



GCE A LEVEL



A400U10–1

WEDNESDAY, 5 JUNE 2024 – AFTERNOON

**BIOLOGY – A LEVEL COMPONENT 1
ENERGY FOR LIFE**

**2 hours plus your additional time
allowance**

Surname: _____

First name(s): _____

Centre Number: _____

Candidate Number: 2 _____

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	15	
2.	18	
3.	18	
4.	19	
5.	21	
6.	9	
Total	100	

(Turn over)

ADDITIONAL MATERIALS

A calculator and a ruler.

**ITEMS INCLUDED WITH QUESTION
PAPER**

A separate Diagram Booklet.

**The Diagram Booklet MUST be handed in
to the invigilators and sent for marking.**

(Turn over)

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball – point pen, black felt tip or your usual method.

Write your name, centre number and candidate number in the spaces on the front cover.

Answer ALL questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

(Turn over)

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part – question.

The assessment of the quality of extended response (QER) will take place in question 6.

The quality of written communication will affect the awarding of marks.

(Turn over)

Answer ALL questions.

1. ATP has been described as the universal energy currency in cells.

(a) (i) DRAW and LABEL a simple diagram to show the structure of ATP.

Space for drawing.

[2 marks]

continued on the next page . . .

(Turn over)

Question 1 (a) continued

- 1. (a) (ii) With reference to the
STRUCTURE OF ATP, explain
what is meant by the term
UNIVERSAL ENERGY
CURRENCY.**

continued on the next page . . . [2 marks]
(Turn over)

Question 1 (a) continued

- 1. (a) (iii) State ONE structural difference between the nucleotides found in DNA compared to those found in an ATP nucleotide.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 1 continued

- 1. (b) Refer to IMAGES 1.1 and 1.2 in the separate Diagram Booklet. In eukaryotic cells ATP is produced mainly by mitochondria and chloroplasts. Electron micrographs of these organelles are shown in IMAGES 1.1 and 1.2**

The endosymbiotic theory proposes that both mitochondria and chloroplasts evolved from prokaryotic ancestors.

continued on the next page . . .

(Turn over)

Question 1 (b) continued

- 1. (b) (i) Identify TWO structural features of mitochondria and chloroplasts that are also found in prokaryotic cells.**

I. _____

II. _____

[2 marks]

- (ii) Name the TWO Domains which contain prokaryotic organisms.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 1 (b) continued

In both mitochondria and chloroplasts ATP synthesis requires the movement of protons and electrons, which results in the transfer of energy to ATP molecules.

- 1. (b) (iii) Complete the table provided separately for**
- Question 1 (b) (iii), to identify WHERE in chloroplasts and mitochondria the following processes in ATP synthesis take place. A spare table has been provided.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 1 continued

- 1. (c) Refer to GRAPH 1.3 in the separate Diagram Booklet.**
- A laboratory experiment was carried out on isolated mitochondria to determine the rate of ATP synthesis. Isolated mitochondria were mixed with 500 μ M of ADP and excess inorganic phosphate. The concentration of ATP was recorded every 25 seconds over a period of 250 seconds. The results are shown in GRAPH 1.3**

continued on the next page . . .

(Turn over)

Question 1 (c) continued

- 1. (c) (i) Use the tangent marked B – C to calculate the rate at 100 seconds following the addition of ADP and STATE THE UNIT of your calculated value.**
- SHOW HOW YOU OBTAINED THE VALUES USED IN YOUR CALCULATION ON GRAPH 1.3**

Space for working continues on the next page.

(Turn over)

Question 1 (c) (i) continued

Rate at 100 s = _____

unit = _____

[4 marks]

continued on the next page . . .

(Turn over)

Question 1 (c) continued

- 1. (c) (ii) Explain why the initial rate calculated using the line marked A was higher than the rate at 100 s.**

[1 mark]

(Total for Question 1 = 15 marks)

(Turn over)

- 2. All animals are consumers and depend on producers as sources of nutrients and energy.**

Due to the increasing human population size, questions have been raised about the sustainability of human consumption of farmed and natural food sources. Some scientists believe that we are approaching the maximum human population that can be sustained by current plant productivity levels.

continued on the next page . . .

(Turn over)

Question 2 (a) continued

2. (a) (i) State the TYPES OF NUTRITION used by the following to obtain energy:

producers _____

consumers _____

[1 mark]

(ii) Plant productivity can be expressed as GPP or NPP. Explain why only NPP is available to consumers.

(Turn over)

[2 marks]

2. (a) (iii) Human population density is increasing exponentially.
Explain what is meant by the term **EXPONENTIAL GROWTH**.

[1 mark]

continued on the next page . . .

(Turn over)

Question 2 (a) continued

- 2. (a) (iv) State the term used to describe the phrase:
‘... maximum human population that can be sustained by current plant productivity levels.’**
-

[1 mark]

continued on the next page . . .

(Turn over)

Question 2 continued

2. (b) NPP is limited by the amount of light energy available to plants and the efficiency at which light energy can be transferred to organic compounds.

(i) Deserts and arctic – alpine regions have very low NPP per km²

Identify ONE DENSITY – INDEPENDENT factor that accounts for the very low NPP per km² of BOTH regions.

continued on the next page . . .

(Turn over)

Question 2 (b) (i) continued

Explain your answer.

[2 marks]

continued on the next page . . .

(Turn over)

Question 2 (b) continued

- 2. (b) (ii) Wavelengths of light between 650 and 750 nm (red light) are absorbed more readily by water than shorter wavelengths (blue light). Use this information and your own knowledge of photosynthesis to explain why marine ecosystems only account for 40 • 8% of global NPP even though they cover 71 • 1% of the world's surface.**
-
-
-

(Turn over)

[3 marks]

continued on the next page . . .

(Turn over)

Question 2 continued

2. (c) In 1987, there were approximately 5×10^9 humans on planet Earth.

The mass of organic matter produced and consumed each year is usually expressed in petagrams (Pg), where $1 \text{ Pg} = 10^{15} \text{ g}$.

(i) Calculate the ANNUAL consumption of organic matter by humans in 1987 if the average consumption of organic matter was 500 g per human per day.

continued on the next page . . .

(Turn over)

Question 2 (c) continued

**EXPRESS YOUR ANSWER
IN PETAGRAMS TO TWO
SIGNIFICANT FIGURES.**

Space for working.

**Annual human consumption of organic
matter = _____ Pg**
[3 marks]

continued on the next page . . .

(Turn over)

Question 2 (c) continued

2. (c) (ii) In 1987, it was estimated that humans harvested $1 \cdot 15 \text{ Pg}$ of global NPP and directly consumed $0 \cdot 76 \text{ Pg}$ of organic matter derived from plants.

Calculate the percentage of harvested NPP lost or wasted by the human population at that time.

Space for working continues on the next page.

(Turn over)

Question 2 (c) (ii) continued

**Percentage of harvested NPP lost or
wasted by humans = _____ %**

[2 marks]

continued on the next page . . .

(Turn over)

Question 2 (c) continued

2. (c) (iii) Annual consumption of animal products by humans in 1987 was estimated at 0.15 Pg. Estimated global consumption of plants by livestock in 1987 was 2.2 Pg.

It has been recommended that humans eat fewer animal products as one way of improving sustainability. Use the data provided to justify this conclusion.

(Turn over)

[3 marks]

(Total for Question 2 = 18 marks)

(Turn over)

- 3. Refer to IMAGE 3.1 in the separate Diagram Booklet. Yeast (*SACCHAROMYCES CEREVISIAE*) is a unicellular fungus that feeds saprotrophically on a range of substrates which are rich in sugars. Yeast is used extensively in the production of bread and sparkling (fizzy) wine through a process known as fermentation. Fermentation is summarised in IMAGE 3.1**

continued on the next page . . .

(Turn over)

Question 3 continued

3. (a) (i) Explain what is meant by the term SAPROTROPHICALLY.

[1 mark]

continued on the next page . . .

(Turn over)

Question 3 (a) continued

3. (a) (ii) Name the type of respiration shown in IMAGE 3.1

[1 mark]

(iii) In IMAGE 3.1, C1, C2, C3 and C6 indicate the number of carbon atoms in different organic molecules.

continued on the next page . . .

(Turn over)

Question 3 (a) (iii) continued

3. (a) (iii) I. Name the molecules that contain 1, 2 and 3 carbon atoms.

C1 _____

C2 _____

C3 _____

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 (a) (iii) continued

- 3. (a) (iii) II. Suggest why the C1 molecule is important when producing bread and why both the C1 and C2 molecules are used when producing sparkling wine.**

(Turn over)

[2 marks]

- 3. (a) (iv) If yeast cells respire for a long time using the process summarised in IMAGE 3.1 they eventually die. When animal cells respire in a similar way it does not cause cell death. Explain these statements.**
-
-
-
-

(Turn over)

[3 marks]

continued on the next page . . .

(Turn over)

Question 3 continued

- 3. (b) Refer to IMAGE 3.2 in the separate Diagram Booklet. During the production of sparkling wine, additional sugar and yeast are added during a second fermentation.**

An experiment was carried out to determine the best sugar to use when producing sparkling wine.

continued on the next page . . .

(Turn over)

Question 3 (b) continued

For each sugar, the following method was followed:

- 1. Add 10 cm^3 of 1 g cm^{-3} yeast suspension to a boiling tube.**
- 2. Add 10 cm^3 of a 2 g cm^{-3} solution of the sugar being tested to a test tube.**
- 3. Place both test tubes in a water bath at 30°C and leave for 5 minutes.**
- 4. Pour the sugar solution into the yeast suspension and mix well.**

continued on the next page . . .

(Turn over)

Question 3 (b) continued

- 5. Cover the surface with a thin layer of oil and place the bung with the delivery tube into the boiling tube as shown in IMAGE 3.2**
- 6. When gas bubbles emerge regularly from the delivery tube, count the number released in one minute.**
- 7. Repeat step 6 for two more periods of 1 minute.**

continued on the next page . . .

(Turn over)

Question 3 (b) continued

3. (b) (i) Both test tubes were left in the water bath for 5 minutes in step 3

Explain why this was necessary.

[1 mark]

continued on the next page . . .

(Turn over)

Question 3 (b) continued

3. (b) (ii) Explain the purpose of the layer of oil.

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 continued

- 3. (c) Refer to TABLE 3.3 in the separate Diagram Booklet.**

Four naturally occurring sugars were tested. TABLE 3.3 shows the results of this experiment.

Both glucose and fructose are sugars containing six carbons. Lactose and sucrose are disaccharides.

continued on the next page . . .

(Turn over)

Question 3 (c) continued

- 3. (c) (i) Explain why glucose and fructose are known as structural isomers of each other.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 3 (c) continued

Refer to IMAGE 3.4 in the separate Diagram Booklet. IMAGE 3.4 shows the hydrolysis of sucrose catalysed by the enzyme sucrase.

- 3. (c) (ii) Name reactant X,
monosaccharide Y and
monosaccharide Z in
IMAGE 3.4**

reactant X _____

monosaccharide Y _____

monosaccharide Z _____

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 (c) continued

- 3. (c) (iii) Give ONE reason why using sucrose as the respiratory substrate resulted in fewer bubbles being produced than when using glucose.**

(Turn over)

[1 mark]

Refer to IMAGE 3.5 in the separate Diagram Booklet. Lactose is the sugar found in milk. IMAGE 3.5 shows the structure of lactose.

- 3. (c) (iv) Suggest an explanation for the results of the experiment for lactose shown in TABLE 3.3**
-
-
-
-

(Turn over)

[2 marks]

(Total for Question 3 = 18 marks)

(Turn over)

- 4. Refer to IMAGES 4.1A and 4.1B in the separate Diagram Booklet. Photosynthetic pigments are compounds which absorb some wavelengths of light and reflect others. IMAGES 4.1A and 4.1B shows the molecular structure of two photosynthetic pigments found in chloroplasts.**

(a) (i) Name the inorganic ion X found in chlorophyll a in IMAGE 4.1A.

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 (a) continued

- 4. (a) (ii) Hydrocarbons, such as carotene, contain atoms of carbon and hydrogen only. Apart from the presence of ion X, explain why chlorophyll a cannot be classified as a hydrocarbon.**
-
-
-
-

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 (a) continued

4. (a) (iii) Carotene is a hydrophobic molecule.

Suggest why carotene molecules are found embedded in thylakoid membranes rather than in the stroma.

(Turn over)

[2 marks]

4. (a) (iv) Research has shown that carotenes have a similar function in membranes to that of cholesterol.
Describe this function.

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 continued

4. (b) Refer to IMAGE 4.2 in the separate Diagram Booklet. In a school laboratory, photosynthetic pigments can be separated and identified using chromatography. This is shown in IMAGE 4.2

(i) Refer to IMAGE 4.3 in the separate Diagram Booklet. Propanone is one of the solvents used to extract and separate the pigments. The safety symbol shown in IMAGE 4.3 is shown on bottles containing this solvent.

continued on the next page . . .

(Turn over)

Question (b) continued

Explain why the method for this practical should include the instruction to make sure that there are no naked flames when this practical is carried out.

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 (b) continued

- 4. (b) (ii) Explain why a pencil is used to draw the origin line on the chromatography paper.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 continued

- 4. (c) Refer to IMAGE 4.4 and TABLE 4.5 in the separate Diagram Booklet. Paper chromatography was used to separate the pigments found in the leaves of a plant. The results are shown in IMAGE 4.4. Reference values for the main photosynthetic pigments are given in TABLE 4.5**

Pigments can be identified by calculating an R_f value and comparing this against reference values obtained using the same solvent and chromatography paper.

continued on the next page . . . (Turn over)

Question 4 (c) continued

- 4. (c) (i) I. Use the following formula to calculate the R_f value for pigment b.**

$$\text{R}_f = \frac{\text{distance travelled by pigment}}{\text{distance travelled by solvent front}}$$

Space for working continues on the next page.

(Turn over)

Question 4 (c) (i) continued

Rf = _____

[2 marks]

**4. (c) (i) II. Use your calculated
Rf value and TABLE 4.5
to identify pigment b.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 (c) continued

- 4. (c) (ii) Suggest why it is important that the calculated R_f values are compared to reference R_f values obtained using the same solvent and chromatography paper.**

(Turn over)

[3 marks]

continued on the next page . . .

(Turn over)

Question 4 continued

4. (d) Refer to IMAGE 4.6 in the separate Diagram Booklet. IMAGE 4.6 summarises the light–dependent and light–independent stages of photosynthesis.

(i) State the term used to describe the PARTICLES OF LIGHT ENERGY.

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 (d) continued

- 4. (d) (ii) Product S is synthesised via an electron transport chain while product T is synthesised from the final electron acceptor of this series of reactions.**
- Name products S and T.**

Product S _____

Product T _____

[2 marks]

continued on the next page . . .

(Turn over)

Question 4 (d) continued

- 4. (d) (iii) At high light intensities, carotene passes energy to other electron acceptor molecules rather than to chlorophyll a. This reduces the rate of photolysis to prevent chlorophyll a being damaged.**
- Some weedkillers inhibit the synthesis of carotene.**

continued on the next page . . .

(Turn over)

Question 4 (d) (iii) continued

Using all the information provided, explain ONE way in which this type of weedkiller can cause plant death.

(Turn over)

[3 marks]

(Total for Question 4 = 19 marks)

- 5. Refer to IMAGE 5 in the separate Diagram Booklet. Avocados (PERSEA AMERICANA) have become a popular food in all parts of the world. More than 50% of world production is based in one Central American country and most are grown in a single region of this country.**

To meet global demand, nearly 90 000 hectares (900 000 000 m²) of land have been converted to avocado plantations. IMAGE 5 shows an avocado plantation.

continued on the next page . . .

(Turn over)

Question 5 continued

**5. (a) With reference to IMAGE 5
suggest how avocado production
may have contributed to:**

(i) biodiversity loss;

[2 marks]

continued on the next page . . .

(Turn over)

Question 5 (a) continued

5. (a) (ii) climate change.

[2 marks]

continued on the next page . . .

(Turn over)

Question 5 continued

5. (b) The original forest shown in IMAGE 5 is an example of a climax community.

(i) State what is meant by the term CLIMAX COMMUNITY.

[1 mark]

continued on the next page . . .

(Turn over)

Question 5 (b) continued

5. (b) (ii) Suggest how the following abiotic factors would have changed following the establishment of the avocado plantation.

Explain your answers.

I. soil moisture content;

(Turn over)

[2 marks]

5. (b) (ii) II. soil fertility.

(Turn over)

[3 marks]

continued on the next page . . .

(Turn over)

Question 5 (b) continued

- 5. (b) (iii) Outline a method that could be used to estimate and compare the plant biodiversity of the original forest and the avocado plantation.**

(Turn over)

[4 marks]

continued on the next page . . .

Question 5 continued

- 5. (c) In North America, 95% of all avocados consumed are of the Hass variety and most are imported from Central America. New varieties of avocado are produced by cross – pollination. Avocados have a high degree of genetic polymorphism. Due to this, most attempts to breed useful new varieties have low success rates.**

continued on the next page . . .

(Turn over)

Question 5 (c) continued

- 5. (c) (i) Use the information to suggest why attempts to breed new useful varieties of avocado have low success rates.**

(Turn over)

[2 marks]

continued on the next page . . .

(Turn over)

Question 5 (c) continued

- 5. (c) (ii) The Hass avocado is highly susceptible to a soil–borne pathogen, PHYTOPHTHORA CINNAMOMI, which causes a disease called root rot. Infected plants wilt easily due to the pathogen affecting transpiration in the plant. Leaf death follows as a result. Use the information given to identify the tissue affected by this pathogen and conclude why infected plants wilt and eventually die.**
-
-

(Turn over)

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(Turn over)

[3 marks]

continued on the next page . . .

(Turn over)

Question 5 (c) continued

5. (c) (iii) Some wild species of avocado show resistance to *P. CINNAMOMI*.

Current practices in establishing avocado plantations are leading to some wild species becoming extinct.

Explain why it is important that these wild species are conserved AND suggest TWO ways of conserving them for the future.

(Turn over)

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(Total for Question 5 = 21 marks)

[2 marks]

(Total for Question 5 = 21 marks)

6. In 2004, it was estimated that approximately 18% of the human population lacked access to safe drinking water.

In most industrialised nations, samples of drinking water are cultured in laboratories. Any bacteria present are identified using microscopic methods. The samples are monitored for the presence and level of different types of faecal bacteria, some of which can be pathogenic. Bacterial load (the number of bacteria per cm^3) is determined using a viable count.

continued on the next page . . .

(Turn over)

Question 6 continued

State the conditions needed to culture bacteria in a laboratory and explain why each of these conditions is required.

Describe how different types of bacteria can be identified using microscopic methods.

Explain what is meant by a viable count and describe how you could determine the bacterial load of a sample of drinking water. (Details of aseptic technique are not required.)

(Turn over)

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(Turn over)

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(Turn over)

[illegible]

(Turn over)

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(Turn over)

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[illegible]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(Turn over)

(Turn over)

(Turn over)

[9 QER marks]

(Total for Question 6 = 9 marks)

TOTAL FOR PAPER = 100 MARKS

END OF PAPER

(Turn over)

[illegible]

(Turn over)

[illegible]

(Turn over)

[illegible]



GCE A LEVEL



A400U10–1

WEDNESDAY, 5 JUNE 2024 – AFTERNOON

BIOLOGY – A LEVEL COMPONENT 1

ENERGY FOR LIFE

**The Diagram Booklet MUST be handed in
to the invigilators and sent for marking.**

Diagram Booklet

Surname: _____

First Name(s): _____

Centre Number: _____

Candidate Number: 2 _____

IMAGE 1.1 and IMAGE 1.2

IMAGE 1.1

a mitochondrion

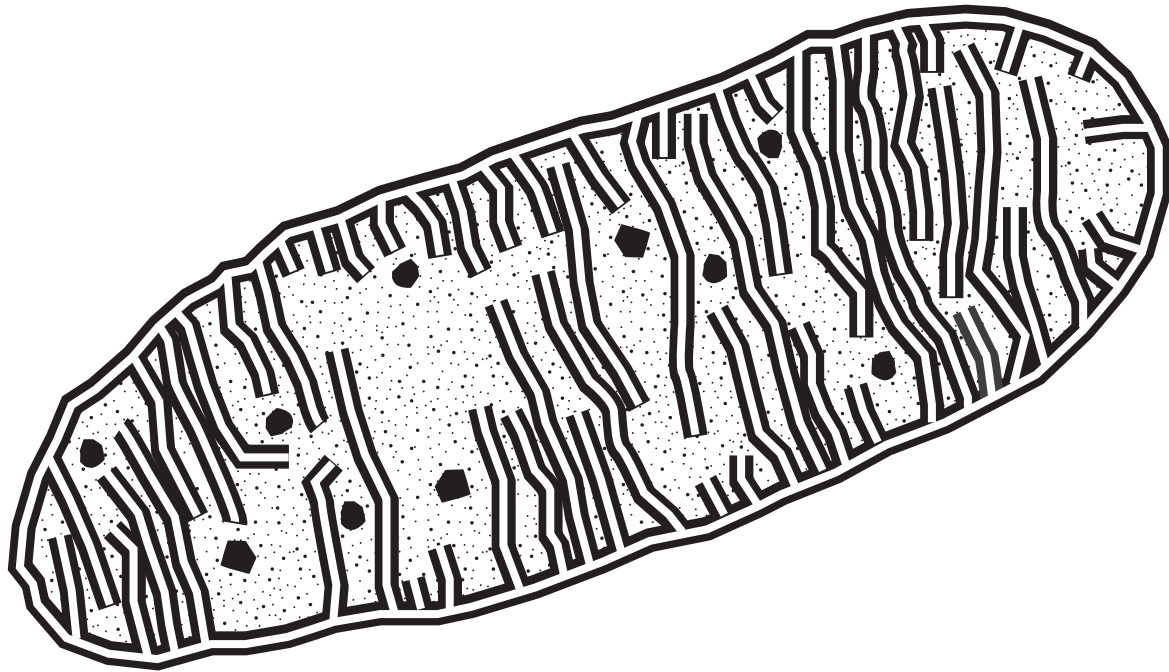
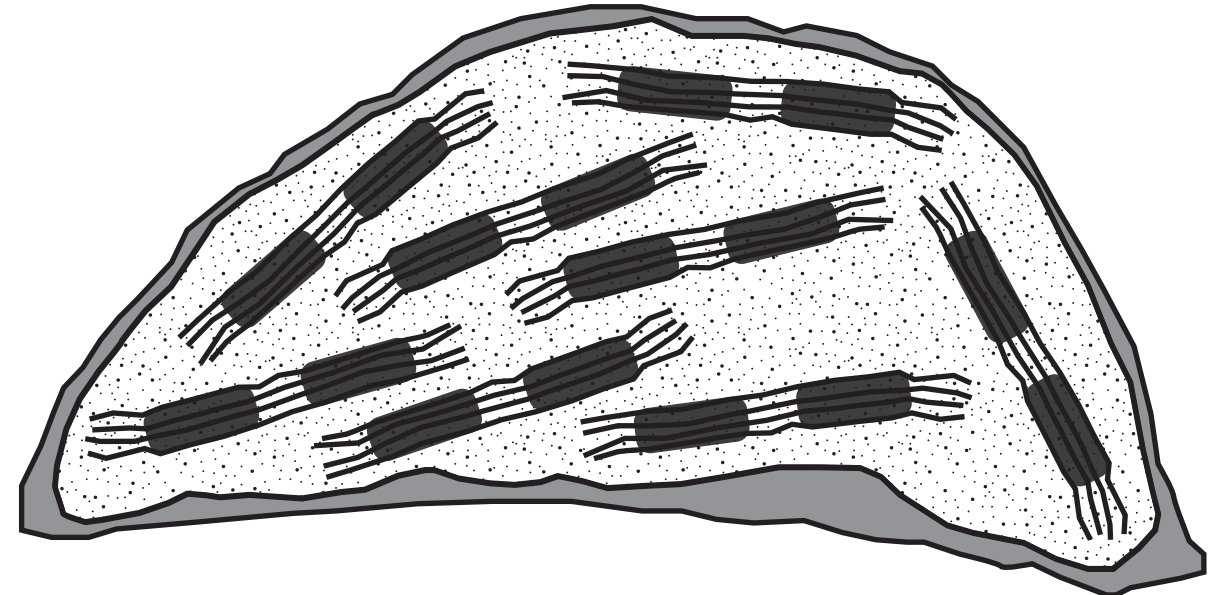


IMAGE 1.2

a chloroplast



QUESTION 1 (b) (iii)

TABLE

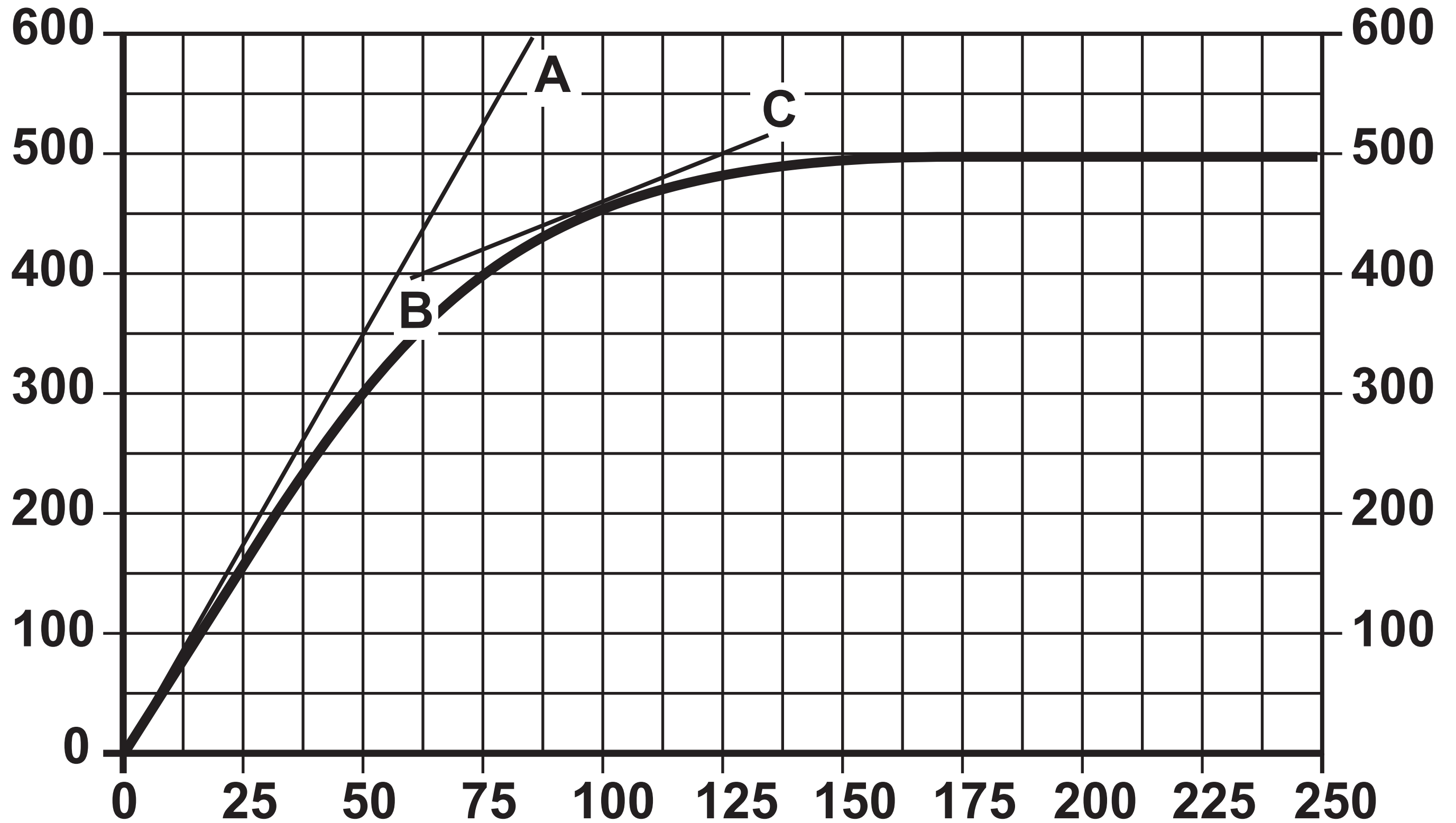
Process in ATP synthesis	Chloroplasts	Mitochondria
Protons are pumped across this membrane by proton pumps using energy from electrons.		
A high concentration of protons is formed here.		

TABLE

Process in ATP synthesis	Chloroplasts	Mitochondria
Protons are pumped across this membrane by proton pumps using energy from electrons.		
A high concentration of protons is formed here.		

GRAPH 1.3

Concentration of ATP (μM)



Time after addition of $500 \mu\text{M}$ of ADP (s)

IMAGE 3.1

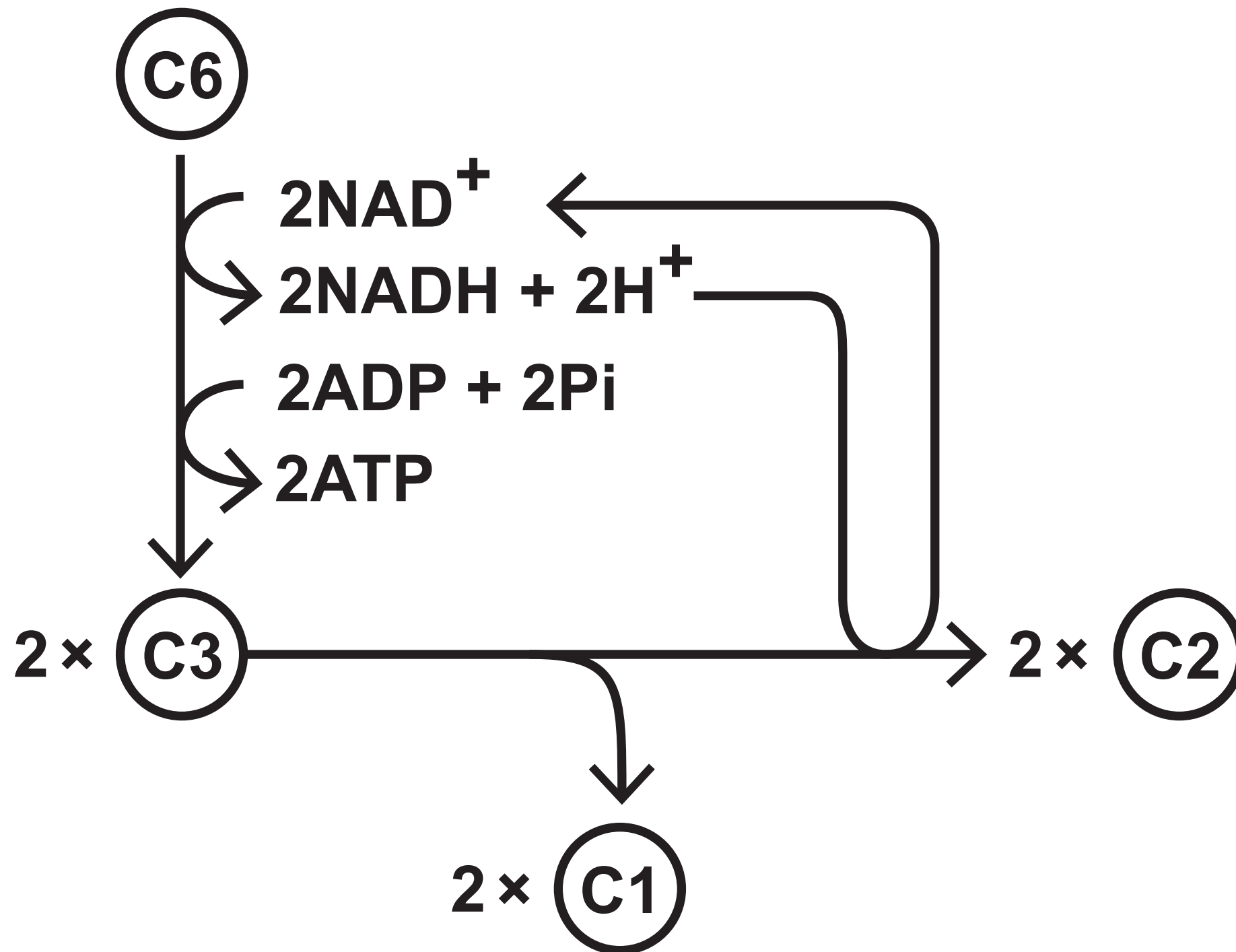


IMAGE 3.2

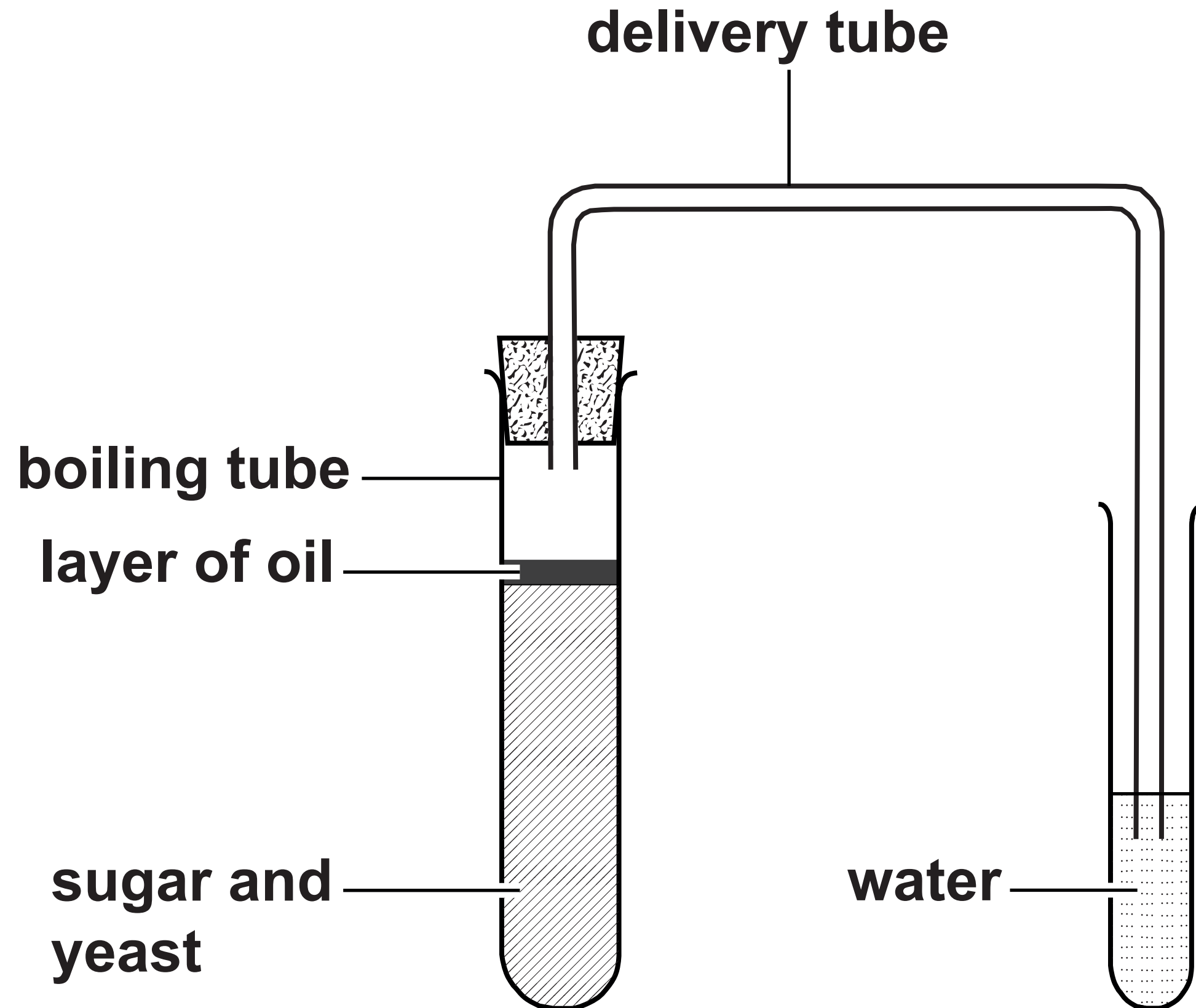
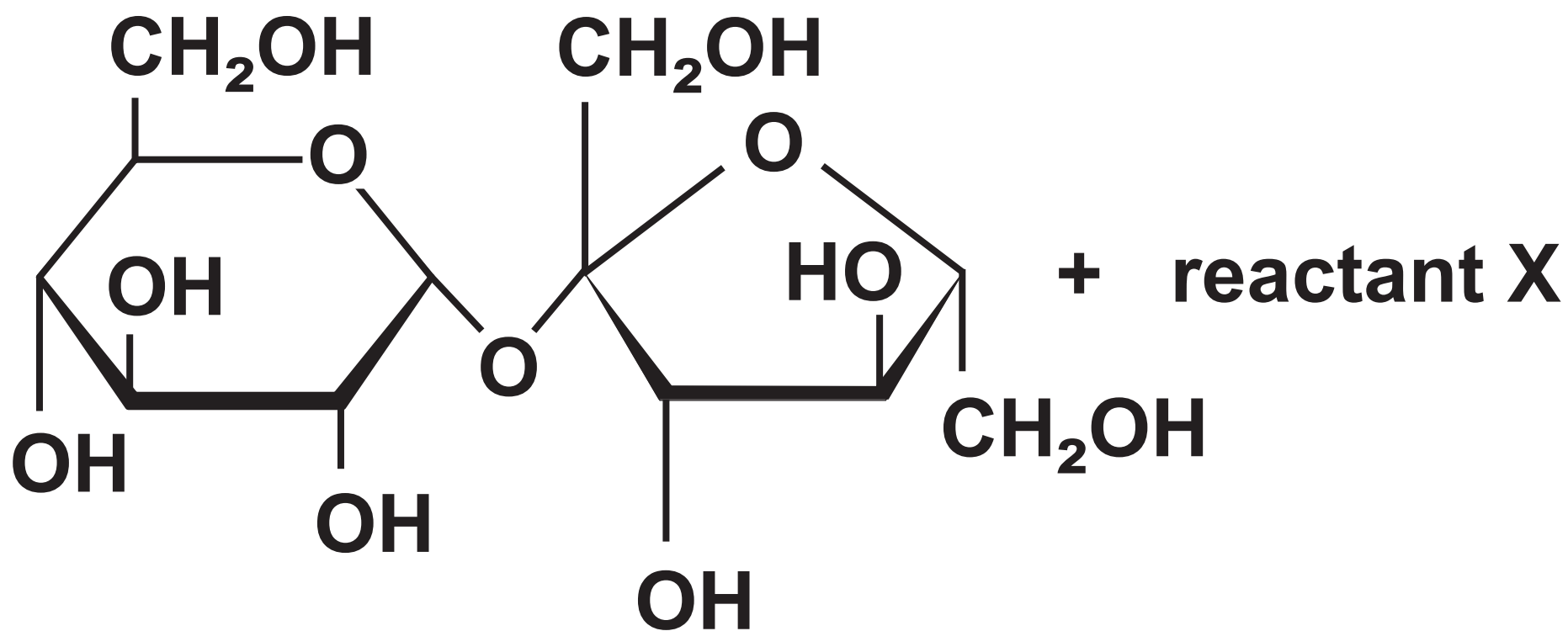


TABLE 3.3

Sugar	Number of bubbles produced in 1 minute			
	Trial 1	Trial 2	Trial 3	mean
fructose	13	14	14	14
glucose	31	48	45	41
lactose	0	0	0	0
sucrose	12	8	11	10

IMAGE 3.4

sucrose



sucrase

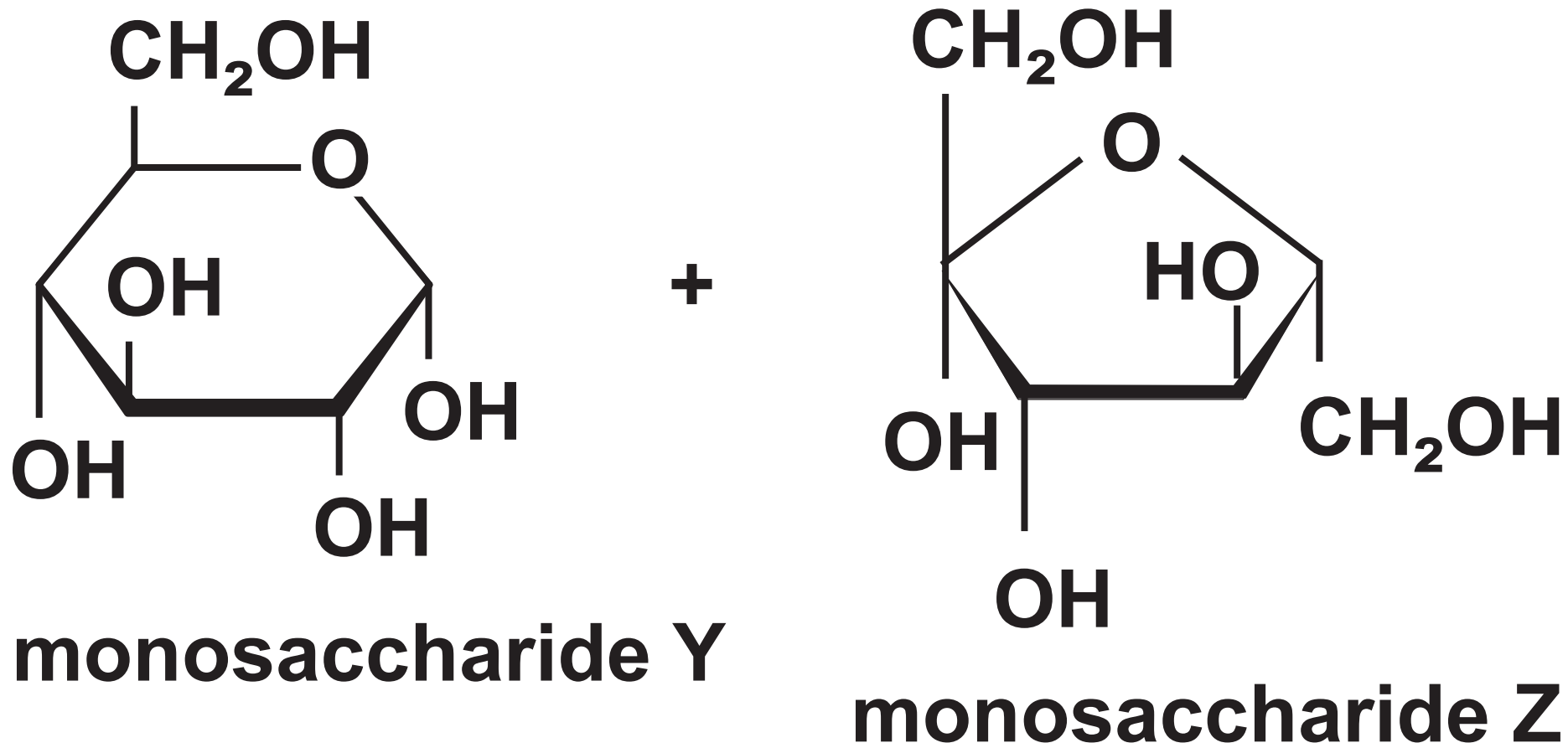
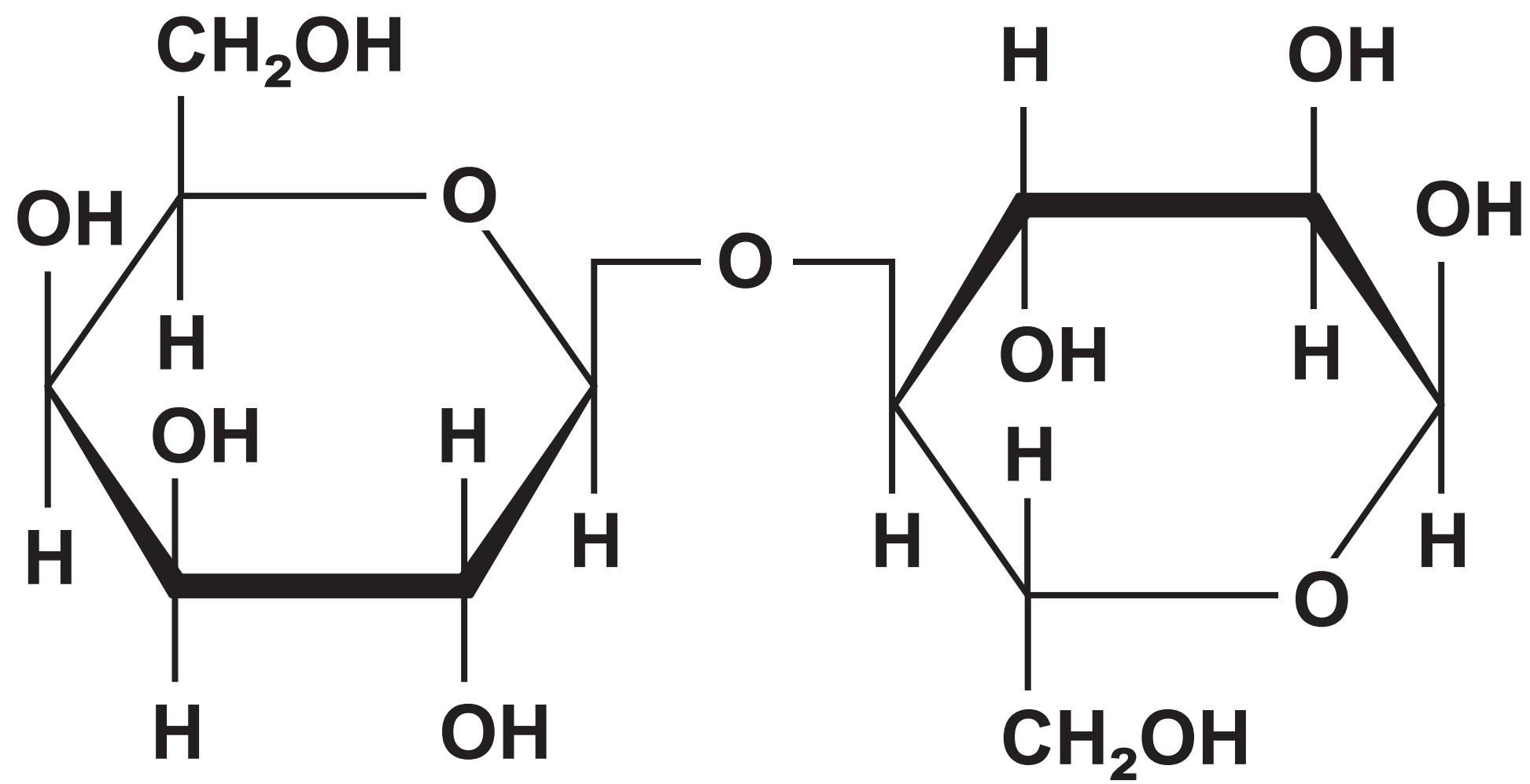


IMAGE 3.5



chlorophyll a

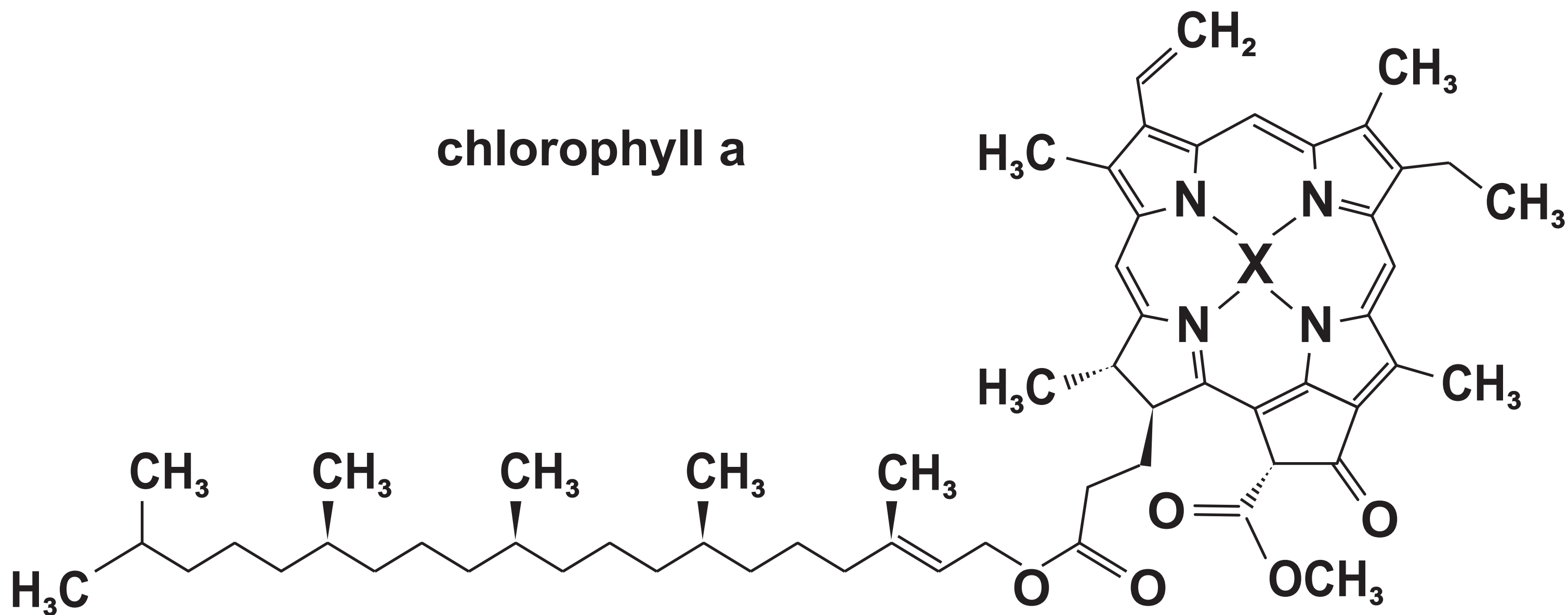


IMAGE 4.1B

carotene

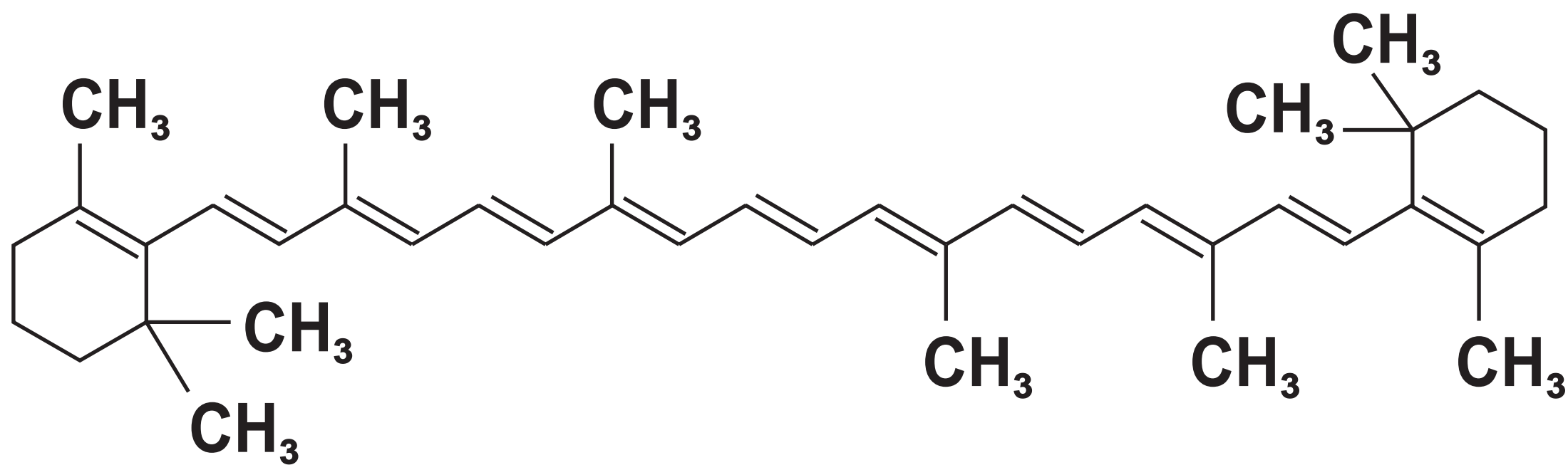


IMAGE 4.2 and IMAGE 4.3

IMAGE 4.2

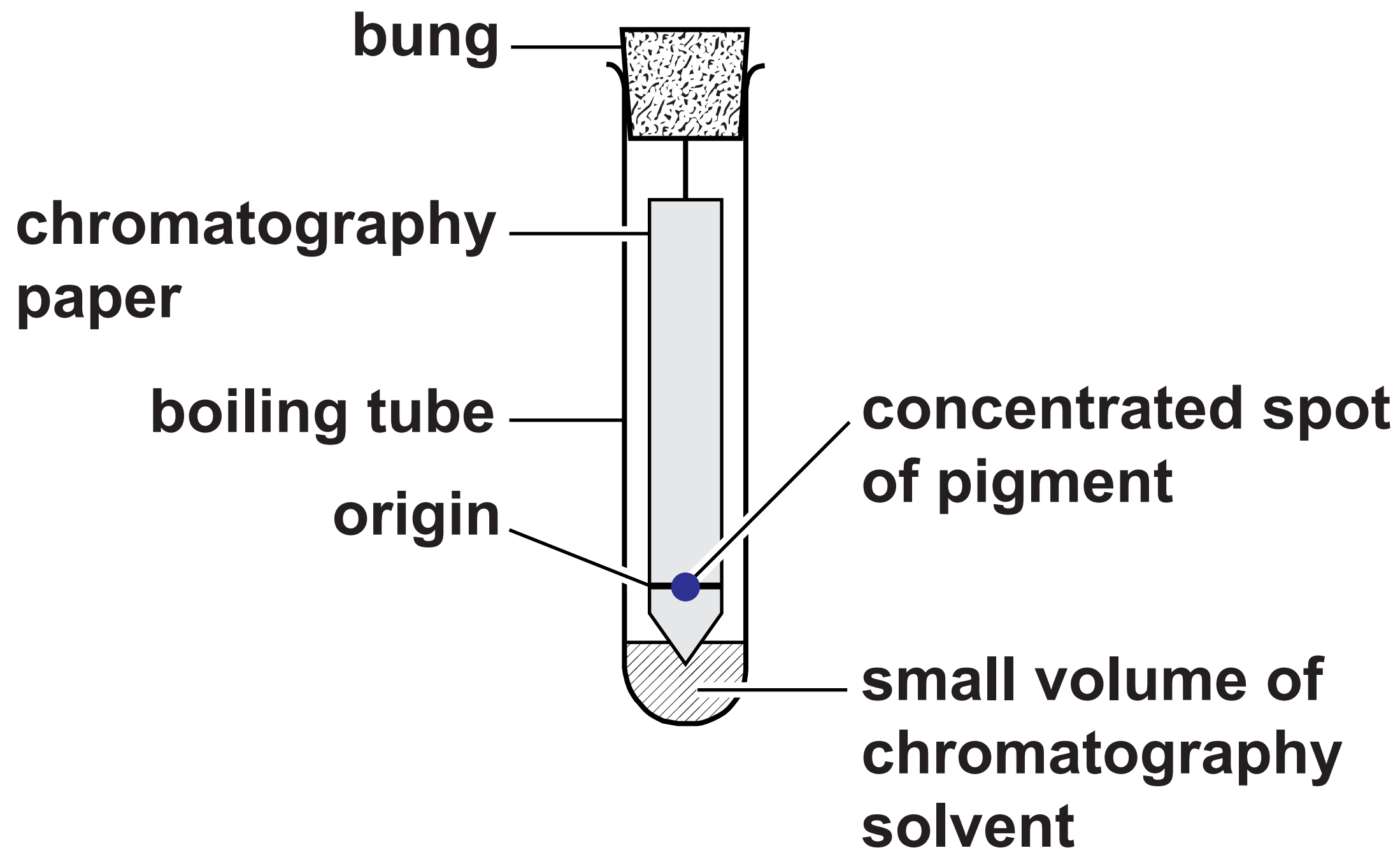


IMAGE 4.3



IMAGE 4.4

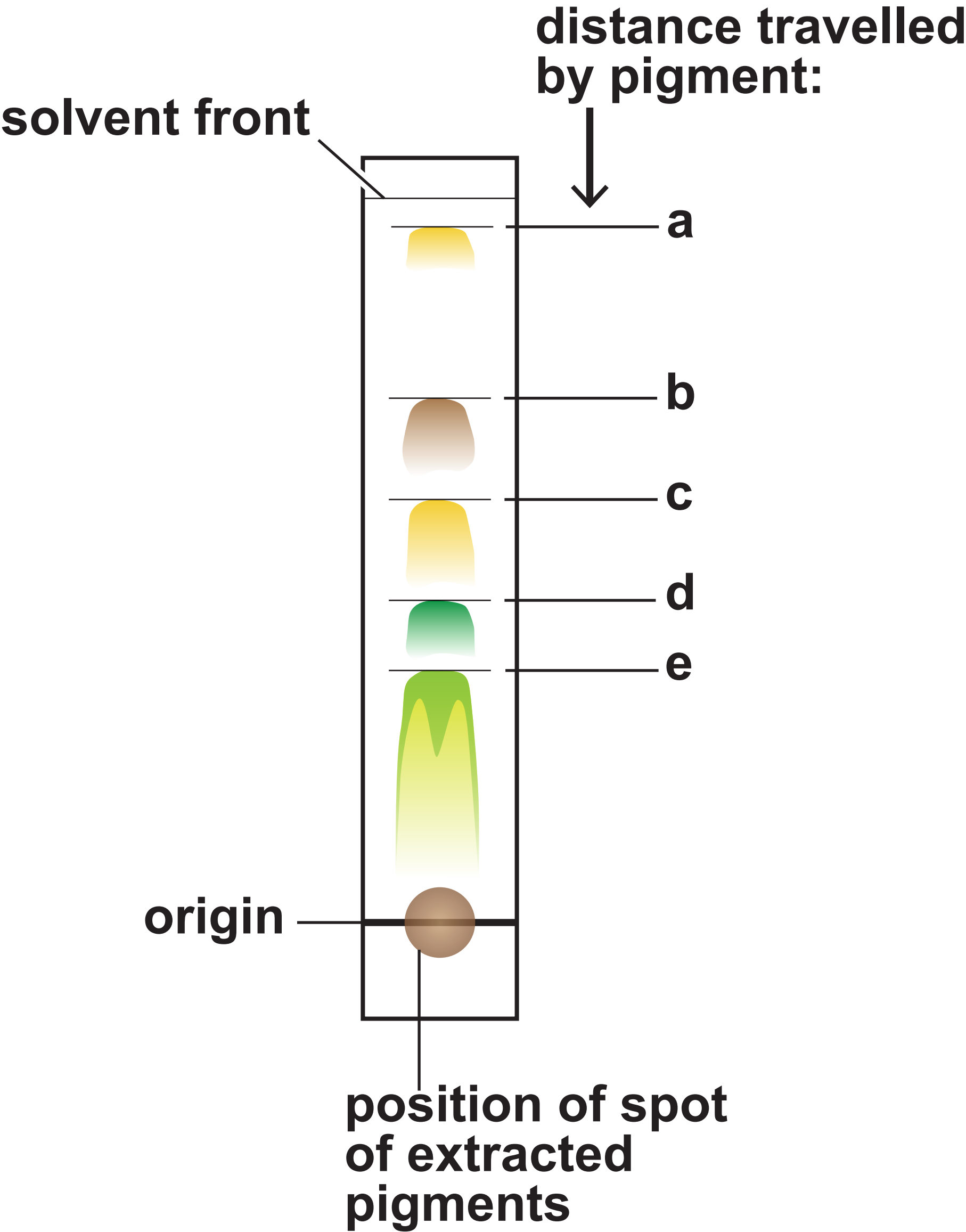


TABLE 4.5

Reference Rf Values	
Pigment	Rf
beta carotene	0•96
chlorophyll <i>a</i>	0•58
chlorophyll <i>b</i>	0•48
phaeophytin	0•70
xanthophylls	0•15 to 0•40

IMAGE 4.6

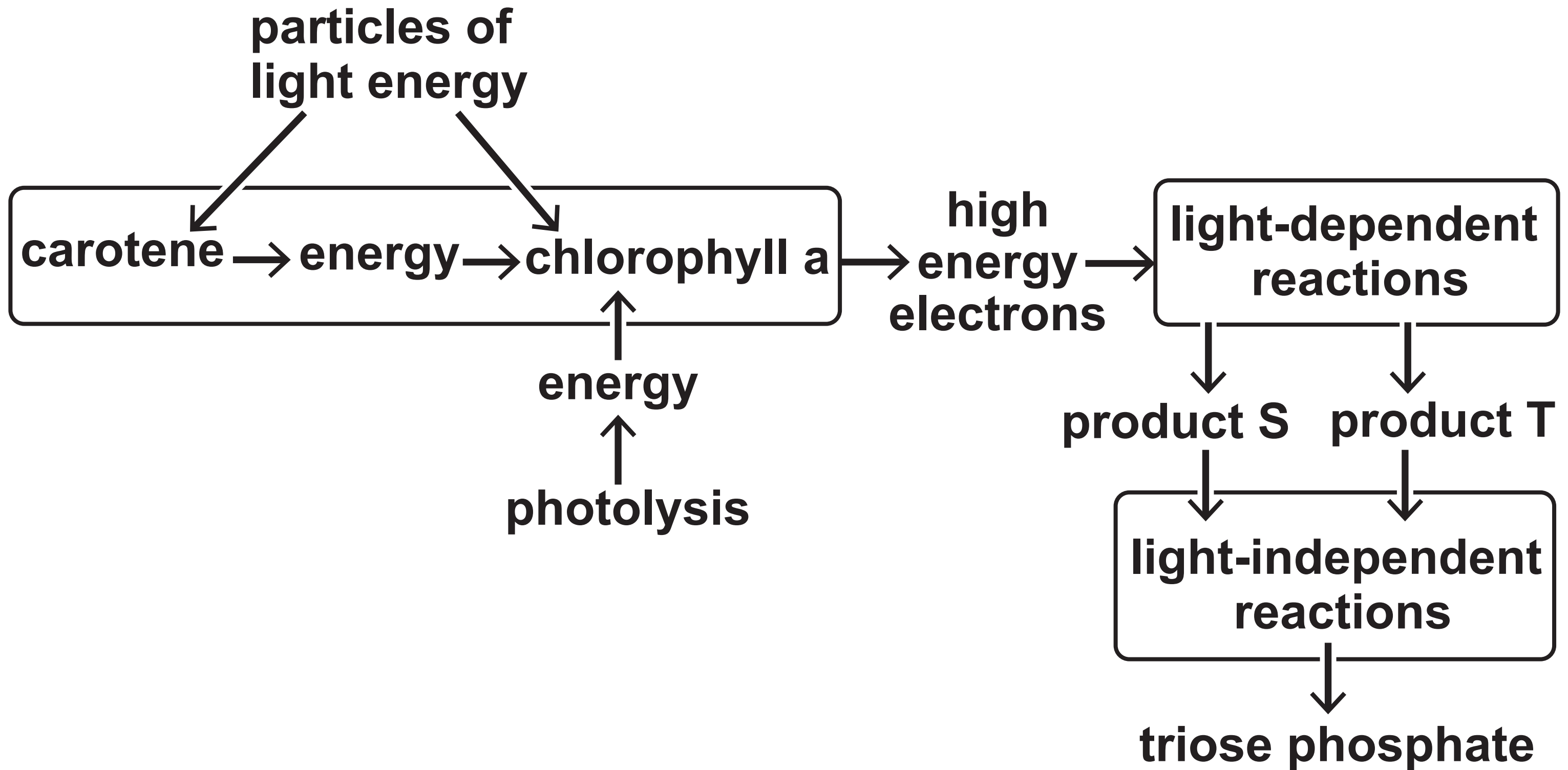
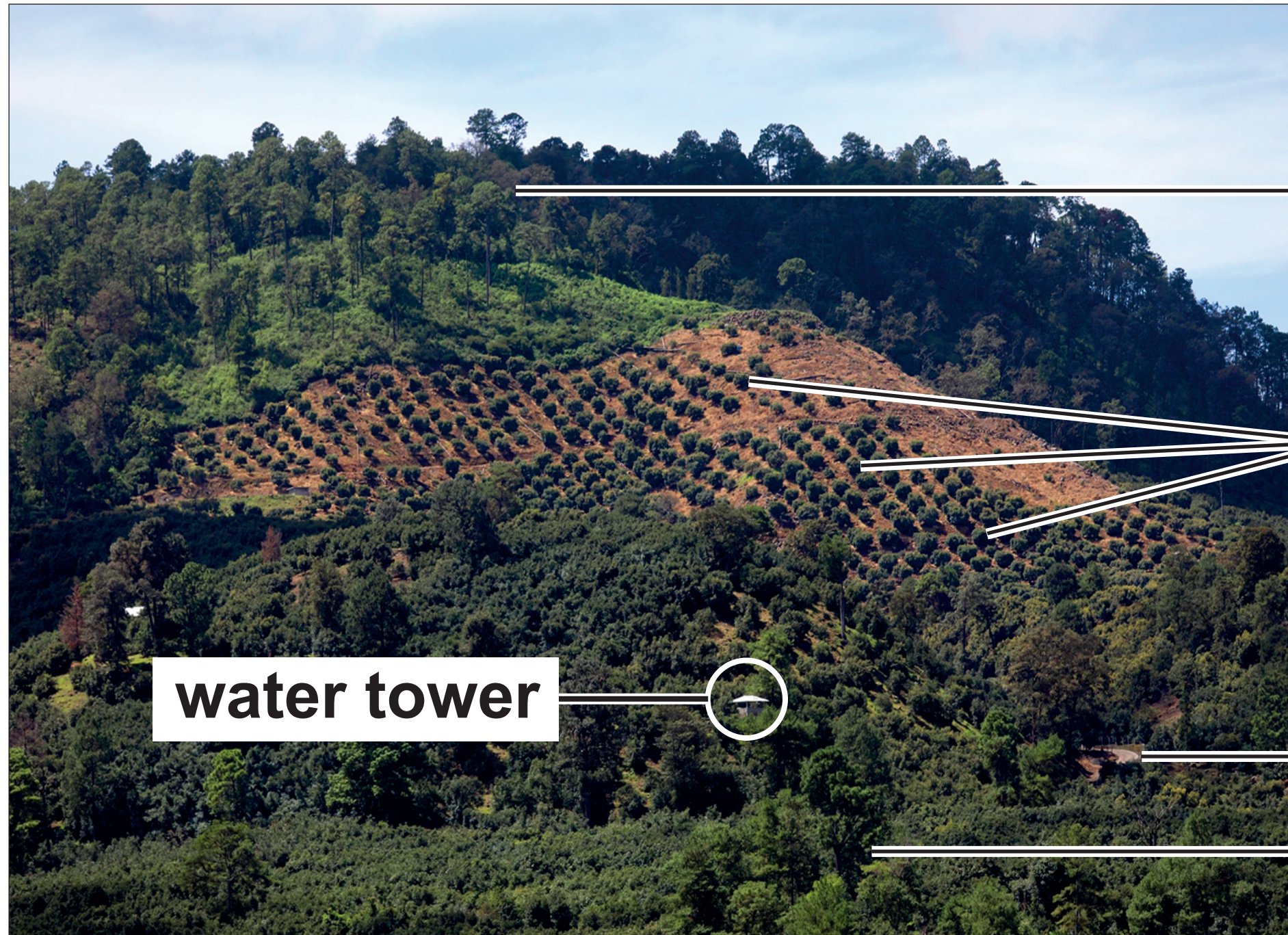


IMAGE 5



original forest

avocado trees

water tower

access road

original forest