

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

BIOLOGY

2804

Central Concepts

Tuesday

21 JUNE 2005

Morning

1 hour 30 minutes

Candidates answer on the question paper.

Additional materials:

Electronic calculator

Ruler (cm/mm)

Candidate Name	Centre Number	Candidate Number												
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TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers, in blue or black ink, in the spaces provided on the question paper.
- Read each question carefully before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- 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	13	
2	13	
3	15	
4	14	
5	12	
6	14	
7	9	
TOTAL	90	

Answer **all** the questions.

1 Fig. 1.1 is a diagram of a section through a mitochondrion.

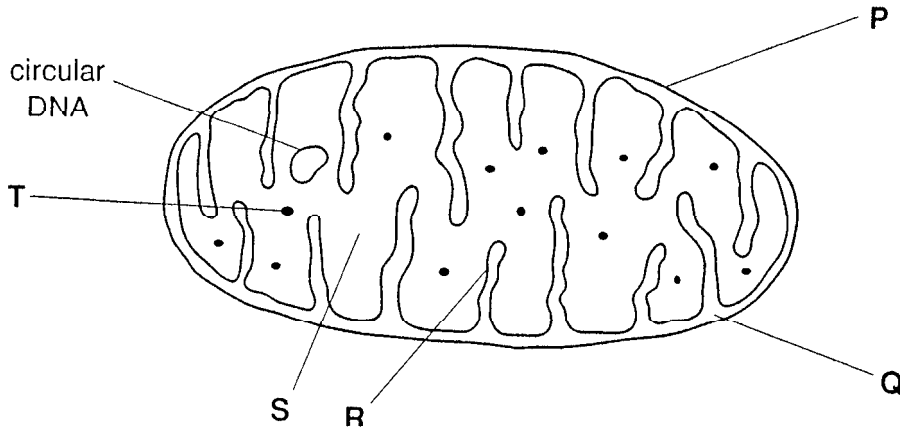


Fig. 1.1

(a) In each case, state the letter which indicates the site of:

the Krebs cycle

oxidative phosphorylation

decarboxylation

[3]

(b) Suggest **one** function of the loop of DNA shown in Fig. 1.1.

.....

.....

.....[1]

Fig. 1.2 is a diagrammatic representation of a section through the inner mitochondrial membrane showing the processes leading to ATP formation.

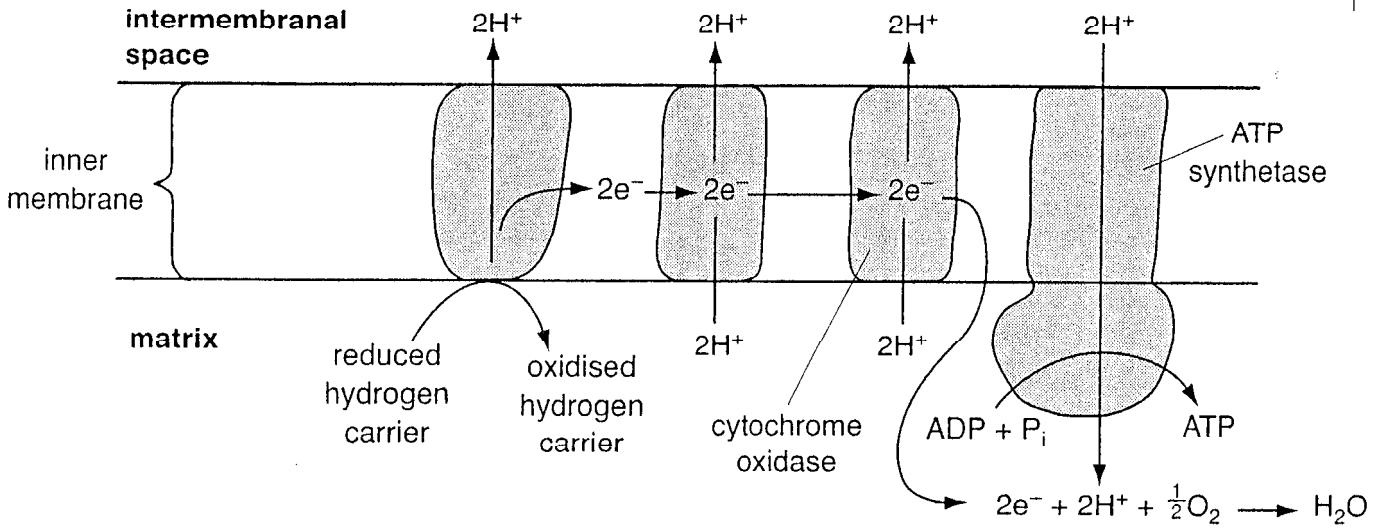


Fig. 1.2

(c) Name a hydrogen carrier that links the Krebs cycle to the electron transport chain.

.....[1]

(d) Explain how oxidative phosphorylation results in the production of ATP.

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.....[5]

(e) The poison cyanide binds with cytochrome oxidase, one of the electron carriers. When this happens, the flow of electrons stops.

Suggest how ingestion of cyanide by humans leads to death by muscle failure.

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.....[3]

[Total: 13]

2 There are several different pigments involved in the light-dependent reactions of photosynthesis in flowering plants.

(a) Name **two** photosynthetic pigments found in flowering plants.

1

2[2]

The pigments are arranged in photosystems that absorb light. There are two photosystems: photosystem I and photosystem II.

(b) State:

(i) the precise site where the photosystems are located in chloroplasts;

.....[1]

(ii) **one** way in which photosystem I differs from photosystem II.

.....[1]

Fig. 2.1 is a diagram that shows the relationship between the light-dependent reactions of photosynthesis and the Calvin cycle in a chloroplast.

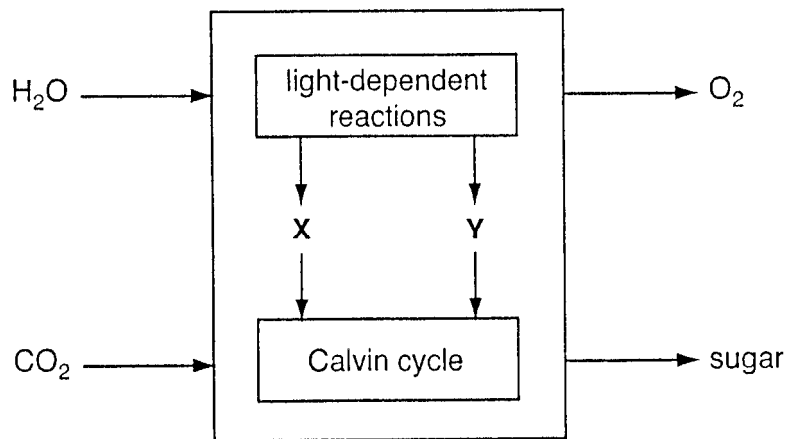


Fig. 2.1

(c) Name the substances **X** and **Y** shown in Fig. 2.1.

X

Y[1]

3 In guinea pigs, the genes for coat texture and coat colour are found on separate chromosomes. The allele for rough coat is dominant to the allele for smooth coat. The allele for black coat is dominant to the allele for white coat.

A black guinea pig with a rough coat was crossed with a white guinea pig with a rough coat. The cross was repeated on a number of occasions and the phenotypes of the offspring were as follows:

- 28 rough and black coats
- 31 rough and white coats
- 11 smooth and black coats
- 10 smooth and white coats

(a) Complete the genetic diagram to explain this cross.

Use the following symbols to represent the alleles:

R = rough r = smooth
B = black b = white

Parental phenotypes: rough and black coat × rough and white coat

Parental genotypes:

Gametes:

Offspring genotypes:

Offspring phenotypes:

Expected phenotypic ratio:[5]

(b) A gene controlling coat colour in cats is **sex linked**. The two alleles of this gene are black and orange. When both the black and orange alleles are present, the coat colour produced is called tortoiseshell.

(i) Define the following terms.

gene
.....
.....
.....[2]

allele
.....[1]

(ii) Explain why there are no male tortoiseshell cats.

.....
.....
.....
.....[2]

(c) The bacterium *Escherichia coli* uses glucose as a respiratory substrate. In the absence of glucose, *E. coli* can use lactose.

Explain how lactose induces the enzyme system involved in its uptake and metabolism.

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.....[5]

4 (a) Explain the term *endocrine gland*.

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[2]

(b) Fig. 4.1 is a flow diagram of the role of the pancreas in controlling blood glucose concentrations. Study the diagram and answer the questions below.

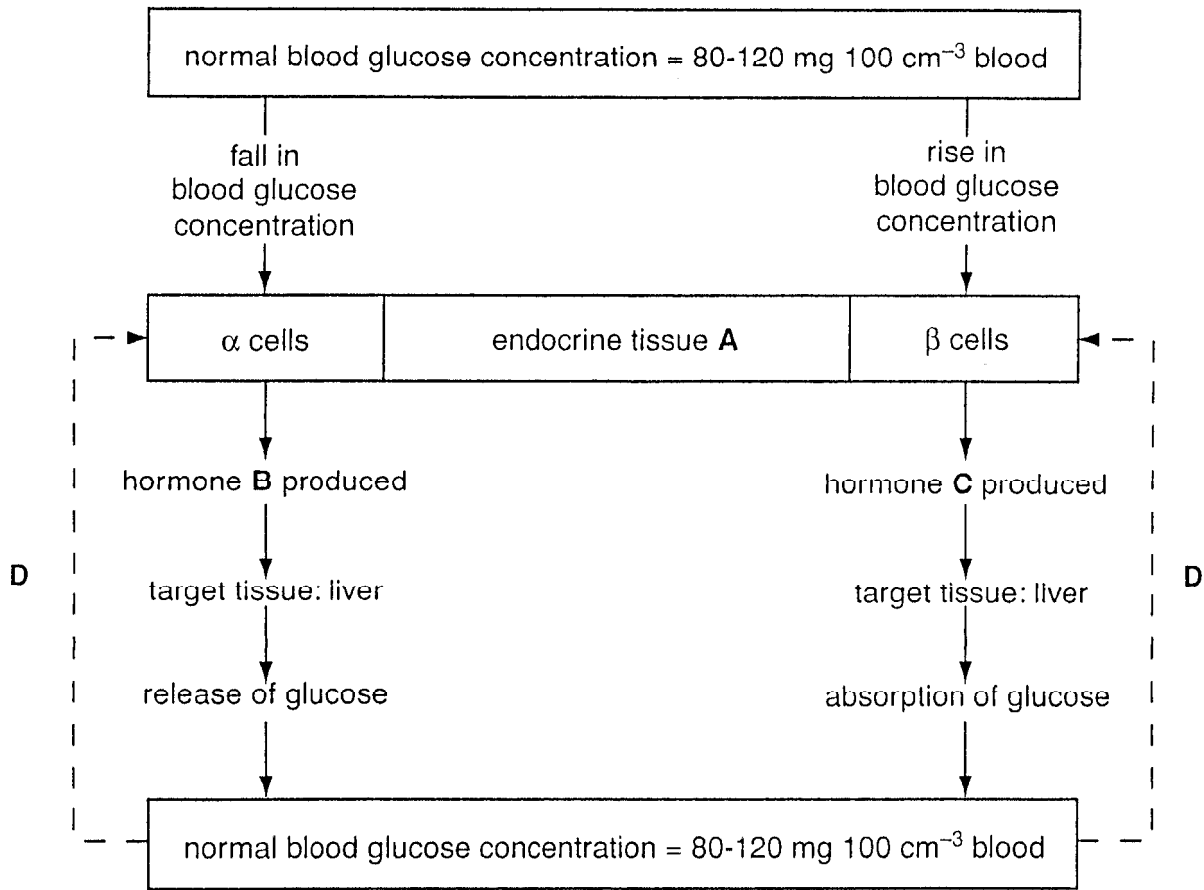


Fig. 4.1

- (i) Name the endocrine tissue labelled **A**.[1]
- (ii) Name the hormone, **B**, produced by the α cells.[1]
- (iii) Name the hormone, **C**, produced by the β cells.[1]
- (iv) Name the process represented by the dotted lines labelled **D**.
[1]

5 Resistance to the poison warfarin is now extremely common in rats. Warfarin inhibits an enzyme in the liver that is necessary for the recycling of vitamin K. This vitamin is involved in the production of substances required for blood clotting. There are two alleles of the gene that codes for this enzyme. Resistant rats have the allele R^R ; rats susceptible to warfarin have the genotype $R^S R^S$.

- Rats susceptible to warfarin die of internal bleeding.
- Homozygous resistant rats do not suffer from internal bleeding if their diet provides more than $70 \mu\text{g}$ of vitamin K per kg body mass per day.
- Heterozygous rats are resistant to warfarin if their diet provides about $10 \mu\text{g}$ of vitamin K per kg body mass per day.

(a) A population of rats was studied in an area where warfarin was used. The dietary intake of the rats was about $15 \mu\text{g}$ of vitamin K per kg body mass per day.

Complete the table below to indicate whether rats of the three genotypes have a **high** or a **low** chance of surviving to maturity in this population. Explain each of your answers.

genotype	chance of surviving to maturity	explanation
$R^R R^R$		
$R^R R^S$		
$R^S R^S$		

[3]

(b) (i) State how the allele for warfarin resistance originated.

.....[1]

(ii) Explain how the allele spread through the population.

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.....[5]

(c) State why this is an example of **natural** selection.

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.....[1]

(d) Explain what is likely to happen to the frequencies of the two alleles (**R^R** and **R^S**) within the rat population over a period of time if warfarin use is discontinued.

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.....[2]

[Total: 12]

- 7 Fig. 7.1 shows a typical bacterial growth curve for a closed system, such as a test tube or conical flask.

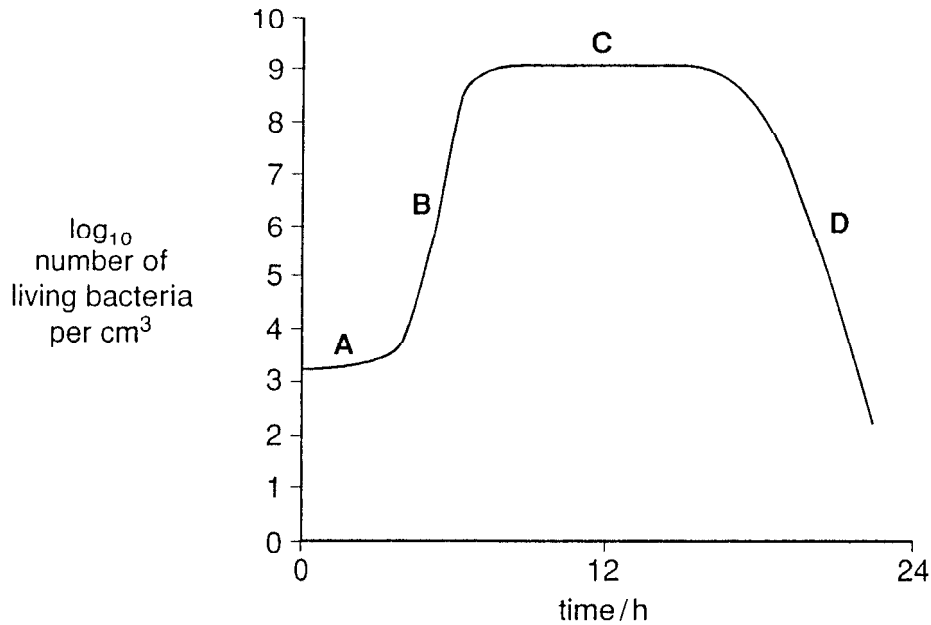


Fig. 7.1

- (a) Complete the table below by writing the appropriate letter from Fig. 7.1 in the spaces provided.

description of stage	letter
cells divide at a constant rate depending upon the composition of the growth medium and the conditions of the incubation	
some cells are dividing and an equal number are dying	
number of living cells is decreasing	
time required for synthesis of inducible enzymes and factors involved in cell division	

[4]

(b) Generation time (**G**) is defined as the length of time (**t**) from one generation to the next.

The mean generation time is calculated using the following formula:

$G = \frac{t}{n}$ where **t** = time and **n** = number of generations

(i) The bacterium *Streptococcus lactis* has been shown to divide 55 times during 24 hours.

Calculate the mean generation time of this bacterium in minutes. Show your working.

Generation time = minutes [2]

(ii) The generation time for *Escherichia coli* in a laboratory can be 20 minutes, but in the intestinal tract it can be as much as 24 hours. Suggest **three** reasons for this difference.

1

.....

2

.....

3

.....[3]

[Total: 9]

END OF QUESTION PAPER