

WITH
Emmatheteachie

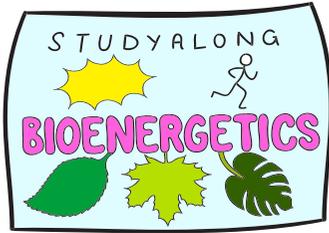


BIOENERGETICS



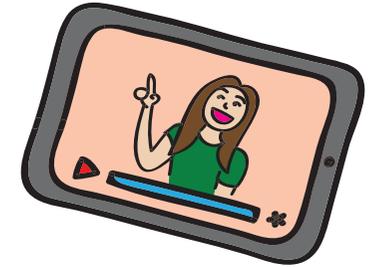
HOW TO STUDYALONG!

BIOLOGY TOPIC 4



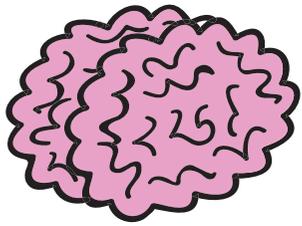
Pick your style!

Print the workbook in the style you want - colour or black & white! B&W is great for de-stressing colouring in & less ink!



Studyalong with me!

Complete the Studyalong tasks while watching my videos, pausing and replaying as much as you want!



Test your brain!

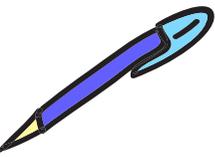
Quick Questions give you the chance to see which bits you've nailed and which bits need another look over!

Save your success!

Track your learning with your very own progress tracker - super satisfying and useful for future revision sessions!



Plants



Examine and excel!

27 exam-style questions to finish off the topic and let you practice your exam technique!

Bonus break!

Take a break and check out the bonus activity at the back for some fun or print a black & white cover page to colour in!



YOUR PROGRESS TRACKER

BIOLOGY TOPIC 4

Colour in the star that shows how you're doing for each section!

MORE REVISION



ALMOST THERE



NAILED IT YEAH!



Notes - add these to help you in future revision sessions, e.g. learn the five uses of glucose.

	MORE REVISION	ALMOST THERE	NAILED IT YEAH!	Notes
Photosynthesis	☆	☆	☆	
The rate of photosynthesis	☆	☆	☆	
Making the most of photosynthesis (Higher Tier)	☆	☆	☆	
How plants use glucose	☆	☆	☆	
Respiration	☆	☆	☆	
Response to exercise	☆	☆	☆	
Metabolism	☆	☆	☆	



CONTENT AND VIDEOS

BIOLOGY TOPIC 4



Scan the **QR code** using your phone or tablet camera (apple devices) or QR reader app (android devices) to load up the videos! Or visit the Emmatheteachie YouTube channel or website and select the "Bioenergetics" playlist.



PHOTOSYNTHESIS



1-3

THE RATE OF PHOTOSYNTHESIS



4-7

MAKING THE MOST OF PHOTOSYNTHESIS (HT)



8-10

HOW PLANTS USE GLUCOSE



11-13

RESPIRATION



14-16

RESPONSE TO EXERCISE



17-19

METABOLISM



20-22

23-33 EXAM-STYLE QUESTIONS 34-40 ANSWERS

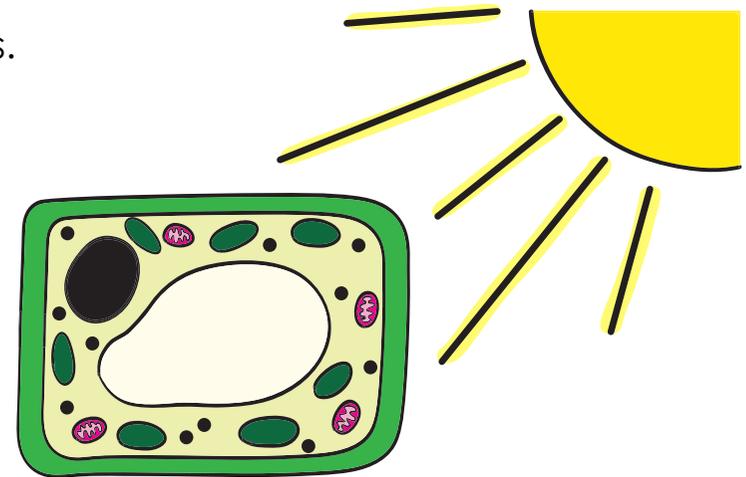
41-42 BONUS ACTIVITY (WOO!) 43 THANK YOU



PHOTOSYNTHESIS



Describe what photosynthesis is and where in the cell it occurs.



Complete the word and symbol equations for photosynthesis:



SYMBOLS

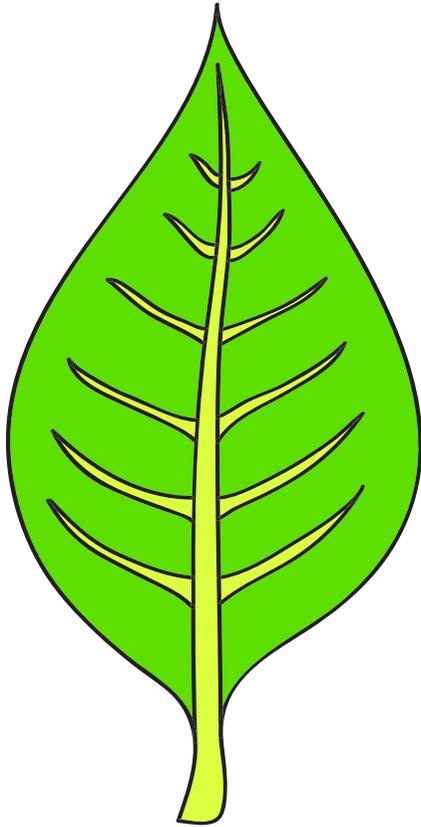


Explain why we call photosynthesis an endothermic reaction.

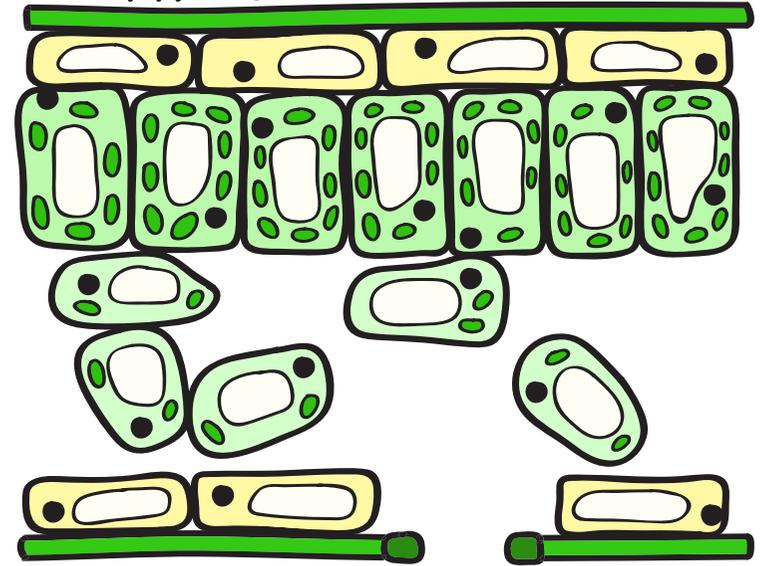




Describe how leaves are adapted to maximise photosynthesis. You may wish to label the diagrams as you do this.



LEAF CROSS-SECTION



PHOTOSYNTHESIS

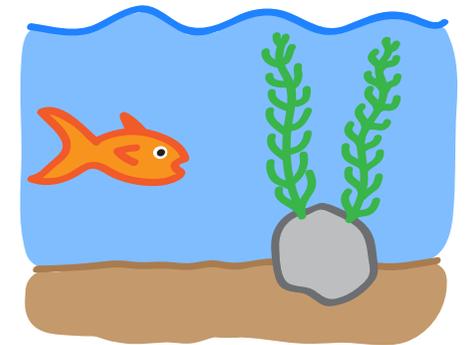
<< QUICK QUESTIONS >>

1. How do plant leaves obtain (get) the water they need for photosynthesis? ([Link to topic 1 - Cell Biology](#))

2. Complete the word equation below for photosynthesis and then write the formula for each chemical directly below it.



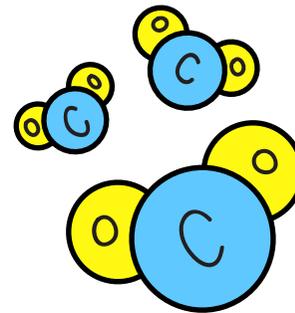
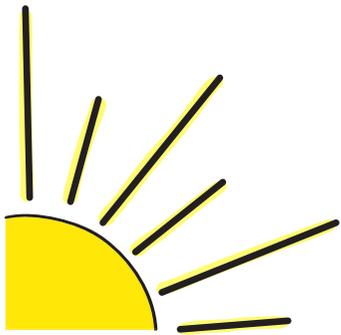
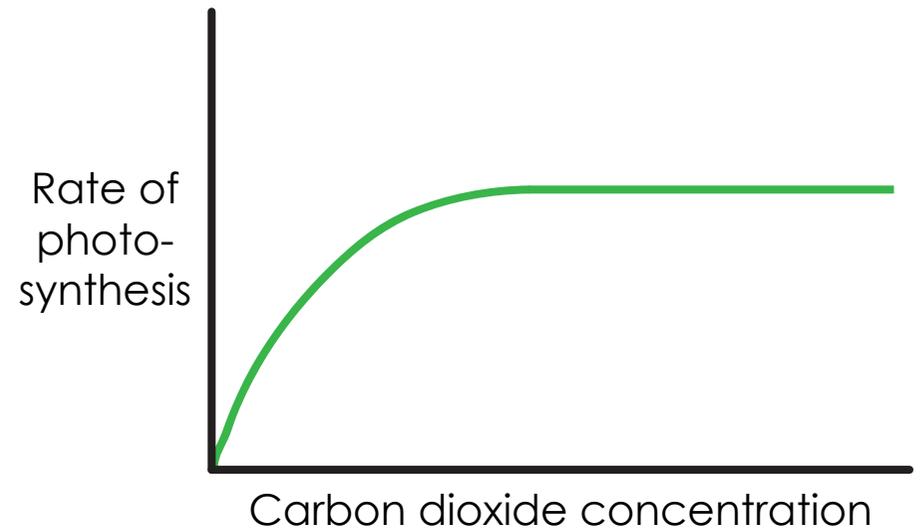
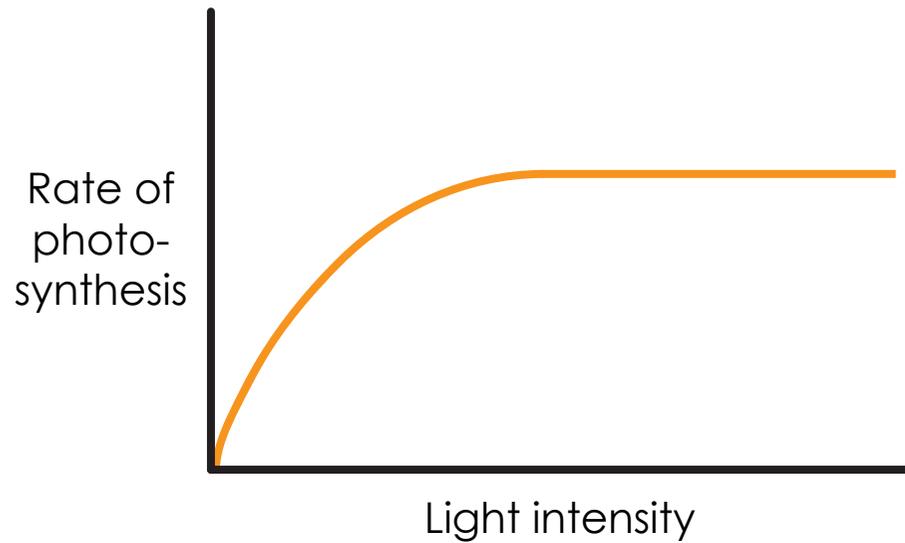
3. Some plants, like pondweed, are aquatic, which means they live underwater. Suggest how they obtain the carbon dioxide needed for photosynthesis.



THE RATE OF PHOTOSYNTHESIS



Label the graphs to show what is the limiting factor at stage. Then, below the graphs, write a brief explanation of why each factor can affect the rate of photosynthesis.



THE RATE OF PHOTOSYNTHESIS

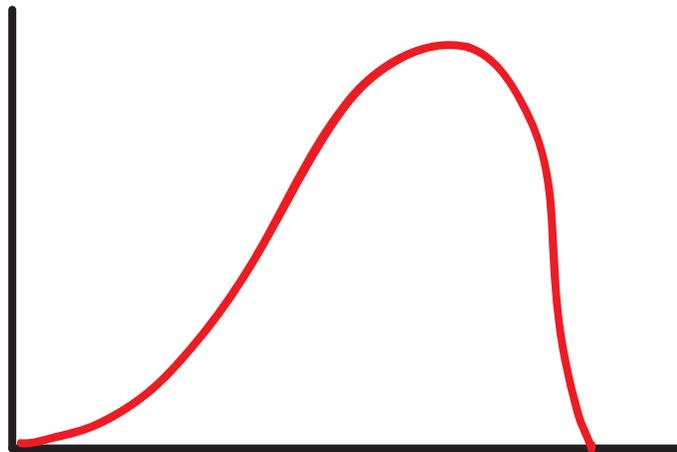


Label the temperature graph to show when temperature is limiting. Include what happens at very high temperatures.



Explain why the amount of chlorophyll can affect the rate of photosynthesis.

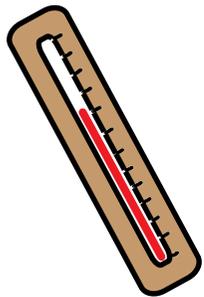
Rate of photosynthesis



Temperature

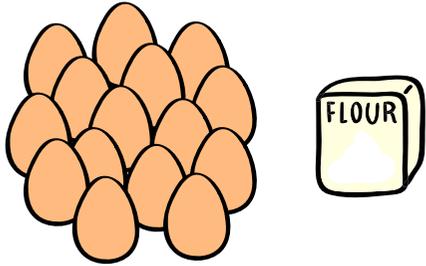


Amount of chlorophyll



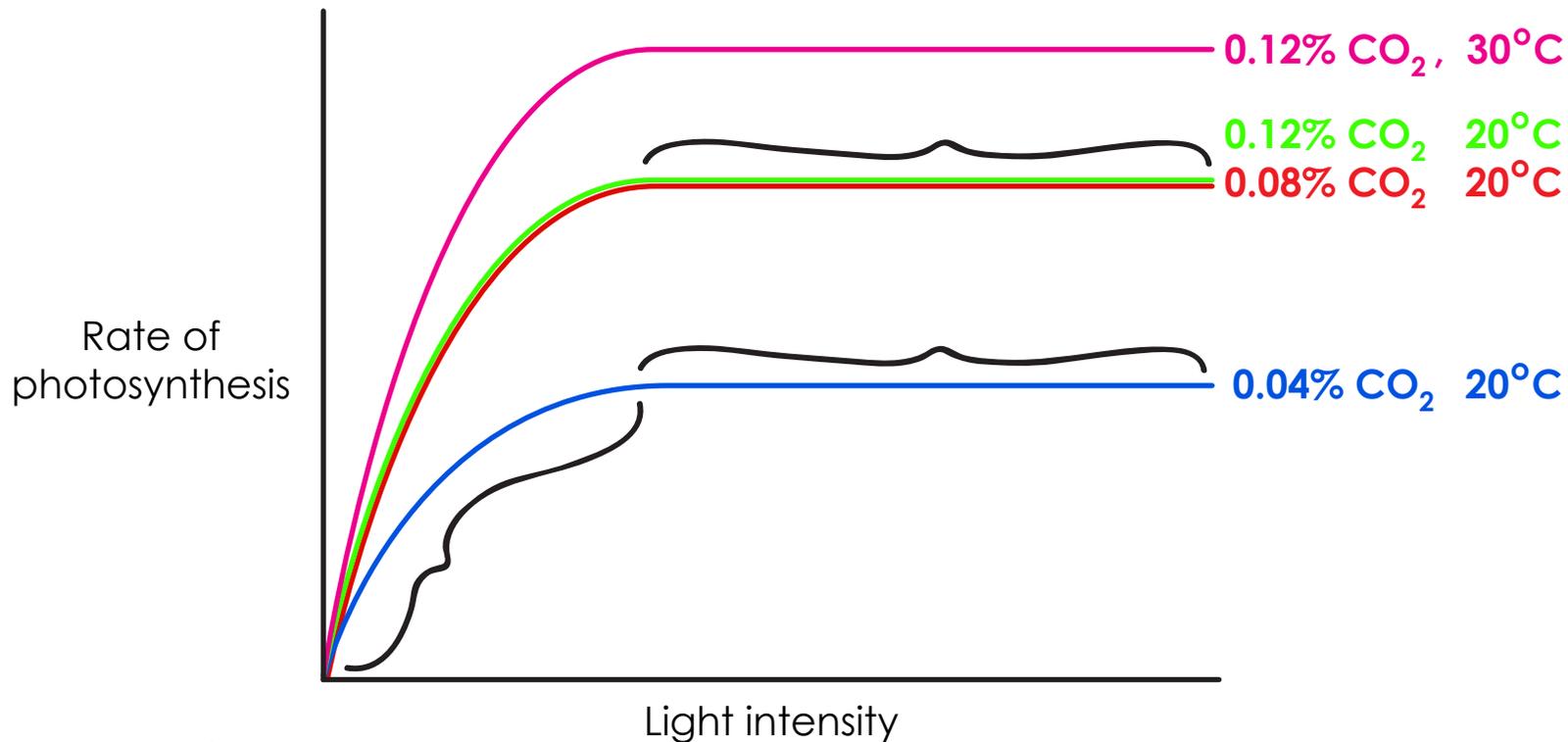
THE RATE OF PHOTOSYNTHESIS

★ Describe how limiting factors can interact, using the “baking a cake” example.



HIGHER TIER

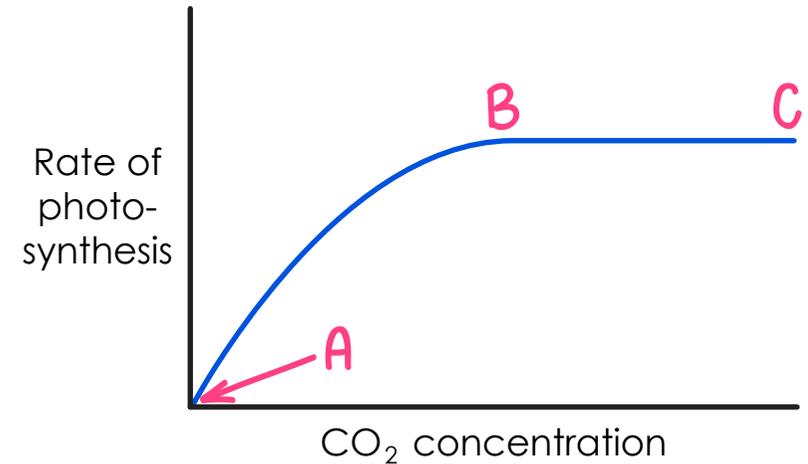
★ Label this graph to show the limiting factors at each section.



THE RATE OF PHOTOSYNTHESIS

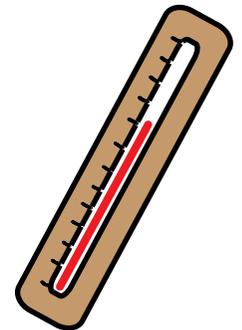
<< QUICK QUESTIONS >>

1. The graph on the right shows how CO_2 concentration affects the rate of photosynthesis. Between which two points is CO_2 concentration a limiting factor?



2. Name two other factors that could be limiting the rate of photosynthesis in this situation.

3. On hot, sunny days, gardeners should monitor their greenhouses to ensure the temperature does not get too high. Explain why, in relation to photosynthesis.

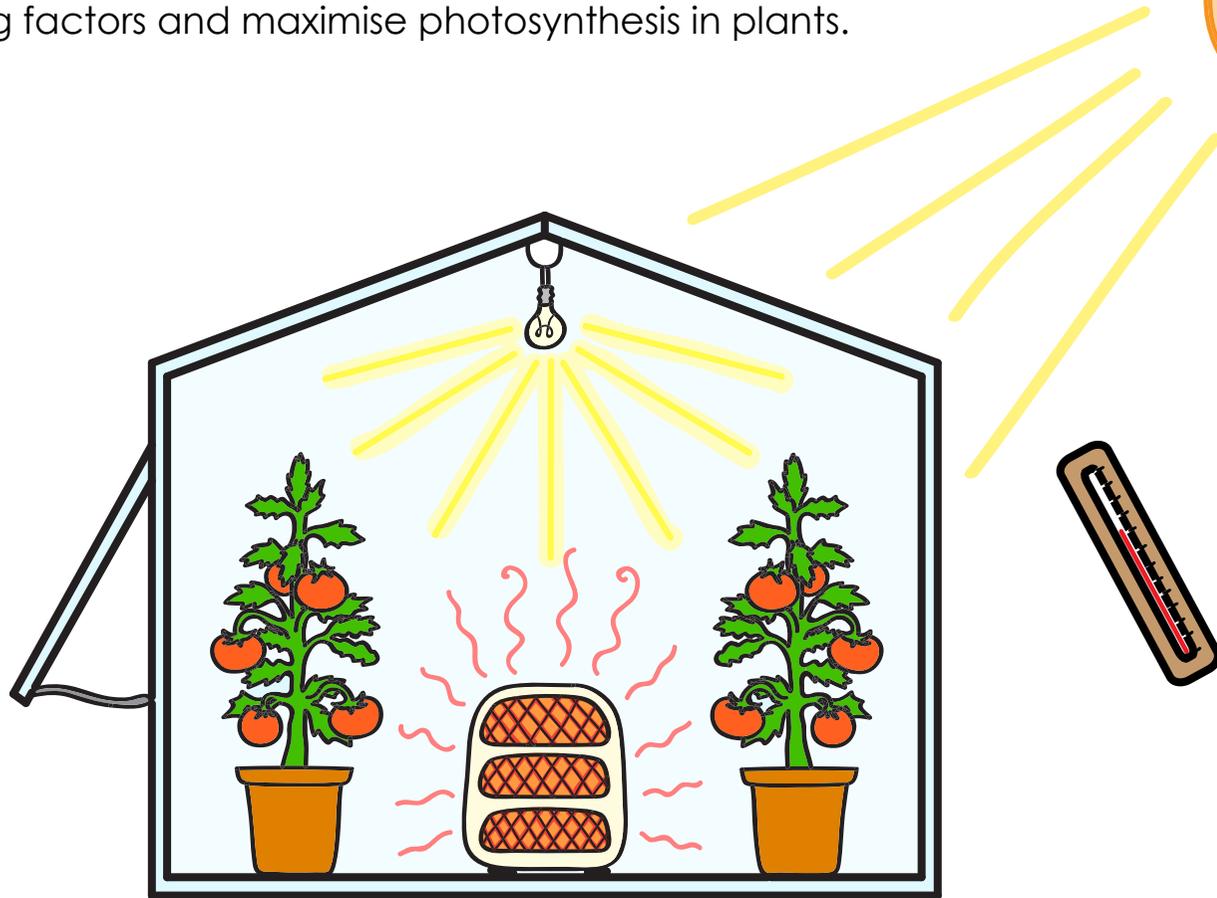


MAKING THE MOST OF PHOTOSYNTHESIS

HIGHER TIER

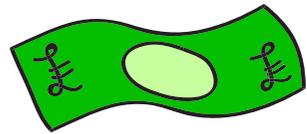


Label the diagram below to show how gardeners can use greenhouses to remove limiting factors and maximise photosynthesis in plants.



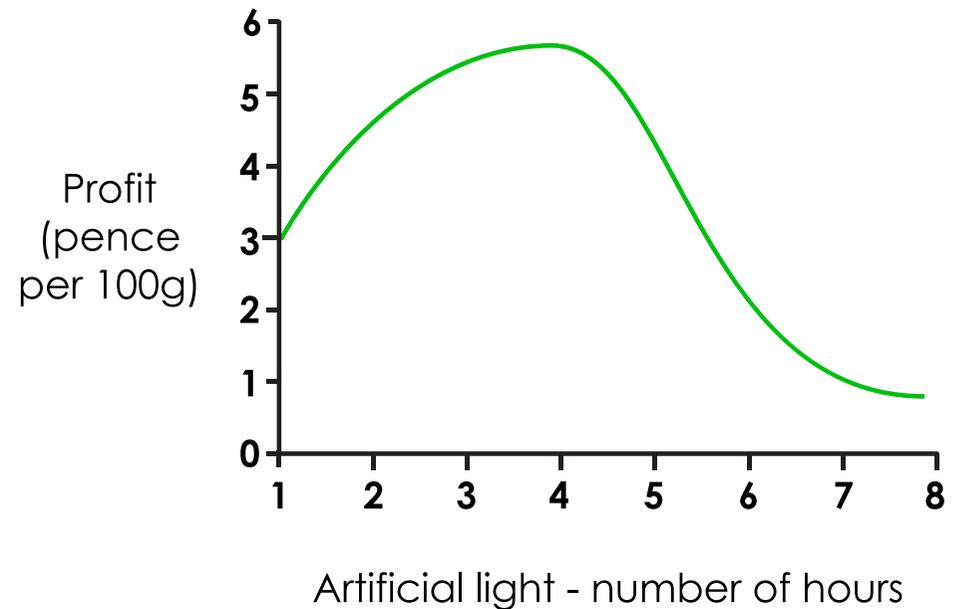
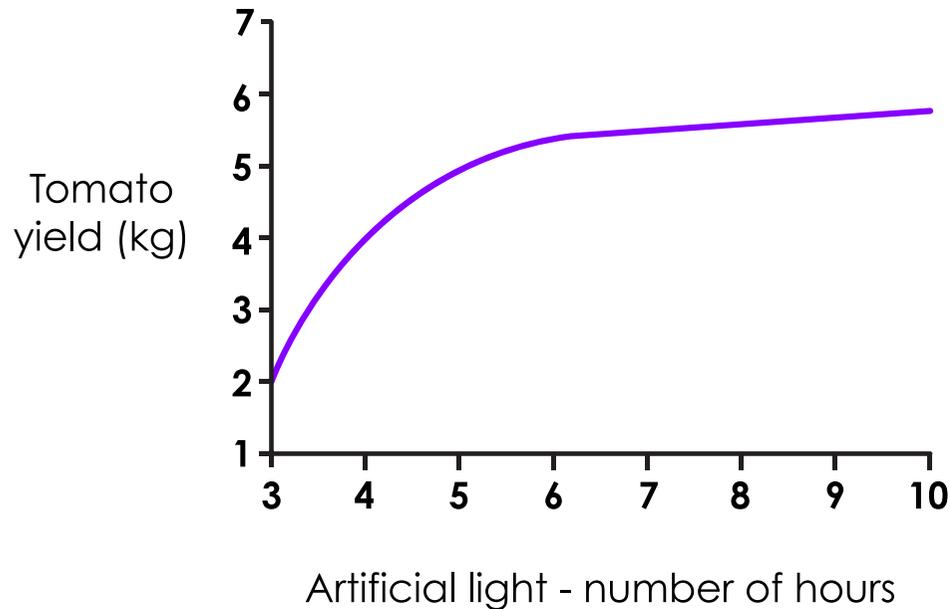
MAKING THE MOST OF PHOTOSYNTHESIS

Describe why it is important for gardeners and farmers to consider profit.



Identify and explain how many hours of artificial light is best for the gardener in each graph below.

HIGHER TIER



MAKING THE MOST OF PHOTOSYNTHESIS

<< QUICK QUESTIONS >>

1. A farmer wants to increase the yield of their lettuce crops using higher carbon dioxide concentrations. They conduct a small experiment and collect these results. Which concentration should the farmer use and why?

CO ₂ concentration (PPM)	400	500	600	700	800
Increase in yield (g)	220	280	290	300	300

2. In this experiment, each 100 PPM increase in CO₂ concentration cost an additional £0.20. Each 10g increase in yield earns £0.10. Using this information and the information in the table, which concentration should the farmer use for maximum profit? Show your working.



HOW PLANTS USE GLUCOSE

★ Describe how plants use glucose using the letters below.

F

O

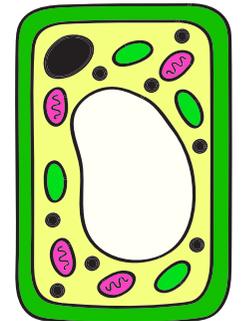
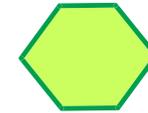
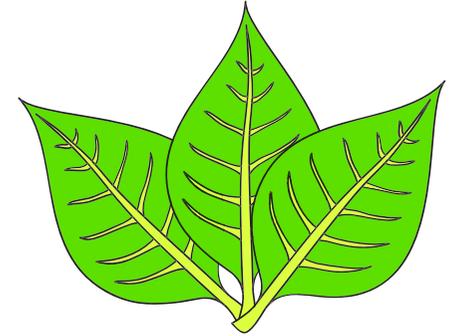
S

R

A

A

C



HOW PLANTS USE GLUCOSE



If the made-up word "FOSRAAC" doesn't work for you, try making up a mnemonic to remember the uses of glucose. Here's how you can make one.

A MNEMONIC IS A SENTENCE YOU CAN USE TO TRIGGER YOUR MEMORY USING THE FIRST LETTER OF EACH WORD

Use the letters below to make a memorable sentence. You can rearrange the letters, but I recommend keeping the "F" and "O" together as they stand for Fats and Oils (which is one use of glucose) and keeping the "A" and "A" together as they stand for Amino Acids (which is one use of glucose).

F O S R A A C

Now you try!

EXAMPLE

Sarah's

Rabbits

Are

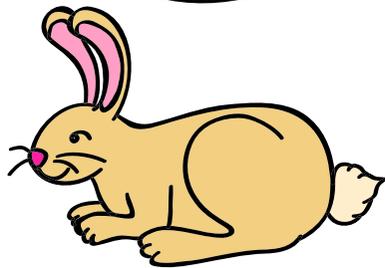
Amazing

For

Often

Cuddling

TIP: Using the name of someone you know makes it more memorable!



TIP: if you can visualise it, you're more likely to remember it!



HOW PLANTS USE GLUCOSE

<< QUICK QUESTIONS >>

1. In animals, glucose is converted into glycogen for storage. What is it converted to in plants?
2. Name two other storage materials that glucose is used to produce.
3. How does glucose play a role in strengthening plant cells?
4. Name the chemical reaction that breaks down glucose.

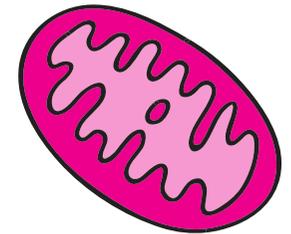


RESPIRATION



★ Describe what respiration is and why it is important.

★ Complete the word equation for aerobic respiration, then write the symbols for each substance below it.



AEROBIC

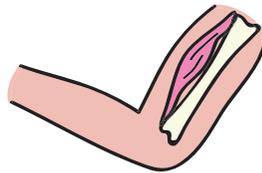
_____ + _____ → _____ + _____



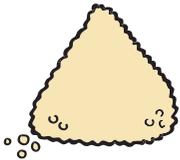
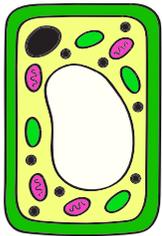
Describe what anaerobic respiration is and how it compares to aerobic respiration in terms of energy transferred. Then complete the word equations below.

ANAEROBIC

Anaerobic respiration in animal muscles:



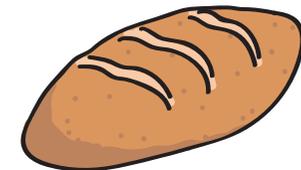
Anaerobic respiration in plant and yeast cells:



+



Name the process of aerobic respiration in yeast and describe its importance.



RESPIRATION

<< QUICK QUESTIONS >>

1. Complete the table by putting a tick or cross in each box to show which type(s) of respiration each statement applies to.

Statement	Aerobic	Anaerobic
Produces lactic acid in muscles		
Incomplete oxidation of glucose		
Exothermic reaction		

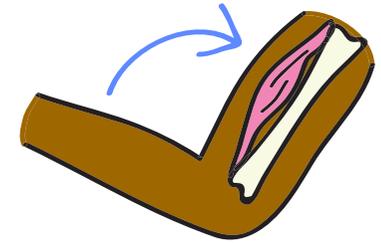
2. Write the word equation for aerobic respiration, then write the chemical formula for each substance below it.

3. Yeast can respire anaerobically - this process is important in the manufacture of bread and alcoholic drinks. What is another name for this process?

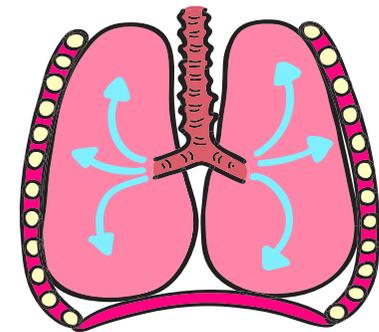
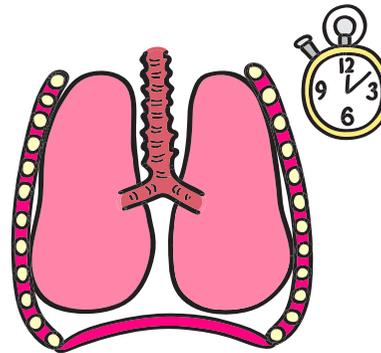
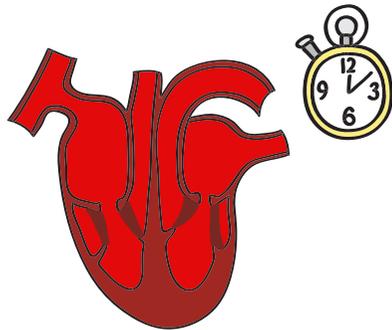
RESPONSE TO EXERCISE



Describe what exercise is and what demands this places on the body.



Describe three changes that the body undergoes during exercise to meet these demands.



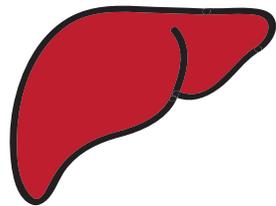
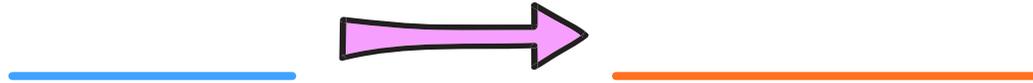
RESPONSE TO EXERCISE

★ Describe the impact of long periods of vigorous activity on the body.



★ Complete the word equation. Then describe why this product is produced and the impact of this on the body.

ANAEROBIC
RESPIRATION



★ Explain what is meant by the term “oxygen debt” (Higher Tier).



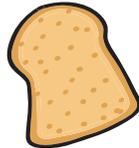
METABOLISM

REACTION
REACTION
REACTION
REACTION
REACTION
+ REACTION

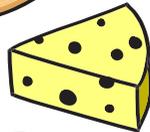
★ Write a definition for metabolism.

★ Describe the six examples of metabolic processes you need to know.

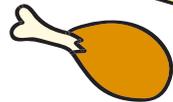
1



CARBOHYDRATES →

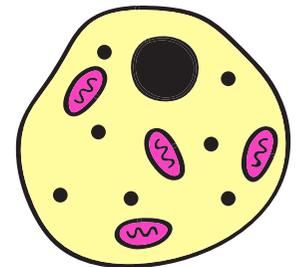
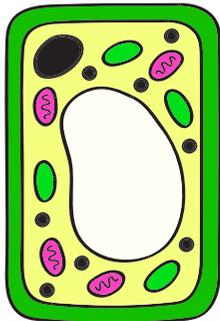


LIPIDS →



PROTEINS →

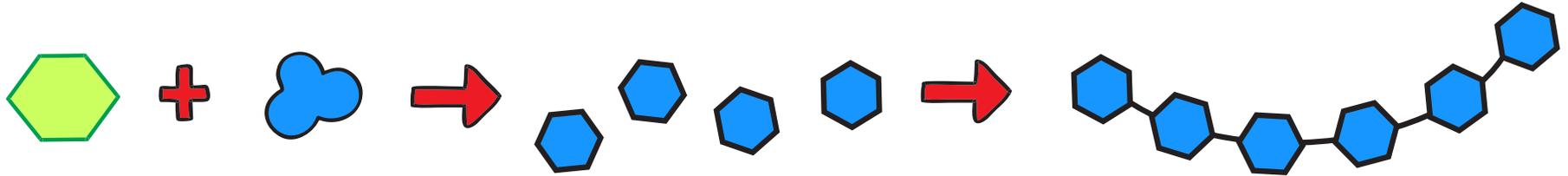
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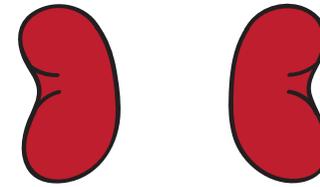
METABOLISM

★ Describe the six examples of metabolic processes you need to know.

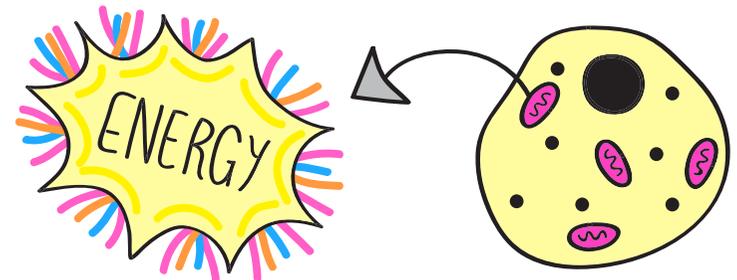
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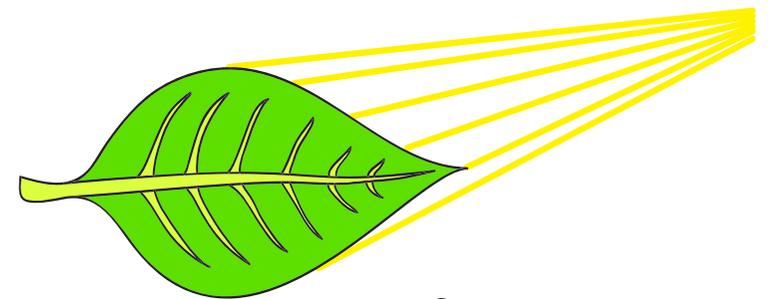
4



5



6



METABOLISM

<< QUICK QUESTIONS >>

1. Glucose is involved in many metabolic processes. State two examples of these.

2. Fill in the gaps for this metabolic process, choosing the correct words from below:

→ +

Glycerol - starch - lipids - proteins - fatty acids

3. Which fundamental metabolic process occurs in all living organisms on earth?



EXAM-STYLE QUESTIONS

BIOLOGY TOPIC 4

1. The substances shown below are involved in the process of photosynthesis. Match the name of each substance to the correct chemical formula using lines. (2)

water •

oxygen •

carbon dioxide •

glucose •

• $C_6H_{12}O_6$

• CO_2

• H_2O

• O_2

2. Complete the word equation for photosynthesis. (1)

_____ + _____ → _____ + _____

3. Besides the reactants, which other condition is necessary for photosynthesis to occur? (1)

4. Glucose is produced during the process of photosynthesis. Describe how this is transported to other parts of the plant. (2)



EXAM-STYLE QUESTIONS

BIOLOGY TOPIC 4

5. Root hair cells are unable to photosynthesise. Identify and name the part of the cell they do not possess. (2)

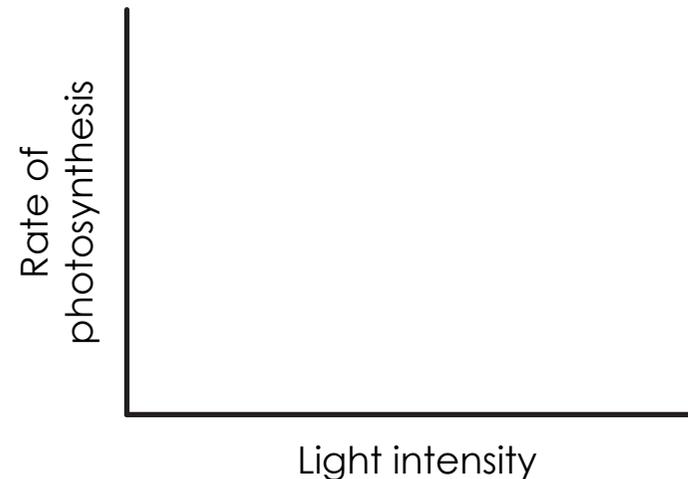
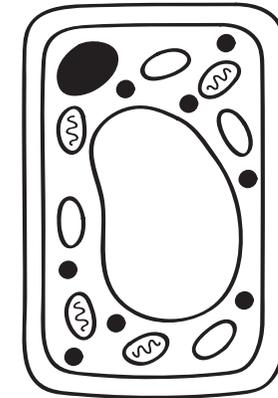
You should:

- draw a straight line to the organelle
- label the line

6. Suggest why root hair cells lack this component. (1)

7. Light intensity is one factor that can limit the rate of photosynthesis. Complete the sketch graph by drawing a line to show how increasing light intensity affects the rate of photosynthesis. (2)

8. High temperatures can decrease the rate of photosynthesis. Explain why. (1)



EXAM-STYLE QUESTIONS

BIOLOGY TOPIC 4

9. A group of students carried out an investigation into carbon dioxide concentration. They moved a lamp different distances from pondweed in a beaker of water and counted the number of bubbles released in one minute at each interval. Here are their results:

Distance (cm)	10	20	30	40	50	60
Number of bubbles released (/min)	32	32	32	25	18	12

A) At which distance does light stop being a limiting factor? (1)

B) Explain how you got your answer to part (A). (1)

C) Calculate how many times lower the light intensity is at 20cm distance from the pondweed, compared to 10cm. Use the inverse square law and show your working out. *Higher Tier only.* (2)



D) In the experiment described above, a separate beaker of water is often placed between the light source and the beaker containing the pondweed. Explain why. (2)

E) The rate of photosynthesis was determined by counting the number of bubbles produced per minute. Give one disadvantage of this method and suggest an alternative method for measuring the rate of photosynthesis. (2)

10. Glucose produced in photosynthesis is important for protein synthesis. Describe the role that glucose plays in this process. (2)

11. Glucose has many uses in plants, including playing a role in protein synthesis, as mentioned in question 10. State four other uses of glucose in plants. (4)

12. The photograph shows a variegated leaf. It is removed from a plant and tested with iodine, which is an orange-brown colour. The green part of the leaf stains blue-black. Explain why. (3)



Image by Gaz D on Pixabay

13. Predict the expected result for the white part of the leaf with iodine. (1)

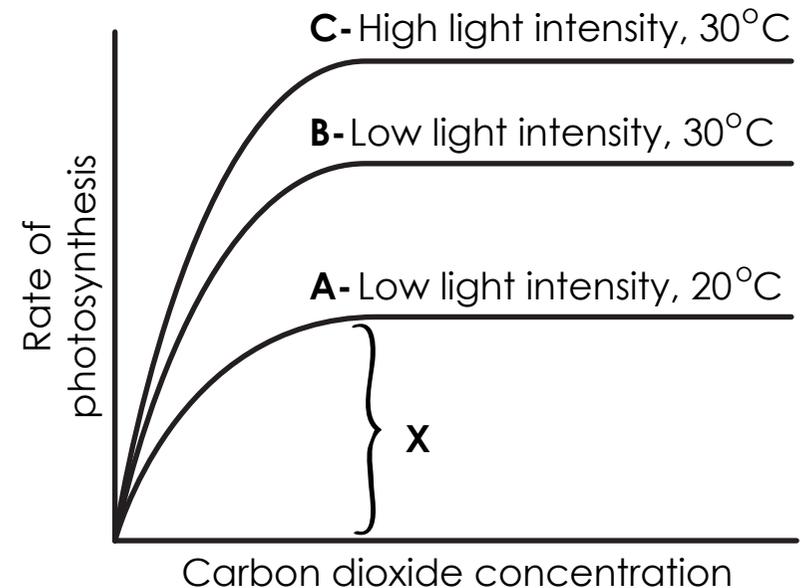


EXAM-STYLE QUESTIONS

BIOLOGY TOPIC 4

14. All parts of question 14 are HIGHER TIER ONLY.
The graph shows the results of three experiments to investigate factors affecting the rate of photosynthesis.

A) In experiment A, the start of the line labelled 'X' is where CO_2 concentration is limiting the rate of photosynthesis. Explain how the graph shows this. (1)



B) In experiment A, the rate of photosynthesis levels off (stops increasing) at a certain point.
Explain why this has happened. (2)

C) Identify and explain which factor is limiting the highest rate of photosynthesis in experiment B. (2)

EXAM-STYLE QUESTIONS

BIOLOGY TOPIC 4

15. Light intensity, carbon dioxide concentration and temperature are all limiting factors of photosynthesis. Name the fourth limiting factor of photosynthesis. (1)
16. Gardeners and farmers can increase the yield of their crops by using greenhouses. Explain how this can be achieved. You should include descriptions of the methods used and explanations of how these increase crop yield. (6)



17. HIGHER TIER ONLY. A farmer is trialling different methods to improve crop yield and profits. Identify the most profitable method by completing the table below. (3)

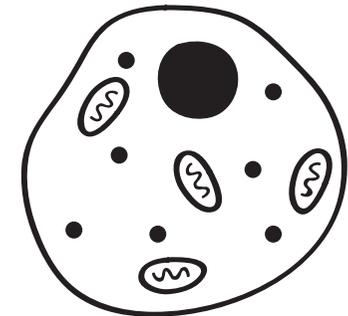
Method	Costs (£)	Profit as a % of costs	Profit (£)
Artificial lights	198	180	
CO ₂ piping	270	140	
Heaters	286	130	

The most profitable method is: _____.

18. Aerobic respiration transfers energy for the cell's activities. Identify and name the part of the cell where this process takes place. (2)

You should:

- draw a straight line to the organelle
- label the line



19. Describe the three main reasons why organisms require energy from respiration. (3)

EXAM-STYLE QUESTIONS

BIOLOGY TOPIC 4

20. Complete the word equation for aerobic respiration in the muscles. (2)

_____ + _____ → _____ + _____

21. During vigorous activity, the body is unable to supply the muscles with sufficient oxygen and it switches to anaerobic respiration. State one advantage and one disadvantage of anaerobic respiration. (2)

22. Plants and yeast are also capable of carrying out anaerobic respiration. State the products of this reaction. (2)

23. Anaerobic respiration in yeast is also known as fermentation. Describe the economic importance of this process to humans. (2)

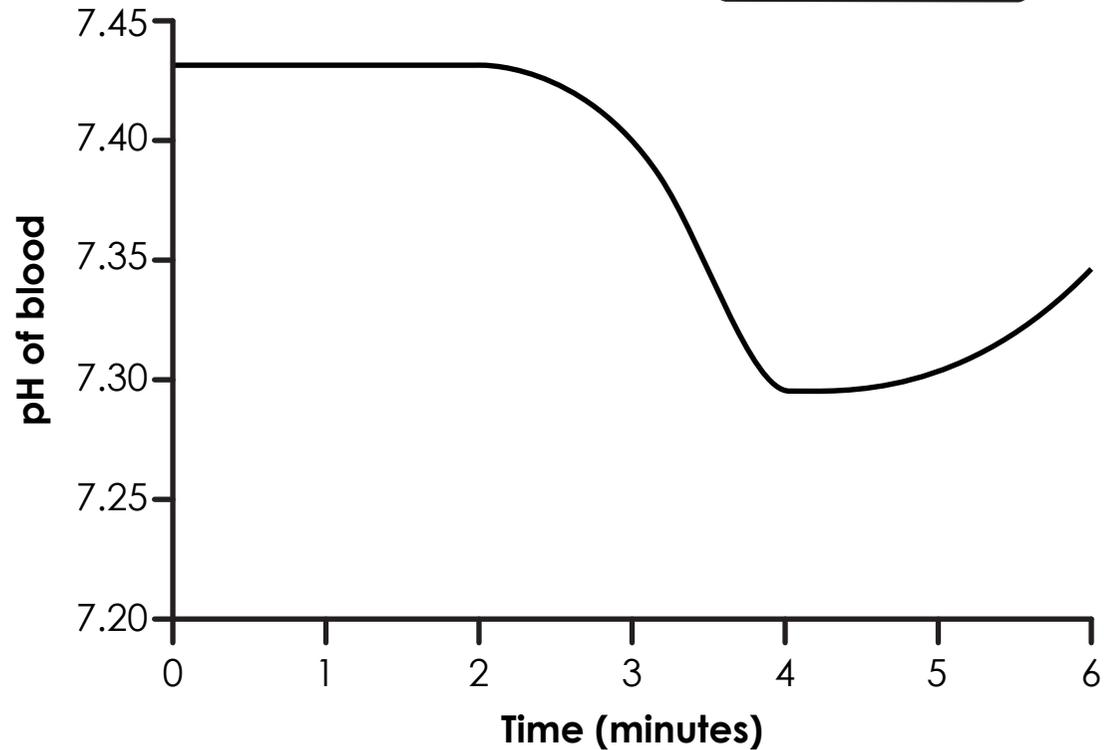


EXAM-STYLE QUESTIONS

24. An athlete runs on a treadmill while having the pH of their blood monitored. Use the graph to answer the following questions:

A) Initially the athlete jogged slowly to warm up. At what time did the athlete begin to sprint? (1)

B) Explain your answer to part (A). (2)



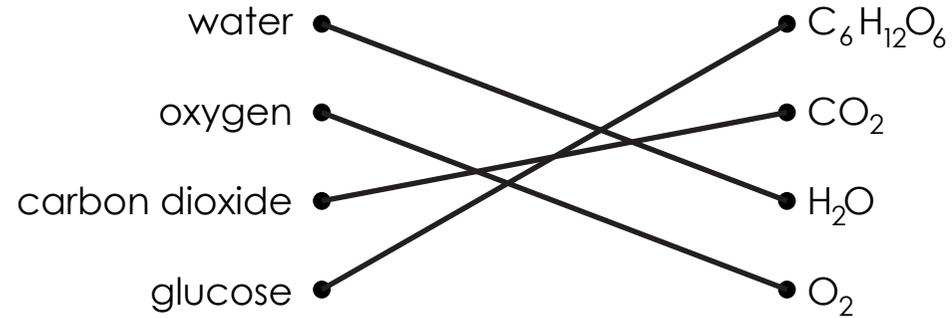
C) HIGHER TIER ONLY. At 4 minutes, the athlete stopped running. Explain why the pH of the blood began to increase. (2)

25. During exercise, the energy demand of the body increases. To help meet this demand, the heart beats faster. State one other change in the body that occurs during exercise, and explain it. (3)
26. The longer a person exercises, the more difficult it becomes to continue to train effectively. Describe what has happened in the muscles to cause this. (2)
27. Define the word “metabolism”. (1)

EXAM-STYLE QUESTIONS

<< ANSWERS >>

1. (2) marks for all correctly matched
(1) mark for 2 correctly matched
(0) marks for 1 or 0 correctly matched

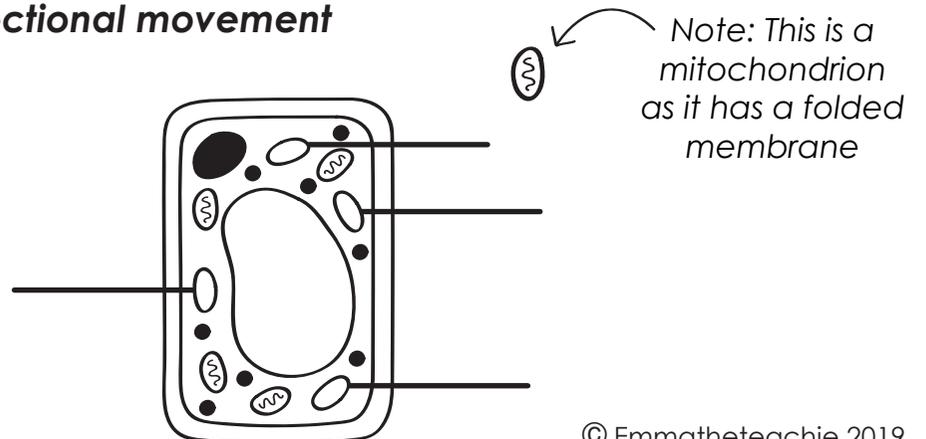


2. Carbon dioxide + water \longrightarrow glucose + oxygen (1)
 - The reactants can be in either order
 - The products can be in either order

3. Light (1)
 - It is also acceptable to say Sunlight or light energy

4. By the phloem (1)
Up and down the plant (1)
 - It is also acceptable to say in both directions / bi-directional movement

5. (1) mark for a correctly drawn line
 - All lines shown are correct answers
 - If more than 1 line is drawn, the mark is lost
 - The line must touch the chloroplast(1) mark for labelling the line with the word chloroplast
 - Chlorophyll is not accepted



EXAM-STYLE QUESTIONS

<< ANSWERS >>

BIOLOGY TOPIC 4

6. Root hair cells are underground so there is no light for photosynthesis (1)

7. The line must begin at (0,0) - the origin (1)

The line must curve and then become a straight, horizontal line (1)

8. At high temperatures, enzymes become denatured (1)

9. A) 30 cm (1)

B) When the light source is moved closer than 30cm

(20cm and 10cm distances) the number of bubbles released does not increase (1)

- It is also acceptable to say when the distance is less than 30 cm, the rate of photosynthesis does not increase / the number of bubbles produced remains at 32.

10. Inverse square law:

$$\text{Light intensity} \propto \frac{1}{\text{distance}^2}$$

- (1) mark for the correct equation
- (1) mark for the correct answers at 10cm and 20cm
- (1) mark for the final answer

At 10 cm:

$$\text{Light intensity} \propto \frac{1}{10^2}$$

$$\text{Light intensity} \propto \frac{1}{100}$$

$$\text{Light intensity} \propto 0.01$$

At 20cm:

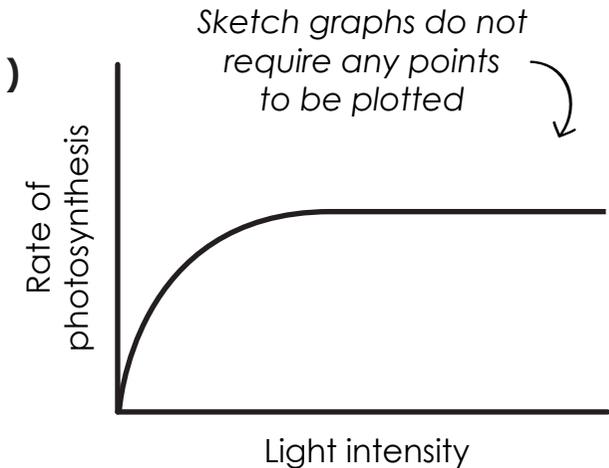
$$\text{Light intensity} \propto \frac{1}{20^2}$$

$$\text{Light intensity} \propto \frac{1}{400}$$

$$\text{Light intensity} \propto 0.0025$$

How many times lower the light intensity is at 20cm than 10cm = $\frac{0.01}{0.0025} = 4$ times lower

- If the correct answer of 4 is given, award 3 marks.



<< ANSWERS >>

D) It is a heat shield (1)

- *Accept a description of this: e.g. it absorbs the heat radiated from the lamp*

It is used because temperature can affect the rate of photosynthesis (1)

- *Accept temperature can affect the results / number of bubbles produced*

E) Disadvantage: high chance of human error (1)

- *It is also acceptable to say that the person may make a mistake / mis-count the bubbles / it is hard to count all of the bubbles*

Alternative method: measure the volume of carbon dioxide produced (1)

- *It is also acceptable to say collect the volume of gas produced, or describe the apparatus used to do this (e.g. a gas syringe)*

10. Glucose is used to produce amino acids (1)

Amino acids are used to produce proteins (1)

- *It is also acceptable to say "synthesise" or "make" instead of "produce"*

- *It is not required to say that nitrate ions are also required to produce amino acids for the mark, although this is correct and a good piece of information*

11. Respiration (1)

Production of fats and oils (1)

Production of cellulose (1)

Converted into starch (1)

12. The green part of the leaf contains starch (1)

The green part of the leaf contains chlorophyll and can photosynthesise (1)

Glucose produced in photosynthesis can be converted into starch (1)

<< ANSWERS >>

13. Orange-brown (1)

The white part of the leaf does not contain chlorophyll and therefore cannot photosynthesis to produce glucose, so no starch will be present

14. A) As the carbon dioxide concentration increases, the rate of photosynthesis increases (1)

B) Temperature (1) is limiting the rate of photosynthesis (1)

- One mark is given for the idea that another limiting factor has been reached.

C) Light intensity is limiting the rate of photosynthesis (1)

When light intensity is increased in experiment C, the maximum rate of photosynthesis increases (1)

15. Amount of chlorophyll (1)

- Accept chlorophyll

16. 1 mark for each of the bullet points below.

A maximum of 4 marks can be gained if only methods are described.

The total number of marks available for this question is (6) marks.

- method: use heaters to increase temperature
- explanation: warm / optimum temperatures increase the rate of photosynthesis
- method: increase the concentration of carbon dioxide by piping it in / using paraffin heaters
- explanation: increased carbon dioxide concentration increases the rate of photosynthesis
- method: use artificial lights when it is dark (night / cloudy weather)
- explanation: this extends the length of time plants can photosynthesise
- method: use fertilisers / enrich soil with mineral ions
- explanation: plants require adequate mineral ions for optimal growth
- method: use pesticides / grow GM crops with pest resistance
- explanation: pests reduce crop yield

EXAM-STYLE QUESTIONS

<< ANSWERS >>

Profit is calculated by either:

1. Turning the profit as a % of costs into a decimal, and then multiplying it by the costs, e.g. for artificial lights:
 $1.80 \times 198 = 356.40$

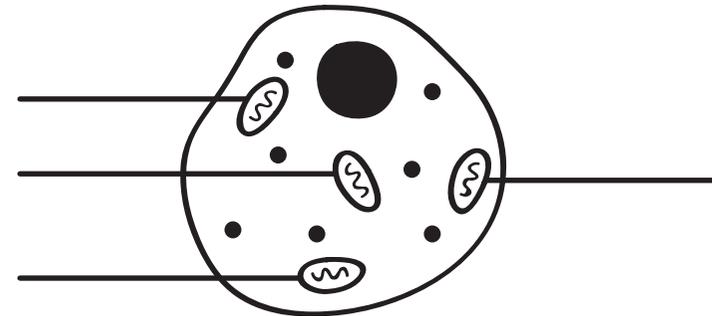
2. Dividing the costs by 100 and then multiplying by the profit as a % of the costs, e.g. for artificial lights:
 $198 / 100 \times 180 = 356.40$

17. (2) marks for three correct profit answers
 (1) mark for one or two correct profit answers

Method	Costs (£)	Profit as a % of costs	Profit (£)
Artificial lights	198	180	356.40
CO ₂ piping	270	140	378.00
Heaters	286	130	371.80

The most profitable method is: CO₂ piping. (1)

18. (1) mark for a correctly drawn line
 - All lines shown are correct answers
 - If more than 1 line is drawn, the mark is lost
 - The line must touch the mitochondrion
 (1) mark for labelling the line with the word mitochondrion
 - The word mitochondria is also accepted



This is the plural of mitochondrion

19. - Movement (1)
 - Keeping warm (1)
 - Chemical reactions to build larger molecules (1)

20. Glucose + oxygen \longrightarrow carbon dioxide + water

The question said word equation, so make sure you have used words and not symbols!

EXAM-STYLE QUESTIONS

BIOLOGY TOPIC 4

<< ANSWERS >>

21. Advantage: energy is transferred (1)
Disadvantage: *EITHER* less energy is transferred than in aerobic respiration OR lactic acid is produced (1)
22. Carbon dioxide (1) ←
Ethanol (1)
- *It is not acceptable to say alcohol*
- You can use symbols and say CO₂ but be careful!
The C and O must be capitalised and the 2
must be sub-script, i.e. small and placed below.*
23. Manufacture of alcoholic drinks (1)
- *Accept manufacture / production of alcohol*
Manufacture of bread (1)
24. A) 2 minutes (1)
- A lower pH = more acidic*
- B) At 2 minutes the pH begins to decrease (1)
Because lactic acid is being produced during anaerobic respiration (1)
- C) Lactic acid is being transported by the blood to the liver (1)
Where it is converted into glucose (1)
25. EITHER:
- The breathing rate increases / more breaths per minute / breathing faster (1)
- This results in more oxygen being delivered to the muscles for aerobic respiration (1)
OR:
- The breathing volume increases / deeper breaths (1)
- This results in more oxygen being delivered to the muscles for aerobic respiration (1)

EXAM-STYLE QUESTIONS

BIOLOGY TOPIC 4

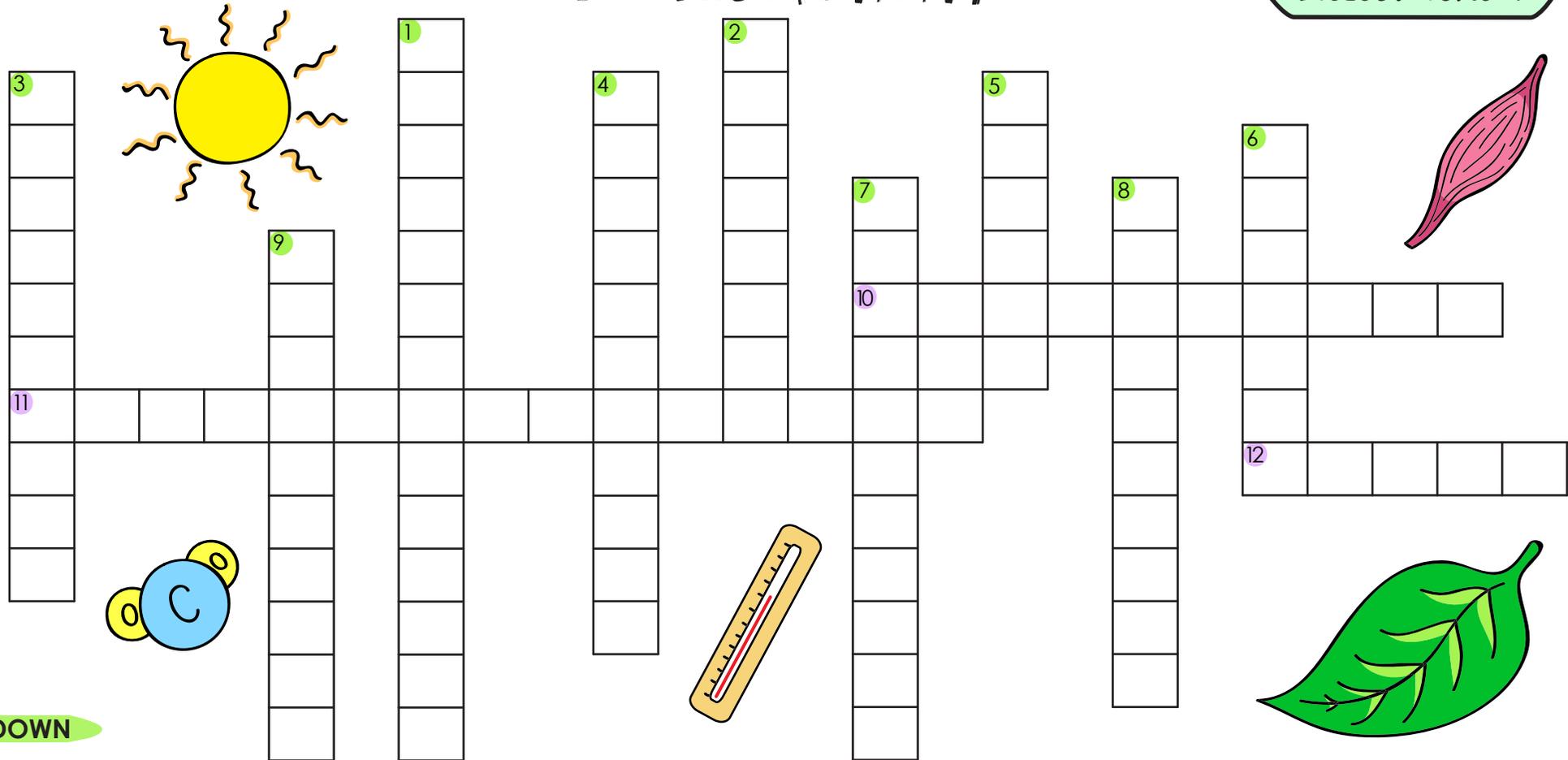
<< ANSWERS >>

26. The muscles have become fatigued (1)
So they cannot contract effectively (1)
27. The sum of all of the chemical reactions in a cell or organism (1)



BONUS ACTIVITY

BIOLOGY TOPIC 4



DOWN

- 1 Process plants and algae use to convert light into food
- 2 Muscles do this to allow the body to move
- 3 Sum of all of the chemical reactions in a cell or organism
- 4 Process that happens in all living organisms
- 5 Plants can convert glucose into this as a storage material
- 6 Product of fermentation
- 7 Green pigment in plant leaves
- 8 Glucose is used to produce these in plants, along with nitrate ions
- 9 A type of reaction that transfers energy to the environment

ACROSS

- 10 This is produced in the muscles if they respire anaerobically
- 11 These can reduce the rate of photosynthesis, e.g. temperature
- 12 Required for photosynthesis to occur



BONUS ACTIVITY - ANSWERS

Did you get all of the answers to the clues? Check here to see!

The crossword puzzle grid contains the following words:

- 3** METABOLISM
- 1** PHOTOSYNTESIS
- 4** RESPIRATION
- 2** CONTRACT
- 5** STARCH
- 6** ETHANOID
- 7** CHLOROPHYLL
- 8** AMINOACIDS
- 9** EXOTOSIS
- 10** LACTIC ACID
- 11** LIMITING FACTORS
- 12** LIGHT

Extra challenge: What other keywords can you come up with from this topic? Write them in this space!



☆☆★ **THANK YOU** ★☆☆

THANKS & BYE!



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AWESOME! ★
REALLY HELPED ME IMPROVE
MY GRADES - SO USEFUL!



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THIS!** Emma ☺