

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 5: ENERGY FOR BIOLOGICAL PROCESSES
AEROBIC RESPIRATION

SCORE

/62

PERCENTAGE

%

STEMUP

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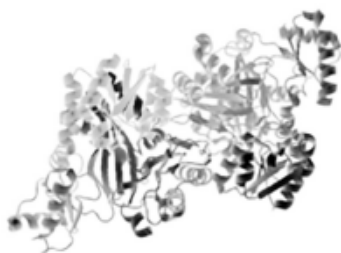
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Q1.

Acetyl CoA is produced in the link reaction when pyruvate is broken down.

The photograph shows a molecule of the enzyme acetyl CoA carboxylase.



This enzyme is involved in the conversion of acetyl CoA into fatty acids.

The enzyme is activated by citrate.

Citrate does not bind at the active site.

Citrate is produced in the Krebs cycle.

The enzyme is inhibited by long chain fatty acyl CoA molecules.

Fatty acyl CoA molecules have a longer carbon chain than acetyl CoA.

(i) Analyse the information to explain how the activity of the enzyme acetyl CoA carboxylase is controlled.

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(ii) Explain why inhibitors of this enzyme may be useful in treating obesity in humans.

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(Total for question = 7 marks)

Q2.

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)

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(b) A larger $VO_2\text{max}$ 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)

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

(3)

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(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)

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(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)

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*(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)

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(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

(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)

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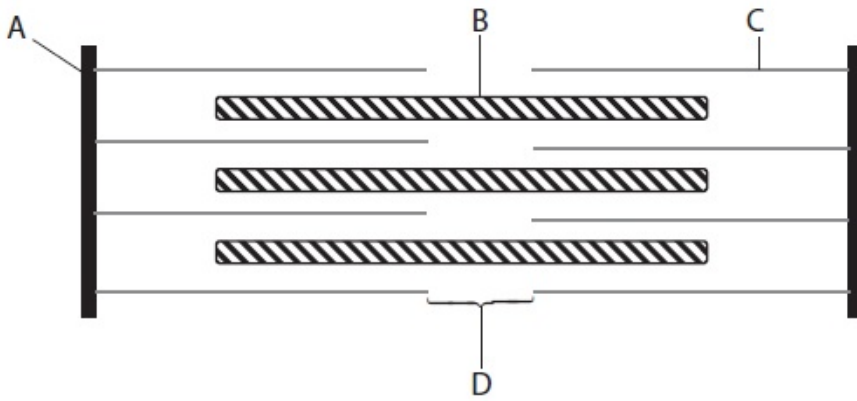
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(i) The titin gene produces a protein that attaches to myosin in a sarcomere (paragraph 30).



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)

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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)

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Show your working.

Answer = ... %

Q3.

(5)

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Q4.

ATP is involved in a wide variety of biological processes such as active transport and muscle contraction.

A typical adult human body has a mass of 62 kg.

It contains approximately 250 g of ATP and has approximately 3.7×10^{13} cells.

(i) Calculate the mean mass of ATP in one cell of a typical human.

Express your answer in standard form.

(2)

Answer g

(ii) Explain why this calculation does **not** give an accurate estimate of the mass of ATP in a nerve cell.

(2)

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Q5.

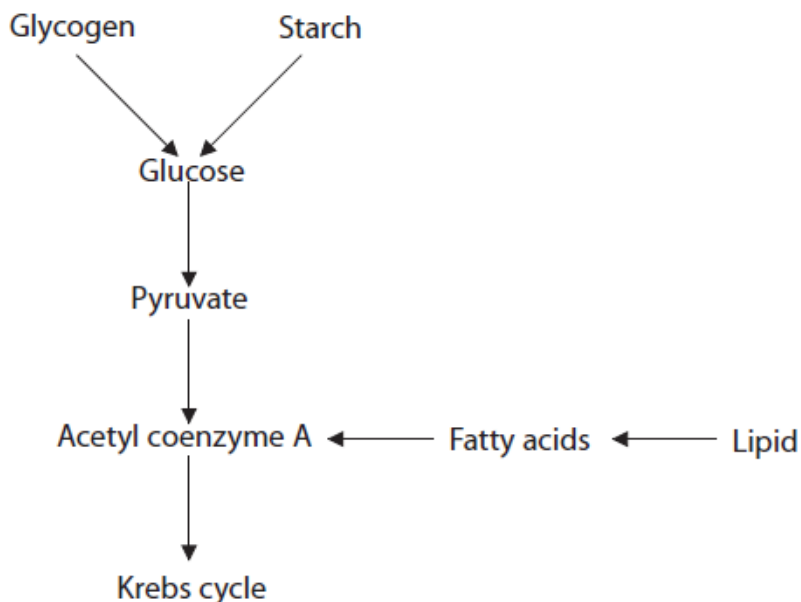
Answer the question with a cross in the box you think is correct ☐. If you change your

mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

Lipids and carbohydrates are used as respiratory substrates.

The respiration of lipids generates more ATP than the respiration of carbohydrates.

The diagram shows some steps in the respiration of carbohydrates and lipids.



(i) Where in a cell does the conversion of pyruvate to acetyl coenzyme A take place?

(1)

- ☒ **A** cytoplasm
- ☒ **B** matrix
- ☒ **C** stroma
- ☒ **D** tonoplast

(ii) Explain why lipids can be respired only in aerobic conditions.

(3)

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(Total for question = 4 marks)

Q6.

Lipids and carbohydrates are used as respiratory substrates.

The respiration of lipids generates more ATP than the respiration of carbohydrates.

The respiratory quotient (RQ) can indicate which substrate is being used in respiration.

The formula used to calculate RQ is

$$\text{RQ} = \frac{\text{volume of carbon dioxide produced}}{\text{volume of oxygen used}}$$

(i) State why the RQ for carbohydrate is 1.0.

(1)

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(ii) The table shows the formula for calculating the volume of oxygen used and the volume of carbon dioxide produced in the respiration of lipids.

The number of carbon atoms in the lipid is represented by n.

Volume of oxygen used / a.u.	Volume of carbon dioxide produced / a.u.
$4.5n + 3.75$	$3n + 6$

Calculate the RQ for a lipid containing 21 carbon atoms.

(2)

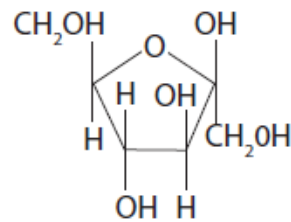
Answer

Q7.

Sperm cells are released into the female genital tract in seminal fluid.

Seminal fluid contains fructose instead of glucose.

The diagram shows the structure of fructose.



(i) Compare and contrast the structure of fructose with the structure of glucose.

(3)

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(ii) Explain the advantages of the presence of fructose in seminal fluid.

(3)

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(Total for question = 6 marks)

Q8.

Lipids and carbohydrates are used as respiratory substrates.

The respiration of lipids generates more ATP than the respiration of carbohydrates.

The respiratory quotient (RQ) can indicate which substrate is being used in respiration.

The formula used to calculate RQ is

$$\text{RQ} = \frac{\text{volume of carbon dioxide produced}}{\text{volume of oxygen used}}$$

Explain why an insect has an RQ of 1.0 at rest and an RQ of 0.7 during flight.

(3)

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Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • citrate binds to another site on the enzyme, activating the enzyme (1) • so that the structure of the enzyme is changed (1) • so that active site binds more effectively to the substrate (1) • an increase in fatty acyl CoA molecules inhibits the substrate binding to the active site (1) • due to competitive inhibition (1)	Accept citrate and fatty acyl CoA molecules act together to regulate the activity of the enzyme	(5)
(ii)	An explanation that makes reference to two of the following: • fewer fatty acids will be made (1) • so that less fat is stored (1) • because the enzyme is being inhibited despite being activated by citrate (1)	Allow (less fat stored so) fat reserves used	(2)

Q2.

Question Number	Answer	Mark
(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
(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
(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
(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
(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
* (f)	QWC – Spelling of technical terms (<i>shown in italics</i>) must be correct and the answer must be organised in a logical sequence) 1. Ca^{2+} leaks out of {cell / <i>cytoplasm</i> / <i>sarcoplasmic reticulum</i>} ; 2. idea of change in Ca^{2+} binding to <i>tropoin</i> ; 3. causes displacement of <i>tropomyosin</i> / eq ; 4. idea of change in number of <i>myosin</i> binding sites exposed ; 5. comment on <i>myosin</i> binding to <i>actin</i> ; 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						
(g)	<table><tr><th>Process</th><th>Two nucleic acids involved in the process</th></tr><tr><td>Transcription of the ACE gene</td><td>DNA & mRNA ;</td></tr><tr><td>Production of ACE at a ribosome</td><td>Any two from: mRNA, tRNA, rRNA ;</td></tr></table>	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 ;	(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
(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
(i)	B ;	(1)

Question Number	Answer	Mark
(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
(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
(l)	1. $1.4 \div 37 =$; 2. 3.8 (%) ; Correct answer gains both 2 marks	(2)

Q3.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An answer that makes reference to the following: Similarities - both use an electron transport chain on membranes (1) - both use ATPase driven by { H^+ gradient / chemiosmosis / eq } (1) - in both, electrons passed from one carrier to another lose energy which drives ATP production (1)	At least one similarity and one difference must be given to gain full marks. Max 2 marks if only 3 similarities provided Max 1 marks if only 2 similarities provided	(5)

	Differences - energy is provided by light in chloroplasts but by { glucose / pyruvate / eq } in mitochondria (1) - ATP is made by photophosphorylation in chloroplasts but by { substrate level / oxidative phosphorylation } in mitochondria (1) - in chloroplasts, electrons are provided by chlorophyll but in mitochondria, electrons are brought by reduced { NAD / FAD } (1) - in chloroplasts, (some) electrons return to chlorophyll whereas in mitochondria, electrons are accepted by oxygen (1)	Max 3 marks if only 4 differences provided Max 2 marks if only 3 differences provided Max 1 marks if only 2 differences provided	
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Q4.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	- correct division of figures provided (1) - answer in correct standard form (1)	<u>Example of calculation</u> $(250 \div 3.7 =) 67.568$ / correct rounding of this figure 6.8×10^{-12} g Must be standard form to 2sf with units Allow full marks for correct answer with no working.	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: - a nerve cell carries out a lot of active transport (1) - so it may have a greater requirement for (1)		(2)

Q5.

Question Number	Answer	Mark
(i)	The only correct answer is B matrix A is incorrect because only glycolysis takes place in the cytoplasm C is incorrect because stroma is in chloroplasts not mitochondria D is incorrect because tonoplasts are in plant cells only	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: - in anaerobic conditions, the pyruvate is used to reoxidise NADH so no Krebs cycle (1) - no oxygen available to act as a (terminal) electron acceptor (1) - so reduced { NAD / FAD / coenzyme} cannot be reoxidised (1) - so no (oxidised) coenzyme to bind {hydrogen ions / protons / H⁺/electrons} (1)	ACCEPT oxygen binds to electrons ACCEPT NADH / FADH₂	(3)

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	when one molecule of carbohydrate is respired the number of carbon dioxide molecules produced is the same as the number of molecules of oxygen used	ACCEPT carbon dioxide produced = oxygen used	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	- volume of both gases calculated (1) - RQ value calculated to {1 / 2} decimal places (1)	<u>Example of calculation:</u> oxygen volume = $4.5 \times 21 + 3.75$ = 98.25 carbon dioxide volume = $3 \times 21 + 6$ = 69 $69 \div 98.25 = 0.70 / 0.7 / 0.702$ ACCEPT ecf	(2)

Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to three of the following: Similarities - both {are hexoses / have formula of $C_6H_{12}O_6$} (1) - both contain covalent bonds (1) Differences - glucose is a hexagon and fructose is a pentagon (1) - glucose has one CH_2OH and fructose has two (1)	ACCEPT have 6 carbons	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: - as a {respiratory substrate / energy source} for the sperm (1) - because movement (through female genital tract) requires ATP (1) - in order to reduce competition for carbohydrates with the {skin / genital tract} {bacteria / cells} (1)	ACCEPT provides energy NB ATP must be mentioned at least once for both mps to be awarded ACCEPT fructose may not be used by skin cells	(3)

Q8.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: - insect is respiring carbohydrates at rest and lipid during flight (1) - respiration of carbohydrate provides enough energy for the insect at rest (1) - it requires more {energy / ATP} (for contraction) (1) - therefore the insect has to respire lipid to provide this energy (1)	NB uses for respires throughout but reference to respiration must be made at least once for full marks to be awarded PIECE TOGETHER	(3)

