

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 5: ENERGY FOR BIOLOGICAL PROCESSES
OXIDATIVE PHOSPHORYLATION

SCORE

/81

PERCENTAGE

%

STEMUP

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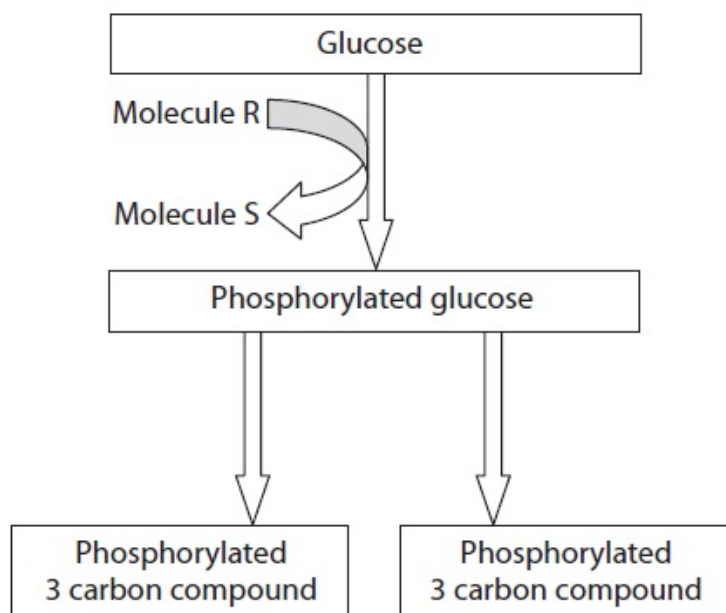
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Q1.

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.



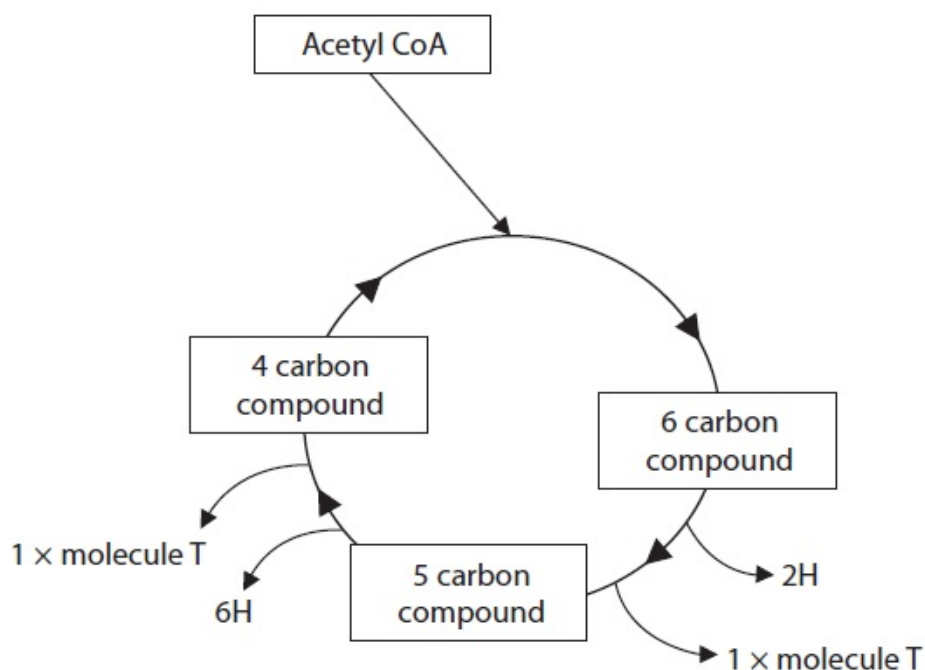
Name the molecules R and S shown in the diagram.

(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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(ii) Using information in the diagram, suggest what would happen in the Krebs cycle if acetyl CoA became unavailable.

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(b) 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**.

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(Total for question = 10 marks)

Q2.

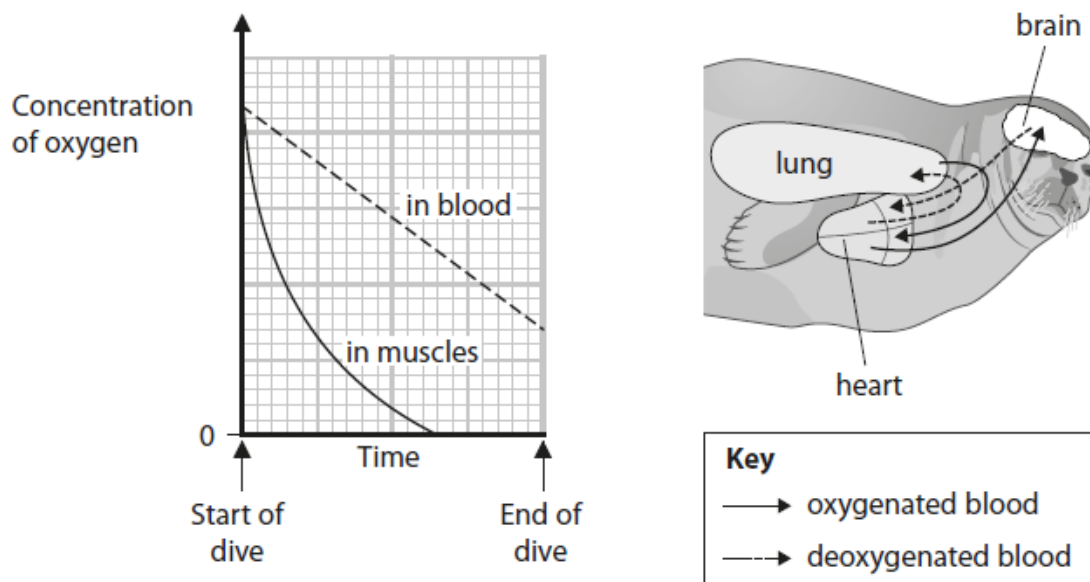
Weddell seals spend a lot of their time swimming underwater, diving to find food and diving to

avoid predators.

However, they do have to come to the surface to breathe.

An investigation studied the change in the concentration of oxygen in the blood and muscles of a Weddell seal during a dive.

The graph shows the results of this investigation and the diagram shows part of the circulation of blood in the seal during the dive.



Analyse the data to explain these results.

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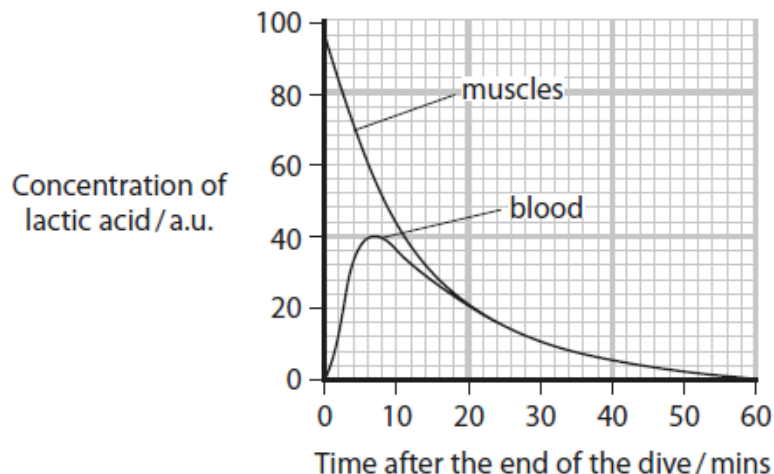
(Total for question = 3 marks)

Q3.

Weddell seals spend a lot of their time swimming underwater, diving to find food and diving to avoid predators.

However, they do have to come to the surface to breathe.

The graph shows the changes in the lactic acid concentration in the muscles and blood of a Weddell seal, after a prolonged dive.



Explain the importance of these changes after the Weddell seal comes to the surface to breathe.

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(Total for question = 3 marks)

Q4.

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).

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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).

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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.

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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).

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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).

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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

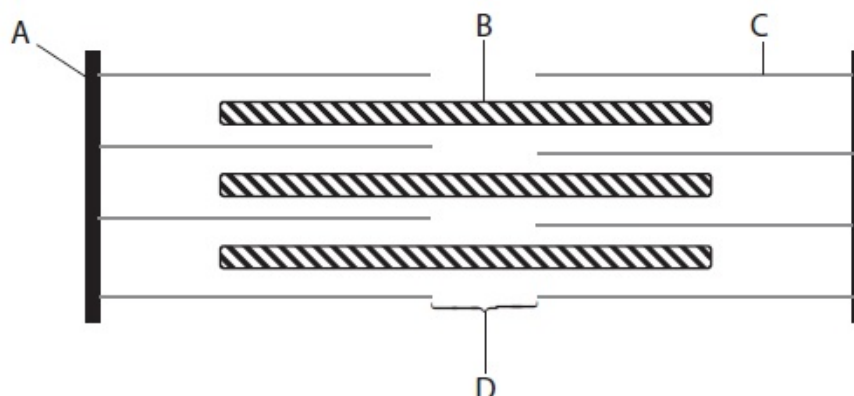
(h) A variant of the APOE gene could put individuals at increased risk in contact sports. DNA profiling is a technique that can be used in genetic screening.

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

(4)

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.

(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)

(I) 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 = 30 marks)

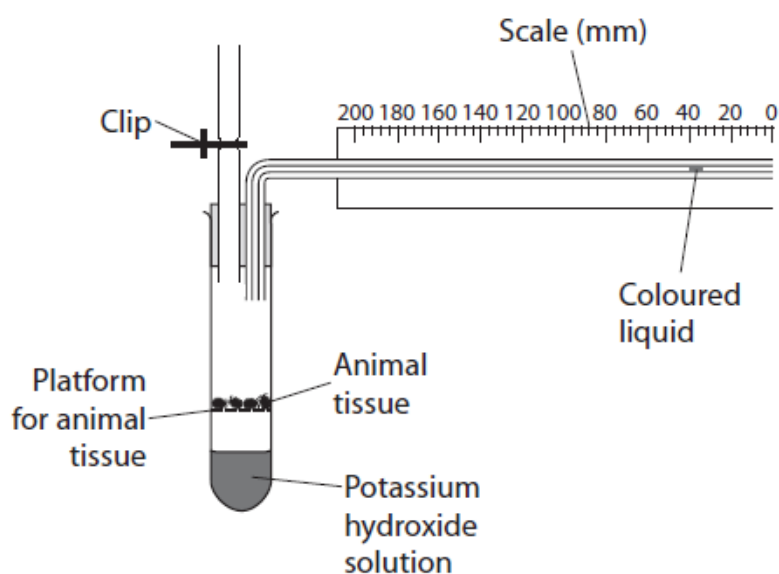
Q5.

The tissues of some animals can carry out anaerobic and aerobic respiration.

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)

(ii) Explain why the coloured liquid did not move in investigation 1.

(3)

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(iii) Reduced NAD ($\text{NADH} + \text{H}^+$) would be formed in investigations 2 and 3.

Describe the fate of reduced NAD in aerobic respiration.

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Q6.

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 question.

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

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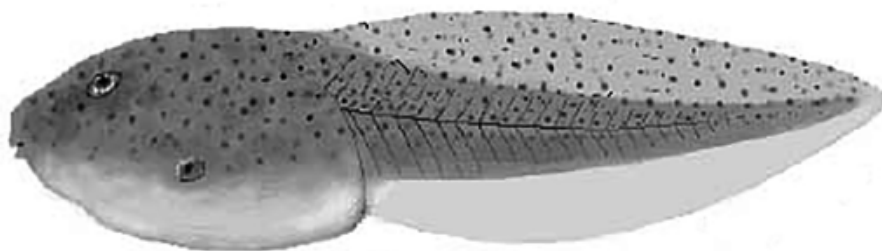
Q7.

The adult American bullfrog, *Rana catesbeiana*, can live in water or on land.

Adult frogs lay eggs in water where they are fertilised.

The fertilised eggs develop into tadpoles that live only in water.

The photograph shows a tadpole.



(i) Human activity can cause pollution that reduces the oxygen concentration in water.

Explain why a low oxygen concentration in the water would lower the pH of the blood of the tadpole.

(3)

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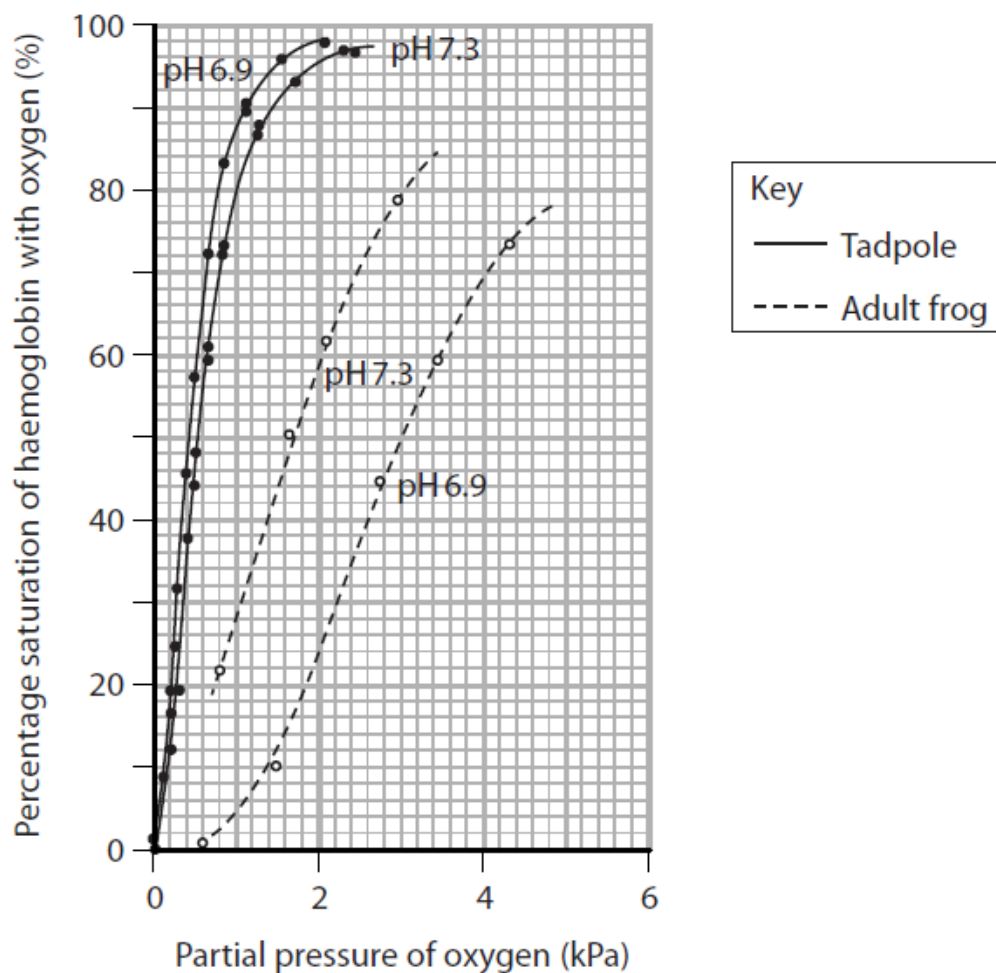
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*(ii) The graph shows the effect of pH on the oxygen dissociation curves of haemoglobin for adult frog blood and tadpole blood.



The adult frog can either live on land or in water. The tadpole always lives in water.

Discuss how the shape and position of the dissociation curves reflect the habitat in which these animals live.

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(Total for question = 12 marks)

Q8.

Hypoxia is an inadequate supply of oxygen to tissues and cells that restricts their function.

The body responds to hypoxia by releasing hypoxia-inducible transcription factors (HIF).

Investigations have shown that one effect of HIF is an increase in the rate of glycolysis in the affected cells.

(i) Explain how HIF could result in an increase in the rate of glycolysis.

(2)

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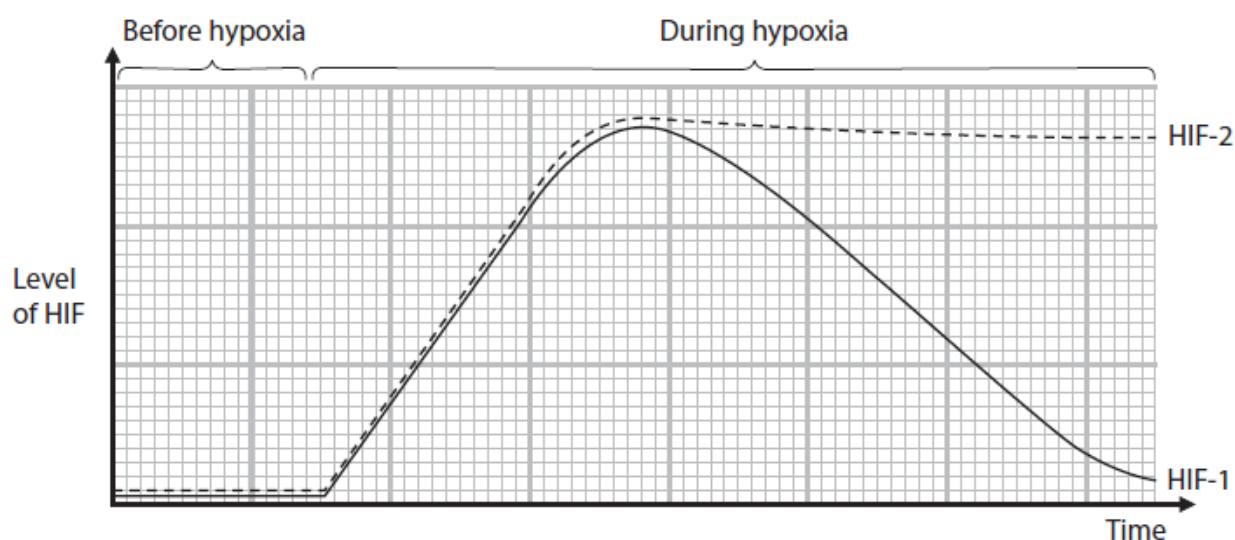
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(iii) The graph shows the changes in levels of two HIFs, HIF-1 and HIF-2, before and during hypoxia.



Compare and contrast the changes in the levels of HIF-1 and HIF-2 during hypoxia.

(2)

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(iv) Explain the changes in levels of HIF-1 and HIF-2 during hypoxia.

(2)

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(Total for question = 10 marks)

Mark Scheme

Q1.

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

Question Number	Answer	Mark
(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
(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
(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)

Q2.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to four of the following: - oxygen in blood decreases as it moves into {muscles / cells / named cell} for (aerobic) respiration (1) - blood retains some oxygen (even though the muscles are depleted) (1) - this is to supply oxygen to the brain so that the cells do not die(1) - oxygen decreases in muscles as it is used to generate ATP formuscle contraction (1)	ACCEPT energy	(3)

Q3.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: - lactic acid (accumulation) in the muscles is toxic (1) - therefore it passes from the muscles into the blood (1) - lactic acid is taken from the muscles to the liver by the blood (1) - drop in pH (caused by lactic acid) will denature enzymes (in thecells / blood) (1)		(3)

Q4.

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>troponin</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)

Q5.

	Answer					Mark
(i)						
	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	☒ ;	☐	☐
						(2)

Question Number	Answer	Additional Guidance	Mark
(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
(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)

Q6.

Question Number	Answer	Additional Guidance	Mark
	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)

Q7.

Question Number	Answer	Mark
(i)	An explanation that makes reference the following: • anaerobic respiration takes place (1) • therefore {lactic acid / lactate} is produced (1) • because pyruvate reduced / NADH oxidised / NADH converted to NAD^+ / NADH donates H^+ or proton or e^- (1)	(3)

Question Number	Indicative content
* (ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Description: D shape of curve is sigmoid / S-shaped tadpole curves are steeper tadpole curves are further to the left than frog curves lower pH moves curve to left in tadpole lower pH moves curve to the right in frog tadpole curves are closer together than frog curves reference to correct comparative % ONCE Explanation: E at higher ppO_2 blood more saturated / as ppO_2 increases saturation increases at lower ppO_2 blood less saturated / as ppO_2 decreases saturation decreases tadpole is more saturated at lower ppO_2 tadpole more dissociation with change in ppO_2 tadpole has higher % saturation than frog tadpole blood has greater affinity than blood movement lowers pH in blood Bohr shift in frog conformational change makes binding easier steep part of curve means small change in ppO_2 causes large change in percentage saturation top part of curve represents situation in gills or lungs bottom part of curve represents situation in tissues Habitat: H less oxygen in water than in air / ppO_2 in water lower than ppO_2 in air (lowering pH) tadpole is more able to obtain oxygen from polluted water (lowering pH) frog more able to release oxygen to tissues during exercise / activity / movement adaptations allow tadpole / frog to survive harder to move in water than on land

Level	Marks	
0	0	No awardable content
1	1-3	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. 1 to 3 from D, E or H
2	4-6	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure. 1H and 4 to 6 in total
3	7-9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts.
		Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. 2H and 7 to 9 plus in total

Q8.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to two of the following: - because HIF can switch on gene (expression) (1) - bind to a promotor region / stimulate transcription / stimulate protein synthesis} (1) - for {enzymes / proteins} involved in glycolysis (1)	ACCEPT increased gene expression ACCEPT increase rate of transcription IGNORE enzymes ACCEPT named {enzyme / protein} involved in glycolysis e.g. enzyme that makes NAD IGNORE NAD otherwise	(2) EXP
Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: (because if conditions are hypoxic) there is not much oxygen available to act as a terminal electron acceptor (1) - therefore the electron transport chain will not operate (1) - therefore ATP production by oxidative phosphorylation will be reduced (1)	ACCEPT no oxygen IGNORE numbers of ATP molecules produced	(4) EXP

	ATP is produced (directly / SLP) during glycolysis (during these anaerobic conditions) (1)		
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Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following: - both HIF-1 and HIF-2 increase (during hypoxia) (1) - levels of HIF-2 remain high (after a small decrease) but levels of HIF-1 fall (1)	DO NOT PIECE TOGETHER IGNORE any explanations given	(2) EXP

Question Number	Answer	Additional Guidance	Mark
(iv)	An explanation that makes reference to two of the following: - HIF-1 and HIF-2 switch on different genes (1) {products / transcription of genes} resulting from the presence of both HIF-1 and HIF-2 are needed in the early stages of hypoxia (1) {products / transcription of gene} resulting from the presence of HIF-2 are needed {for longer periods of hypoxia / to sustain glycolysis} (1)	ACCEPT bind to different promotor regions ACCEPT converse for HIF-1	(2) EXP