 4 9 1 A 0 1 5 2 0
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7 The scientific article you have studied is adapted from articles in New Scientist. Use the information from the article and your own knowledge to answer the following questions.

(a) Name one 'retinal photoreceptor protein' (second paragraph on page 2) and describe its function.

(2)

(b) Explain what is meant by 'The human genome project could help to change that' (fourth paragraph on page 2).

(2)

(c) Suggest why genes are only partly responsible for the development of cancer and heart disease.

(3)

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(d) Attempts to treat cystic fibrosis with gene therapy have not yet been successful.

Use information in the article to suggest reasons why inserting the correct gene into a cell may not be all that is required.

(3)

*(e) Explain how RNA templates are used to specify the chemical structure of a protein.

(6)

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(f) Explain how a transcription factor might 'recognise a particular stretch of DNA' (first paragraph on page 4).

(2)

(g) Use the information in the article to describe ways in which new genes can arise.

(5)

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(h) Explain how NF-k B might have a role in the development of atherosclerosis.

(2)

(i) Explain why a DNA strand is not read 'in six different ways' (eighth paragraph on page 8).

(2)

(j) About 10 million years ago, an event led to the production of antifreeze protein in one Antarctic fish. Explain why almost all Antarctic fish now contain antifreeze protein.

(3)

(Total for Question 7 = 30 marks)

TOTAL FOR PAPER = 90 MARKS

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Mark Scheme (Results)
January 2011

GCE

GCE Biology (6BI05/01)

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January 2011

Publications Code UA026143

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

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GENERAL INFORMATION

The following symbols are used in the mark schemes for all questions:

Symbol	Meaning of symbol
; semi colon	Indicates the end of a marking point
Eq	Indicates that credit should be given for other correct alternatives to a word or statement, as discussed in the Standardisation meeting
/ oblique	Words or phrases separated by an oblique are alternatives to each other
{} curly brackets	Indicate the beginning and end of a list of alternatives (separated by obliques) where necessary to avoid confusion
() round brackets	Words inside round brackets are to aid understanding of the marking point but are not required to award the point
[] square brackets	Words inside square brackets are instructions or guidance for examiners
[CE] or [TE]	Consecutive error / transferred error

Crossed out work

If a candidate has crossed out an answer and written new text, the crossed out work can be ignored. If the candidate has crossed out work but written no new text, the crossed out work for that question or part question should be marked, as far as it is possible to do so.

Spelling and clarity

In general, an error made in an early part of a question is penalised when it occurs but not subsequently. The candidate is penalised once only and can gain credit in later parts of the question by correct reasoning from the earlier incorrect answer.

No marks are awarded specifically for quality of language in the written papers, except for the essays in the synoptic paper. Use of English is however taken into account as follows:

- the spelling of technical terms must be sufficiently correct for the answer to be unambiguous
  e.g. for amylase, 'ammalase' is acceptable whereas 'amylose' is not
  e.g. for glycogen, 'glicojen' is acceptable whereas 'glucagen' is not
  e.g. for ileum, 'illeum' is acceptable whereas 'ilium' is not
  e.g. for mitosis, 'mytosis' is acceptable whereas 'meitosis' is not

- candidates must make their meaning clear to the examiner to gain the mark.

- a correct statement that is contradicted by an incorrect statement in the same part of an answer gains no mark – irrelevant material should be ignored

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Question Number	Answer	Mark
1(a)(i)	D ;	**(1)**

Question Number	Answer	Mark
1(a)(ii)	B ;	**(1)**

Question Number	Answer	Mark
1(b)	1. {hold / attaches / eq} bones together / eq ; 2. idea that still allows movement (at the joint) / eq ;	**(2)**

Question Number	Answer	Mark
1(c)	1. comment on time needed for repair / eq ; 2. reference to difference in composition of {P and Q} e.g. ligament has more elastic fibres , P is inelastic, P is less flexible ; 3. idea of need to (gradually) stretch repaired tissue ;	**max (2)**

Question Number	Answer	Mark
1(d)	1. less damage (to tissue) / eq ; 2. short time for recovery / eq ; 3. social benefit e.g. more patients can be treated ; 4. idea of economic benefit e.g. cheaper than invasive surgery ; 5. idea of less anaesthetic needed ;	**max (3)**

Question Number	Answer	Mark
2(a)(i)	between 7 and 8 <u>hours</u> / 8 <u>hours</u> ;	**(1)**

Question Number	Answer	Mark
2(a)(ii)	1. idea of not enough time (in the dark) ; 2. idea that {Pfr /active phytochrome} levels remain too high ; 3. reference to threshold e.g. once Pfr below a certain level (flowering happens) ; 4. flowering {stimulated / eq} (by fall in Pfr) ;	**max (2)**

Question Number	Answer	Mark
2(b)	1. reference to control ; 2. idea of comparison e.g. to show that flowering would not happen (without the cover) / eq ;	**(2)**

Question Number	Answer	Mark
2(c)	1. six hours too short (to cause flowering in plant E) / eq ; 2. eight hours {is long enough / causes flowering / eq} ; 3. idea of enough stimulus if part of the plant is in the dark for {8 hours / long time / enough time / eq} ; 4. leaf is (photo) receptor / eq ; 5. {phytochrome / Pfr / Pr} in leaves ; 6. signal must be passed to {growing points/site of flower production} from leaves / eq ;	**max (4)**

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Question Number	Answer	Mark
2(d)	1. idea of {flowering / development /eq} happens at the right time ; 2. therefore flowers when insects available / leaf fall in autumn / same species flower at the same time / seeds germinate at the right time / eq ; 3. idea that day length changes to a set pattern e.g. always {short days in winter / long days in summer} ; 4. comparison with other less regular stimuli e.g. temperature ;	**max (3)**

Question Number	Answer	Mark
3(a)	1. (L-Dopa) can reach brain / unlike dopamine treatment / eq; 2. converted to dopamine (in brain) / eq ; 3. increases dopamine levels in the brain / eq ; 4. Parkinson's disease has low dopamine levels / reduces symptoms of Parkinson's disease / eq ;	**max (2)**

Question Number	Answer	Mark
3(b)	1. reference to {higher levels of / more} serotonin / eq ; 2. reference to synapse / eq ; 3. {inhibits / eq} reabsorption (into neurone) / eq ; 4. may reverse pumps to release more serotonin / eq ;	**max (3)**

Question Number	Answer	Mark
3(c)(i)	to mimic Parkinson's disease / Parkinson's disease has low dopamine levels / eq ;	**(1)**

Question Number	Answer	Mark
3(c)(ii)	1. (rationalist view) overall good should outweigh harm (to animals) ; 2. (absolutist view) all use (of animals) unacceptable ; 3. idea of as few animals as possible used in the trial ; 4. welfare of animals should be important / eq ;	**max (3)**

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Question Number	Answer	Mark
3(d)	1. test {small sample / eq} {for safety / of healthy individuals} / eq ; 2. large sample of {patients / tested for effectiveness} / eq ; 3. reference to clinical trials on {1000s / larger sample} ; 4. reference to double blind {trials /tests} ; 5. reference to placebo ; 6. idea of representative sample e.g. take into account sex, age ;	**max (3)**

Question Number	Answer	Mark
4(a)	$3.5 \times 10^{-3} \div 1.7 \times 10^{-6}$ / $(3.5 \div 1.7) \times 10^{3}$; =2059 {million / $\times 10^{6}$}/ 2058.8 {million / $\times 10^{6}$} / 2 058 823 530 ; <u>Note:</u> 2 marks for correct answer 1 mark for incorrect answer but correct working	**(2)**

Question Number	Answer	Mark
4(b)(i)	fast twitch (fibre) / type II (fibre) ;	**(1)**

Question Number	Answer	Mark
4(b)(ii)	1. (ATP from) phosphorylation of ADP / eq ; 2. energy required (for phosphorylation) / eq ; 3. reference to glycolysis / glucose converted to pyruvate / eq ; 4. pyruvate {converted to lactate / reduced /eq} ; 5. idea that makes NAD available ; 6. reference anaerobic respiration ; 7. in (cell) cytoplasm / eq ; 8. ATP from oxidative phosphorylation in mitochondria / eq ; 9. idea that phosphocreatine is involved in production of ATP ;	**max (5)**

Question Number	Answer	Mark
4(b)(iii)	1. ATP supply limited / eq ; 2. reference to {anaerobic respiration / lots of lactate / eq} / eq ; 3. pH is lower / eq ; 4. affects enzymes / prevents muscle contraction / eq ;	**max (2)**

Question Number	Answer	Mark
5(a)	glycolysis ;	**(1)**

Question Number	Answer	Mark
5(b)(i)	B ;	**(1)**

Question Number	Answer	Mark
5(b)(ii)	C ;	**(1)**

Question Number	Answer	Mark
5(c)(i)	1. oxygen {to oxidise hydrogen / as hydrogen acceptor / as final acceptor of electron transport chain} / eq ; 2. reference to reduced {coenzyme / NAD / FAD / eq} ; 3. (reduced coenzyme) from {glycolysis / Krebs Cycle / eq} ; 4. comparison of two {oxygen uptake / respiration rates} from pyruvate, molecules B and C e.g. respiration rate faster in pyruvate than molecule B ; 5. reference to uptake of substrate compared e.g. uptake of molecule B faster than molecule C ; 6. comparison of diffusion rate / molecular size / eq ; 7. comment on oxidation level of substrate e.g. ratio H:O in molecule /eq ; 8. relative quantity of {reduced coenzyme / eq} produced / eq ; 9. pH effect of pyruvate more favourable for {enzyme / reaction} / eq ; 10. number of carbon atoms of {C lower than B} / eq ;	**max (4)**

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Question Number	Answer	Mark
5(c)(ii)	1. lactate can be converted to {pyruvate / eq} ; 2. increases oxygen requirement / reference to oxygen debt / eq ; 3. idea of most potential for oxidation / e.g. can make the most {reduced coenzyme / eq} ;	**max (2)**

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Question Number	Answer	Mark
6(a)	1. idea that stimulation generated from within (muscle) e.g. no external stimulation ; 2. idea of brings about depolarisation ;	**(2)**

Question Number	Answer	Mark
***6(b) QWC**	(QWC – Spelling of technical terms *(shown in italics)* must be correct and the answer must be organised in a logical sequence) 1. reference to {*Sinoatrial node / SAN*} ; 2. initiates *depolarisation* / eq ; 3. passes through (wall of) *atria* / eq ; 4. causes *atrial* {*systole* / eq} ; 5. *AVN* conducts to *ventricles* / eq ; 6. reference to {*Purkyne* fibres / bundle of *His*} ; 7. ventricular {*systole* / eq} follows (from apex) / eq ; 8. atrioventricular valves closed (and prevent flow to atria) ; 9. *semilunar* valves opened by pressure / eq ; 10. blood forced into *arteries* / eq ; 11. changed pressure in {*diastole* / eq} closes *semilunar* valves ;	**max (6)**

Question Number	Answer	Mark
7(a)	1. rhodopsin / iodopsin ; Any one from: 2. broken down by light / / generates {action potentials / nerve impulses} / / appropriate reference to {black and white / monochromatic / colour / trichromatic} vision ;	**max (2)**

Question Number	Answer	Mark
7(b)	1. sequencing of human DNA / eq ; 2. {provides knowledge / eq} of human genetics / eq ;	**(2)**

Question Number	Answer	Mark
7(c)	1. lifestyle / environmental factors / eq ; 2. such as {carcinogens / eq} ; 3. such as {diet / obesity / inactivity} / eq ; 4. such as infections / eq ; 5. genes may make it more likely / eq ;	**max (3)**

Question Number	Answer	Mark
7(d)	1. gene {needs to be switched on / expressed / eq} ; 2. by transcription factors / eq ; 3. in order to produce {mRNA / protein / CFTR} ; 4. (transcription factors) might not be present / eq ;	**max (3)**

Question Number	Answer	Mark
***7(e) QWC**	(QWC – Spelling of technical terms *(shown in italics)* must be correct and the answer must be organised in a logical sequence) 1. triplet code / eq ; 2. represents amino acid (sequence) / eq ; 3. (mRNA) binds to ribosome / eq ; 4. reference to {anticodon / codon} ; 5. tRNA decodes mRNA / provides correct amino acid / eq ; 6. idea of two tRNA sites in the ribosome ; 7. two amino acids brought together / eq ; 8. joined with peptide bond / eq ; 9. reference to peptidyl transferase ; 10. idea that sections of DNA are {templates for / transcribed into} RNA ;	**max (6)**

Question Number	Answer	Mark
7(f)	1. bonds to DNA / eq ; 2. idea of sequence of bases recognised ; 3. (sequence of bases) has unique shape / eq ; 4. idea of bonding in DNA recognised ;	**max (2)**

Question Number	Answer	Mark
7(g)	1. accumulation of small mutations / eq ; 2. changes existing genes / eq ; 3. idea of gene duplication and one mutates ; 4. which allows mutation without losing function ; 5. (subfunctionalism) separates functions into separate genes / eq ; 6. (retroposition) produces DNA {without introns / from mRNA} / eq ; 7. idea of (frameshift) reads genetic code from new starting point ; 8. idea that junk DNA can become an active gene ;	**max (5)**

Question Number	Answer	Mark
7(h)	1. causes inflammation / eq ; 2. atheroma can lead to atherosclerosis / eq ;	**max (2)**

Question Number	Answer	Mark
7(i)	1. idea of non-overlapping code ; 2. reference to {start codon / there is a frame / RNA polymerase binding site} / eq ; 3. only one {template / eq} strand / eq ; 4. reference to direction of reading of strand e.g. 5'-3' ;	**max (2)**

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Question Number	Answer	Mark
7(j)	1. selective advantage / eq ; 2. (characteristic) passed to more offspring / eq ; 3. increased frequency of allele in population / eq ; 4. reference to speciation ;	**max (3)**

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Edexcel GCE

Biology

Advanced

Unit 5: Energy, Exercise and Coordination

Friday 25 June 2010 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
6BI05/01

You must have:
A copy of the scientific article taken from New Scientist articles (enclosed)

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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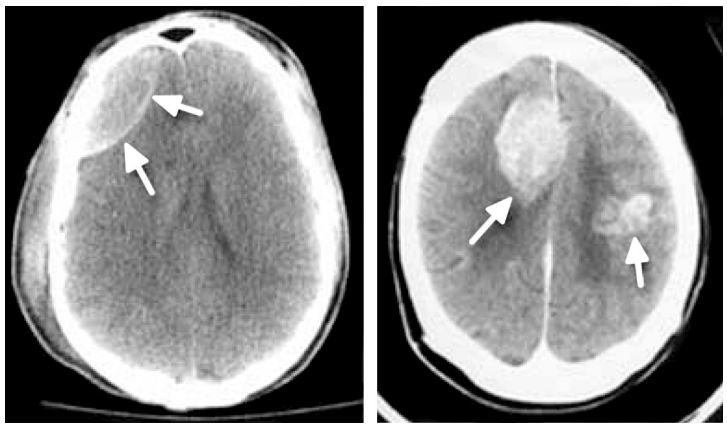
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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Computed tomography (CT) and functional magnetic resonance imaging (fMRI) are used to investigate brain structure and function.
The CT scans below show two different human brains with abnormal areas. These areas are indicated by arrows.



Magnification × 0.2

(a) Describe how these images could help a doctor to determine appropriate treatment of the abnormalities.

(2)

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(b) Explain why the abnormalities in these two brains could cause different symptoms.

(2)

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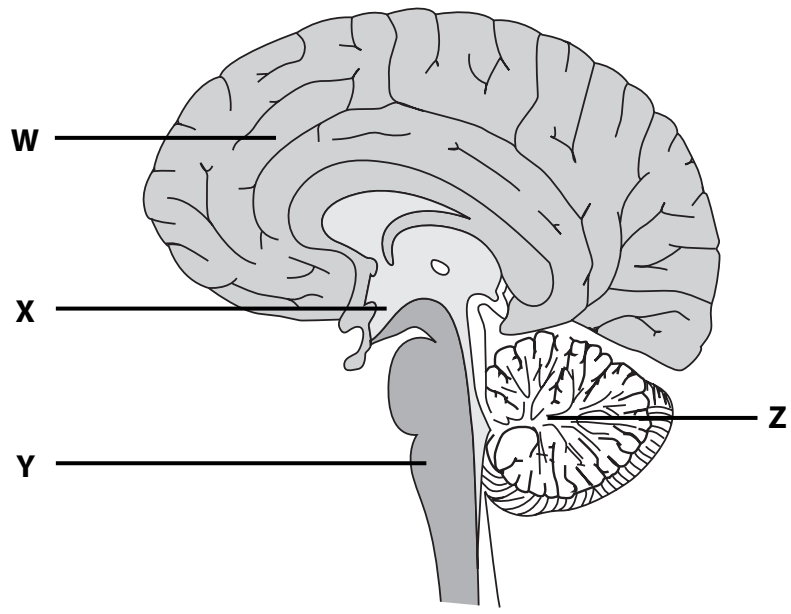
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(c) Describe how fMRI is used to investigate brain function.

(2)

(d) The diagram below shows a section through the human brain.



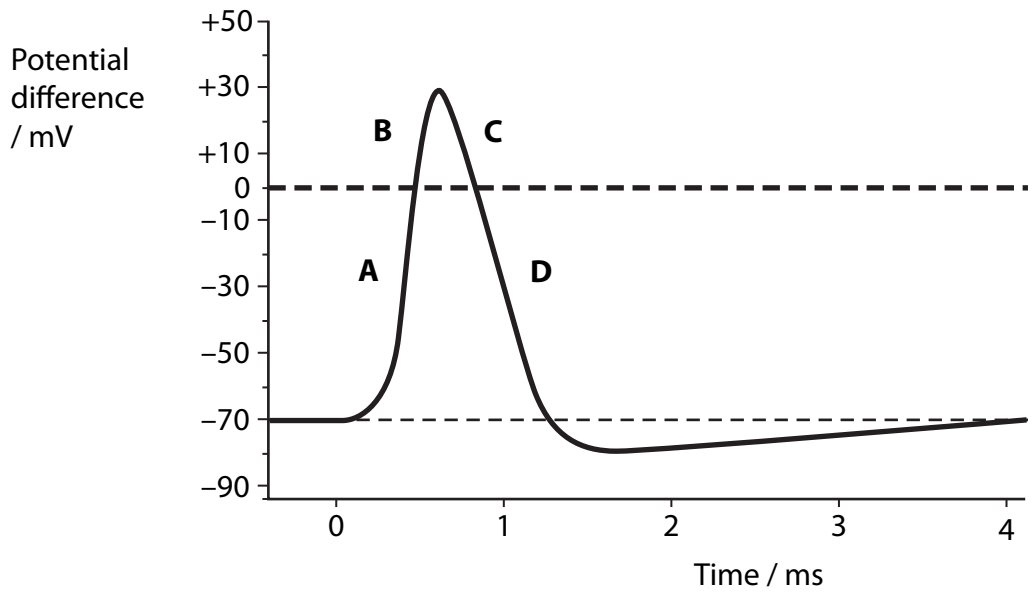
For each of the activities below, indicate the region of the brain **W**, **X**, **Y** or **Z** which will be most involved. Put a cross ☒ in the box corresponding to the correct letter.

(4)

Activity	Region of brain			
	W	**X**	**Y**	**Z**
Regulating core temperature	☒	☒	☒	☒
Climbing stairs	☒	☒	☒	☒
Regulating carbon dioxide in the blood	☒	☒	☒	☒
Choosing a gift	☒	☒	☒	☒

(Total for Question 1 = 10 marks)

2 The diagram below shows changes in potential difference across the membrane of a neurone during an action potential.



(a) Describe the events that begin the depolarisation of the membrane of a neurone.

(2)

.....

.....

.....

.....

(b) Complete the table below to show which ions are able to move across the membrane at positions **A** and **D** shown in the diagram.

Put a cross ☒ in the box if the membrane is permeable to the ion.

(2)

Position on diagram	Permeable to sodium ions	Permeable to potassium ions
A	☒	☒
D	☒	☒

N 3 7 0 9 6 A 0 4 2 0

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(c) Give an explanation for the movement of ions at position **C** on the diagram.

(3)

(d) Explain how the potential difference across the membrane is returned to the resting level in the time between 1.5 ms and 4.0 ms on the diagram.

(3)

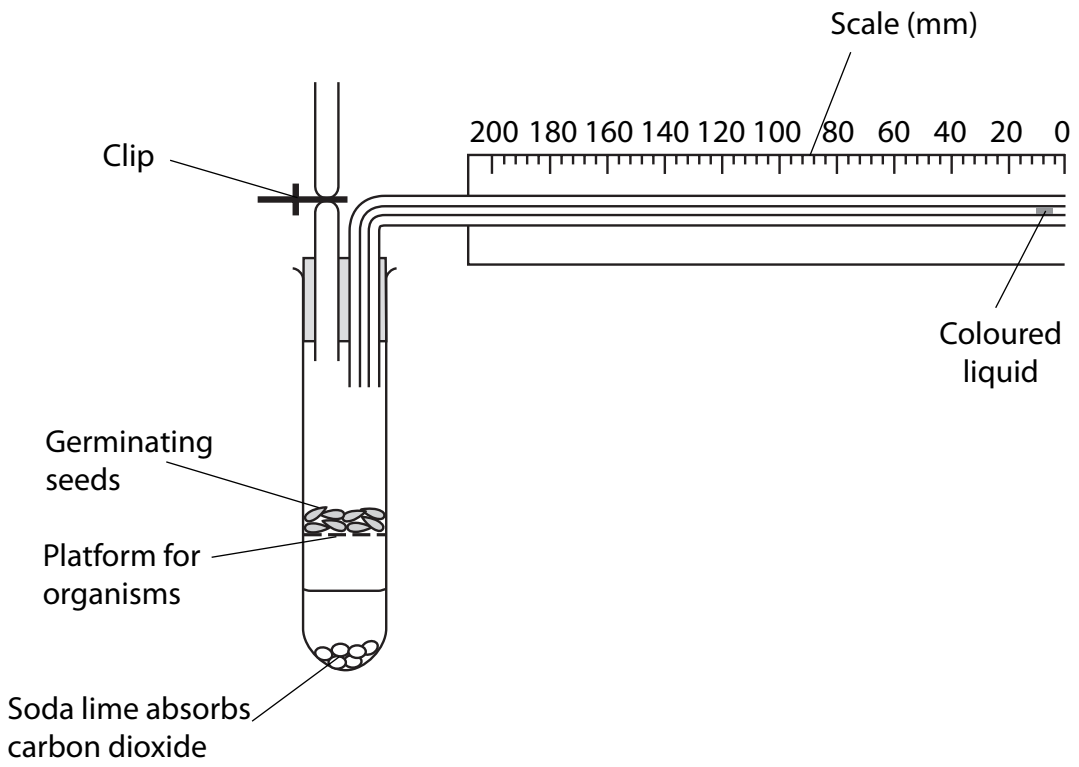
(Total for Question 2 = 10 marks)

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3 The apparatus shown in the diagram below was used to measure the rate of respiration of germinating seeds in air. The distance moved by the coloured liquid was measured at 15-minute intervals for one hour.

This was repeated with the air replaced by nitrogen gas.

The rate of respiration of small insects in air was measured using the same apparatus.



(a) Suggest reasons for absorbing carbon dioxide in this apparatus.

(2)

N 3 7 0 9 6 A 0 6 2 0

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(b) The table below shows results recorded by a student using this apparatus.

Organism	Distance moved by liquid in 15-minute intervals / mm				Mean rate of respiration / mm min^{-1}
Germinating seeds	7	6	5	6	0.4
Germinating seeds in nitrogen gas	0	0	0	0	0
Insects	12	11	13	12	

(i) In the space below, calculate the mean rate of respiration for the insects, expressed as movement of liquid in millimetres per minute.
Show your working.

(2)

Answer ..... mm min^{-1}

(ii) The seeds in the experiment with nitrogen gas continued to germinate.
Suggest an explanation for the lack of movement of the liquid.

(2)

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(iii) Suggest **two** reasons why a valid comparison cannot be made between the mean rates of respiration of the germinating seeds in air and the insects.
For each reason, suggest a modification that would allow a valid comparison.

(4)

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(Total for Question 3 = 10 marks)

N 3 7 0 9 6 A 0 8 2 0

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4 Electrical activity in heartbeats can be recorded using electrocardiograms (ECG). An ECG includes recording of the activity of the sinoatrial node (SAN).

(a) Describe the role of the SAN in controlling heartbeats.

(2)

(b) Describe how the cardiovascular centre, in the medulla oblongata, affects the SAN during exercise.

(2)

(c) ECGs can be used to diagnose abnormalities in the heartbeat. One such abnormality is a ventricular ectopic beat. This occurs when a region of the ventricle has a similar effect on the heart as the sinoatrial node (SAN).

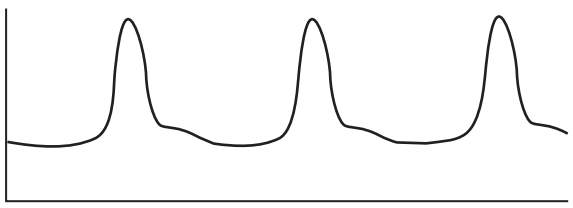
The diagrams below show a normal ECG trace and a trace that shows a ventricular ectopic beat, labelled E. The traces were recorded from left to right. Changes in blood pressure in the pulmonary artery are shown over the same period of time.

Normal heart

ECG



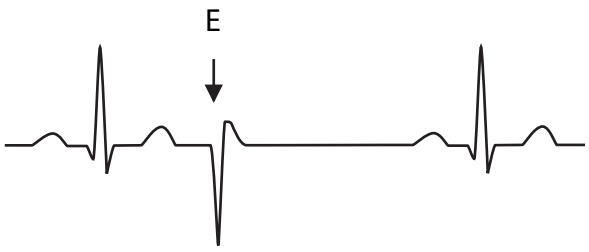
Change in blood pressure in pulmonary artery / kPa



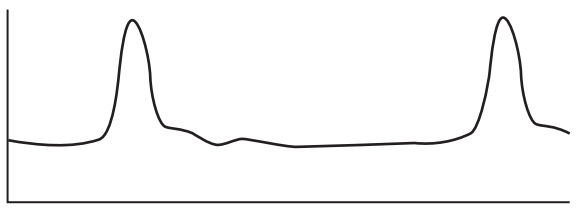
Time / seconds

Heart with ectopic beat

ECG



Change in blood pressure in pulmonary artery / kPa



Time / seconds

N 3 7 0 9 6 A 0 1 0 2 0

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*Describe the effect of the ectopic beat on heart activity and suggest an explanation for this effect.

(5)

(d) Performance-enhancing drugs may affect heart activity. Outline **one** ethical position relating to whether these drugs should be banned.

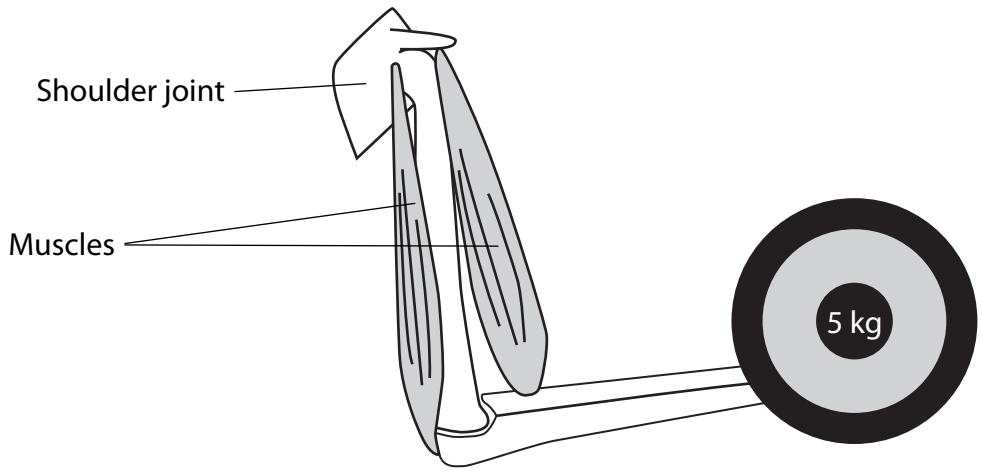
(2)

(Total for Question 4 = 11 marks)

N 3 7 0 9 6 A 0 1 1 2 0

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5 The diagram below shows the arrangement of muscles and bones in an arm.
A 5 kg mass was held steady in the position shown and then lifted upwards towards the body.



(a) In the table below, show which of the muscles are contracted when holding the mass steady and when lifting it. Put a cross ☒ in the box beside muscles that are **contracted**.

(2)

Muscle	**Muscle contracted when**	
	Holding steady	**Lifting upwards**
Extensor	☒	☒
Flexor	☒	☒

(b) Name the structures that connect muscles to bones.

(1)

.....

(c) Explain why muscles occur in antagonistic pairs.

(2)

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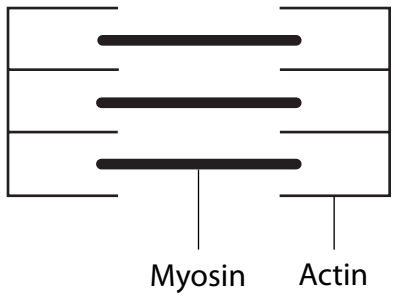
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N 3 7 0 9 6 A 0 1 2 2 0

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(d) The diagram below shows the arrangement of actin and myosin myofilaments in part of an extended muscle.



Complete the diagram below to show accurately the arrangement of actin and myosin when the muscle is contracted.

(3)



*(e) Describe and explain the role of calcium ions and ATP in muscle contraction.

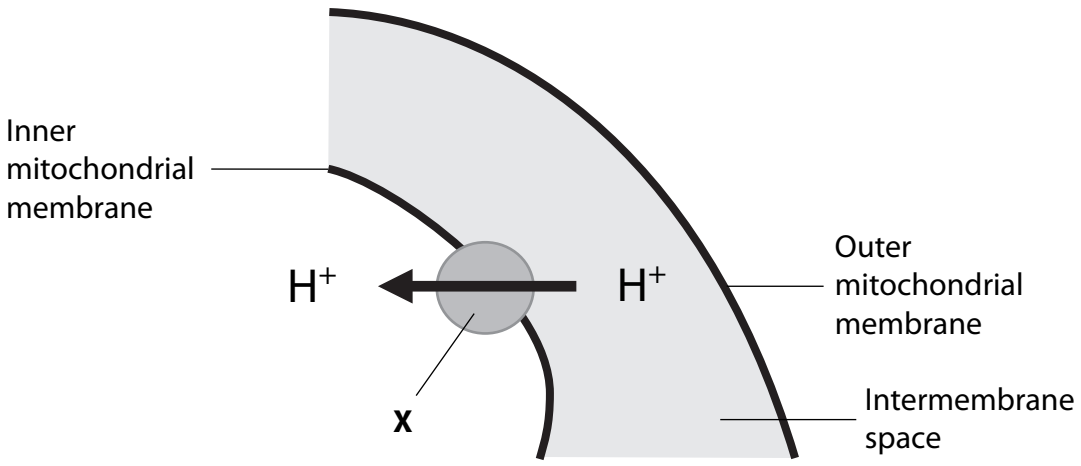
(5)

(Total for Question 5 = 13 marks)

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6 The diagram below shows part of the process of chemiosmosis in a mitochondrion.



(a) Name the enzyme labelled **X** involved in chemiosmosis.

(1)

.....

(b) Explain how a high concentration of hydrogen ions (H^+) is maintained in the intermembrane space.

(3)

.....

.....

.....

.....

.....

(c) Describe the role of the hydrogen ion concentration gradient in making available an accessible supply of energy for biological processes.

(2)

.....

.....

.....

.....

(Total for Question 6 = 6 marks)

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7 The scientific document you have studied is adapted from articles in New Scientist. Use the information from the article and your knowledge to answer the following questions.

(a) Outline the process by which 'more molecules of the enzymes' are produced (last paragraph on page 7).

(4)

(b) Explain how the fluid mosaic model of membrane structure makes it possible to change the number of adrenoceptors (first paragraph on page 9).

(2)

(c) Explain, using examples from the text, how scientific opinion can be 'deeply divided' when based on the same evidence.

(3)

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*(d) (i) Discuss the treatments for Parkinson's disease described in the article. Include particular benefits and any ethical issues and possible problems associated with these treatments.

(7)

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(ii) Compare the changes in brain chemistry that are linked to Parkinson's disease with those that are linked to depression.

(2)

(e) Suggest similarities between nerve cells in *Caenorhabditis elegans* expressing the ChR2 gene and cells of the mammalian retina.

(3)

(f) Using an example from the text, explain how a virus can introduce genes into specific cells.

(3)

(g) Suggest how the presence of bradykinin could affect tissues.

(2)

(h) Suggest the factors that need to be accounted for in the design of drug trials of painkillers.

(4)

(Total for Question 7 = 30 marks)

TOTAL FOR PAPER = 90 MARKS

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Mark Scheme (Results)
June 2010

GCE

GCE Biology (6BI05/01)

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Summer 2010

Publications Code UA023563

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

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GENERAL INFORMATION

The following symbols are used in the mark schemes for all questions:

Symbol	Meaning of symbol
; semi colon	Indicates the end of a marking point
eq	Indicates that credit should be given for other correct alternatives to a word or statement, as discussed in the Standardisation meeting
/ oblique	Words or phrases separated by an oblique are alternatives to each other
{} curly brackets	Indicate the beginning and end of a list of alternatives (separated by obliques) where necessary to avoid confusion
() round brackets	Words inside round brackets are to aid understanding of the marking point but are not required to award the point
[] square brackets	Words inside square brackets are instructions or guidance for examiners
[CE] or [TE]	Consecutive error / transferred error

Crossed out work

If a candidate has crossed out an answer and written new text, the crossed out work can be ignored. If the candidate has crossed out work but written no new text, the crossed out work for that question or part question should be marked, as far as it is possible to do so.

Spelling and clarity

In general, an error made in an early part of a question is penalised when it occurs but not subsequently. The candidate is penalised once only and can gain credit in later parts of the question by correct reasoning from the earlier incorrect answer.

No marks are awarded specifically for quality of language in the written papers, except for the essays in the synoptic paper. Use of English is however taken into account as follows:

- the spelling of technical terms must be sufficiently correct for the answer to be unambiguous
  e.g. for amylase, 'ammalase' is acceptable whereas 'amylose' is not
  e.g. for glycogen, 'glicojen' is acceptable whereas 'glucagen' is not
  e.g. for ileum, 'illeum' is acceptable whereas 'ilium' is not
  e.g. for mitosis, 'mytosis' is acceptable whereas 'meitosis' is not

- candidates must make their meaning clear to the examiner to gain the mark.

- a correct statement that is contradicted by an incorrect statement in the same part of an answer gains no mark – irrelevant material should be ignored

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Question Number	Correct Answer	Mark
1(a)	1. nature of abnormality e.g. bleeding, ref. to density ; 2. {location / eq} of abnormality ; 3. {extent / size/ eq} of abnormality ; 4. likely problems e.g. accessibility for surgery ;	**max (2)**

Question Number	Correct Answer	Mark
1(b)	1. (found in) different {regions / eq} of brain / eq ; 2. the right hand brain has {more / two/ eq} abnormalities ; 3. different areas of brain have different functions / eq ; 4. {symptoms / eq} depend on region of brain affected / eq ; 5. idea of different types of abnormality can cause different symptoms ;	**max (2)**

Question Number	Correct Answer	Mark
1(c)	1. detects level of oxygenation of the blood /measures changes in blood flow within brain / eq ; 2. {increased flow / more oxygen / eq} suggests increased activity / eq ; 3. study brain activity related to {stimuli / tasks / eq} ;	**max (2)**

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Question Number	Correct Answer	Mark
1(d)		**(4)**

	W	X	Y	Z	
Regulating core temperature		☒			;
Climbing stairs				☒	;
Regulating carbon dioxide in the blood			☒		;
Choosing a gift	☒				;

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Question Number	Correct Answer	Mark
2(a)	1. depolarisation of adjacent {membrane / eq} / eq ; 2. changes PD across membrane / eq ; 3. opens sodium {gates / eq} ; 4. sodium ions move into (the neurone) ;	**max (2)**

Question Number	Correct Answer	Mark
2(b)	**Position on diagram** / **Permeable to sodium ions** / **Permeable to potassium ions** A ☒ ; D ☒ ;	**(2)**

Question Number	Correct Answer	Mark
2(c)	1. correct {reference to / description of} diffusion gradient (of potassium ions) ; 2. correct {reference to / description of} electrochemical gradient ; 3. increased permeability (of membrane) to potassium ions / eq ; 4. reference to potassium {gates / eq} open / eq ; 5. reference to sodium {gates / eq} closed / eq ;	**max (3)**

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Question Number	Correct Answer	Mark
2(d)	1. PD less negative / eq 2. idea that the membrane remains permeable to potassium ions ; 3. potassium ions {move because of charge difference / eq} ; 4. into {nerve cell / neurone / axon / eq} ; 5. idea that potassium ion is removing a positive charge (from the outside) ; 6. idea that equilibrium is established e.g. diffusion gradient balanced by potential difference ;	**max (3)**

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Question Number	Correct Answer	Mark
3(a)	1. carbon dioxide produced in respiration / eq ; 2. affects {volume / pressure} of gas / eq ; 3. allows measurement of oxygen used / eq ;	**max (2)**

Question Number	Correct Answer	Mark
3(b)(i)	Two marks for correct answer 0.8 (mm min^{-1}) ;; if incorrect allow one mark for correct working 1. 48 ; OR 1. 12 ; 2. ÷ 60 to give answer ; OR 2. ÷ 15 to give answer	**(2)**

Question Number	Correct Answer	Mark
3(b)(ii)	1. no oxygen available/no oxygen uptake ; 2. reference to anaerobic respiration ; 3. carbon dioxide produced is absorbed / eq ; 4. no (net) change of {volume / pressure} of gas ;	**max (2)**

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Question Number	Correct Answer	Mark
3(b)(iii)	1. {mass / eq} of organism may differ ; 2. use same mass / express results per unit mass / eq ; 3. temperature changes / eq ; 4. control temperature using a water bath / eq ; 5. pressure may affect volume of gas / eq ; 6. use of control with no organisms, at the same time / eq ;	**max (4)**

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Question Number	Correct Answer	Mark
4(a)	1. {initiates / eq} heartbeat / eq ; 2. (starts) wave of excitation / depolarisation ; 3. {determines / eq} heart rate ;	**max (2)**

Question Number	Correct Answer	Mark
4(b)	1. {increased / eq} impulses to SAN / eq ; 2. (via) sympathetic {nervous system / eq } ; 3. stimulates more frequent depolarisation in SAN / eq ; 4. increases {heart rate / cardiac output} /eq ;	**max (2)**

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Question Number	Correct Answer	Mark
***4(c)**	(QWC – Spelling of technical terms *(shown in italics)* must be correct and the answer must be organised in a logical sequence) 1. changes {electrical activity / *depolarisation*} of heart / eq ; 2. peak is reversed / eq ; 3. idea that peak is earlier than expected ; 4. no change in pressure in *pulmonary artery* ; 5. (because) little blood in *ventricles* ; 6. missed normal wave after E / longer gap before next wave / eq ; 7. missed (effective) *contraction* after E ; 8. early *depolarisation* leaves *ventricle* insensitive ; 9. idea that the wave of *depolarisation* is prevented ; 10. reference to *refractory* period / eq ;	**max (5)**

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Question Number	Correct Answer	Mark
4(d)	1. idea that (absolutists) say drugs should not be used at any time ; 2. should not allow athletes to be pressured into using drugs ; 3. risk to health / eq ; 4. gain unfair advantage / eq ; 5. other harmful substances banned / eq ; 6. burden on care services / eq ; 7. idea that (relativists) say that drugs could be used under some circumstances ; 8. idea that they could be used for medication ; 9. drugs (in the body) can be difficult to legislate for / eq ;	**max (2)**

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Question Number	Correct Answer	Mark
5(a)	Mark for each correct row **Muscle** / **Muscle contracted when**: **Holding steady** / **Lifting upwards** Extensor: X Flexor: X X ;;	**(2)**

Question Number	Correct Answer	Mark
5(b)	tendons ;	**(1)**

Question Number	Correct Answer	Mark
5(c)	1. idea that muscles cannot extend themselves ; 2. need opposing muscle to extend / eq ; 3. antagonistic muscle allows control (of movement) / eq ;	**max (2)**

Question Number	Correct Answer	Mark
5(d)	1. all fibres same length and width as original ; 2. Z lines closer together ; 3. more overlap of actin and myosin ;	**(3)**

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Question Number	Correct Answer	Mark
***5(e) QWC**	(QWC – Spelling of technical terms *(shown in italics)* must be correct and the answer must be organised in a logical sequence) 1. reference to {*vesicles* / *t-tubules* / *sarcoplasmic reticulum*} contain *calcium ions* ; 2. {binds / eq} to *troponin* ; 3. *tropomyosin* moves exposing binding sites / eq ; 4. for *myosin* /eq ; 5. needs ATP to remove *calcium ions* / eq ; 6. ATP provides energy for changing shape of *myosin* / eq ; 7. ATP is required to {break cross bridges / eq} ; 8. ATP for synthesis of *neurotransmitter* / eq ;	**max (5)**

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Question Number	Correct Answer	Mark
6(a)	ATPase / ATP synthetase ;	**(1)**

Question Number	Correct Answer	Mark
6(b)	1. (H^+ ions) from reduced NAD / eq ; 2. H^+ ions pumped into inter membrane space / eq ; 3. reference to energy needed (for pump) / eq ; 4. reference to movement of electrons along ETC /eq; 5. (ETC on) inner membrane / cristae;	**max (3)**

Question Number	Correct Answer	Mark
6(c)	1. H^+ ions follow diffusion gradient / eq ; 2. idea that this causes an energy change or makes energy available ; 3. ATP is formed / eq ; 4. idea that this occurs on stalked particles ; 5. ATP is energy source for (biological processes) / eq ;	**max (2)**

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Question Number	Correct Answer	Mark
7(a)	1. idea that enzymes are proteins ; 2. reference to transcription ; 3. gene / eq ; 4. reference to mRNA ; 5. reference to translation (of mRNA) ; 6. reference to genetic code / eq ; 7. reference to {ribosome / polysomes} ; 8. reference to tRNA ; 9. idea that amino acids bonded / polypeptide produced ;	**max (4)**

Question Number	Correct Answer	Mark
7(b)	1. adrenoceptors are {proteins / glycoproteins} ; 2. phospholipids can move in the membrane / eq ; 3. can be {added to / removed from / move around in} {phospholipid bilayer / membrane} ; 4. adrenroceptors can interact with phospholipids e.g. {hydrophobic / hydrophilic} interactions ;	**max (2)**

Question Number	Correct Answer	Mark
7(c)	1. {incomplete / insufficient} data / eq ; 2. different interpretations of data / eq ; 3. & 4. credit any two examples from the text e.g. evidence from noradrenaline, electrical stimulation, multifactorial problem, antidepressant drugs, pain killers, gender ;;	**max (3)**

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Question Number	Correct Answer	Mark
***7(d)(i)**	(QWC – Spelling of technical terms *(shown in italics)* must be correct and the answer must be organised in a logical sequence) **Drug therapy** 1. idea that it affects the whole brain ; 2. idea that it is difficult to get dose right ; **DBS (Deep Brain Stimulation)** 3. targets specific area of the brain / eq ; 4. relieves tremors /eq ; 5. has effects on {other areas of the brain / other cell types} ; 6. has short term side effects e.g. laughing, crying ; 7. has long term side effects e.g. depression, mood swings, suicidal tendencies ; 8. invasive procedure has risk / eq ; **Gene therapy** 9. corrects chemical imbalance / eq ; 10. precise group of cells affected / eq ; **Light therapy** 11. very precise effects / eq ; 12. requires genetic modification / eq ; 13. genes from different species / eq ; **General** (Gene or light therapy) 14. dangers of using virus as vector / eq ; 15. ethical issues of genetic modification / eq ;	**max (7)**

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Question Number	Correct Answer	Mark
7(d)(ii)	1. both caused by {lack / eq} of neurotransmitter ; 2. Parkinson's {lack / eq} of dopamine ; 3. depression {lack / eq} of serotonin ;	**max (2)**

Question Number	Correct Answer	Mark
7(e)	1. light affects pigments / eq ; 2. rhodopsin / iodopsin (in mammals) ; 3. (changes in pigment) result in action potentials /nerve impulses / eq ; 4. pigments (in cones) respond to {specific / eq} wavelength / eq ;	**max (3)**

Question Number	Correct Answer	Mark
7(f)	1. virus acts as a vector ; 2. reference to human cold virus ; 3. virus has specific surface proteins / eq ; 4. match surface{proteins / receptors / eq} of target cell ; 5. binding to surface protein promotes entry to cell / eq ; 6. idea that genes can be incorporated into {host DNA / eq}	**max (3)**

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Question Number	Correct Answer	Mark
7(g)	1. {causes / involved in / eq} inflammation / eq ; 2. vasodilation / eq ; 3. increased blood flow / eq ; 4. increased {permeability / leakage} of blood vessels ; 5. Oedema / swelling / eq ; 6. reference to temperature increase ; 7. reference to histamine / mast cells ; 8. idea that phagocytes / macrophages move to site ;	**max (2)**

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Question Number	Correct Answer	Mark
7(h)	1. representative sample / eq ; 2. (sufficiently) large sample / eq ; 3. double blind testing ; 4. reference to placebo ; 5. objective measurement of effects / eq ; 6. (collecting / analysing) separate data sets for males and female / eq ; 7. other factors need to be {controlled / measured} e.g. hormone levels in females, socioeconomic, nutrition ; 8. reference to other models e.g. animals, tissue culture ; 9. appropriate comment on safety issues e.g. toxicity ; 10. consideration of time e.g. between dose and observation, long term data ;	**max (4)**

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