Review Cell Respiration and Photosynthesis

1. Which way do the protons flow when ATP is synthesized in mitochondria?

A. From the inner matrix to the intermembrane space

B. From the intermembrane space to the inner matrix

C. From the intermembrane space to the cytoplasm

D. From the cytoplasm to the intermembrane space

(Total 1 mark)

2. Which two colours of light does chlorophyll absorb most?

A. Red and yellow

B. Green and blue

C. Red and green

D. Red and blue

(Total 1 mark)

3. The average surface area for the inner membranes of mitochondria in a epithelial cell is 40 m^2 g^{-1}. The surface area of the inner membrane of mitochondria from heart muscle cells is over 200 m^2 g^{-1}.

What is the reason for the large surface area of the inner membranes of the mitochondria in the heart muscle cells?

A. They contain enzymes to hydrolyse ADP and inorganic phosphate to ATP.

B. They contain enzymes to oxidize ADP and inorganic phosphate to ATP.

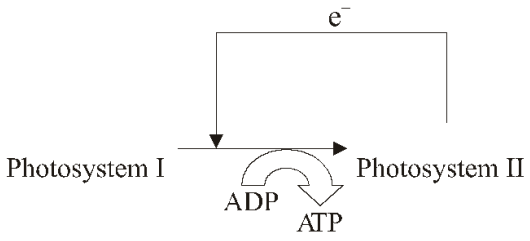
C. They contain enzymes to reduce ADP and inorganic phosphate to ATP.

D. They contain enzymes to condense ADP and inorganic phosphate to ATP.

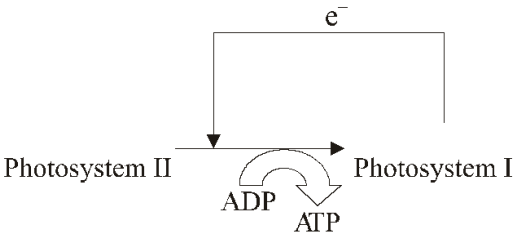
(Total 1 mark)

4. Which diagram represents the process of cyclic photophosphorylation?

A.



B.



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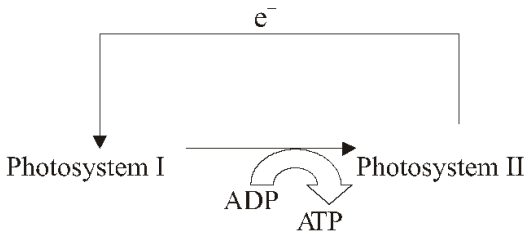
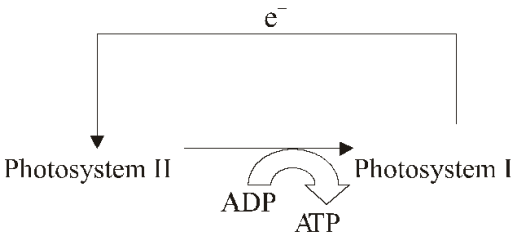


D.



(Total 1 mark)

5. During which process are oxygen molecules directly involved during cellular respiration?

A. Glycolysis

B. Krebs cycle

C. Oxidation of pyruvate to acetyl CoA

D. Accepting electrons at the end of the electron transport chain

(Total 1 mark)

6. Which is **not** a product of the Krebs cycle?

A. CO_2

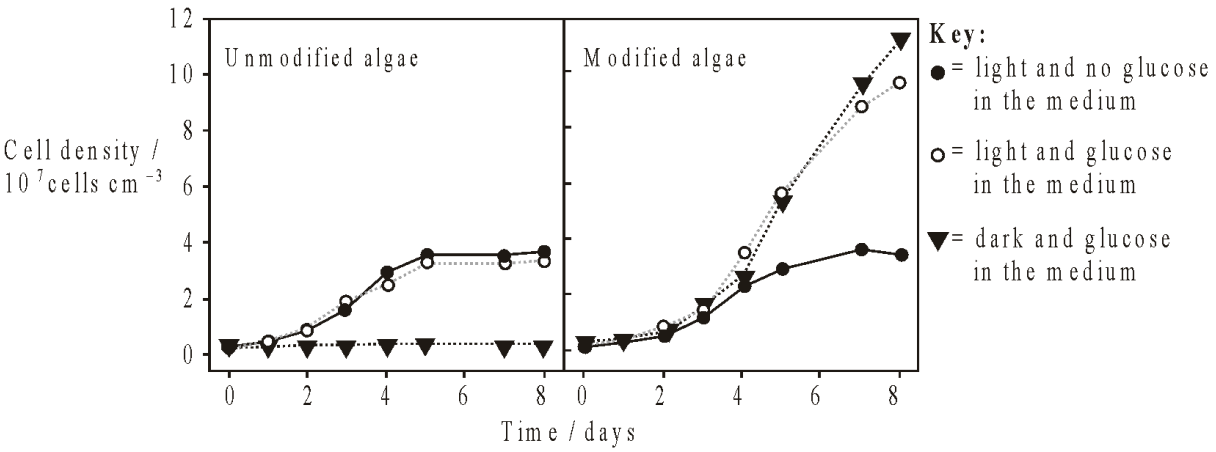
B. $NADH + H^+$

C. Pyruvate

D. ATP

(Total 1 mark)

8. The unicellular green alga *Phaeodactylum tricornutum* is photosynthetic. Cell biologists genetically modified this organism by adding a glucose transporter gene. The modified and unmodified algae were grown in a nutrient medium under a series of different conditions and the growth rate of the cells was measured.



[Source: L A Zaslavskaia, et al., Adapted (2001) *Science*, **292**, pages 2073–2075]

(a) State the role of glucose in the metabolism of cells.

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(1)

(b) Deduce where you would expect to find the glucose transporter protein in the modified algae cells.

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(2)

(c) Compare the effect of light on the modified and the unmodified cells.

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(2)

Commercially, unmodified algae are grown in shallow sunlit ponds or illuminated containers. The cells only grow in the top few centimetres. However, the modified algae can grow at any depth.

(d) Explain why the modified algae can grow at any depth whereas the unmodified algae can only grow at the surface.

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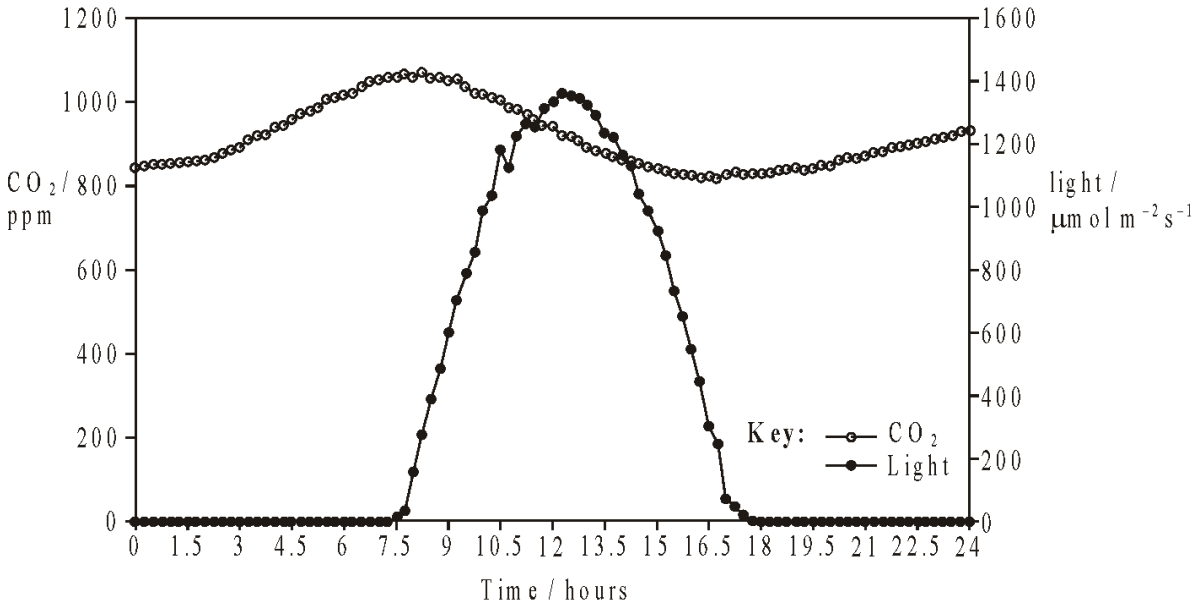
(3)

(Total 8 marks)

9. Biosphere 2, an enormous greenhouse built in the Arizona desert in the USA, has been used to study five different ecosystems. It is a closed system so measurements can be made under controlled conditions. The effects of different factors, including changes in carbon dioxide concentration in the greenhouse, were studied. The data shown below were collected over the course of one day in January 1996.



[Source: http://www.Ideo.columbia.edu/martins/climate_water/labs/lab6/labinstr6/html]

(a) (i) Identify the time of day when the sun rose.

.....

(1)

(ii) Identify the time of minimal CO_2 concentration.

.....

(1)

(b) Determine the maximum difference in the concentration of CO_2 over the 24-hour period.

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.....

(1)

(c) Suggest reasons for changes in CO_2 concentration during the 24-hour period.

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(2)
(Total 5 marks)

10. (a) (i) Identify the cell organelle shown in the micrograph below.

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(1)

(ii) Identify the structure labelled I above and explain how it is adapted for the organelle to function efficiently.

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.....

.....

(3)

(b) Describe the role of acetyl CoA in the metabolism of lipids.

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(2)

(Total 6 marks)

11. During photosynthesis in plants, light energy is absorbed by chlorophyll. This energy is then used to carry out photolysis, which supply substances that are needed to convert carbon dioxide into organic molecules such as glucose.

(a) State the names of **two** products of photolysis in photosynthesis.

1. .....

2. .....

(2)

(b) Explain briefly **one** method for measuring the rate of photosynthesis in a plant.

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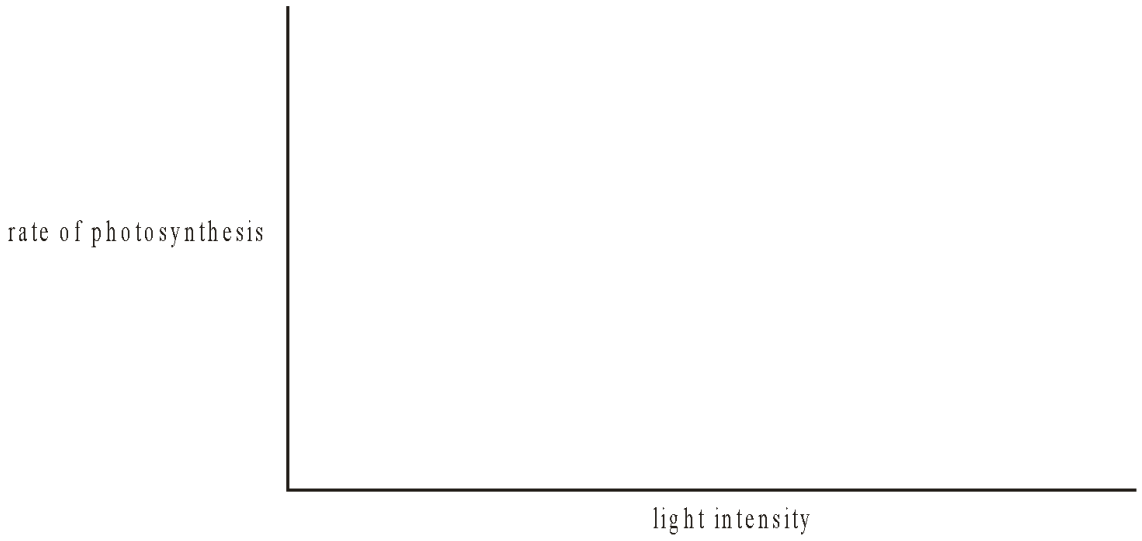
(2)

(c) The rate of photosynthesis is affected by light intensity. Draw a line on the graph below to show the relationship between light intensity and the rate of photosynthesis.



(2)

(d) State **two** factors in the environment of a plant, apart from light intensity, that can affect the rate of photosynthesis in the plant.

1. .....

2. .....

(2)
(Total 8 marks)

12. (a) State **two** functions of proteins with a named example of each.

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.....

(2)

(b) Explain chemiosmosis as it occurs during cell respiration.

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.....

(2)
(Total 4 marks)

13. Explain the reactions involving the use of light energy that occur in the thylakoids of the chloroplast.

(Total 8 marks)

~~**14.** Describe how Calvin's lollipop experiment showed the flow of carbon through a plant.~~

~~**(Total 5 marks)**~~

15. Distinguish between anaerobic and aerobic cell respiration in eukaryotes**. [4]**

16. Explain the light-independent processes of photosynthesis in plants. **[8]**

17. Explain the role of cristae in mitochondria. **[3]**

1.

B

[1]

2.D

[1]

3. D

[1]

4.

B

[1]

5. D

[1]

6.

C

[1]

7.

A

[1]

8.

(a)

substrate for respiration / energy source / for ATP production;
material for growth of cell walls;
precursor for other molecules (*eg* amino acids);

1 max

(b) glucose must be transported from the extracellular fluid / culture medium to the cytoplasm / transported to the cell;
the transporter molecules must be located on the cell (surface) membrane;

2

(c) in the presence of light but no glucose, both modified and unmodified algae grow in the same way;
in the presence of light and glucose, the unmodified algae show no change but the modified algae grow faster and for a longer period of time;
in the absence of light but with glucose, the unmodified algae do not grow at all but the modified algae grow as well as when there is light and glucose;

2 max

(d) algal cells are pigmented green / have chlorophyll;
pigments absorb light for photosynthesis;
the more the algae grow, the more light is absorbed (so shading algae below them);
unmodified algae floating deeper in the water receive less light / are shaded and starve;
modified algae (given glucose) can carry on metabolising even if they are shaded / do not need light;

3 max

[8]

9.

(a)

(i)

07:30 / 7.30 am / 7.5 hours (*accept answers in range up to 07.45*)

1

(ii) 17:00 / 5.00 pm (± ½ hour)

1

(b) 250 ppm (± 30 ppm) (*unit required*)

1

(c) at night / darkness / no light only respiration occurs so CO_2 increases;
in day / with light both respiration and photosynthesis occur / photosynthesis exceeds respiration in day;
CO_2 is used by photosynthesis and level decreases;
when sun sets, CO_2 again increases as only respiration occurs;

2 max

[5]

10.

(a)

(i)

mitochondrion

1

(ii) crista;

*Award **[1]** for each of the following, up to **[2 max]**.*

folded membrane;
provides large surface area;
for electron transport chain / site of ATP synthesis;
moves protons to inter membrane space from matrix;

3 max

(b) fatty acids oxidized / broken down;
form two-carbon atom (acetyl) fragments;
which are passed to Krebs' cycle to be metabolized;

2 max

[6]

11.

(a)

oxygen;
hydrogen / reduced NADP (NADPH) / H^+ / protons;
ATP;

2 max

(b) measure oxygen production over a fixed period of time / rate;
collect bubbles of oxygen (from water plant);
or
measure carbon dioxide uptake over a fixed period of time / rate;
measure (colour) change of pH indicator / other method over a fixed period of time / rate;
or
measure increase in biomass / height / leaf size etc over a fixed period of time / rate;
harvest replicate samples at time intervals for biomass determination;

2 max

(c) straight line increase;
followed by a plateau at high light intensities;

2

(d) temperature;
carbon dioxide concentration;
water / humidity;

2

[8]

12.

(a)

*Award **[1]** for any two correct examples.*
hormones *eg* insulin;
enzymes *eg* amylase;
structural *eg* collagen;
movement *eg* myosin / actin;
transport *eg* hemoglobin;
defence *eg* antibodies / immunoglobin;

2 max

(b) ATP synthesis is coupled to electron transport / H^+ movement;
occurs over the (inner) mitochondrial membrane;
electrons are transported through carriers;
energy released by electron transport;
protons / H^+ pumped across the membrane;
ATP synthetase transports H^+;
uses energy to make ATP;

2 max

[4]

1. **13.**

a. chlorophyll / photosystem absorbs light;
b. electron raised to higher energy level / photoactivated;
c. splitting of water / photolysis replaces electron;
d. passing of excited electrons between chlorophyll molecules in photosystems;
e. electron passed from photosystem II to carriers (in thylakoid membrane);
f. production of ATP in this way is called photophosphorylation;
h. electron causes pumping of protons into the thylakoid;
i. proton gradient used by ATPase to drive ATP production;
j. electron passes to photosystem I at end of carrier chain;
k. electron re-excited and emitted by photosystem I;
1.electron passed to / used to reduce $NADP^+$;
m. NADPH + H+ / reduced NADP produced;
n. cyclic photophosphorylation using photosystem I
o. electron carriers and ATPase only;
Accept any of the above points if clearly drawn and correctly labelled in a diagram.

[8]

14.

Radioactive carbon-14 is added to a 'lollipop' apparatus containing green algae (Chlorella)

Light is shone on the apparatus to induce photosynthesis (which will incorporate the carbon-14 into organic compounds)

After different periods of time, the algae is killed by running it into a solution of heated alcohol (stops cell metabolism)

Dead algal samples are analysed using 2D chromatography, which separates out the different carbon compounds

Any radioactive carbon compounds on the chromatogram were then identified using autoradiography (X-ray film exposure)

By comparing different periods of light exposure, the order by which carbon compounds are generated was determined

Calvin used this information to propose a sequence of events known as the Calvin cycle (light independent reactions)

15.

	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)*

16.
a. occurs in stroma (of chloroplast);
b. energy/ATP and NADPH provided by the light-dependent reactions;
c. Calvin cycle;
d. carbon dioxide fixed to RuBP / carboxylation of RuBP/ribulose bisphosphate;

e. by RuBP carboxylase/rubisco;
f. forms unstable 6C compound / forms 6C compound which splits;
g. glycerate 3-phosphate (is produced by carbon fixation);
h. (glycerate phosphate) to triose phosphate/3C sugar by reduction/adding hydrogen;
i. using NADPH/reduced NADP;
j. triose phosphate/3C sugar converted to form hexose/glucose (phosphate);
k. most/$^{5}/_{6}$ of triose phosphate used for regeneration of RuBP;
l. ATP used to regenerate RUBP/convert glycerate 3-phosphate to triose phosphate;

17.

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