Metabolism Test C *[50 marks]*

1. Which process occurs during the light-dependent reaction of photosynthesis? *[1 mark]*

A. ATP, CO_2 and H_2O are produced.

B. CO_2 is used to produce carbohydrates.

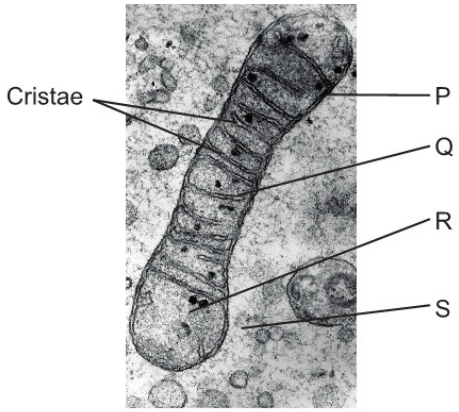
C. ATP and O_2 are produced.

D. RuBP is phosphorylated.

Markscheme

C

2. The image shows a portion of a cell containing a mitochondrion.



[Source: 'TEM of a mitochondrion' by Prof. R. Bellairs. Credit: Prof. R. Bellairs. CC BY 4.0.]

Where do glycolysis and electron transport occur?

	Glycolysis	Electron transport
A.	P	R
B.	R	Q
C.	R	R
D.	S	Q

Markscheme

D

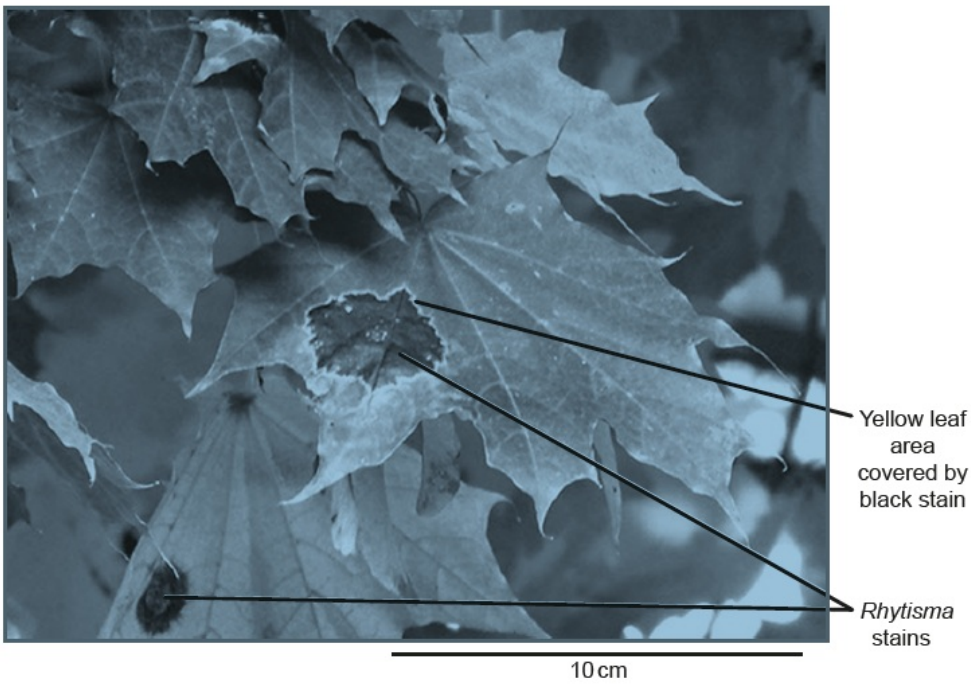
3. What is the relative wavelength in the visible spectrum of red light and blue light and are these colours absorbed or reflected by chlorophyll? *[1 mark]*

	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 fungus *Rhytisma* grows on the leaves of certain trees, causing a yellow leaf area in which chlorophyll is no longer present. A black, tar-like stain later spreads out. *[1 mark]*



[Source: © International Baccalaureate Organization 2017]

What happens in the leaf when Rhytisma is present?

I. An increase in the intake of carbon dioxide

II. A reduction in the production of oxygen

III. An increase in the loss of water

A. I only

B. II only

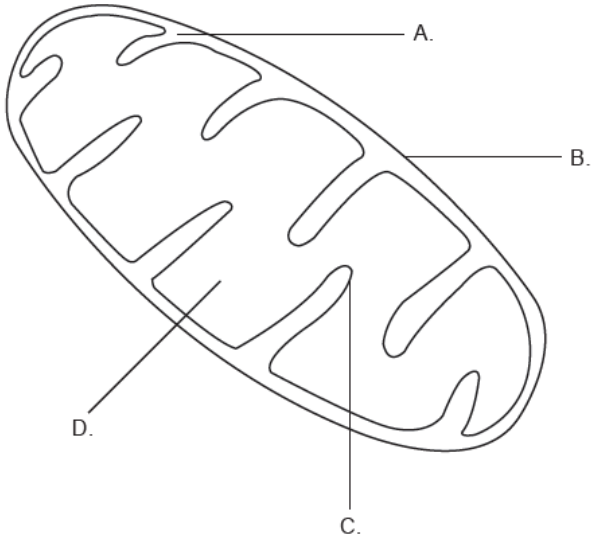
C. II and III only

D. I, II and III

Markscheme

B

5. The diagram shows a mitochondrion. Which letter indicates the structure where ATP synthase is located? *[1 mark]*



Markscheme

C

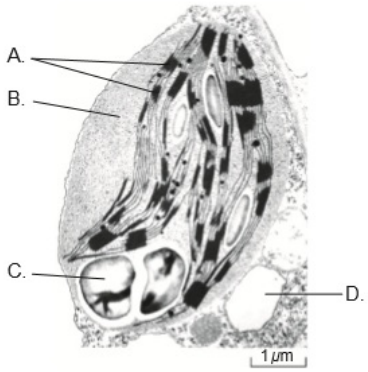
6. Which pair of molecules are products of aerobic and anaerobic cell respiration in some organisms? *[1 mark]*

	Aerobic cell respiration	Anaerobic cell respiration
A.	oxygen	pyruvate
B.	lactate	adenosine triphosphate
C.	carbon dioxide	glucose
D.	adenosine triphosphate	carbon dioxide

Markscheme

D

7. The electron micrograph shows part of a plant cell. Where do the light-independent reactions of photosynthesis take place? *[1 mark]*



[Source: adapted from http://themicroscopicplant.weebly.com]

Markscheme

B

8. From which substrate is the first carbon dioxide molecule released during cellular respiration? *[1 mark]*

A. Glucose

B. Pyruvate

C. Acetyl CoA

D. Citrate (a C_6 intermediate compound in the Krebs cycle)

Markscheme

B

9. 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

10. What happens during glycolysis for one molecule of glucose? *[1 mark]*

A. Two pyruvates are formed.
B. There is a net gain of two NADPH + H^+.
C. There is a net loss of two ATP.
D. Two acetyl CoA are formed.

Markscheme

A

11. What happens in both respiration and photosynthesis? *[1 mark]*

A. Triose phosphates are decarboxylated.
B. NADPH is produced.
C. ATP is produced.
D. Electrons pass through ATP synthase.

Markscheme

C

12. What is light energy used for in photolysis? *[1 mark]*

A. Formation of hydrogen and oxygen
B. Formation of carbon dioxide only
C. Formation of ATP and glucose
D. Formation of oxygen only

Markscheme

A

13. How does chlorophyll respond to the red, green and blue wavelengths in white light? *[1 mark]*

	Red	Green	Blue
A.	reflects	reflects	absorbs
B.	absorbs	reflects	reflects
C.	reflects	absorbs	reflects
D.	absorbs	reflects	absorbs

Markscheme

D

14. In a chloroplast where are the enzymes of the Calvin cycle located? *[1 mark]*

A. Thylakoid membranes
B. Stroma
C. Grana
D. Outer membrane of chloroplast

Markscheme

B

15. What are the effects of changing carbon dioxide concentration on the rate of photosynthesis? *[1 mark]*

I. At low and moderate carbon dioxide concentrations, decreases cause the rate of photosynthesis to fall.
II. At high carbon dioxide concentrations, increases do not alter the rate of photosynthesis.
III. At high carbon dioxide concentrations, increases cause the rate of photosynthesis to fall.

A. I only
B. I and II only
C. I and III only
D. III only

Markscheme

B

16. 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

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 NADH + H^+
B. Pyruvate is decarboxylated, acetyl reacts with coenzyme A, forming NADH + H^+
C. Pyruvate reacts with coenzyme A, forming NADH + H^+
D. Pyruvate is decarboxylated, reacting with coenzyme A, reducing NADH + 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

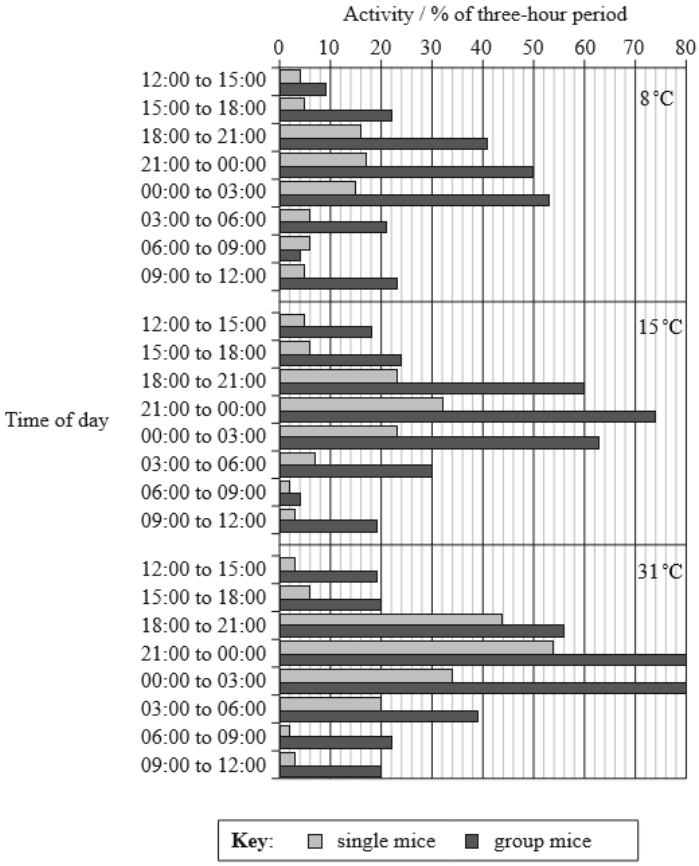
20. What is the role of NADH + H^+ in aerobic cell respiration? *[1 mark]*

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)

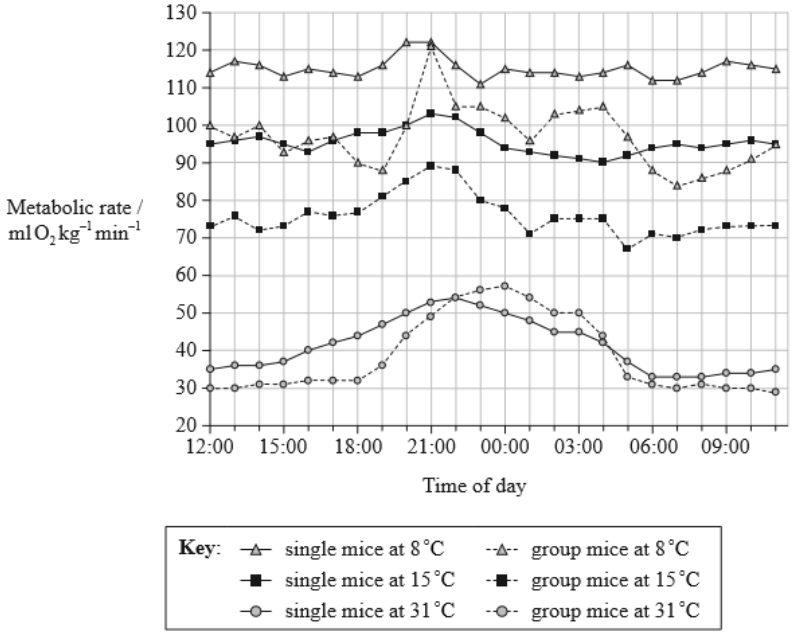
Outline the relationship between activity and temperature from 21:00 to 03:00 in all of the mice.

21b. *[1 mark]*

Markscheme

as temperature increases activity increases/positive correlation.

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.

21c. State the relationship between temperature and metabolic rate. *[1 mark]*

Markscheme

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

21d. 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*)

21e. 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.

21f. Explain why oxygen consumption is used as a measure of metabolic rate. *[2 marks]*

Markscheme

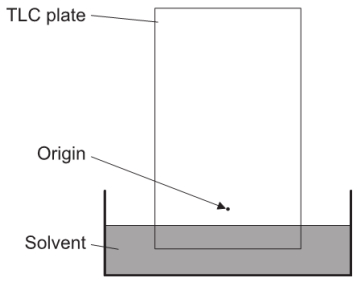
oxygen is required for (aerobic) respiration;
respiration produces ATP/releases energy/heat in the mice;
metabolic rate is a measure of total energy released/consumed in the body / oxygen consumption is proportional to energy released/consumed in body/ proportional to metabolic rate;

21g. 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;

R_f values for photosynthetic pigments may be determined using the technique of thin-layer chromatography (TLC).



22a. Outline what happens when spinach extract is spotted on a TLC plate and placed into a container of solvent. *[2 marks]*

Markscheme

a. solvent will move up «the TLC plate/stationary phase»

b. pigments will move up «the TLC plate/stationary phase carried by solvent»

c. pigments will move at different rates/separate

[Max 2 Marks]

22b. Explain what the R_f values represent in chromatography. *[3 marks]*

Markscheme

a. $R_f = \frac{\text{distance moved by pigment}}{\text{distance moved by solvent «front»}}$

OR

distance moved by pigment relative to distance moved by solvent

b. each pigment has/is represented by a specific R_f «value»

c. used to identify different pigments

d. R_f «value» depends on density/solubility/polarity of the pigment in solvent

Allow "compound" or "molecule" instead of pigment

[Max 3 Marks]

22c. State **two** photosynthetic pigments that could be identified using chromatography. *[1 mark]*

Markscheme

chlorophyll
carotene
xanthophyll

Accept other valid pigments

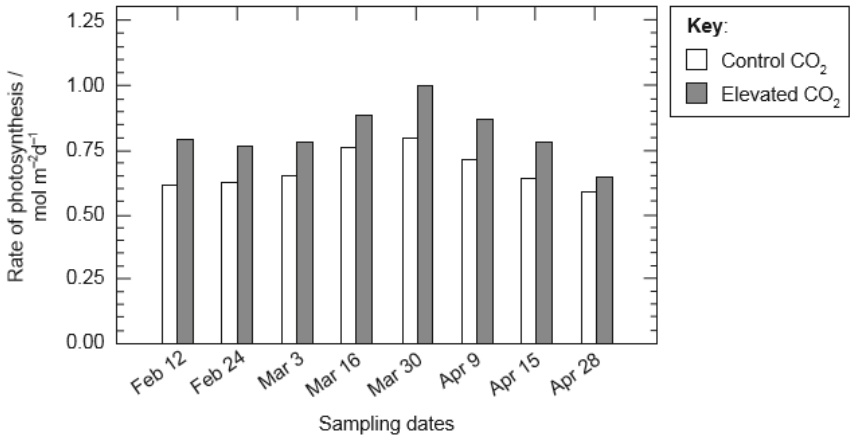
Do not accept pigments named by colour

*Award **[1]** for any two correct*

*Award **[1]** for chlorophyll a **AND** (chlorophyll) b*

[Max 1 Mark]

In a study carried out at the University of Arizona, the effects of increased CO_2 concentration on the rate of photosynthesis in spring wheat, *Triticum aestivum*, were investigated over the course of an entire growing season (from the beginning of February to the end of April). The rate of photosynthesis was measured as the rate of CO_2 uptake from the time of emergence from the seed to maturity. The control plants were grown at a normal air CO_2 concentration while the test plants were grown at an elevated CO_2 concentration.



[Source: R. L. Garcia, S. P. Long, G. W. Wall, C. P. Osborne, B. A. Kimball, G. Y. Nie, P. J. Pinter, R. L. Lamorte and F. Wechsung (1998) 'Photosynthesis and conductance of spring-wheat leaves: field response to continuous free-air atmospheric CO2 enrichment.' *Plant, Cell and Environment*, **21**, pages 659–669.
© Blackwell Science 1998. Used with permission from Wiley.]

23a. Describe the pattern of CO_2 uptake in the control plants. *[2 marks]*

Markscheme

a. constant/low increase in February and early March;
b. increasing to a peak in late March;
c. decrease throughout April;

23b. Outline the effect of increased carbon dioxide concentration on CO_2 uptake. *[2 marks]*

Markscheme

a. increased CO_2 leads to greater (rate of) photosynthesis;
b. greatest effect on March 30th;
c. smallest effect on April 28th;
d. effect is not constant / difference varies;

23c. Discuss how CO_2 uptake in this investigation may be affected by other limiting factors. *[3 marks]*

Markscheme

a. temperature/light intensity may be limiting factors;
b. temperature on sample days may have affected (rate of)photosynthesis/higher temperatures may increase (rate of) photosynthesis / vice versa;
c. light intensity may have affected (rate of) photosynthesis in earlier days/higher light intensity for longer may increase (rate of) photosynthesis / vice versa;
d. water/rainfall must be same for both groups;
e. control and test plants must be grown under the same conditions/other named abiotic variable;

24a. State the location of high proton concentration caused by electron transport in the mitochondrion. *[1 mark]*

Markscheme

inter-membrane space / outside inner membrane / between outer and inner membrane

24b. Outline the role of oxygen in cellular respiration. *[2 marks]*

Markscheme

in the electron transport chain;

final electron/hydrogen acceptor;

combines with H^+ (and electrons) to produce water;

24c. Explain how any **two** structural features of the mitochondrion are related to its function. *[2 marks]*

Markscheme

cristae for increasing surface area;

small inter-membrane space for rapid build-up of concentration gradient;

matrix with chemical concentration to support unique chemical reactions;

25. Distinguish between anaerobic and aerobic cell respiration in eukaryotes. *[3 marks]*

Markscheme

	aerobic	anaerobic
a.	requires oxygen	no oxygen;
b.	(in cytoplasm and) mitochondria	in cytoplasm;
c.	Krebs cycle	no Krebs cycle;
d.	large yield of ATP/energy	small yield of ATP;
e.	CO_2 and water *(both needed)*	lactate (animals);
f.		ethanol + CO_2 (yeast/plants); *(both needed)*

*Award **[1]** for each contrasting characteristic.*

Table format is not necessary for the marks.

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