

ADVANCED GCE
BIOLOGY

2804

Central Concepts

WEDNESDAY 30 JANUARY 2008

Afternoon

Time: 1 hour 30 minutes

Candidates answer on the question paper.

Additional materials: Electronic calculator
 Ruler (cm/mm)



Candidate Forename

Candidate Surname

Centre Number

Candidate Number

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Do **not** write outside the box bordering each page.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is 90.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	11	
2	15	
3	15	
4	15	
5	20	
6	14	
TOTAL	90	

This document consists of **20** printed pages and **4** blank pages.

Answer **all** the questions.

- 1 (a) In this question, one mark is available for the quality of use and organisation of scientific terms.

Fig. 1.1 shows a typical bacterial population growth curve as might be gained from growing a bacterial culture in a closed system such as a conical flask containing a nutrient broth.

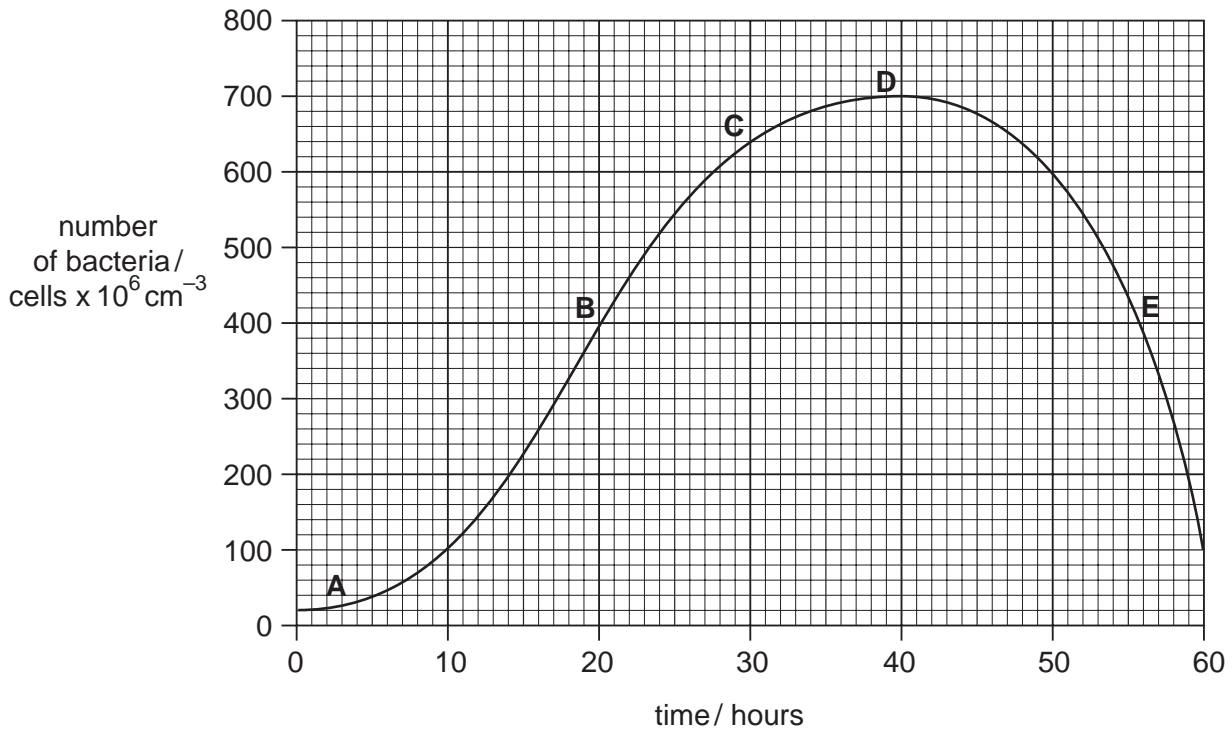


Fig. 1.1

Explain the shape of the growth curve shown in Fig. 1.1.

You may find it helpful to refer to the letters **A** to **E** in your answer.

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Quality of Written Communication [1]

(b) The limpet, *Patella vulgata*, is a common intertidal mollusc found on rocky shores around the British Isles. It is a herbivore and feeds off microscopic algae which it scrapes off the surface of rocks.

The size of the population in a particular locality is maintained at the carrying capacity by a number of density-dependent factors.

(i) Define the term *carrying capacity*.

.....
..... [1]

(ii) State **two** density-dependent factors that control the size of the population.

1

2 [2]

[Total: 11]

- 2 (a) Prokaryotic cells have operons. An operon consists of a group of genes that act together to control a biochemical pathway. An example is the *lac* operon.

Fig. 2.1 shows the components of the *lac* operon and its regulator gene which is some distance away.

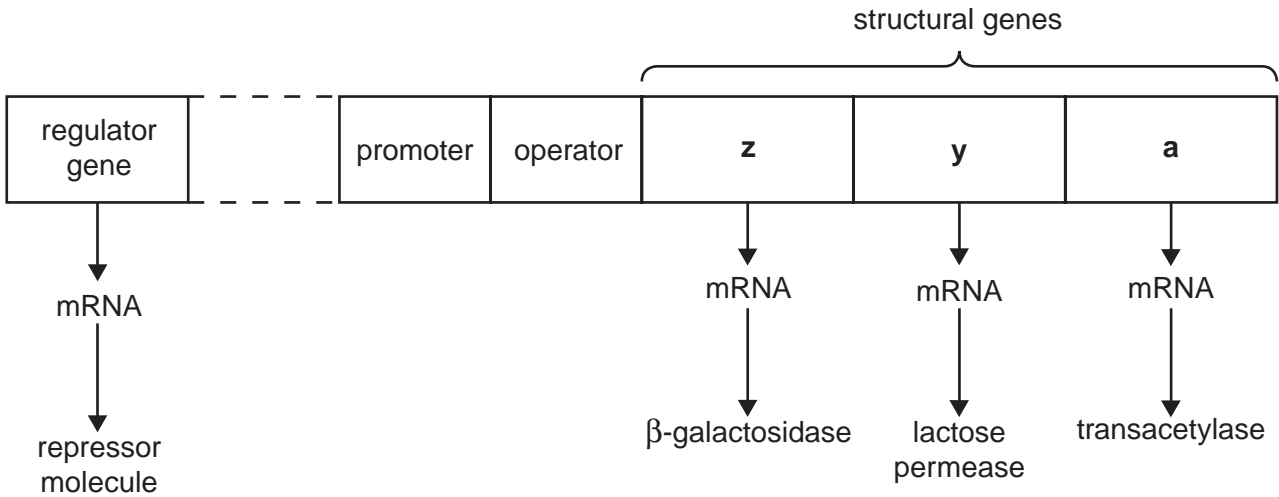


Fig. 2.1

- (i) What type of macromolecule is the repressor molecule?

..... [1]

- (ii) Describe what happens to the repressor molecule if lactose is present.

.....

 [2]

- (iii) Name the component of the *lac* operon that the repressor molecule binds to.

..... [1]

- (b) A strain of the bacterium, *Escherichia coli*, has been discovered that has a mutation in the regulator gene. One aspect of the phenotype of this mutant is that it produces large quantities of β-galactosidase at all times.

- (i) Define the term *phenotype*.

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 [1]

(ii) Explain why a mutation in the regulator gene leads to the constant production of β -galactosidase.

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..... [4]

- (c) Mutations also occur in human genes. A rare form of rickets that is not successfully treated with vitamin D therapy is caused by a mutant allele on the X chromosome. Rickets is a childhood disorder involving softening and weakening of the bones. It can be caused by a lack of vitamin D, calcium or phosphate.

Fig. 2.2 shows a pedigree chart for a family that has a history of this condition.

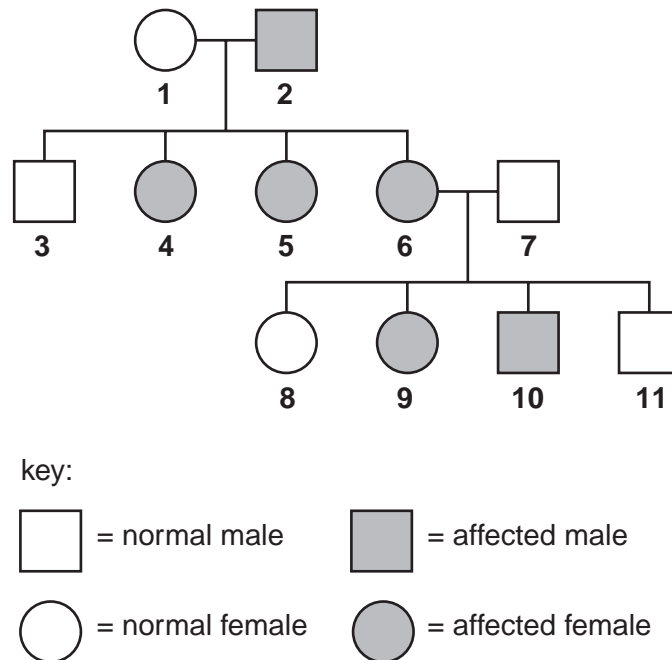


Fig. 2.2

- (i) Using the symbols: X^R = mutant allele on X chromosome
 X^r = normal allele on X chromosome

state the genotypes of the following individuals.

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3

9

10

[4]

- (ii) The gene in which this mutation occurs, codes for a protein carrier found in the proximal convoluted tubule of the kidney. This protein is involved in phosphate transport across membranes.

Suggest why individuals with this mutant allele show symptoms of rickets.

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..... [2]

[Total: 15]

- 3 In the potato plant, *Solanum tuberosum*, the stem develops from a bud on the parent tuber. Buds on the stem below ground level develop into underground stems during summer. The tips of these underground stems eventually swell into tubers, as shown in Fig. 3.1.

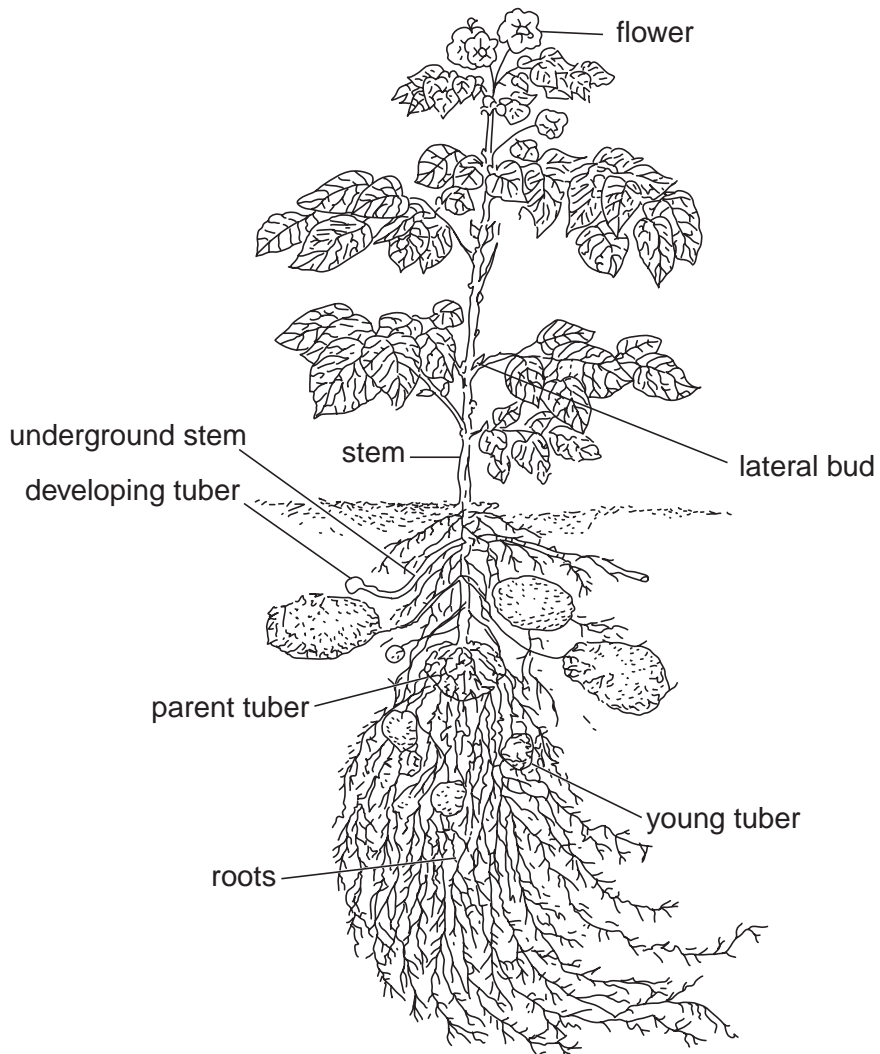


Fig. 3.1

- (a) Lateral buds on the stem above ground level remain inactive and growth only occurs at the apex of the stem.

State the name of this phenomenon.

..... [1]

(b) Fig. 3.2 shows the effect on the development of lateral buds of applying auxin (IAA) and/or gibberellin (GA) to stems, each of which has had the bud at the apex removed. Lanolin is a chemical that has no effect on plant tissues.

In each case the lanolin was applied to the cut end of the stem as shown by the shaded regions in Fig. 3.2.

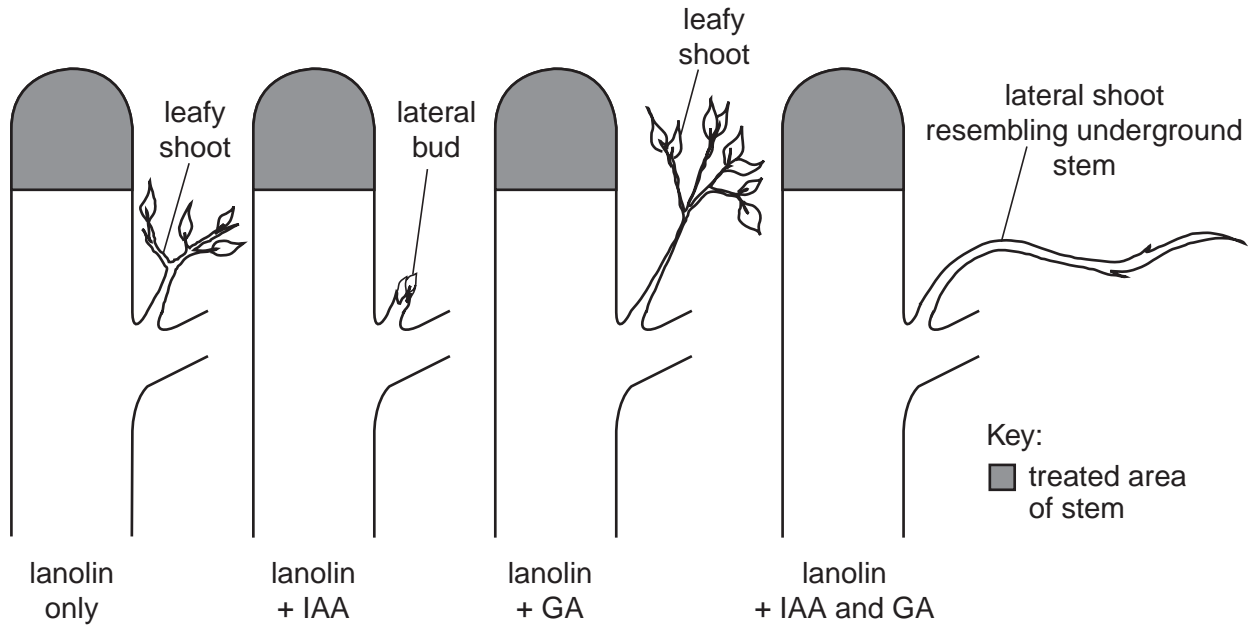


Fig. 3.2

Describe the effect of IAA and GA on lateral bud development in potato plants.

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..... [4]

(c) There are over 100 cultivated varieties of potato plants. Cultivated varieties show increased resistance to diseases, such as black dot caused by the fungus *Colletotrichum coccodes*.

(i) State **three** characteristic features of the Kingdom Fungi.

- 1
- 2
- 3 [3]

(ii) Describe how artificial selection of potato plants has taken place.

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..... [5]

(iii) Suggest how a population of black dot resistant potato plants could be produced from a single resistant plant.

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..... [2]

[Total: 15]

11
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- 4 (a) The first stage in respiration involves the conversion of one molecule of glucose into two molecules of a 3C compound that can enter mitochondria when oxygen is present.

State:

- (i) the name of this stage [1]
- (ii) where this stage occurs in the cell [1]
- (iii) the name of the 3C compound formed [1]
- (iv) the **total** number of ATP molecules formed during this stage [1]

- (b) In this question, one mark is available for the quality of spelling, punctuation and grammar.

Reduced NAD is another product of the first stage of respiration.

Describe the role and fate of reduced NAD in respiring yeast cells, both in the presence and absence of oxygen.

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Quality of Written Communication [1]

(c) In mammals, anaerobic respiration in muscle tissue results in the production of molecules of lactate.

Describe how the production of lactate in muscle tissue differs from anaerobic respiration in yeast.

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..... [3]

[Total: 15]

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5 (a) Fig. 5.1 shows the principal biochemical pathways associated with glucose and glycogen in mammals.

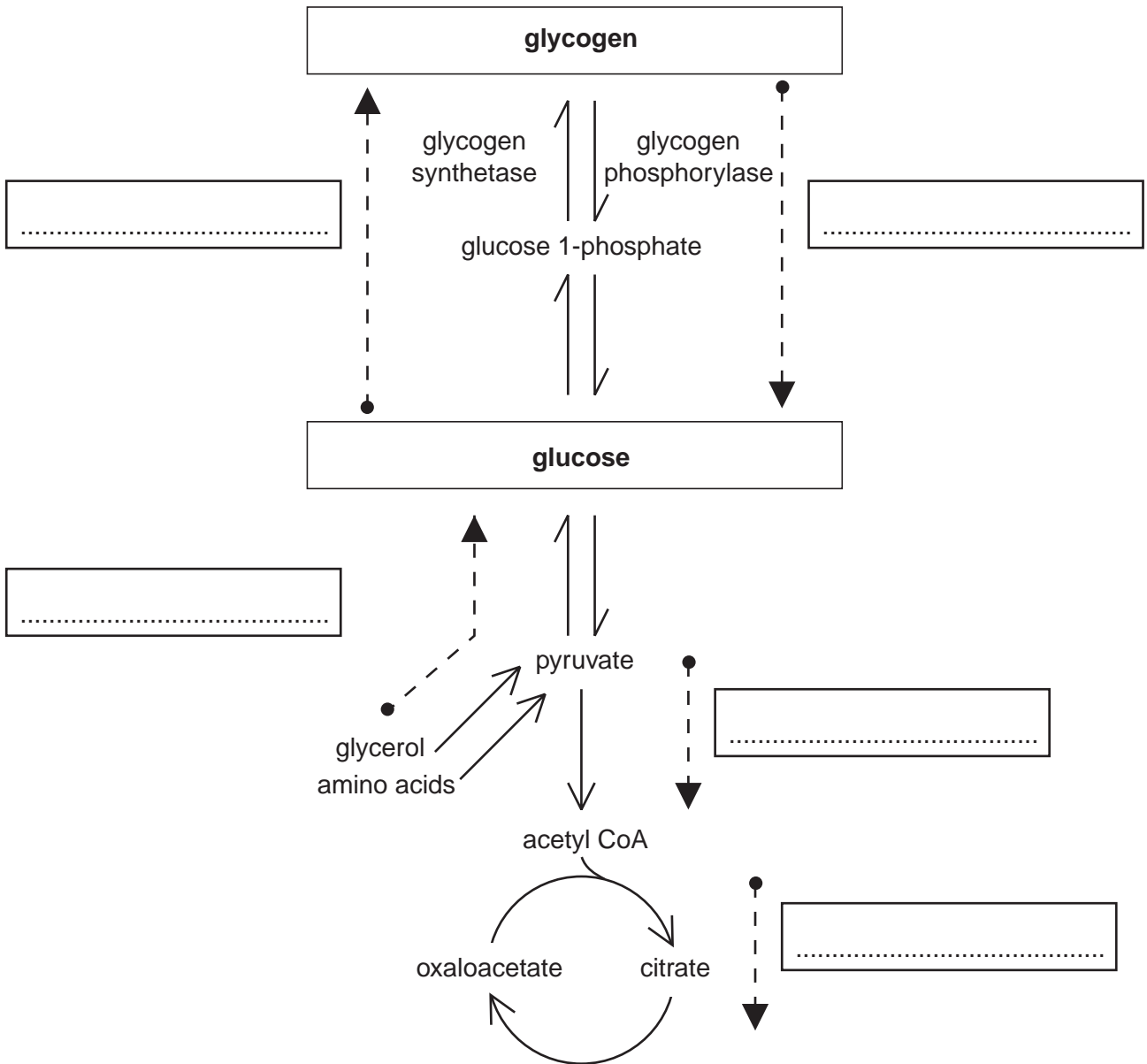


Fig. 5.1

Complete Fig. 5.1 by writing the names of the biochemical pathways listed below in the spaces provided.

- | | | |
|-----------------------|------------------------|----------------------|
| | glycogenesis | link reaction |
| glycogenolysis | gluconeogenesis | Krebs cycle |

[5]

(b) Fig. 5.2 shows the activity of the enzymes glycogen phosphorylase and glycogen synthetase in the liver of a rat after consumption of a glucose meal.

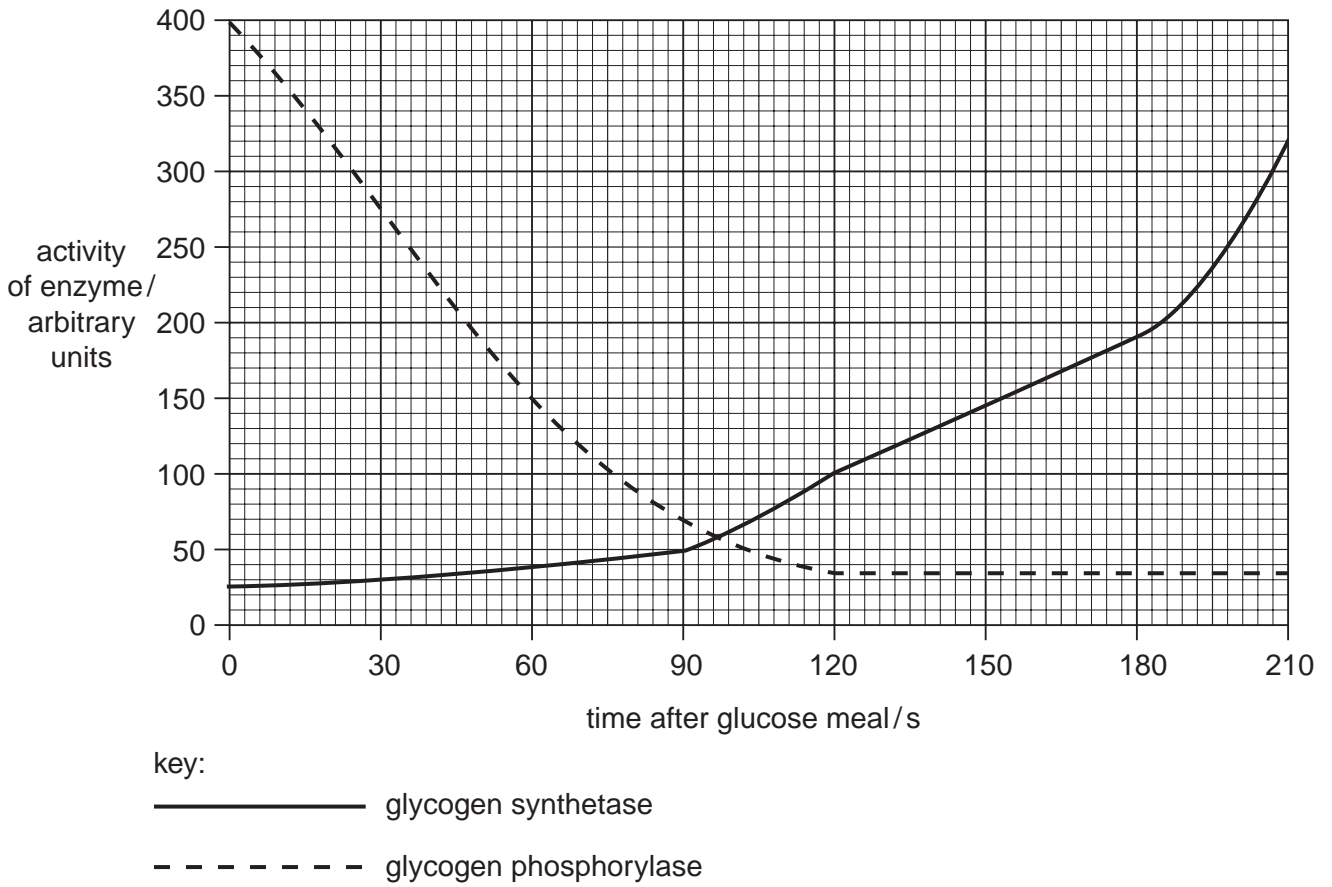


Fig. 5.2

(i) Calculate the percentage **decrease** in glycogen phosphorylase activity in the first minute following the glucose meal.

Show your working and express your answer to the **nearest whole number**.

Answer = % [2]

- (ii) Explain the changes in the activity of the two enzymes shown in Fig. 5.2 following the consumption of a glucose meal. You should refer to the biochemical pathways shown in Fig. 5.1.

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- (c) The pancreas consists of both endocrine and exocrine tissue. The endocrine tissue produces the hormones insulin and glucagon, both of which are involved in the regulation of blood glucose.

- (i) Name the endocrine tissue found in the pancreas.
..... [1]

- (ii) Name the cells that secrete insulin.
..... [1]

(d) Insulin circulates throughout the whole body. Receptors for insulin are found on cells of the liver, adipose tissue and muscle tissue. The number of receptors on the target cells decreases if insulin levels remain high for long periods, resulting in the target cells becoming insensitive (unresponsive) to insulin. This condition is commonly associated with obesity, where affected individuals can become insulin resistant and show the symptoms of diabetes mellitus.

(i) Suggest **both** the specific location and the chemical structure of the receptors.

location

chemical structure

..... [2]

(ii) State **two** changes that will occur within cells possessing insulin receptors when the insulin binds to the receptors.

1

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..... [2]

(e) Explain why the injection of insulin is **not** useful in the treatment of obesity-related diabetes.

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..... [2]

[Total: 20]

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6 (a) The rate of photosynthesis is determined mainly by environmental limiting factors. These are light intensity, the availability of carbon dioxide and temperature. Water supply has indirect effects by influencing the availability of carbon dioxide.

(i) Define the term *limiting factor*.

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 [1]

(ii) Explain how water shortage could have an indirect effect on photosynthesis by influencing the availability of carbon dioxide.

.....

 [2]

(b) Some plants, such as wood sorrel, *Oxalis acetosella*, nearly always grow in shade where light intensity is commonly a limiting factor for photosynthesis. They are known as shade plants. Plants that live in open habitats, for example the daisy, *Bellis perennis*, are called sun plants.

Fig. 6.1 shows the net rate of photosynthesis of sun and shade plants in response to increasing light intensity. The net rate of photosynthesis is defined as:

mass of CO₂ fixed in photosynthesis *minus* mass of CO₂ produced in respiration, per unit time

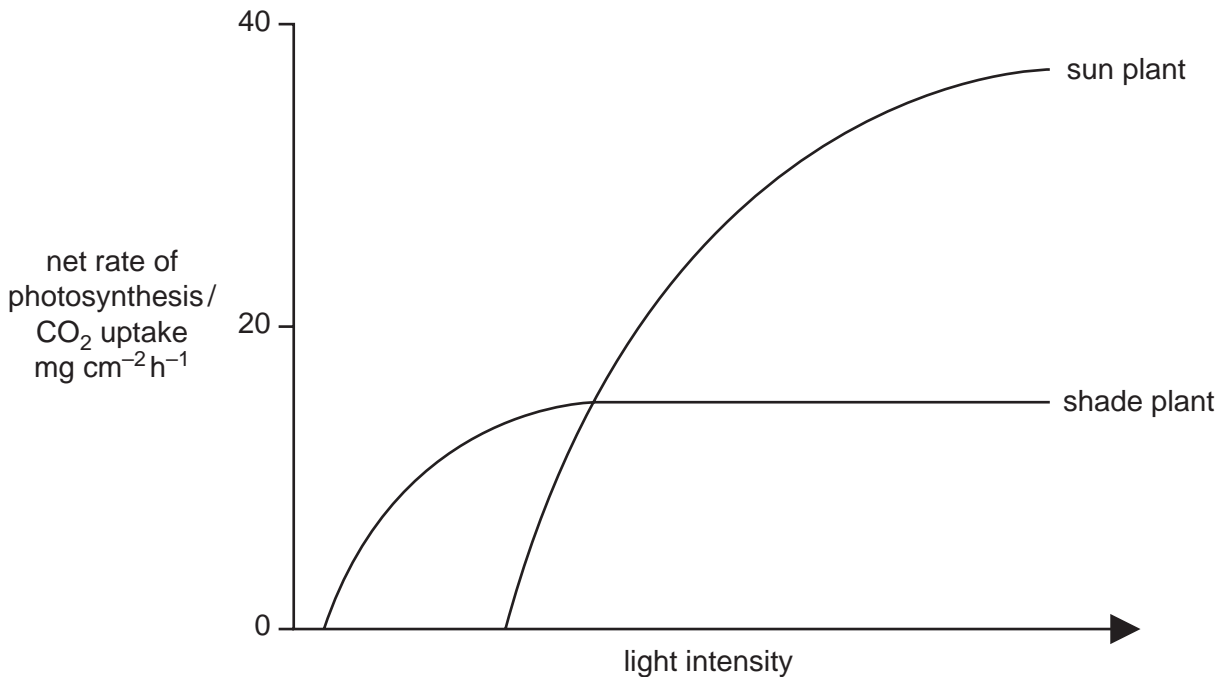


Fig. 6.1

Using Fig. 6.1, describe the responses of sun and shade plants to increasing light intensity.

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..... [2]

(c) Leaves of wood sorrel have been shown to have very low respiration rates per unit leaf area. Fig. 6.2 shows sections through the leaves of typical sun and shade plants.

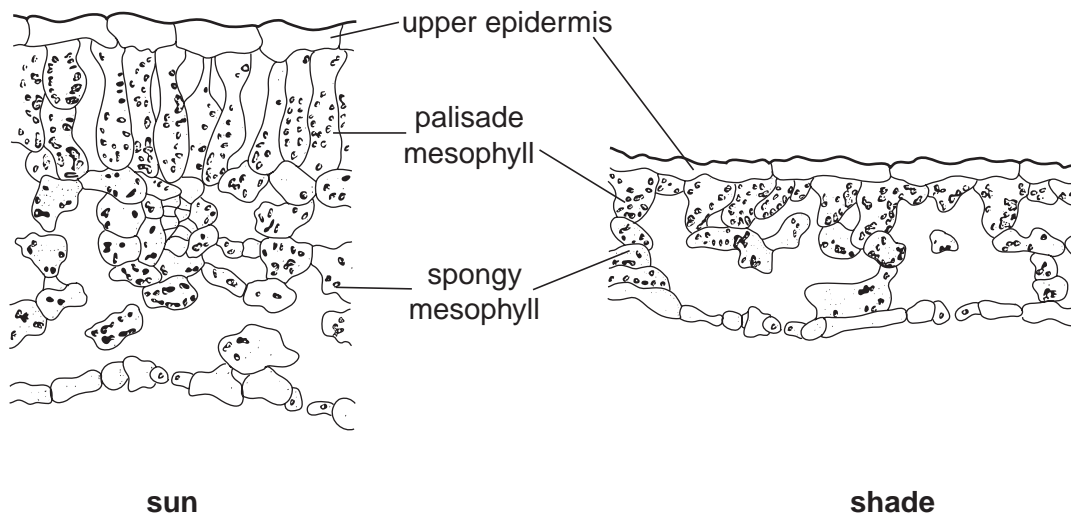


Fig. 6.2

(i) With reference to Fig. 6.2, suggest why the leaves of wood sorrel have low rates of respiration.

..... [1]

(ii) Explain why a low rate of respiration in leaves is an adaptation to low light intensities.

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..... [3]

(d) A large number of seedlings of common orache, *Atriplex patula*, were grown for several weeks in different environmental conditions as follows:

- group 1 – high light intensities
- group 2 – intermediate light intensities
- group 3 – low light intensities.

When fully grown, the net rate of photosynthesis at different light intensities was measured for each group. The results obtained are shown in Fig. 6.3.

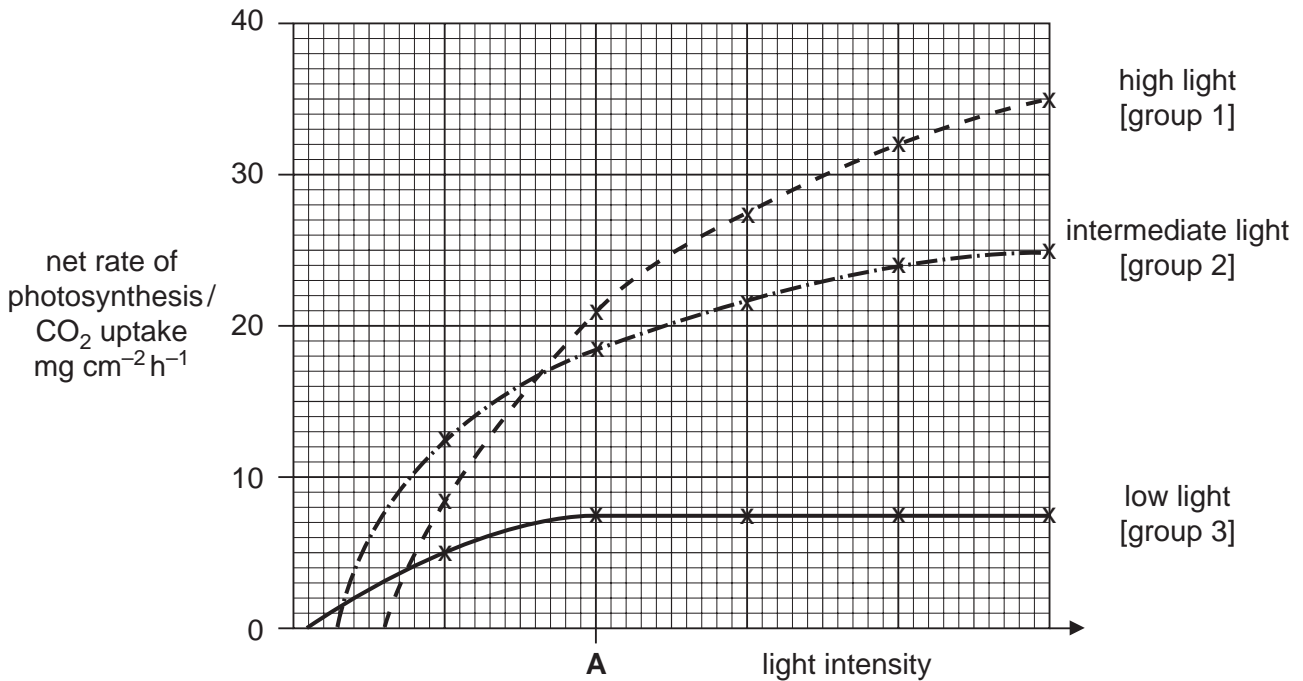


Fig. 6.3

(i) State the net rate of photosynthesis for plants in groups 1 and 3 at light intensity A on Fig. 6.3.

group 1

group 3 [2]

(ii) Suggest how adaptation to light intensity is controlled in *A. patula*.

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 [3]

[Total: 14]

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Copyright Acknowledgements:

Fig. 6.2 Adapted from Irene Ridge (ed.), *Plant Physiology*, p73, Hodder & Stoughton, 1991.

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