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Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Level

BIOLOGY **9700/06**

Paper 6 Options

October/November 2006

1 hour

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre Number, Candidate Number and Name in the spaces at the top of this page.
Write in dark blue or black pen in the spaces provided on the Question Paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** the questions set on **one** of the options.
At the end of the examination, **enter the number of the option you have answered in the grid below.**

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
The options are:
1 – Mammalian Physiology (page 2)
2 – Microbiology and Biotechnology (page 12)
3 – Growth, Development and Reproduction (page 20)
4 – Applications of Genetics (page 27)

OPTION ANSWERED	
FOR EXAMINER'S USE	
1	
2	
3	
4	
TOTAL	

This document consists of **34** printed pages and **2** blank pages.

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OPTION 1 – MAMMALIAN PHYSIOLOGY

1 Fig. 1.1 is a micrograph of contracted striated muscle.

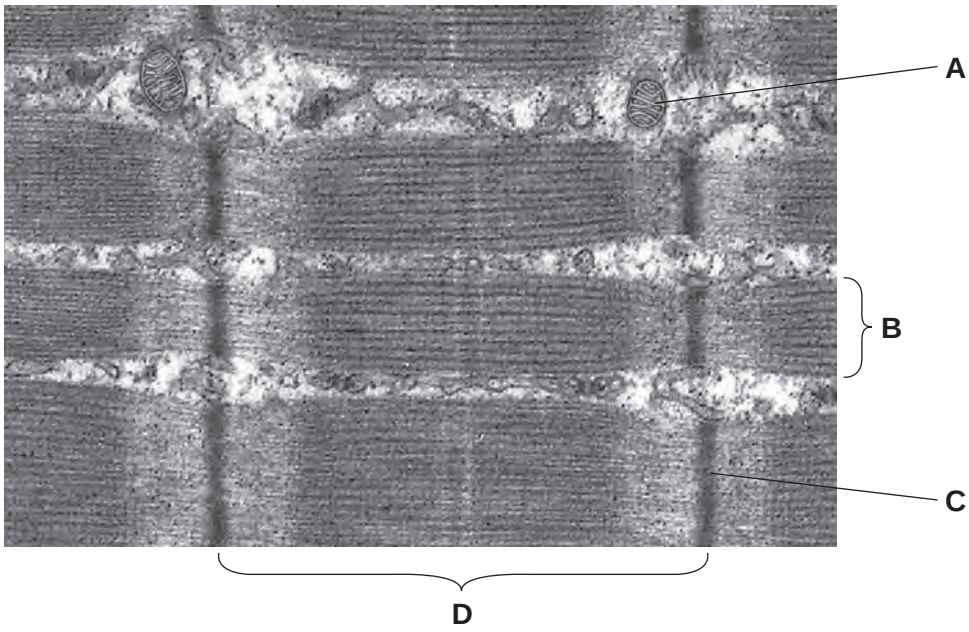


Fig. 1.1

(a) (i) Name **A** to **D**.

A .....

B .....

C .....

D .....[2]

(ii) State two differences that you would see in structure **D** when this muscle is relaxed.

1. .....

.....

2. .....

.....[2]

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(b) In Duchenne muscular dystrophy, DMD, a faulty version of the protein dystrophin, that forms the Z lines, is produced.

The gene for dystrophin is found on the X chromosome. The allele that causes DMD is recessive.

With the help of a genetic diagram, show how a boy with DMD may be born to two parents who do not have this condition. **State the meaning of the symbols that you use.**

[4]

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[Turn over

(c) Dystrophin normally anchors the actin filaments to the sarcolemma (cell surface membrane) of the myofibrils. A lack of dystrophin therefore leads to a lack of support for the actin filaments.

Use this information to suggest how the faulty version of dystrophin affects the function of a muscle.

.....

.....

.....

.....

.....[3]

(d) Describe the roles of troponin and tropomyosin in muscle contraction.

.....

.....

.....

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.....

.....

.....[4]

[Total: 15]

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2 There is a strong link between the concentration of cholesterol in the blood and the risk of suffering a heart attack. However, cholesterol is an important compound from which steroid hormones are made. It is also a component of cell membranes.

One of the roles of the liver is to maintain and regulate blood cholesterol levels. A negative feedback mechanism regulates the rate at which liver enzymes synthesise cholesterol.

(a) Outline the way in which a negative feedback mechanism can help to maintain a relatively constant level of cholesterol in the blood.

.....

.....

.....[2]

(b) Statins are drugs that inhibit one of the enzymes in the liver which is involved in the synthesis of cholesterol. Table 2.1 shows the results of a very large trial in which more than 20 000 people took part. Half of the people took statins each day for four years, while the other half took a placebo (a preparation that did not contain statins). Neither of the groups knew whether they were being given statins or a placebo.

Table 2.1

	taking statins	taking a placebo
total number of deaths	1300	1500
number of deaths from disease of the circulatory system	800	900
number of people who suffered a heart attack	900	1200

(i) State the reason for using a placebo in trials such as this.

.....

.....[1]

(ii) Calculate the percentage decrease in the number of deaths in the group taking statins compared with the group taking a placebo. Show your working.

.....% [2]

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[Turn over

(iii) State whether these results support the hypothesis that statins reduce cholesterol levels. Explain your answer.

.....

.....

.....[2]

(c) Explain why taking statins is likely to have a greater effect on lowering blood cholesterol levels than reducing cholesterol intake in the diet.

.....

.....

.....

.....

.....[3]

[Total: 10]

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3 **(a)** Explain the difference between *mechanical digestion* and *chemical digestion*.

.....

.....

.....

.....[3]

(b) Fig. 3.1 shows a skull of a large predatory cat. Predators are carnivores that kill and eat other animals.



Fig. 3.1

Explain how each of the following features of the skull is an adaptation for a carnivorous diet.

(i) the articulation of the jaw

.....

.....

.....[2]

(ii) the shape of the molar teeth

.....

.....

.....[2]

[Total: 7]

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4 The sense of balance depends upon nerve impulses arriving in the brain from several different receptors, including the hair cells in the inner ear. The information from these receptors is integrated within the brain. Appropriate nerve impulses are then sent to muscles to maintain posture and balance.

(a) Name

(i) the part of the inner ear in which the receptors for balance are found,

.....[1]

(ii) the part of the brain that coordinates movement and posture.

.....[1]

(b) Fig. 4.1 shows the position of some of the hair cells that sense movement of the head.

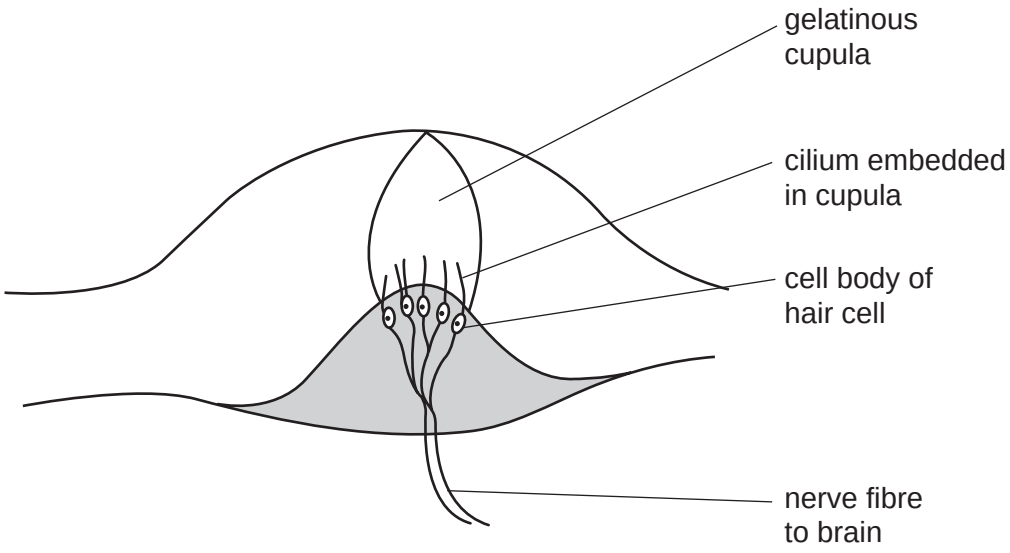


Fig. 4.1

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Fig. 4.2 shows the frequency with which nerve impulses are generated by a hair cell as a person

- begins to rotate their head
- continues rotating their head, and
- stops rotating their head.

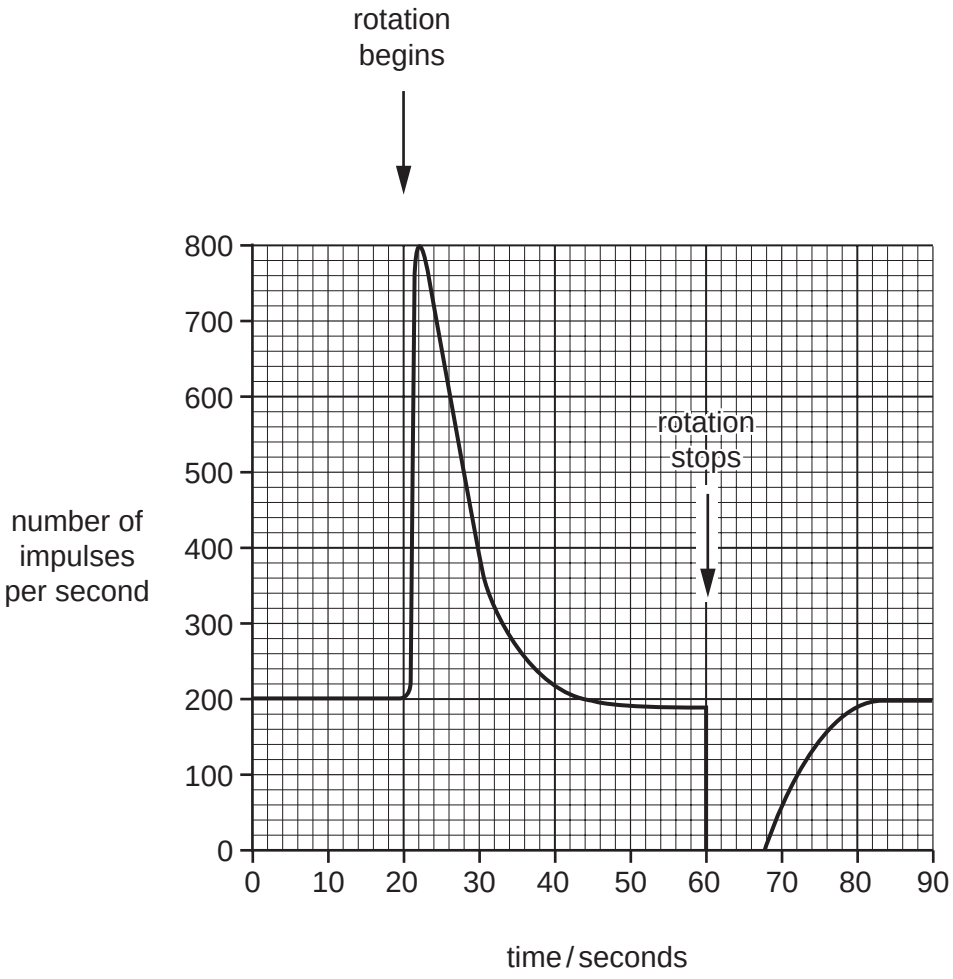


Fig. 4.2

(i) With reference to Fig. 4.2, describe the effect on the generation of nerve impulses by the hair cell as the person

begins to rotate the head, ...

.....

.....

stops rotating the head. .....

.....

.....[3]

(ii) With reference to Fig. 4.1, explain how these effects are brought about.

.....

.....

.....

.....

.....

.....[3]

[Total: 8]

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Option 2 begins on page 12

OPTION 2 – MICROBIOLOGY AND BIOTECHNOLOGY

1 Fig. 1.1 shows the percentage of bacteria from human faeces that are resistant to antibiotics in relation to the quantities of antibiotics used in each of a number of years over a period of forty years.

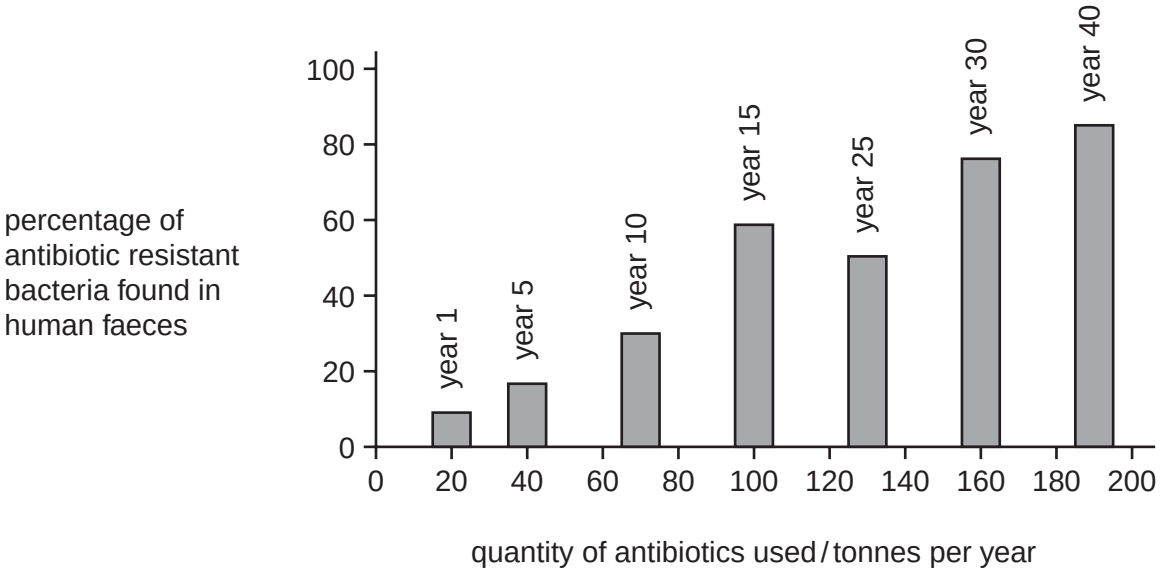


Fig. 1.1

(a) (i) With reference to Fig. 1.1, describe how the quantity of antibiotics used changed during this 40 year period.

.....

.....

.....

.....[3]

(ii) Explain the relationship between the percentage of resistant bacteria and the quantity of antibiotics used.

.....

.....

.....

.....

.....

.....

.....[4]

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(iii) Suggest **one** reason why the practice of adding antibiotics to animal feed should be restricted.

.....

.....[1]

(b) Bacteria from the faeces of people suffering from diarrhoea were cultured. Standard samples of the cultures were plated onto four different growth media, A, B, C and D to test for antibiotic resistance.

- growth medium A did not contain any antibiotic
- growth medium B contained the antibiotic ampicillin
- growth medium C contained the antibiotic tetracycline
- growth medium D contained both antibiotics.

Table 1.1 shows the results of these tests.

Table 1.1

growth medium	A	B	C	D
number of bacterial colonies	250	157	203	150

(i) Compare the effectiveness of ampicillin and tetracycline against these faecal bacteria.

.....

.....

.....[2]

(ii) Calculate the percentage of bacteria resistant to **both** ampicillin and tetracycline. Show your working.

.....% [2]

(c) The antibiotic ampicillin is a modified form of penicillin. Describe how penicillin acts on bacteria.

.....

.....

.....

.....[3]

[Total: 15]

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[Turn over

2 Fig. 2.1 shows the structure of the bacteriophage, λ.

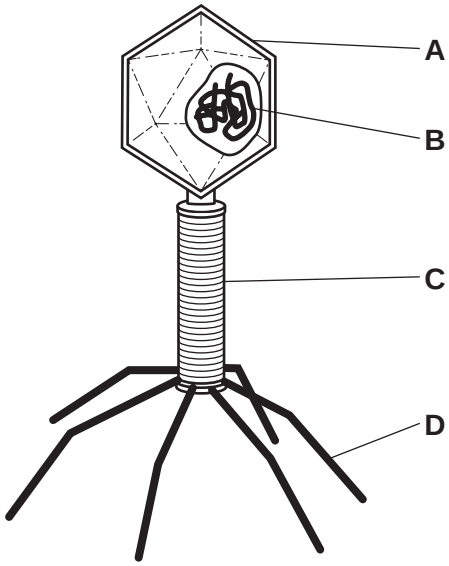


Fig. 2.1

(a) Name **A** to **D**.

A .....

B .....

C .....

D .....[2]

(b) The bacteriophage, λ, is a virus that infects the bacterium *Escherichia coli*.

State **one** structural difference between a λ bacteriophage and a bacterium.

.....

.....[1]

(c) Outline how the bacterium *E. coli* reproduces asexually.

.....

.....

.....

.....

.....

.....[3]

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(d) The λ bacteriophage has both a lytic and a lysogenic life cycle.

Fig. 2.2 shows the **lysogenic** cycle of the λ bacteriophage.

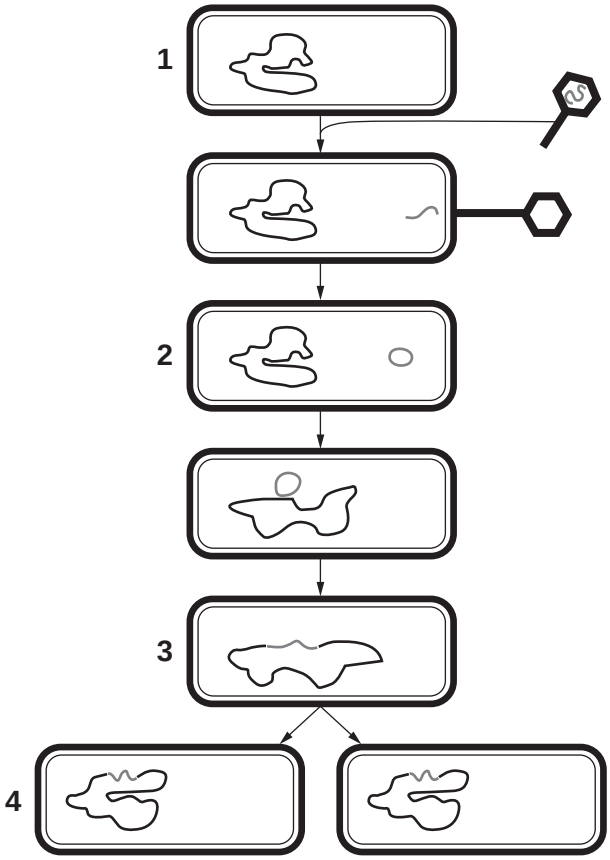


Fig. 2.2

Outline the events occurring between

*stages **1** to **2***,

.....

.....

*stages **2** to **3**,*

.....

.....

*stages **3** to **4**.*

.....

.....[3]

[Total: 9]

3 Fig. 3.1 shows a procedure for producing new plants by pollen culture.

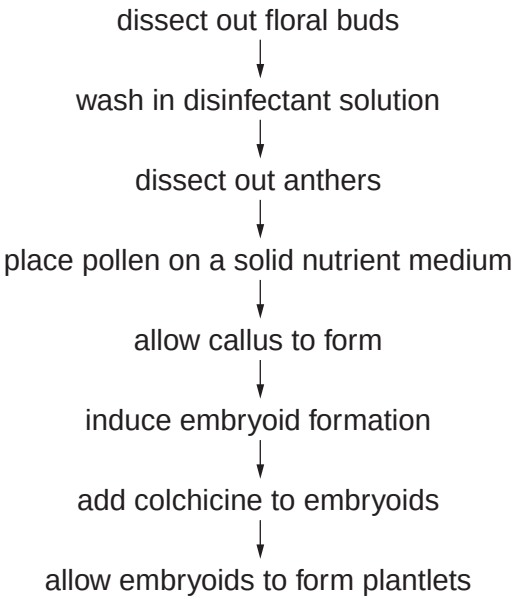


Fig. 3.1

(a) With reference to Fig. 3.1, state the purpose of

(i) washing the floral buds in disinfectant solution,

.....

.....[1]

(ii) adding colchicine to the embryoids.

.....

.....[1]

(b) Anther culture can be used to produce hybrid plants by fusing haploid cells. Suggest how the procedure shown in Fig. 3.1 may be modified to produce a hybrid plant.

.....

.....

.....[2]

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(c) The solid medium used to culture pollen contains nutrients required for the growth of the pollen. State how **two** named nutrients are used by the pollen.

.....

.....

.....

.....

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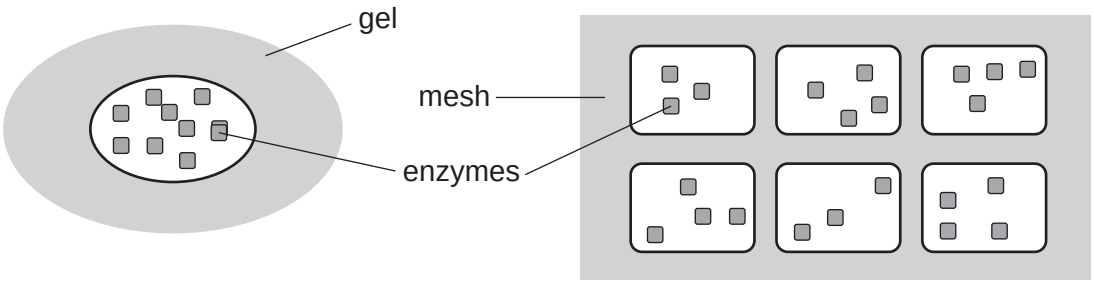
.....

.....[4]

[Total: 8]

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4 Fig. 4.1 shows two different ways of immobilising enzymes by entrapment.



gel encapsulation fibrous polymer mesh

Fig. 4.1

(a) With reference to Fig. 4.1,

(i) suggest **two** reasons why enzymes in biological washing powders are now added to the detergent in encapsulated form instead of powdered form,

.....

.....

.....[2]

(ii) state **one** disadvantage of immobilising enzymes.

.....[1]

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(b) Whole microorganisms can be immobilised in the same way as enzymes. Fig. 4.2 shows a fermenter containing immobilised microorganisms used for continuous culture.

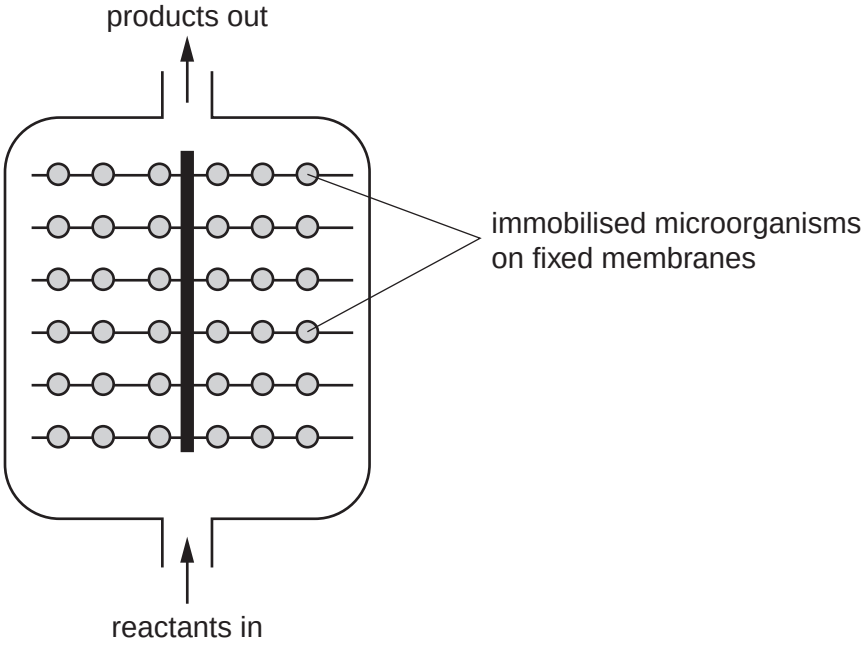


Fig. 4.2

(i) Explain the term *continuous culture*.

.....

.....

.....

.....[2]

(ii) Suggest why a continuous culture that uses immobilised microorganisms should **not** be stirred.

.....

.....[1]

(c) Producing amino acids using an enzyme immobilised in a system similar to that shown in Fig. 4.2 is approximately 60% less costly than using batch culture.

Give two reasons why the cost of using an immobilised enzyme system is less.

1. .....

.....

2. .....

.....[2]

[Total: 8]

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OPTION 3 – GROWTH, DEVELOPMENT AND REPRODUCTION

1 **(a)** Complete Table 1.1 to show the method of asexual reproduction and a named example.

Table 1.1

kingdom	method of asexual reproduction	named example
Prokaryotae		
Protoctista		
Animalia		

[3]

(b) The green microorganism, *Euglena*, was grown in a liquid culture. The number of cells in a representative sample of the culture was counted each day for a week and used to estimate the number of cells per cm^3 of the culture. The results are shown in Fig. 1.1.

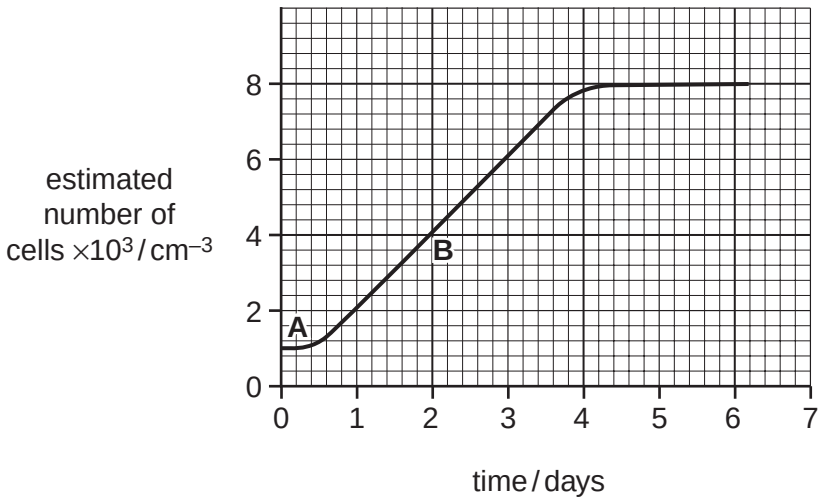


Fig. 1.1

With reference to Fig. 1.1,

(i) name the stages **A** and **B**,

A .....

B .....[2]

(ii) explain why, after 5 days, the number of cells does not increase.

.....

.....

.....

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.....

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.....[4]

(c) The culture needed to be kept at an optimum temperature of 26 °C.

Describe and explain what would happen to the culture if the temperature rose above this optimum temperature.

.....

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.....

.....

.....[3]

(d) In the experiment described in **(b)**, the growth of *Euglena* was measured by counting cells.

Describe **one** other method that could be used to measure the population growth of this organism.

.....

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.....

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.....[3]

[Total: 15]

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2 **(a)** Fig. 2.1 is a diagram of the stages in the development of one follicle in a human ovary.

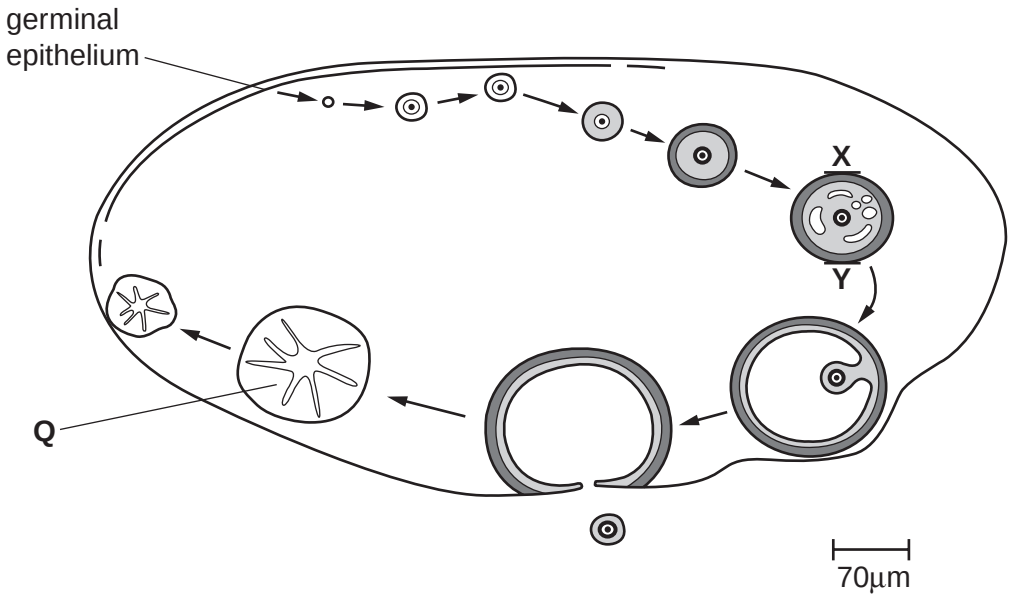


Fig. 2.1

(i) Calculate the actual length in µm from **X** to **Y** across the ovarian follicle. Show your working.

..... µm [2]

(ii) Name structure **Q** and state its function.

name .....

function .....

.....[2]

(b) The germinal epithelium divides to form the primary oocytes.

(i) Name the type of cell division used to form a primary oocyte.

.....[1]

(ii) State the chromosome number present in one primary oocyte.

.....[1]

(iii) Outline how the primary oocyte continues its development.

.....

.....

.....

.....

.....

.....[3]

[Total: 9]

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3 **(a)** Proteas are dicotyledonous plants that produce seeds which become dormant. Plant growth regulators are involved in the control of this seed dormancy.

Some proteas are found in a habitat with an annual mean temperature of 29 °C and an annual rainfall of 6 cm which all falls in one month of the year. Bush fires are common in such habitats, and protea seeds mostly germinate after rain, around sites where fires have recently burned.

(i) Describe two advantages to proteas of seed dormancy.

1. .....

.....

2. .....

.....[2]

(ii) Outline how plant growth regulators may maintain seed dormancy.

.....

.....

.....[2]

(iii) Using the information above, state the factors that are most likely to break the dormancy of protea seeds.

.....

.....

.....

.....[2]

(b) A plant growth regulator, gibberellin, is used by brewers to make barley seeds germinate simultaneously.

Explain how gibberellin brings about germination.

.....

.....

.....

.....

.....[3]

[Total: 9]

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4 **(a)** Fig. 4.1 shows three longitudinal sections of an individual daisy flower during the pollination period.

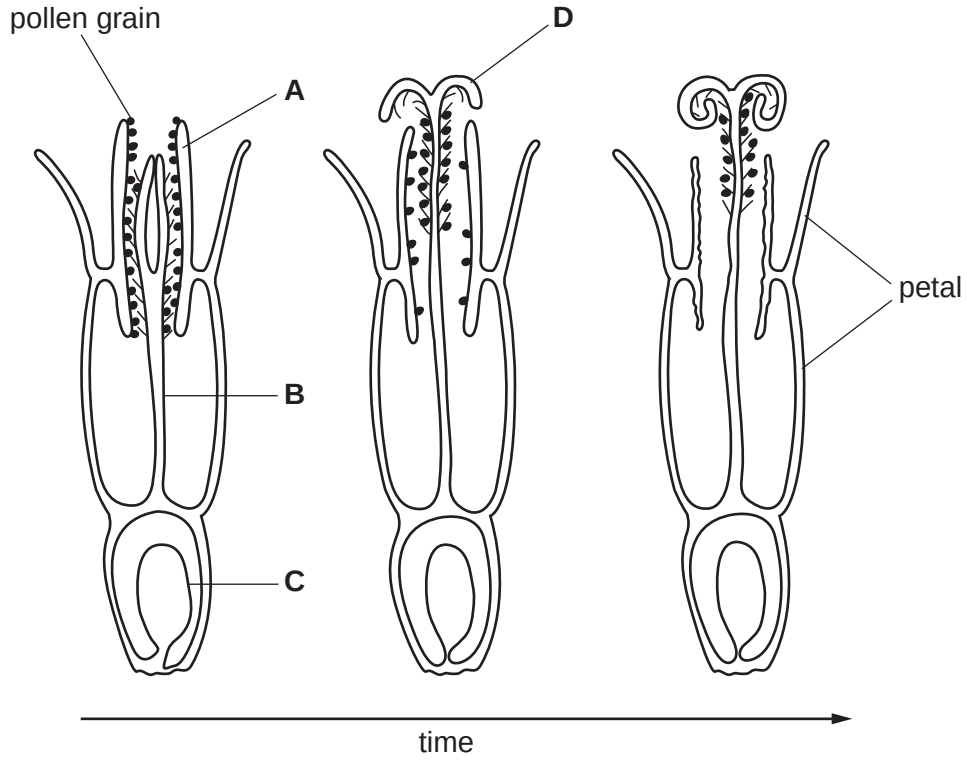


Fig. 4.1

With reference to Fig. 4.1,

(i) name **A** to **D**,

A ..... **B** .....

C ..... **D** .....[2]

(ii) state **one** feature of this flower that encourages cross-pollination.

.....

.....

.....[1]

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[Turn over

(b) Daisies attract insects. The effect of insects visiting the flowers on the number of seeds produced was investigated. Some daisies were isolated from insects. Others received between one and 50 insect visits.

The percentages of flowers that produced seeds are shown in Table 4.1.

Table 4.1

number of insect visits	percentage of flowers producing seed
0	90
1	90
10	92
20	95
50	95

With reference to Fig. 4.1 and Table 4.1,

(i) explain these results,

.....

.....

.....

.....[2]

(ii) suggest, with a reason, whether there is likely to be any difference in the genetic variation shown by the seeds of daisies receiving many insect visits and those receiving none.

.....

.....

.....

.....[2]

[Total: 7]

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OPTION 4 – APPLICATIONS OF GENETICS

1 **(a)** The large perennial Asian grass, *Miscanthus*, is now being grown in Europe as a source of biofuel.

The *Miscanthus* grown for this purpose is a single clone of a sterile triploid hybrid of *M. sacchariflorus* x *M. sinensis* which is propagated from tissue culture.

(i) Outline the process of cloning plants from tissue culture.

.....

.....

.....

.....

.....

.....

.....[4]

(ii) Suggest why a triploid hybrid is sterile.

.....

.....

.....[2]

(iii) Describe **one** problem that may arise from growing a single clone.

.....

.....

.....[2]

(b) A trial was set up in southern Germany to see if the two parent species of the sterile hybrid could be grown successfully in Europe and to compare their growth with that of the hybrid. Some of the results of the trial are shown in Table 1.1.

Table 1.1

characteristic	*M. sacchariflorus*	*M. sinensis*	hybrid *M. sacchariflorus x M. sinensis*
ability to withstand cold winters	poor	good	poor
flowering time	late	early	very late
mean harvestable dry mass / tonne $ha^{-1}y^{-1}$	12.5	20.0	25.5
fertility	fertile	fertile	sterile

With reference to Table 1.1, describe a possible selective breeding programme for producing an improved variety of *Miscanthus* for growing in Europe as a source of biofuel.

.....

.....

.....

.....

.....

.....

.....[4]

(c) *M. sinensis* is grown in European gardens as an ornamental plant. Many ornamental garden plants show variation in their phenotypes and genotypes.

Explain how such variation has arisen in garden plants.

.....

.....

.....

.....

.....[3]

[Total: 15]

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2 **(a)** Asian strains of the bacterium causing cholera, *Vibrio cholerae*, have a 100 kilobase length of DNA, called SXT, which confers resistance to four commonly used antibiotics. SXT is also present in other bacterial species.

(i) State what is meant by a *100 kilobase length* of DNA.

.....

.....[1]

(ii) Describe how pieces of DNA, such as SXT, may be passed from one species of bacterium to another.

.....

.....

.....

.....

.....[3]

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(b) Transfer of DNA from one species of bacterium to another is thought to be increased by the so-called 'SOS response' of bacteria to DNA damage.

Measurements were made of the frequency of transfer of SXT from two species of donor bacteria grown in the presence or absence of two antibiotics:

- mitomycin, which is known to damage DNA,
- ciprofloxacin, which is commonly prescribed for use against bacterial infections.

The results of the investigation are shown in Fig. 2.1.

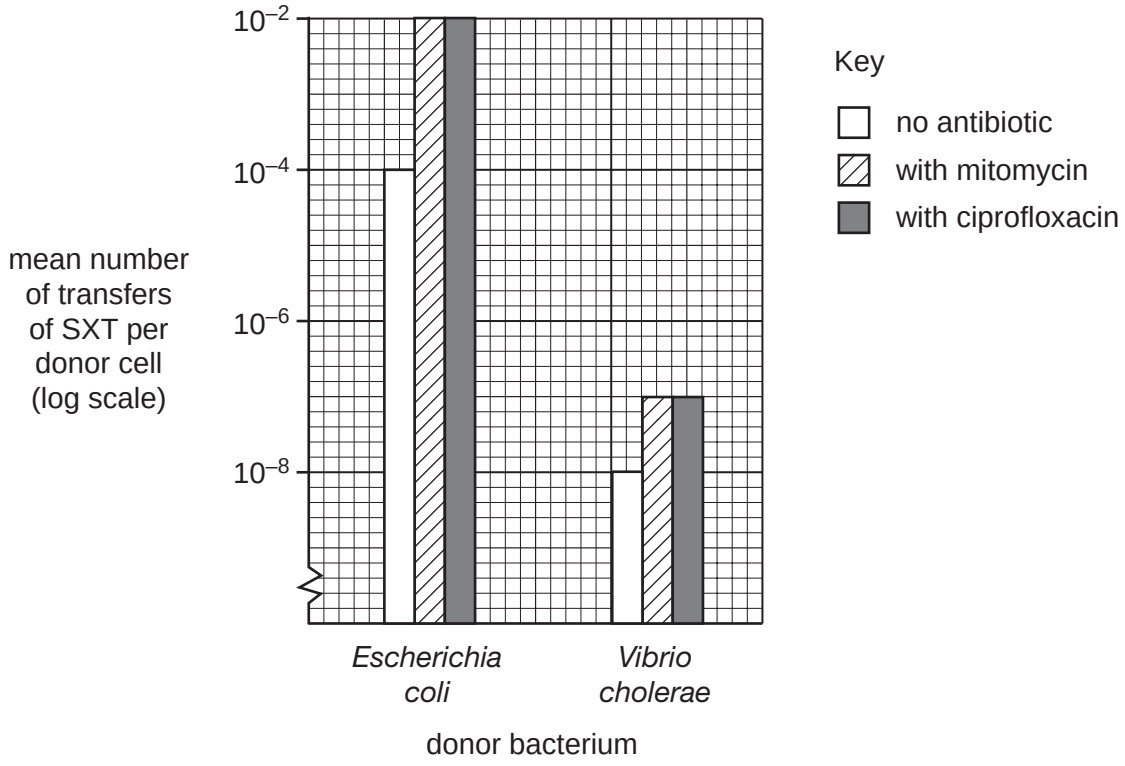


Fig. 2.1

With reference to Fig. 2.1,

(i) calculate the increase in the mean number of transfers per donor cell when *E. coli* is grown in the presence of mitomycin.
Show your working.

..... [2]

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(ii) compare the effect of the antibiotics on transfer of SXT from the two species of donor bacteria,

.....

.....

.....

.....[3]

(iii) suggest the likely effect on the bacterial gene pool when an infected patient who has been prescribed ciprofloxacin takes only a few of the tablets.

.....

.....[1]

[Total: 10]

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3 **(a)** State three differences between the inheritance of cystic fibrosis (CF) and of Huntington's disease (HD).

	CF	HD
1		
2		
3		

[3]

(b) In genetic testing for HD, fragments of DNA are cut from an individual's alleles and separated by gel electrophoresis to determine their length.

Four members of a family affected by HD were tested:

- **A** is the father of **B** and developed symptoms of HD in old age;
- **B** is the mother of **D** and developed symptoms of HD in middle age;
- **C** is the **unaffected** father of **D**;
- **D** is the son of **B** and **C** and developed symptoms of HD as a child.

The results of the genetic test are shown in Fig. 3.1.

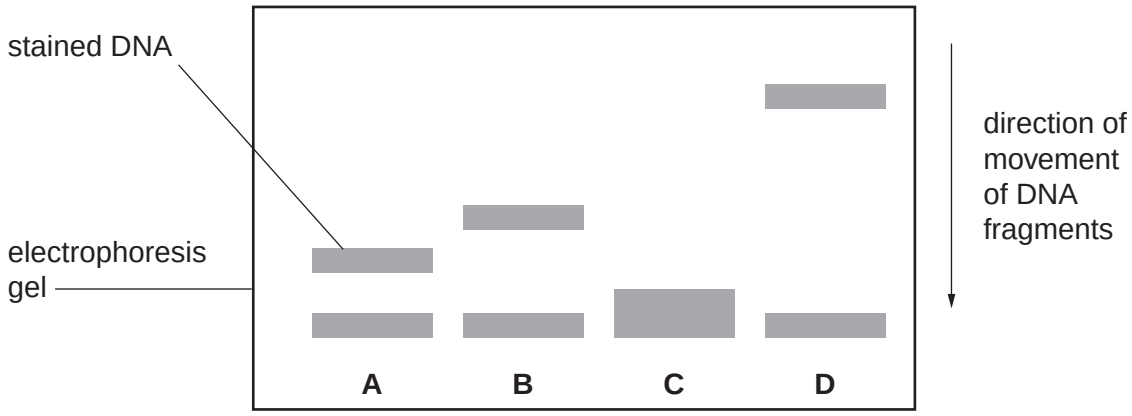


Fig. 3.1

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With reference to Fig. 3.1,

(i) describe the relationship between length of DNA fragment and age of onset of HD,

.....

.....

.....[2]

(ii) explain the differences in positions of DNA fragments from the different members of the family in this test.

.....

.....

.....

.....

.....[3]

[Total: 8]

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4 The Millennium Seed Bank has begun a programme of collecting seeds of the plants endemic to some islands.

Examples of the number of endemic species on these islands are shown in Table 4.1.

Table 4.1

island	number of endemic species
Bermuda	15
Cayman Islands	24
St. Helena	60
Turk and Caicos Islands	9

(i) Describe how a seed bank is maintained.

.....

.....

.....

.....[3]

(ii) Explain the need to maintain seed banks of the endemic plants of these islands.

.....

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.....

.....

.....

.....

.....[4]

[Total: 7]

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