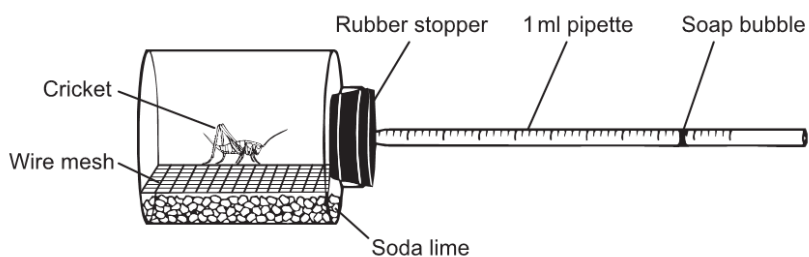


Metabolism Test D [50 marks]

1. A cricket was placed in a respirometer at constant temperature for ten minutes. The soap bubble moved along the pipette. [1 mark]



[Source: © International Baccalaureate Organization 2017]

What was measured by the movement of the soap bubble?

- A. Production of carbon dioxide
- B. Volume of excretory products
- C. Oxygen consumption
- D. Release of heat

Markscheme

C

2. Which process occurs during the light-dependent reaction of photosynthesis? [1 mark]
- A. ATP, CO₂ and H₂O are produced.
 - B. CO₂ is used to produce carbohydrates.
 - C. ATP and O₂ are produced.
 - D. RuBP is phosphorylated.

Markscheme

C

3. What is the relative wavelength in the visible spectrum of red light and blue light and are these colours absorbed or reflected by chlorophyll? [1 mark]

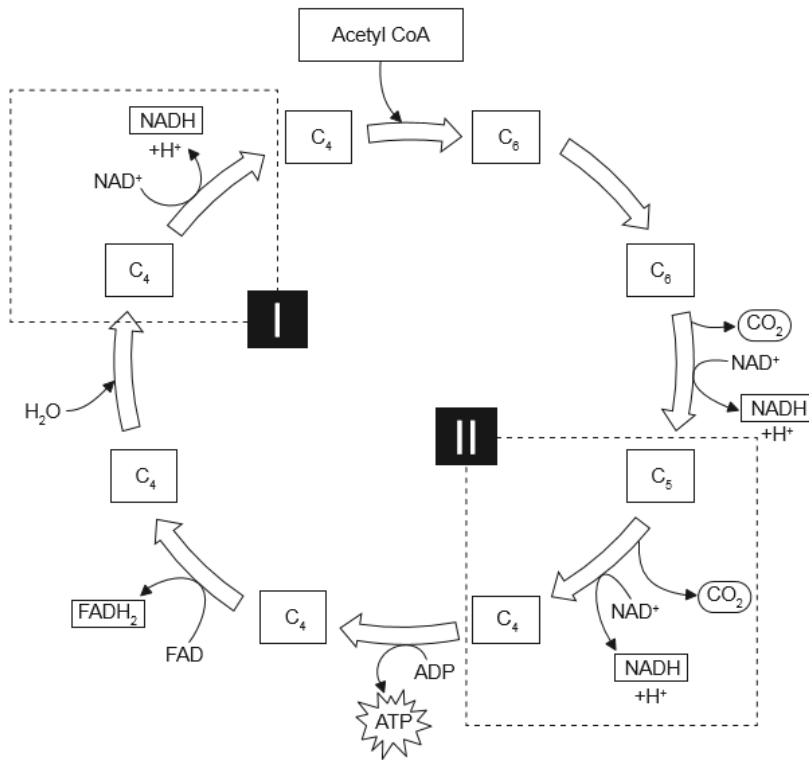
	Red light		Blue light	
A.	longest wavelength	absorbed	shortest wavelength	absorbed
B.	shortest wavelength	reflected	longest wavelength	reflected
C.	longest wavelength	absorbed	shortest wavelength	reflected
D.	shortest wavelength	absorbed	longest wavelength	absorbed

Markscheme

A

4. The diagram represents the Krebs cycle.

[1 mark]



[Source: CAMPBELL, NEILA.; REECE, JANE B., *BIOLOGY*, 7th, ©2005, p.68. Reprinted by permission of Pearson Education, Inc., New York, New York.]

What processes are occurring at I and II?

	Process I	Process II
A.	C ₄ is being reduced	NAD ⁺ is being oxidized
B.	NAD ⁺ is being decarboxylated	C ₅ is being oxidized
C.	NADH is being reduced	C ₅ is being decarboxylated
D.	NAD ⁺ is being reduced	C ₅ is being decarboxylated

Markscheme

D

5. Which molecule would first contain ¹⁴C if the alga *Chlorella* was grown in the presence of light and radioactive CO₂?

[1 mark]

- A. Glycerate 3-phosphate
- B. Glucose
- C. Rubisco
- D. Ribulose biphosphate (RuBP)

Markscheme

A

6. What products of the light-dependent reactions are used in the light-independent reactions? [1 mark]
- A. ATP and NADPH
 - B. NADPH and ribulose biphosphate (RuBP)
 - C. CO₂ and ATP
 - D. ATP and O₂

Markscheme

A

7. Where in a eukaryotic cell does the Krebs cycle take place? [1 mark]
- A. In the cytoplasm
 - B. Between the inner and outer membranes of the mitochondria
 - C. In the matrix of the mitochondria
 - D. On the surface of the cristae

Markscheme

C

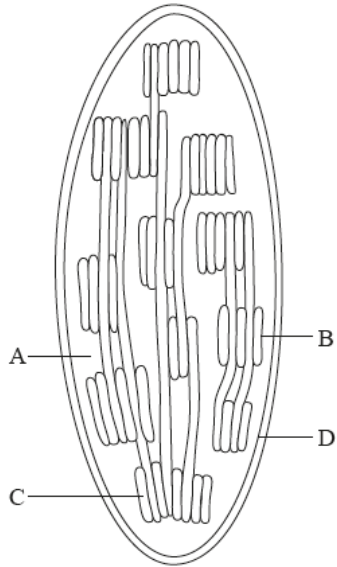
8. What process occurs during the light-independent reactions of photosynthesis? [1 mark]
- A. Oxygen is released into the atmosphere.
 - B. Protons are pumped from the thylakoid space to the stroma.
 - C. RuBP is carboxylated then regenerated in the Calvin cycle.
 - D. Triose phosphate is converted to glycerate 3-phosphate.

Markscheme

C

9. Where is ATP synthase located?

[1 mark]



[Source: © International Baccalaureate Organization 2014]

Markscheme

B

10. What substance is produced from glucose during anaerobic respiration in all organisms?

[1 mark]

- A. Carbon dioxide
- B. Ethanol
- C. Lactate
- D. Pyruvate

Markscheme

D

11. What is the source of the oxygen released into the atmosphere in photosynthesis?

[1 mark]

- A. Glucose
- B. Carbon dioxide
- C. Chlorophyll
- D. Water

Markscheme

D

12. In cell respiration, what is the name of the process where glucose is broken down into pyruvate? [1 mark]
- A. Electron transport chain
 - B. Krebs cycle
 - C. Link reaction
 - D. Glycolysis

Markscheme

D

13. What is the energy absorbed by chlorophyll used directly for in plants? [1 mark]
- I. To produce ATP
 - II. To split water
 - III. To fix CO₂
- A. I only
 - B. III only
 - C. I and II only
 - D. II and III only

Markscheme

C

14. What is the total number of ATP molecules used and produced during glycolysis? [1 mark]

	ATP used during glycolysis	ATP produced during glycolysis
A.	2	2
B.	0	2
C.	2	4
D.	4	4

Markscheme

C

15. Where precisely in the cell do the reactions of the Krebs cycle take place? [1 mark]
- A. In the cytoplasm
 - B. In the space between the inner and outer membrane of the mitochondria
 - C. On the surface of cristae in the mitochondria
 - D. In the fluid matrix of the mitochondria

Markscheme

D

16. How do cells capture the energy released by cell respiration? [1 mark]
- A. They store it in molecules of carbon dioxide.
 - B. They produce glucose.
 - C. The energy is released as pyruvate.
 - D. They produce ATP.

Markscheme

D

17. Which process produces the most ATP per molecule of glucose? [1 mark]
- A. Anaerobic respiration in a yeast cell
 - B. Aerobic respiration in a bacterial cell
 - C. Glycolysis in a human liver cell
 - D. The formation of lactic acid in a human muscle cell

Markscheme

B

18. What is the link reaction in aerobic respiration? [1 mark]
- A. Pyruvate is carboxylated, acetyl reacts with coenzyme A, reducing $\text{NADH} + \text{H}^+$
 - B. Pyruvate is decarboxylated, acetyl reacts with coenzyme A, forming $\text{NADH} + \text{H}^+$
 - C. Pyruvate reacts with coenzyme A, forming $\text{NADH} + \text{H}^+$
 - D. Pyruvate is decarboxylated, reacting with coenzyme A, reducing $\text{NADH} + \text{H}^+$

Markscheme

B

19. What is chemiosmosis? [1 mark]
- A. Coupling of ATP synthesis to the electron transport and proton movement
 - B. Phosphorylation of glucose in the mitochondrial matrix
 - C. H^+ ions moving down a concentration gradient into the mitochondrial matrix
 - D. Activation of ATPase in order to synthesize ATP

Markscheme

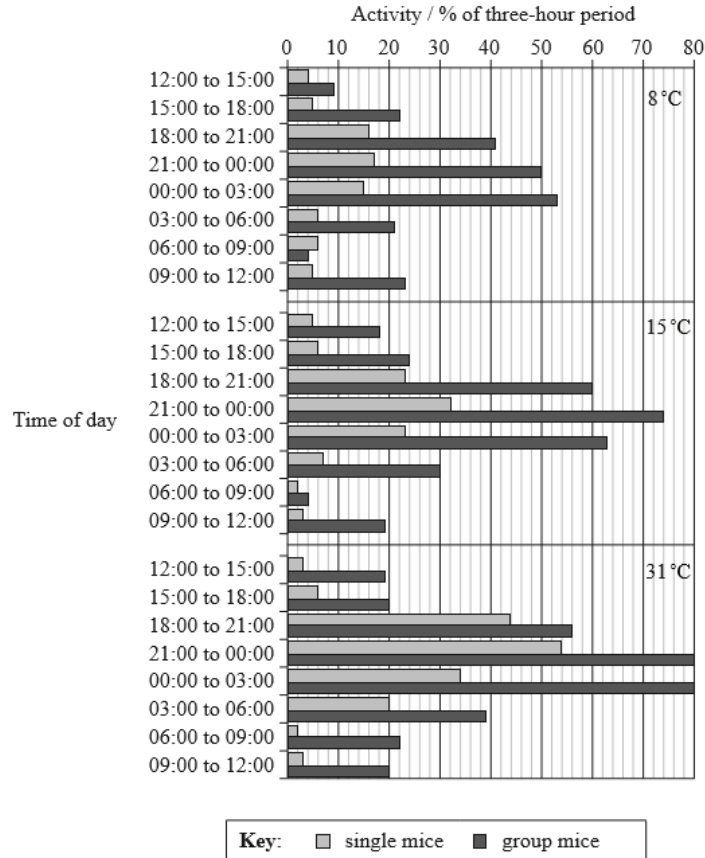
A

20. What is the role of $\text{NADH} + \text{H}^+$ in aerobic cell respiration? [1 mark]
- A. To transfer hydrogen to the electron transport chain
 - B. To reduce intermediates in the Krebs cycle
 - C. To accept electrons from the electron transport chain
 - D. To combine with oxygen to produce water

Markscheme

A

Investigators carried out experiments to find the relationship between the energy used by mice (the metabolic rate) and their activity. They found that the amount of time mice are active depends on the time of day, whether they are single or in groups and on the temperature of their surroundings. The bar chart below shows the percentage of time mice were active during three-hour periods at three different temperatures.



L. E. Mount and J. V. Willmott (1967) *Journal of Physiology*, 190, pages 371–380. Published by Wiley-Blackwell. Used with permission.

21a. Calculate how many minutes the group mice are active between 21:00 and 00:00 at 8°C.

[1 mark]

Markscheme

90 (minutes)

21b. Outline the relationship between activity and temperature from 21:00 to 03:00 in all of the mice.

[1 mark]

Markscheme

as temperature increases activity increases/positive correlation.

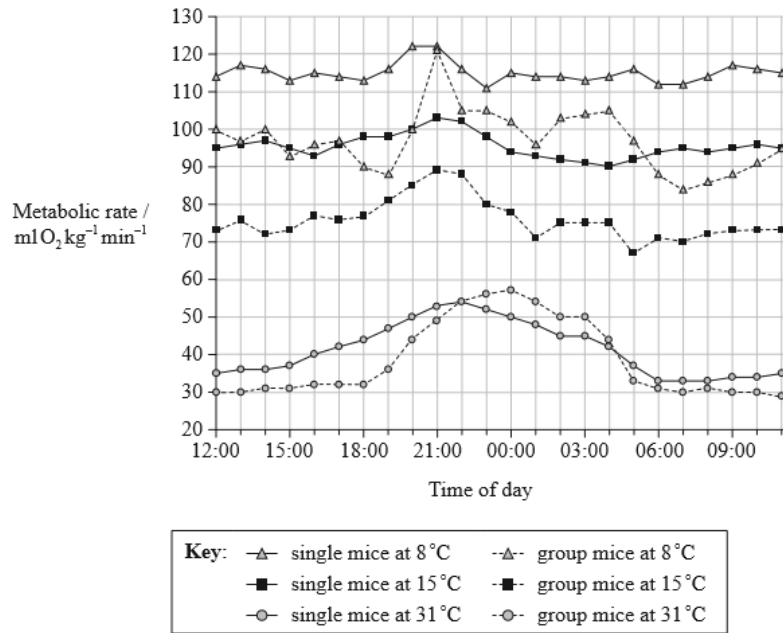
21c. Animals which are active at night are nocturnal. Suggest **one** advantage for mice being nocturnal.

[1 mark]

Markscheme

avoid predators / less competition for food

The investigators also found that the metabolic rate of the mice changed at different times of the day. Mice were kept at one of the three constant temperatures for 24 hours and their oxygen consumption was measured. The graph below shows the results for single mice and the mean values for group mice.



L. E. Mount and J. V. Willmott (1967) *Journal of Physiology*, 190, pages 371–380. Published by Wiley-Blackwell. Used with permission.

21d. State the relationship between temperature and metabolic rate.

[1 mark]

Markscheme

as temperature increases metabolic rate decreases/negative correlation (*accept converse*)

21e. Compare the results for the single mice at 15°C with those for the group mice at 15°C .

[2 marks]

Markscheme

metabolic rate of group mice is always less than single mice; (*accept converse*)
 both follow similar pattern of increases/decreases/fluctuations at same time of day;
 fluctuations greater in group mice;
 both most active/higher metabolic rate during evening/21:00; (*accept any reference to times between 18:00 and 00:00*)

21f. Suggest **one** reason why the results differ for single mice and group mice.

[1 mark]

Markscheme

single mice need to produce more heat/have greater heat loss because of greater surface exposed to air / group mice huddle together to reduce the surface exposed to air
Allow any other reasonable answer.

21g. Explain why oxygen consumption is used as a measure of metabolic rate.

[2 marks]

Markscheme

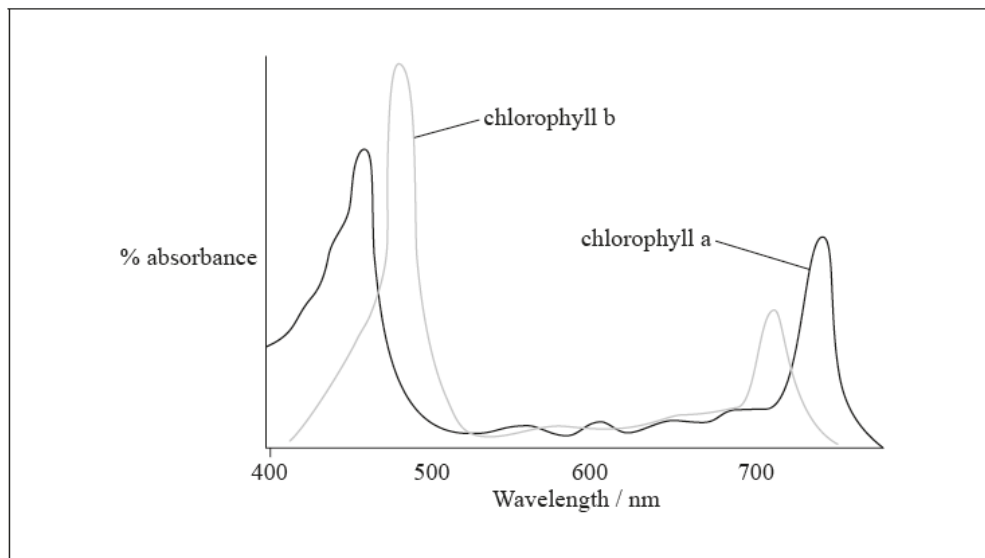
oxygen is required for (aerobic) respiration;
respiration produces ATP/releases energy/heat in the mice;
metabolic rate is a measure of total energy released/consumed in the body / oxygen consumption is proportional to energy released/consumed in body/ proportional to metabolic rate;

21h. Using the data from both graphs, evaluate the hypothesis that increased activity causes an increase in metabolic rate in mice. [2 marks]

Markscheme

metabolic activity high when mice more active supports the hypothesis;
activity is normally correlated with energy consumption;
but another factor may be causing both to increase at the same time / correlation does not always establish cause and effect;
grouping/environmental temperature also affect metabolic rate;

22a. The graph shows the absorption spectrum for two types of chlorophyll. [3 marks]



[Source: © International Baccalaureate Organization 2014]

- Sketch on the graph, the action spectrum of photosynthesis.
- Explain the relationship between the absorption spectrum for chlorophyll and action spectrum of photosynthesis for green plants.

Markscheme

(i) line slightly above absorption spectrum with peaks in red and blue and a trough between but not as low as for absorption spectrum
(ii) energy/light absorbed by pigments/chlorophyll is used for photosynthesis;
peaks in action spectrum correspond to peak absorption by chlorophyll;
differences due to absorption by accessory/other pigments (eg carotene);
least absorption in green range/approximately 600nm as most light reflected;

22b. Outline photoactivation of photosystem II in the light-dependent reaction of photosynthesis. [2 marks]

Markscheme

light/photon absorbed by pigment molecules (in photosystem II)/chlorophyll;
energy/electrons passed to chlorophyll molecule at the reaction centre;
causes electron to be raised to higher energy level / electron is excited;
this electron passed along chain of carrier molecules in photosystem II;

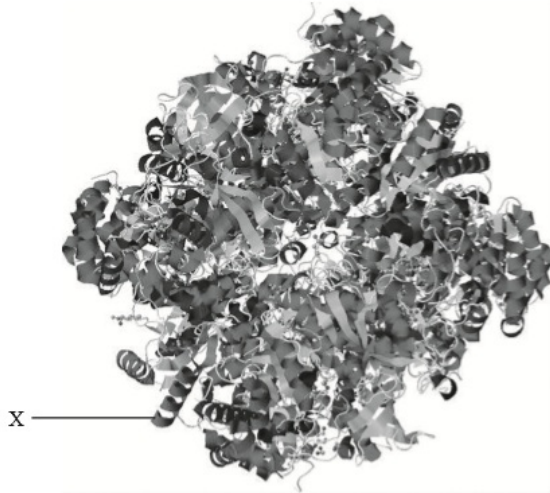
23. Outline which methods of ATP production are used in muscle fibres during different intensities of exercise.

[2 marks]

Markscheme

both anaerobic and aerobic are used depending on the intensity of the exercise;
as intensity increases more anaerobic / at low intensity more aerobic;
creatine phosphate used for brief bursts of intense exercise;

The following image represents a model of ribulose biphosphate (RuBP) carboxylase (also known as Rubisco) from the green alga *Chlamydomonas*.



[Source: Image from the RCSB Protein Data Bank: <http://www.pdb.org/pdb/explore/jmol.do?structureId=1GK8&bionumber=1>]

- 24a. Identify the level of protein structure of the part labelled X.

[1 mark]

Markscheme

secondary (structure) / α helix

- 24b. State the role of ribulose biphosphate (RuBP) carboxylase in the Calvin cycle.

[1 mark]

Markscheme

fixes/adds carbon/ CO_2 to RuBP

25a. Distinguish between oxidation and reduction in biological reactions.

[2 marks]

Oxidation	Reduction

Markscheme

	<i>oxidation</i>	<i>reduction</i>
a.	loss of electrons	gain of electrons;
b.	oxygen (often) gained	oxygen (often) lost;
c.	hydrogen (often) lost	hydrogen (often) gained;
d.	energy lost	energy gained;

25b. State **two** products of glycolysis.

[1 mark]

-
-

Markscheme

- ATP;
 - NADH / H⁺;
 - three-carbon (atom) compound/pyruvate;
- Award [1] for any two of the above.

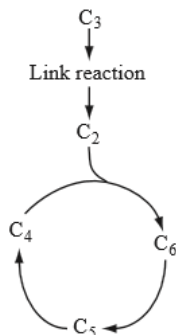
25c. Explain the role of cristae in mitochondria.

[3 marks]

Markscheme

- increase the surface area of inner (mitochondrial) membrane; (*note: mitochondria is in the stem*)
- allow electron transport because of embedded protein electron carriers;
- facilitate proton pumping because of high surface to volume ratio/increased surface area;
- increase ATP production because of ATP synthase/synthatase embedded in membrane;

The diagram below shows part of the respiratory pathway. The number of carbon atoms in each molecule is indicated.

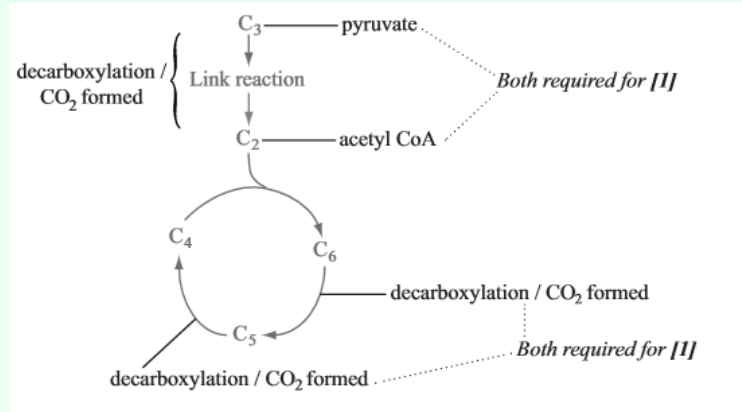


26a. Label pyruvate and acetyl coenzyme A on the diagram above.

[1 mark]

Markscheme

(i) and (ii)

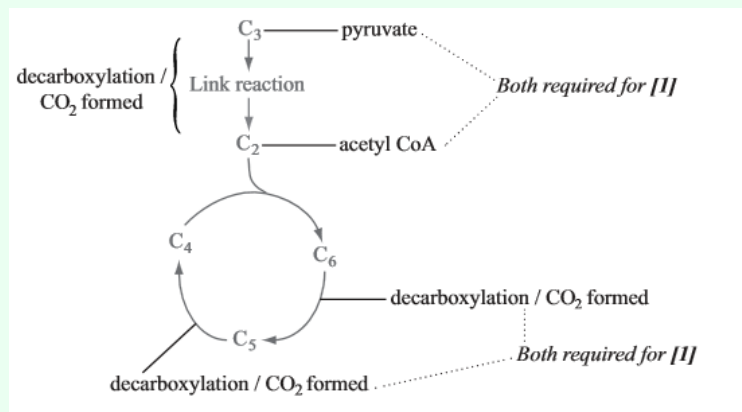


26b. Indicate **two** places where decarboxylation occurs on the diagram.

[1 mark]

Markscheme

(i) and (ii)



26c. List **one** product other than carbon dioxide formed in this stage of respiration.

[1 mark]

Markscheme

NADH + H⁺ / FADH₂ / ATP (or GTP)

26d. State precisely where in a cell this stage of respiration is occurring.

[1 mark]

Markscheme

matrix of mitochondrion

