Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Level

BIOLOGY **9700/06**

Paper 6 Options

May/June 2005

1 hour

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 and on all separate answer paper used.
Write in dark blue or black pen.
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 the questions set on **one** of the options only.
Answer **all** four questions from your chosen option only.

Within your chosen option, write your answers to the Questions in the spaces provided on the Question Paper. 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 28)

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 **(a)** Fig. 1.1 is a diagram of three cells in the epithelial tissue of a villus from the ileum.

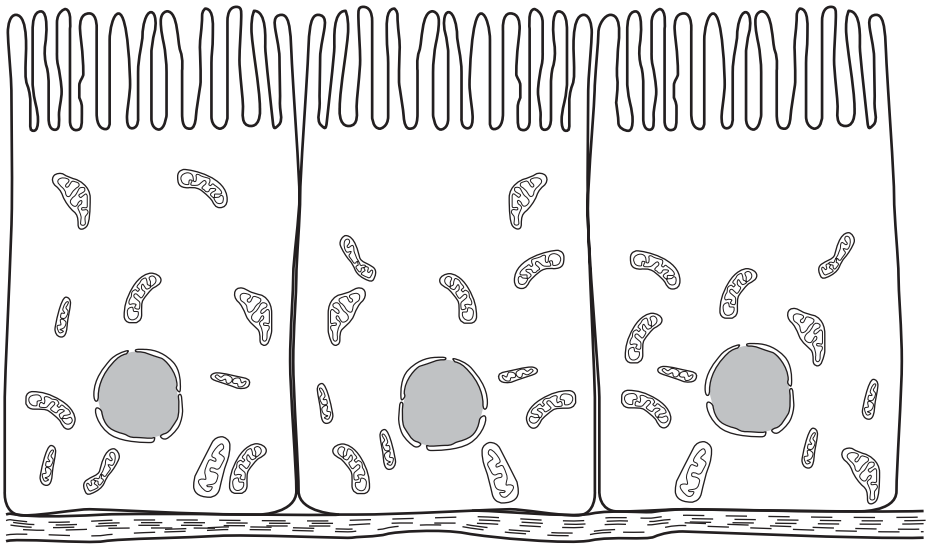


Fig. 1.1

(i) Describe the role of this tissue in digestion.

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.....[2]

(ii) Describe **one** way in which this tissue is adapted for its function of absorption.

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.....

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.....[2]

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(b) Glucose is absorbed into the villus epithelial cells. A sheet of these cells was placed in a 100 µmol dm^{-3} solution of glucose. The uptake of glucose into the cells was measured at intervals for five minutes. The experiment was repeated with the addition of phlorrhizin, which inhibits active transport of glucose. The results are shown in Fig. 1.2.

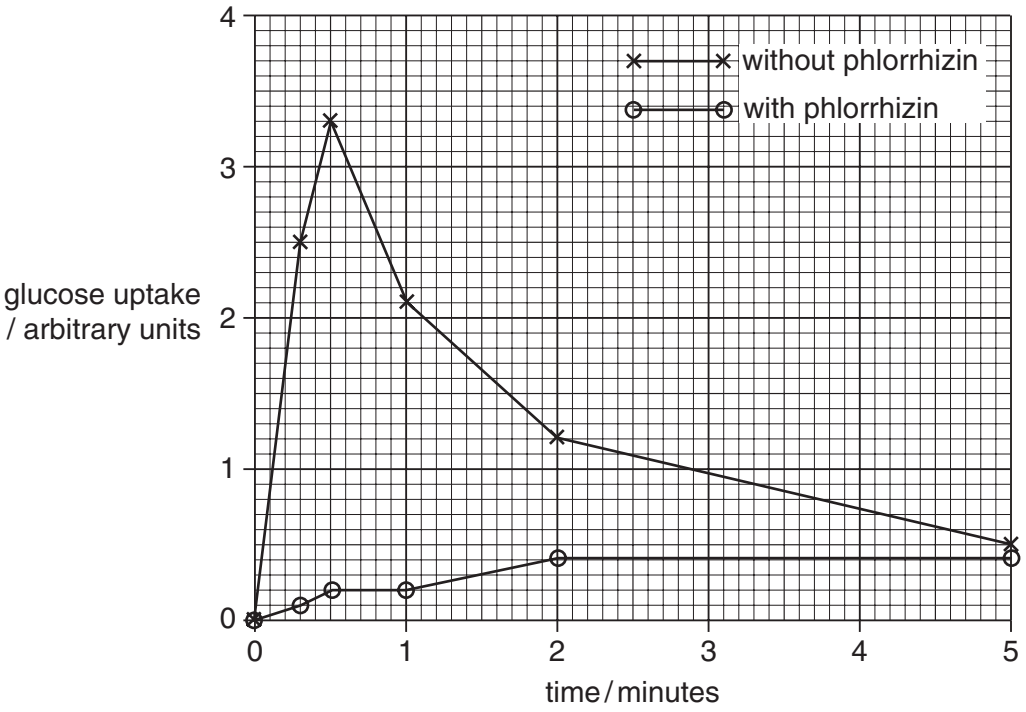


Fig. 1.2

With reference to Fig. 1.2,

(i) compare the uptake of glucose with and without the presence of phlorrhizin;

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.....

.....[2]

(ii) explain the reasons for the differences you have described.

.....

.....

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.....[2]

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(c) Irritable bowel syndrome is a condition in which the smooth muscles of the alimentary canal contract too much and too often. Peppermint oil can be used to treat this. Peppermint oil inhibits the contraction of smooth muscle by reducing the availability of calcium ions.

Explain why reducing the availability of calcium ions inhibits muscle contraction.

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.....[4]

(d) An investigation was carried out to determine whether peppermint oil affected the uptake of glucose in the ileum. Epithelial cells were exposed to a 100 μmol dm^{-3} solution of glucose, plus various concentrations of peppermint oil. The quantity of glucose taken into the cells after 10 seconds was measured. The results are shown in Fig. 1.3.

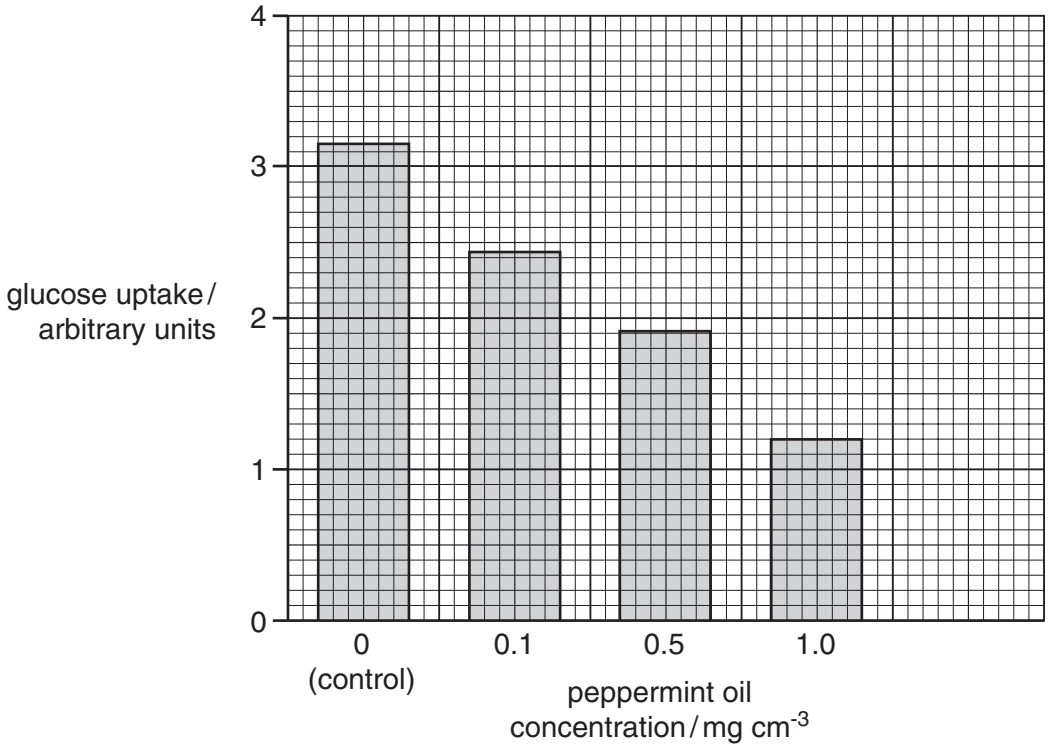


Fig. 1.3

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(i) Calculate the percentage decrease in glucose uptake with a peppermint oil concentration of 1.0 mg cm^{-3}, compared with the control.
Show your working.

answer ..... [2]

(ii) Peppermint oil is a lipid. With reference to this information and to your knowledge of the structure of cell membranes, suggest how peppermint oil may disrupt the uptake of glucose into the cells by active transport.

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.....[1]

[Total: 15]

2 Fig. 2.1 shows the structure of the human ear.

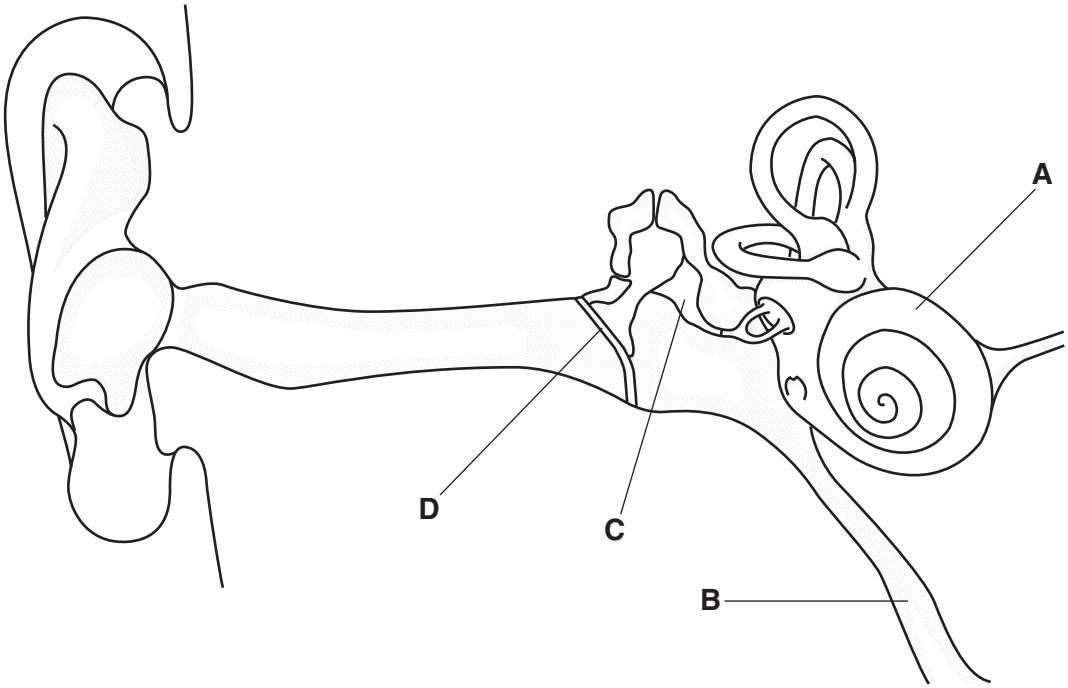


Fig. 2.1

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

A .....

B .....

C .....

D ..... [2]

(b) State the function of part **B**.

.....

.....[1]

(c) Describe how the semicircular canals enable a person to keep their balance during movement.

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.....[3]

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(d) Children may suffer from a condition known as 'glue ear'. The middle ear becomes filled with a thick, viscous substance.

Explain why this may cause temporary deafness.

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.....[2]

[Total: 8]

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3 Fig. 3.1 shows how the human nervous system is organised.

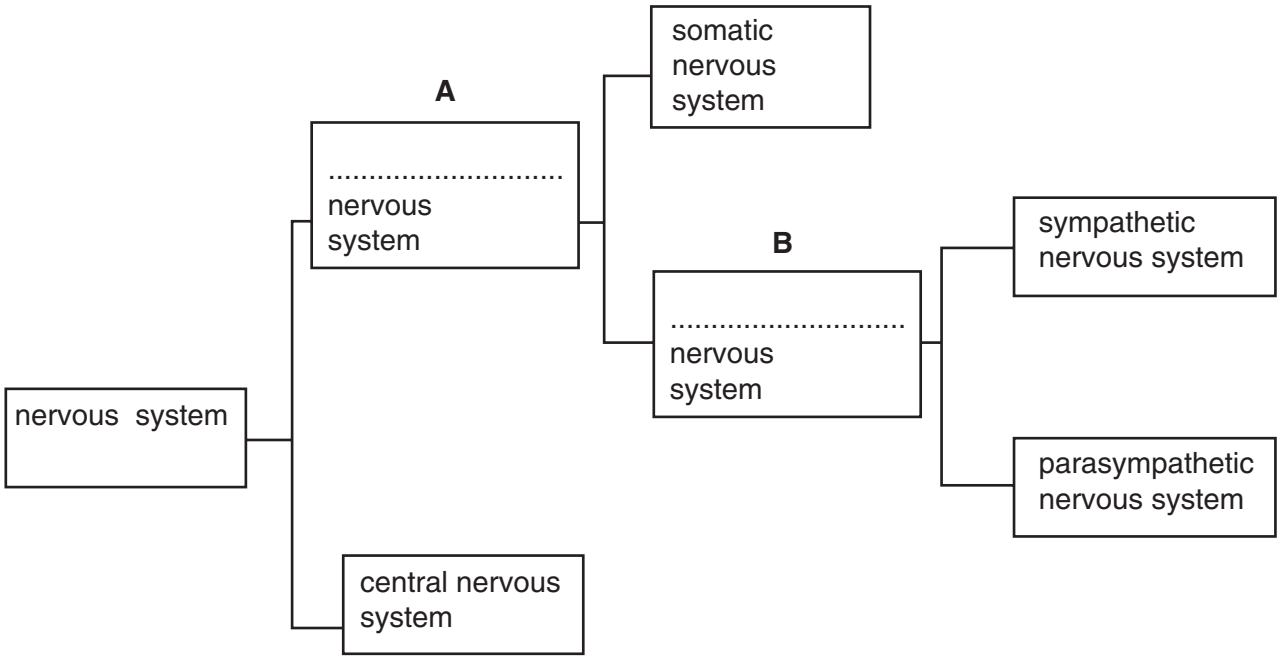


Fig. 3.1

(a) Complete Fig. 3.1 by naming parts **A** and **B**. [2]

(b) The heart, like most internal organs, is supplied with nerves from both the sympathetic and parasympathetic nervous systems. The neurones in these nerves form synapses with muscle tissue in the sino-atrial node (SAN).

Fig. 3.2 shows how the rate of heartbeat of a mammal changed when the sympathetic and parasympathetic nerves were stimulated at different frequencies. The frequency of stimulation was measured in hertz (Hz), i.e. the number of stimulations per second.

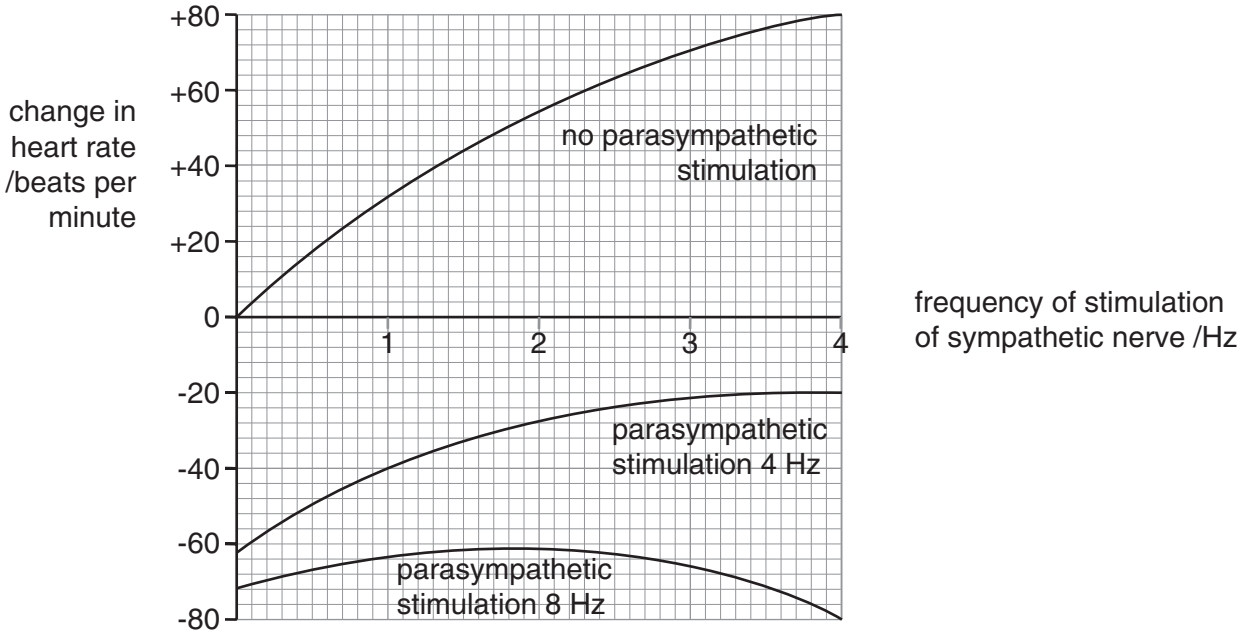


Fig. 3.2

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(i) Describe the effect on the heart rate when the frequency of stimulation of the sympathetic nerve is increased, while the parasympathetic nerve is not being stimulated at all.

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.....

.....[2]

(ii) Describe the effect of increasing the frequency of stimulation of the parasympathetic nerve, while the frequency of stimulation of the sympathetic nerve remains constant at 2 Hz.

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.....[2]

(iii) Explain, with reference to synaptic transmission, how stimulation of the SAN by these two nerves produces such different effects.

.....

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.....[2]

[Total: 8]

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For Examiner's Use

4 Liver cells contain large quantities of rough endoplasmic reticulum, where proteins are synthesised. Some of these proteins are secreted into the blood, where they remain as plasma proteins.

(a) Fig. 4.1 is a diagram of the structure of part of a liver lobule.

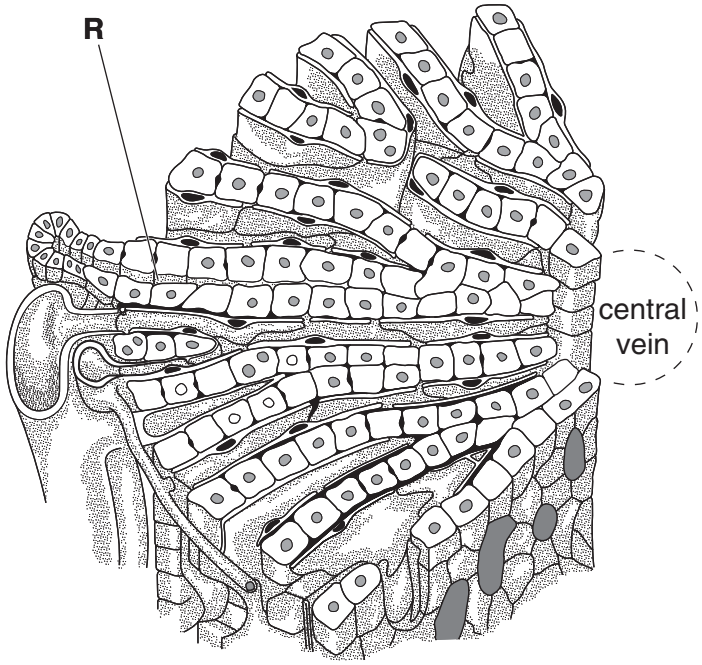


Fig. 4.1

There are two types of channel radiating out between the liver cells in a lobule. Blood vessels are found at the centre and outer edge of the lobule.

(i) On Fig. 4.1, use a label line and the letter **P** to indicate a blood vessel which carries blood **to** the liver from the small intestine. [1]

(ii) On Fig. 4.1, use a label line and the letter **Q** to indicate a blood vessel which would take away plasma proteins secreted by the liver cells. [1]

(iii) State what is secreted into the channel labelled **R**.

.....[1]

(b) The plasma proteins secreted by the liver cells include albumin and fibrinogen.

(i) Explain how the presence of albumin and other plasma proteins in blood plasma helps to prevent too much tissue fluid building up between body cells.

.....

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.....[3]

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(ii) Describe the role of fibrinogen in the formation of a blood clot.

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.....[3]

[Total: 9]

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OPTION 2 – MICROBIOLOGY AND BIOTECHNOLOGY

1 **(a)** **(i)** Describe the organisation of the genetic material inside bacterial cells.

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.....[3]

(ii) Describe a technique by which a pure culture of bacteria could be isolated from a sample of water.

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.....[4]

(b) The forestomachs of baleen whales have been found to contain over 1000 different species of anaerobic bacteria. Several species have been identified that can break down hydrocarbons, including naphthalene and anthracene, which are found in crude oil.

(i) State two specific conditions required for the bacteria from the stomachs of baleen whales to grow in the laboratory.

1. .....

.....

2. .....

.....[2]

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(ii) It is unlikely that these bacteria existed before crude oil pollution became a serious problem in the seas. Explain how the bacteria that break down naphthalene and anthracene might have evolved in the stomachs of whales.

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.....[3]

(c) In the past, species of bacteria capable of breaking down crude oil into harmless products have only been able to work on the surface of an oil spill. Trials are currently taking place on oil spills of up to 25 dm^3 in volume, using these recently isolated bacteria from the stomachs of whales.

Explain why the recently isolated bacteria are likely to be more effective at breaking down oil spills.

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.....[3]

[Total: 15]

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2 In 1998, the drinking water for the town of Walkerton in Canada was contaminated with the pathogenic bacterium, *Escherichia coli* O157:H7. This was due to untreated sewage being sprayed on rural land. As a result many of the local population suffered severe abdominal cramps and diarrhoea. Two lysogenic bacteriophages, VT1 and VT2, within *E. coli* have been shown to be responsible for toxin production resulting in the symptoms of the disease.

(a) Explain the term *lysogenic*.

.....

.....

.....[2]

(b) A recommended treatment for the pathogenic *E. coli* is to use the antimicrobial agent norfloxacin (NFLX). An investigation was carried out using the pathogenic *E. coli* in nutrient broth in four different concentrations of NFLX. The cultures were incubated for two days and the increase in optical density of the cultures was measured. The results are shown in Fig. 2.1.

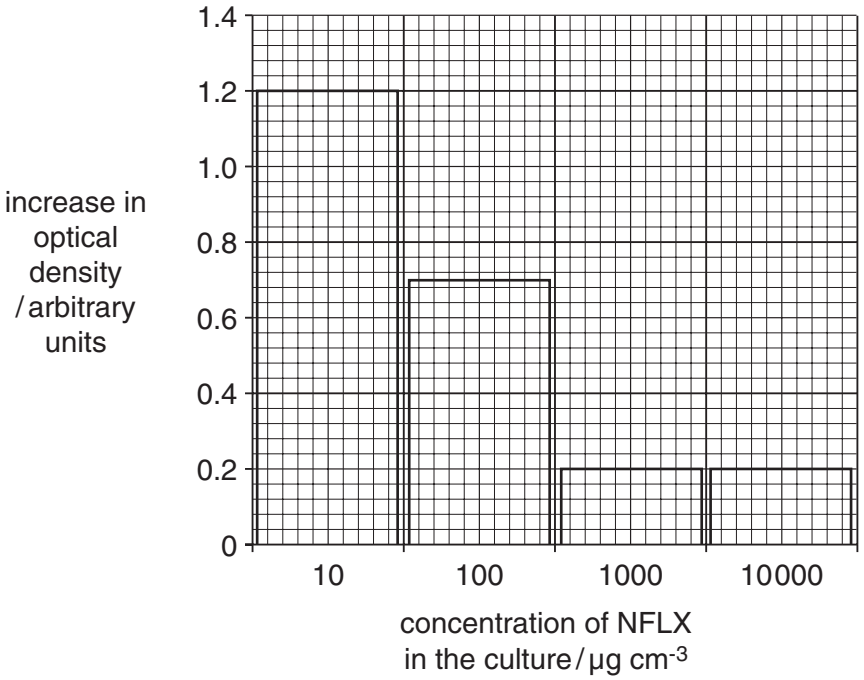


Fig. 2.1

(i) Describe how the concentrations of NFLX shown in Fig. 2.1 were made up from a stock solution of 100 000 µg cm^{-3}.

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.....[3]

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(ii) Explain the results shown in Fig. 2.1.

.....

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.....[3]

[Total: 8]

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[Turn over

3 **(a)** Fig. 3.1 is a photomicrograph of *Penicillium*.

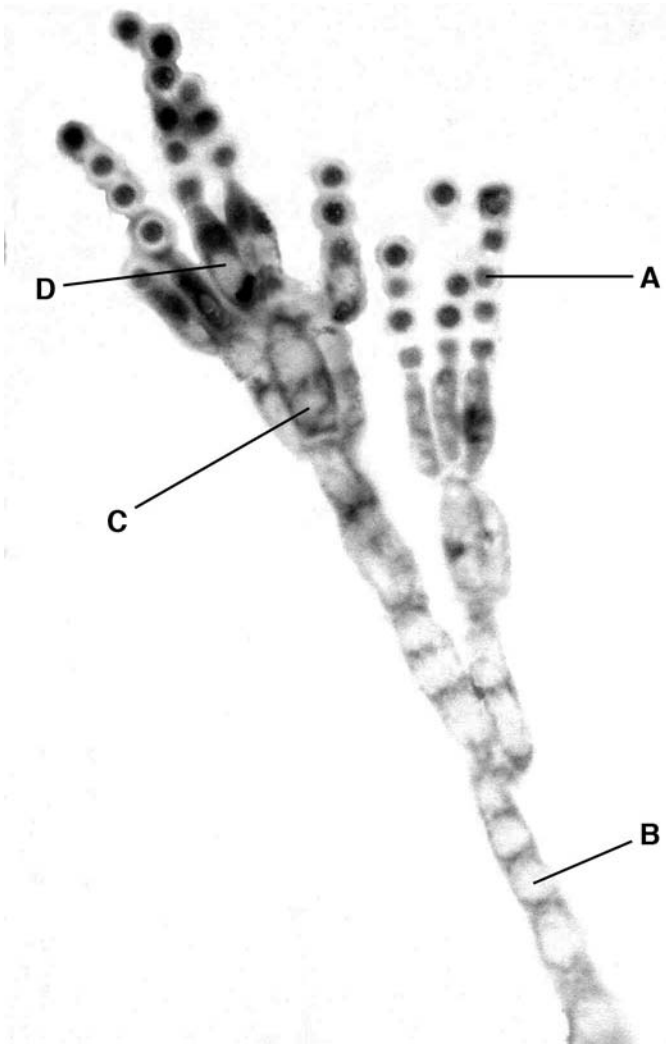


Fig. 3.1

Name **A** to **D**.

A .....

B .....

C .....

D ..... [2]

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(b) Penicillin is produced from *Penicillium* in batch culture.

(i) Explain the term *batch culture*.

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.....[3]

(ii) List three factors that must be carefully controlled during the process.

1. .....

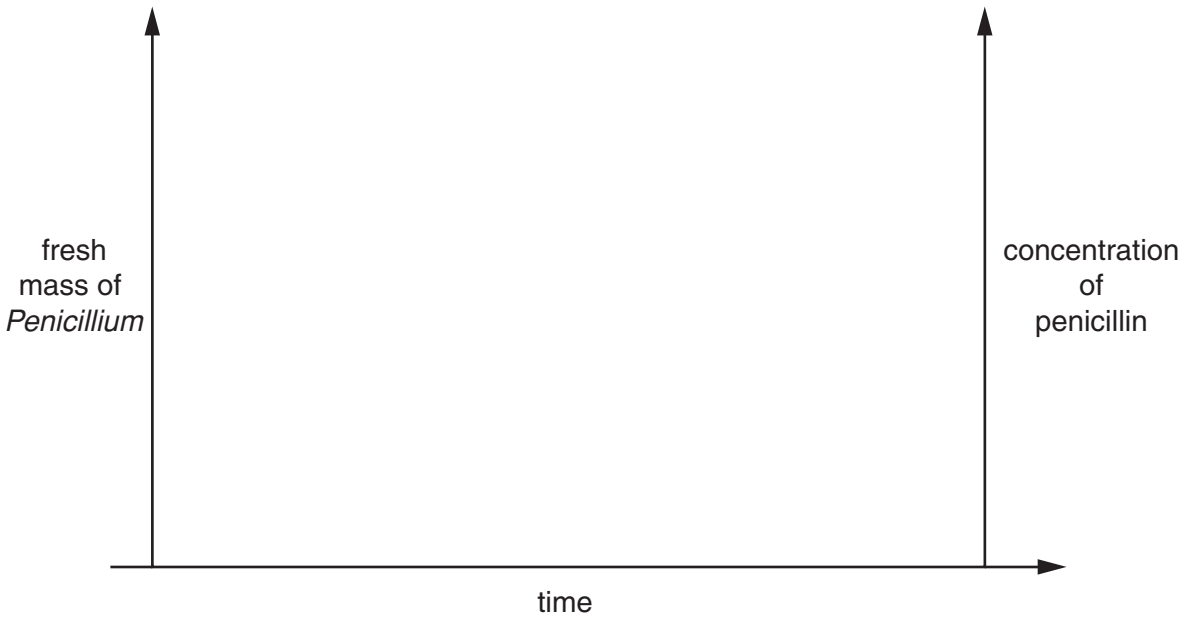
2. .....

3. .....[3]

(c) Sketch two curves on Fig. 3.2 to illustrate

- the growth of *Penicillium*;
- the concentration of penicillin.

Label each curve.



[2]

Fig. 3.2

[Total: 10]

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4 **(a)** The alcohol in beer is produced by yeast fermentation. Improvements in the biotechnology of beer production have enabled brewers to produce beers with higher alcohol contents. Table 4.1 gives the final alcohol and initial sugar content of a number of beers produced by the improved processes.

Table 4.1

beer	country of origin	final alcohol content %	initial sugar content %
A	UK	10.4	22.0
B	Germany	11.0	29.5
C	Belgium	12.0	26.3
D	Switzerland	14.0	27.3
E	USA	17.5	40.0
F	Nigeria	5.0	12.0

(i) With reference to Table 4.1, describe the relationship between the final alcohol content and the initial sugar content.

.....

.....

.....[2]

(ii) Explain why it is not possible to produce beer with higher alcohol contents than some of those shown in Table 4.1.

.....

.....

.....[2]

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(b) Fig. 4.1 shows part of a haemocytometer grid. The chamber contains a sample of yeast cells from beer **A** which has been diluted 1000 times. The large squares, with the double lines, measure 0.2 mm × 0.2 mm with a depth of 0.1 mm.

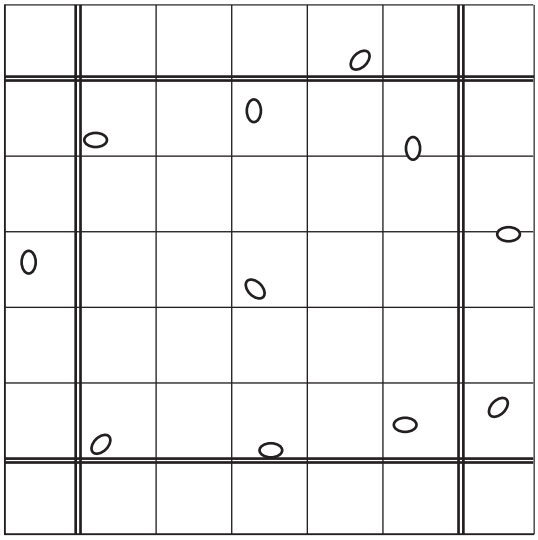


Fig. 4.2

Calculate the total number of cells in 1 mm^3 of beer **A**. Show your working.

answer ..... [3]

[Total: 7]

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[Turn over

OPTION 3 – GROWTH, DEVELOPMENT AND REPRODUCTION

1 **(a)** In the process of cloning plants from tissue culture, meristematic cells are grown on nutrient media to form a callus.

Explain why it is necessary to use meristematic cells to form a callus.

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.....[3]

(b) Successful growth of plant cells in tissue culture depends on the presence of plant growth regulators.

Samples of tobacco callus, each with a mass of 2.0 g, were transferred onto nutrient media containing:

- auxin at a constant concentration;
- one of two cytokinins, **A** or **B**, at different concentrations.

The fresh mass of the callus was found after growing for one month on the different media. The results are shown in Fig. 1.1.

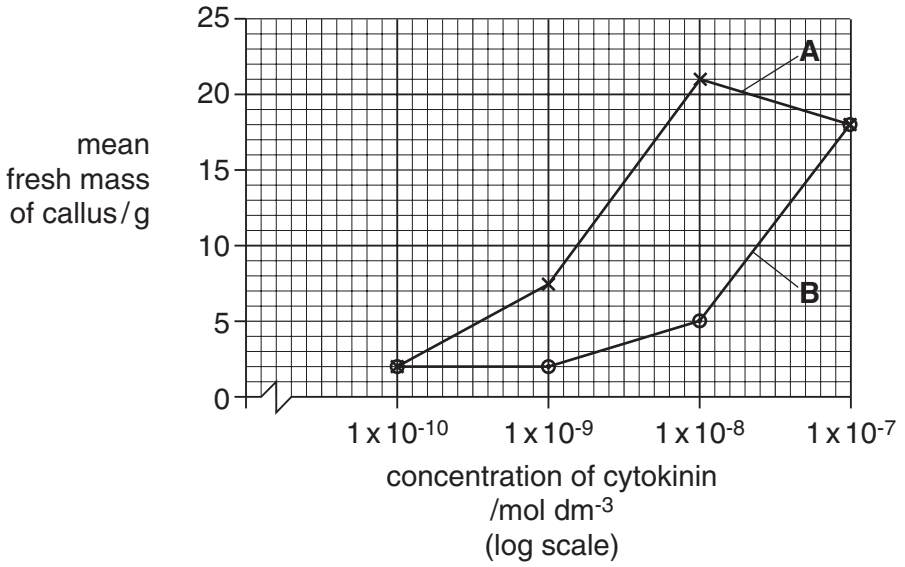


Fig. 1.1

(i) Explain why it would have been preferable to have found the **dry** mass, rather than the fresh mass, of the callus at the end of the investigation.

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.....[3]

(ii) Describe how the dry mass of the samples could have been found.

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.....[3]

(iii) With reference to Fig. 1.1, compare the effect of cytokinins **A** and **B** on callus growth.

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.....[3]

(c) Describe **one** role of auxins in the control of plant growth.

.....

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.....[3]

[Total: 15]

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2 **(a)** Flowers of the white Australian daisy, *Chrysanthemum frutescens*, are pollinated by insects.

White crab-spiders live on the flowers and prey on visiting insects. The crab-spiders reflect ultraviolet light, but the daisy flowers do not.

Counts were made of the numbers of honeybees visiting daisies, with and without crab-spiders, when offered a choice.

The experiment was repeated with a transparent covering over each daisy to block any scent.

The percentages of honeybees choosing to visit different daisies are shown in Fig. 2.1.

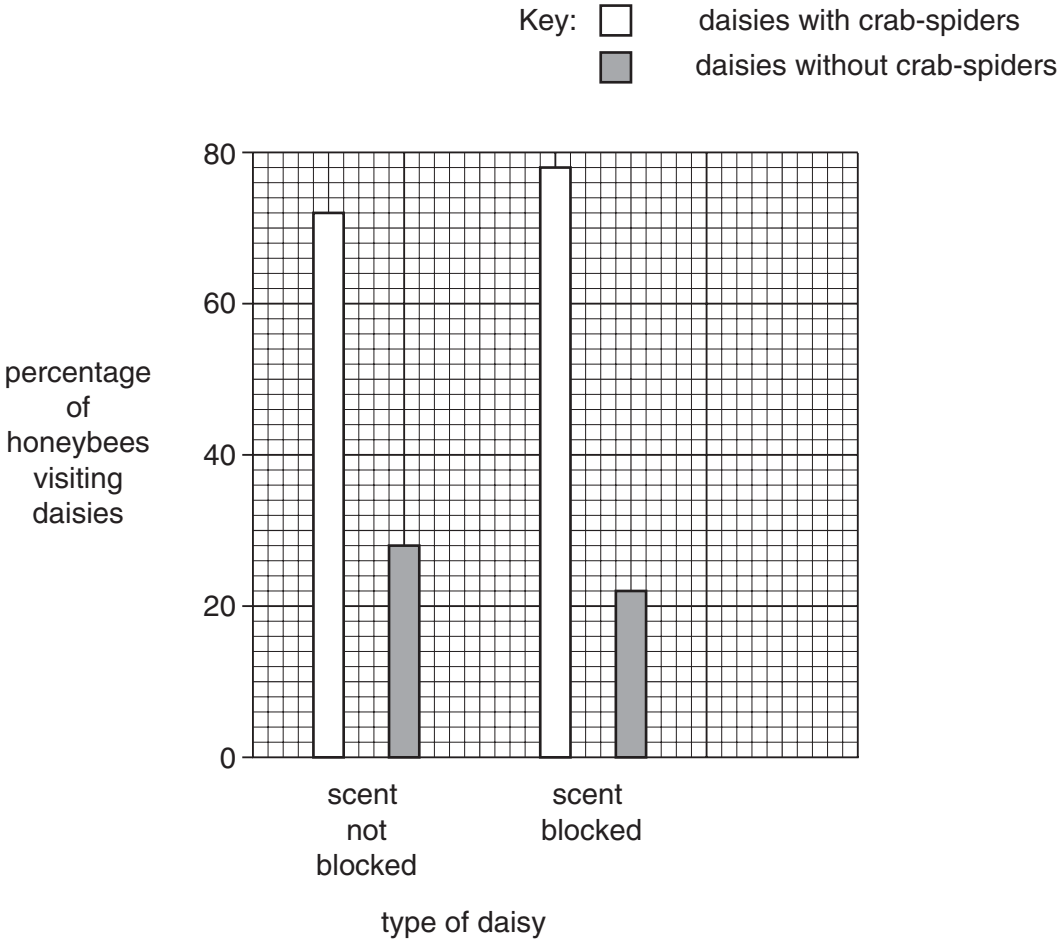


Fig. 2.1

With reference to Fig. 2.1,

(i) describe the honeybees' choices of daisies to visit;

.....

.....

.....[2]

(ii) explain these choices;

.....

.....

.....

.....[3]

(iii) suggest advantages to the crab-spiders of their white colouring and ability to reflect ultraviolet light.

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.....[2]

(b) *C. frutescens* is normally cross-pollinated.

Describe how the **genetic** outcomes of self-pollination differ from those of cross-pollination.

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.....

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.....[3]

[Total: 10]

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For Examiner's Use

3 **(a)** State two roles of luteinising hormone (LH) in the human menstrual cycle.

1. .....

.....

2. .....

.....[2]

(b) A number of healthy men and women were each given a single injection of gonadotrophin releasing hormone (GnRH). The concentration of LH in their blood was measured at the time of the injection and at intervals afterwards. The results are shown in Fig. 3.1.

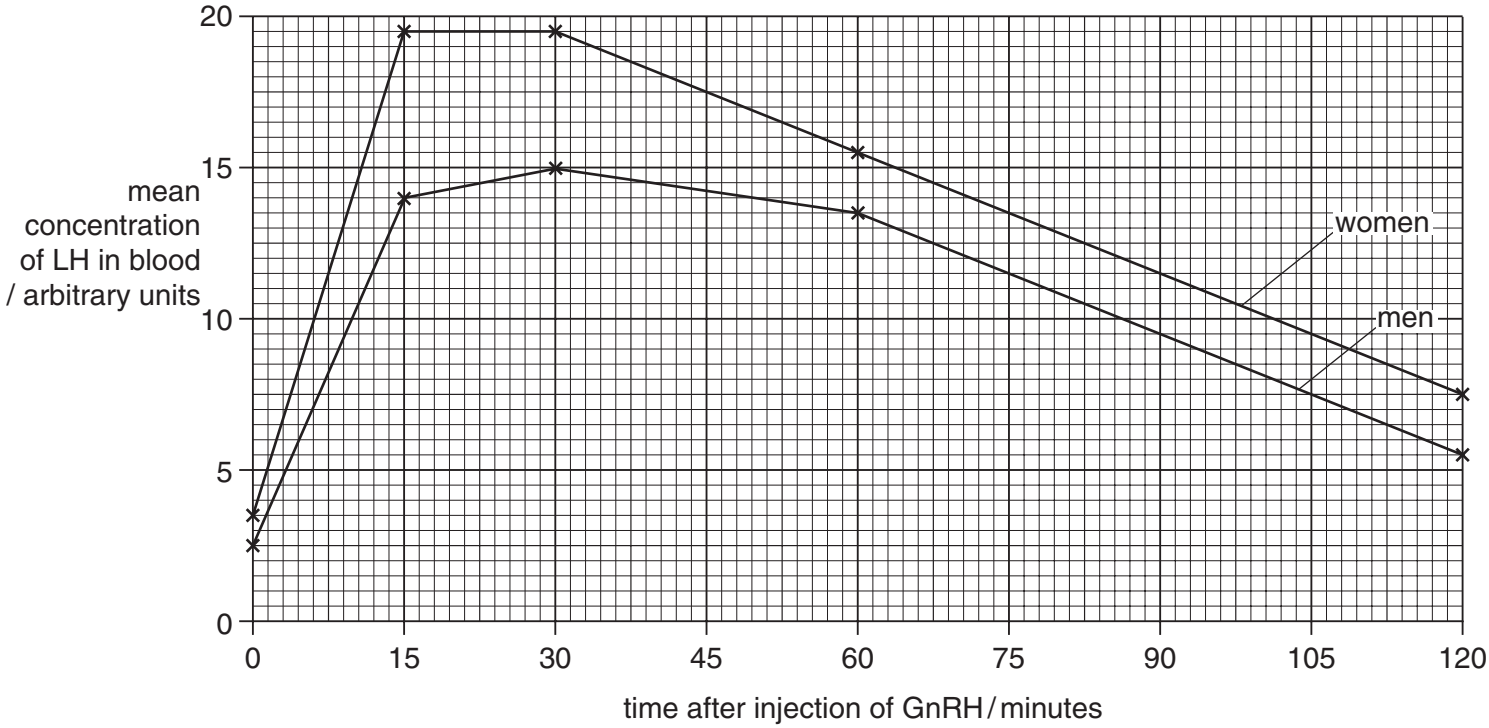


Fig. 3.1

With reference to Fig. 3.1,

(i) describe the effect of injecting GnRH into men and women;

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.....

.....

.....[3]

(ii) find the time after injection of GnRH at which the mean concentration of LH in men has fallen to half its maximum value. Show your working;

answer ..... minutes
[2]

(iii) state **one** factor that would have been taken into account when selecting a group of women for this experiment.

.....

.....[1]

[Total: 8]

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4 **(a)** Fig. 4.1 is a diagram showing the blood supply of part of the placenta. The arrows show the direction of blood flow.

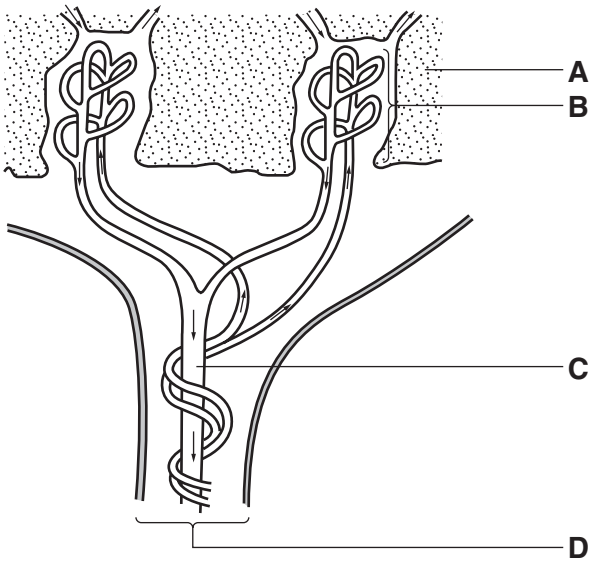


Fig. 4.1

Name **A** to **D**.

A .....

B .....

C .....

D ..... [2]

(b) **(i)** State three mechanisms involved in the transfer of **named** substances between mother and fetus.

1. .....

.....

2. .....

.....

3. .....

.....[3]

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(ii) State how the structure of the placenta is adapted for such transfer.

.....

.....

.....[2]

[Total: 7]

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OPTION 4 – APPLICATIONS OF GENETICS

1 **(a)** Chloroquine-resistant (CQR) malarial parasites, *Plasmodium falciparum*, were first reported in the 1950s and are now widespread. The resistance is caused by mutations of a gene called *pfcrt*.

(i) Distinguish between a *gene mutation* and a *chromosome mutation*.

.....

.....

.....[2]

(ii) Explain whether resistance to chloroquine in *P. falciparum* is an example of continuous or discontinuous variation.

.....

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.....[2]

(iii) Explain why CQR *P. falciparum* are now widespread.

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.....[4]

(b) Analysis of *pfcrt* in CQR *P. falciparum* from different parts of the world shows differences in one section of the gene only. The amino acid sequences coded for by this section are shown in Table 1.1, together with the amino acid sequence coded for by the allele found in parasites that are still susceptible to chloroquine (non-CQR).

The amino acid sequence coded for by the rest of the gene is the same in all cases.

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Table 1.1

allele of *pfcrt* gene	amino acid sequence coded for by allele of *pfcrt* gene
non-CQR	—Cys—Met—Asn—Lys—His—Ala—Glu—Asn—Ile —Met—
CQR from Africa	—Cys—Ile —Glu—Thr—His—Ser—Glu—Ser—Ile —Ile —
CQR from Asia	—Cys—Ile —Glu—Thr—His—Ser—Glu—Ser—Thr—Ile —
CQR from Peru and Brazil	—Ser—Met—Asn—Thr—His—Ser—Gln—Asp—Leu—Arg—
CQR from Colombia	—Cys—Met—Glu—Thr—Gln—Ser—Gln—Asn—Ile —Thr—

With reference to Table 1.1,

(i) calculate the mean number of different amino acids coded for by CQR alleles in comparison with the non-CQR allele. Show your working;

.....[2]

(ii) suggest why the CQR alleles from Africa and Asia code for such similar sequences.

.....

.....

.....[2]

(c) Each change from the sequence of amino acids coded for by the non-CQR allele can be produced by altering a single base in the DNA code for each amino acid.

Explain why altering a single base in the DNA code for an amino acid can result in the presence of a different amino acid in a protein.

.....

.....

.....

.....[3]

[Total: 15]

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2 **(a)** Describe the harmful **genetic** effects of inbreeding.

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.....[3]

(b) Californian sea lions were investigated to see whether inbreeding increased their susceptibility to infection.

Each sea lion's DNA was analysed by genetic fingerprinting to find its extent of inbreeding.

Explain how the banding patterns of a genetic fingerprint can show whether or not an animal is inbred.

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.....

.....[3]

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(c) The mean extent of inbreeding was found for sea lions suffering from three types of infection:

- bacterial infections;
- helminth infections;
- herpes virus infections.

A control group of sea lions with no such infections were found **not** to be inbred. The results are shown in Fig. 2.1.

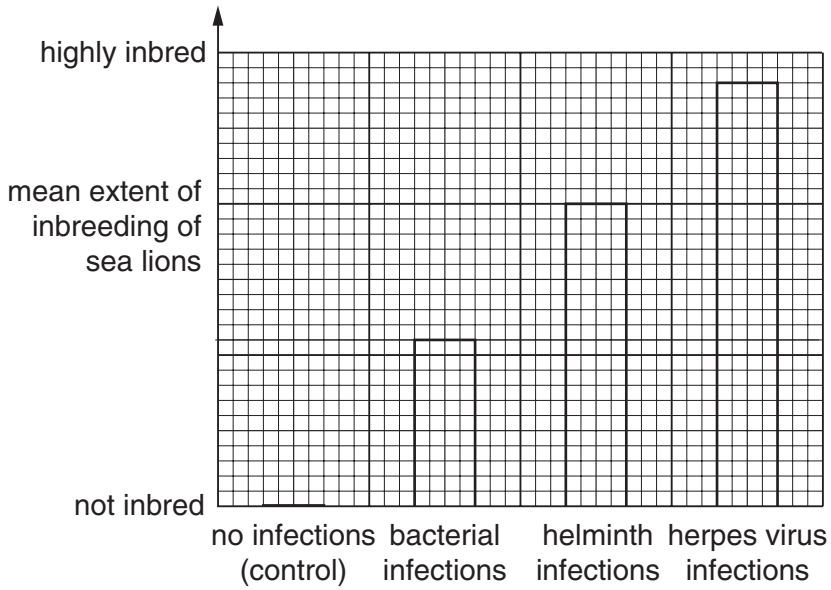


Fig. 2.1

With reference to Fig. 2.1,

(i) describe the effect of inbreeding on the susceptibility of sea lions to infections;

.....

.....

.....[2]

(ii) suggest why inbreeding affects the susceptibility of sea lions to infections.

.....

.....

.....[2]

[Total: 10]

3 **(a)** Some mothers of infants with Down's syndrome have a mutation of a gene coding for an enzyme involved in the metabolism of methyl groups. A lack of methyl groups on DNA results in mistakes in the segregation of chromosomes during cell division and in structural mutations of chromosomes.

Explain how Down's syndrome may result from

(i) mistakes in the segregation of chromosomes during cell division;

.....

.....

.....

.....[2]

(ii) structural mutations of chromosomes.

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.....[2]

(b) The gene mutation referred to in **(a)** also affects the metabolism of the vitamin folic acid. Abnormal folic acid metabolism is seen in mothers of infants with neural tube disorders (NTD).

Two groups of families, in Israel and in the Ukraine, were investigated to see whether there was any link between the incidence of Down's syndrome and NTD. The results are shown in Table 3.1.

Table 3.1

group of families	number of pregnancies	number of cases of Down's syndrome	expected number of cases of Down's syndrome	probability of result occurring by chance
families at risk of NTD (Israel)	1492	11	1.87	p = 0.00001
group of families	number of pregnancies	number of cases of NTD	expected number of cases of NTD	probability of result occurring by chance
families at risk of Down's syndrome (Ukraine)	1847	7	1.37	p = 0.001

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With reference to Table 3.1,

(i) explain whether the observed numbers of Down's syndrome and NTD are **significantly different** from the numbers expected;

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.....

.....[2]

(ii) describe the evidence for a link between Down's syndrome and NTD in these families.

.....

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.....[2]

[Total: 8]

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[Turn over

4 A pure-breeding, tall tomato plant with green leaves was crossed with a pure-breeding, dwarf tomato plant with mottled yellow and green leaves. All the resulting F_1 generation were tall with green leaves.

The F_1 plants were test-crossed and produced offspring with the following phenotypes:

tall with green leaves	43
tall with mottled leaves	7
dwarf with green leaves	5
dwarf with mottled leaves	45
	100

The ratio of phenotypes **expected** in a dihybrid test-cross such as this is 1:1:1:1.

(a) Using the symbols **A**/**a** for height and **B**/**b** for leaf colour, draw a genetic diagram of the test-cross to show that the expected ratio is 1:1:1:1.

[3]

(b) Explain the difference between the expected and actual results of the test-cross.

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.....[4]

[Total: 7]

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