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CAMBRIDGE INTERNATIONAL EXAMINATIONS

General Certificate of Education Advanced Level

BIOLOGY **9700/6**

PAPER 6 Options

OCTOBER/NOVEMBER SESSION 2002

1 hour

Additional materials:
Answer paper

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page and on all separate answer paper used.

Answer the questions set on **one** of the options.

Within your chosen option, Questions 1 and 2 are to be answered in the spaces provided on the question paper. Question 3 is to be answered on the separate answer paper provided.

The answer to Question 3 should be illustrated by large, clearly labelled diagrams, where appropriate.

At the end of the examination,

1. fasten all separate answer paper securely to the question paper;
2. enter the number of the option you have answered in the grid below.

INFORMATION FOR CANDIDATES

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

The options are:

1 – Biodiversity (page 2)
2 – Biotechnology (page 8)
3 – Growth, Development and Reproduction (page 13)
4 – Applications of Genetics (page 20)

OPTION ANSWERED	
FOR EXAMINER'S USE	
1	
2	
3(a)	
3(b)	
TOTAL	

This question paper consists of 24 printed pages.

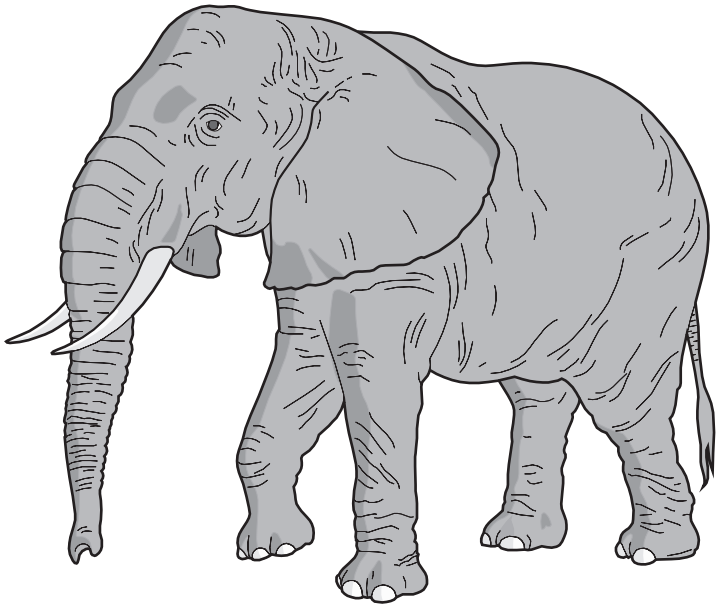
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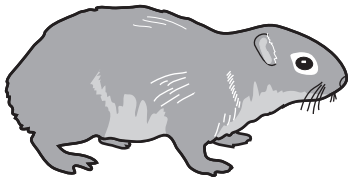
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OPTION 1 – BIODIVERSITY

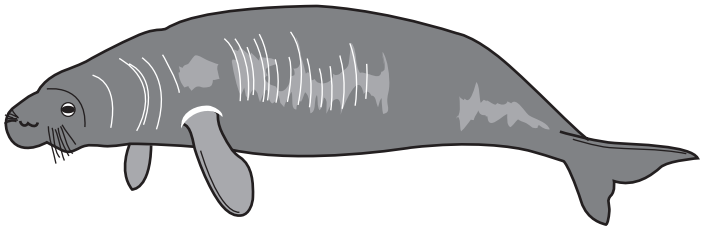
1 **(a)** Fig. 1.1 shows the African elephant, *Loxodonta africana*, and two of its closest relatives, the rock hyrax, *Procavia capensis*, and the dugong, *Dugong dugong*. The elephant and hyrax are terrestrial animals, while the dugong is aquatic.



African elephant
body length = 700 cm



Rock hyrax
body length = 45 cm



Dugong
body length = 300 cm

Fig. 1.1

(i) Explain why the limbs of the elephant have a relatively larger diameter in proportion to overall body size than those of the hyrax.

.....

.....

.....[2]

(ii) With reference to their environments, explain the differences in body shape and structure between the elephant and the dugong.

.....

.....

.....

.....[3]

(b) A survey was carried out to investigate the relationship between human population density and elephant population density in Zimbabwe. Twenty five sites were sampled, all within a 15 000 km^2 area in the north of the country. Elephant populations were estimated by flying over the area and counting elephants seen from the air. The results are shown in Fig. 1.2. Each point represents the results from one of the sites sampled.

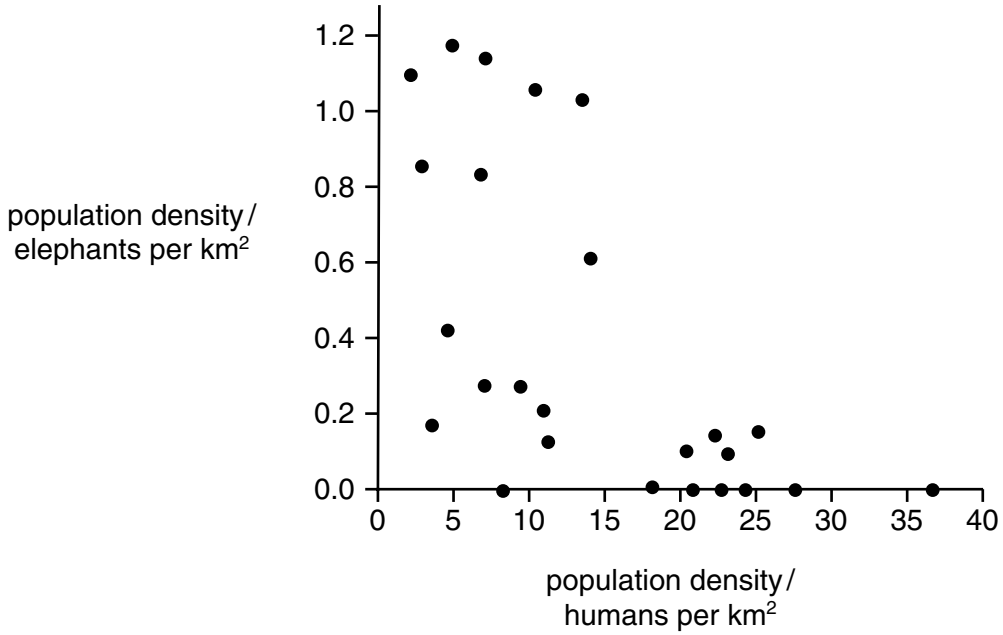


Fig. 1.2

(i) Describe, and suggest explanations for, the pattern shown by the elephant populations at **low** human population densities.

.....

.....

.....

.....[3]

(ii) Explain why elephant populations are very low in areas where human population density is high.

.....

.....

.....

.....

.....[2]

(c) In 1987, a scheme called Communal Areas Management Programme for Indigenous Resources (Campfire) was introduced in some areas of Zimbabwe. Under this scheme, local people are allowed to manage the wildlife and other resources on the land where they live. This includes allowing tourists to hunt and kill wild animals, such as elephants. The hunters pay a 'trophy fee' for each animal that they kill. The number of elephants that can be hunted under this scheme is calculated to ensure sustainability.

(i) Suggest what is meant by the term 'sustainability'.

.....

.....

.....[2]

(ii) Describe the information that will be needed in order to calculate the number of elephants that can be killed each year.

.....

.....

.....

.....[3]

[Total : 15]

For Examiner's Use

2 **(a)** Fig. 2.1 shows the above-ground parts of the orchid *Masdevallia caudata*.



Fig. 2.1

(i) State **one** feature, visible in Fig. 2.1, that indicates that this plant is an angiospermophyte.

.....[1]

(ii) State two features, visible in Fig. 2.1, that indicate that this plant is a monocotyledon.

1. .....

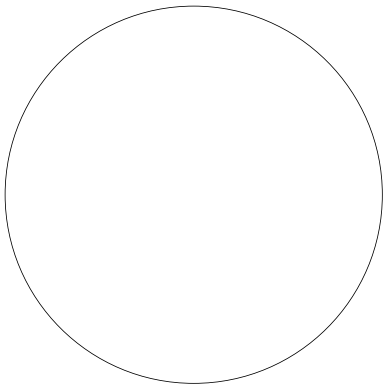
2. .....[2]

(iii) Describe the type of root system that you would expect to be present on this plant.

.....

.....[2]

(iv) On the outline below of a transverse section of the stem of this orchid, sketch the positions of the vascular bundles that you would expect to find.



[1]

[Turn over

(b) Table 2.1 lists three plant phyla and three features that may be found in them.

Complete the table by placing a tick to indicate when a feature is present in a phylum and a cross to indicate when it is not. (Do not leave any boxes blank.)

Table 2.1

feature	bryophytes	filicinophytes	coniferophytes
dominant stage is diploid sporophyte			
vascular tissue present			
xylem vessels present			

[5]

(c) Describe two ways in which the life cycle of an angiospermophyte shows more complete adaptation to life on dry land than that of a bryophyte.

1. .....

.....

.....

2. .....

.....

.....[4]

[Total : 15]

3 Either

(a) Describe

(i) the structure and [6]

(ii) mode of nutrition [6]

of the fungus *Penicillium*.

(iii) With reference to their structure and mode of replication, discuss the extent to which viruses can be considered to be living organisms. [8]

[Total : 20]

Or

(b) With reference to

(i) a bony fish and [6]

(ii) a locust, [6]

explain how animals overcome the problems of gaseous exchange in water and in air.

(iii) Describe how a locust moves when on the ground. [8]

[Total : 20]

OPTION 2 – BIOTECHNOLOGY

1 Kefir is an unusual fermented drink that originated in Eastern Europe. It is made by adding a special mixed culture of bacteria and yeast to milk. The yeast ferments lactose, whilst the bacteria produce a viscous gum that holds the microorganisms together in gelatinous lumps. This allows the kefir 'grains' to be separated from the milk, once fermentation is complete. The finished product is a refreshing, fizzy drink.

(a) Fig. 1.1 shows the change in pH during fermentation.

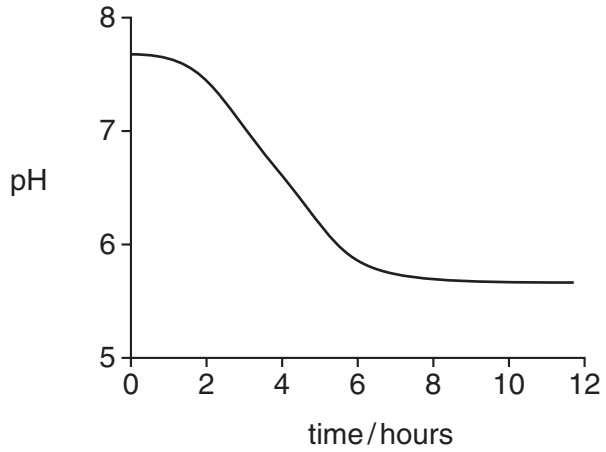


Fig. 1.1

With reference to Fig. 1.1,

(i) describe the processes that bring about the change in pH;

.....

.....

.....

.....[2]

(ii) explain the shape of the curve.

.....

.....

.....

.....

.....[4]

(b) Explain how the drink becomes fizzy.

.....

.....

.....[2]

(c) The composition and flavour of kefir vary significantly depending on whether the source of milk is from a cow, goat, sheep or horse.

Suggest three reasons for this.

1. .....

2. .....

3. .....[3]

(d) Suggest two uses of kefir 'grains'.

1. .....

2. .....[2]

(e) State how the production of kefir is

(i) similar to yoghurt production;

.....

.....[1]

(ii) different from yoghurt production.

.....

.....[1]

[Total : 15]

For Examiner's Use

2 There have been many recent advances in the use of tissue culture in the micropropagation of plants. One technique now being used is the clonal propagation of expensive house plants, such as orchids.

(a) Explain briefly why two different tissue culture techniques are used in the propagation of two **named** agricultural plants.

1. .....

.....

.....

2. .....

.....

.....[4]

(b) **(i)** State why the plant tissue cultures are initially grown in sterile conditions.

.....

.....[2]

(ii) State two suitable tissues from which to propagate plants, such as orchids.

1. .....

2. .....[2]

(c) An investigation was carried out into the effect of different cytokinin concentrations on plant development in tissue culture. All other factors were kept constant. The results obtained after six weeks are shown in Table 2.1.

Table 2.1

	percentage cytokinin concentration		
	0	20	40
mean number of roots	20	0	0
mean number of shoots	4	15	25
size of shoots	small	large	medium

With reference to Table 2.1, state the conclusions that can be drawn from the investigation.

.....

.....

.....

.....

.....[3]

(d) Complete Table 2.2 by identifying four different ingredients of growth media, other than cytokinin. State what each is used for in the developing plant tissues.

Table 2.2

ingredient	use in developing tissue
	.....
	.....
	.....
	.....

[4]

[Total : 15]

3 Either

(a) Describe and explain the role of microorganisms in

(i) sewage disposal; [8]

(ii) composting; [6]

(iii) extraction of heavy metals. [6]

[Total : 20]

Or

(b) (i) Explain what is meant by the terms *monoclonal antibody* and *biosensor*. [6]

(ii) Discuss the uses of monoclonal antibodies in the diagnosis and treatment of diseases. [8]

(iii) Describe how a biosensor can monitor blood glucose. [6]

[Total : 20]

OPTION 3 – GROWTH, DEVELOPMENT AND REPRODUCTION

1 In human fetuses, three different types of red blood cells are produced during their development. Embryonic red blood cells are large, spherical and contain nuclei, later fetal red blood cells are intermediate in size and mainly non-nucleated. Towards the end of pregnancy, adult red blood cells, which are smaller, are formed. Fig. 1.1 shows percentages of the three types of red blood cell before and after birth.

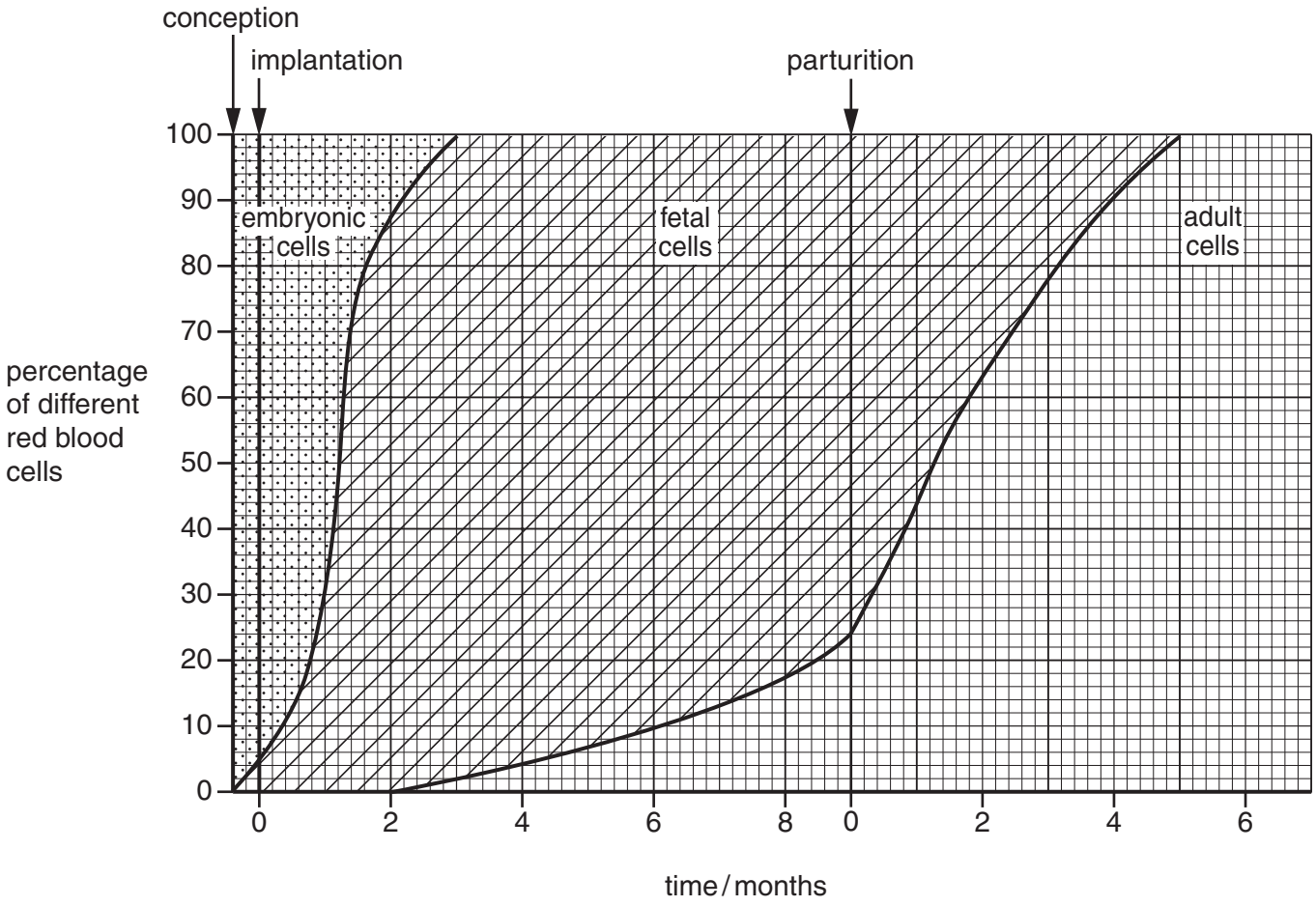


Fig. 1.1

(a) With reference to Fig. 1.1,

(i) state what is meant by the terms conception and parturition;

conception .....

parturition .....[1]

(ii) state the percentages of each type of red blood cell after eight months of development;

.....[1]

(iii) suggest **one** reason why a sharp rise in fetal red blood cells occurs after implantation.

.....[1]

[Turn over

(b) Adult red blood cells are smaller than embryonic red blood cells.

State two other ways in which adult red blood cells differ from embryonic red blood cells.

1. .....

2. .....[2]

(c) Each of the three types of red blood cell produces its own type of haemoglobin with a different affinity for oxygen. Fig. 1.2 shows the dissociation curves of embryonic haemoglobin, fetal haemoglobin and maternal haemoglobin.

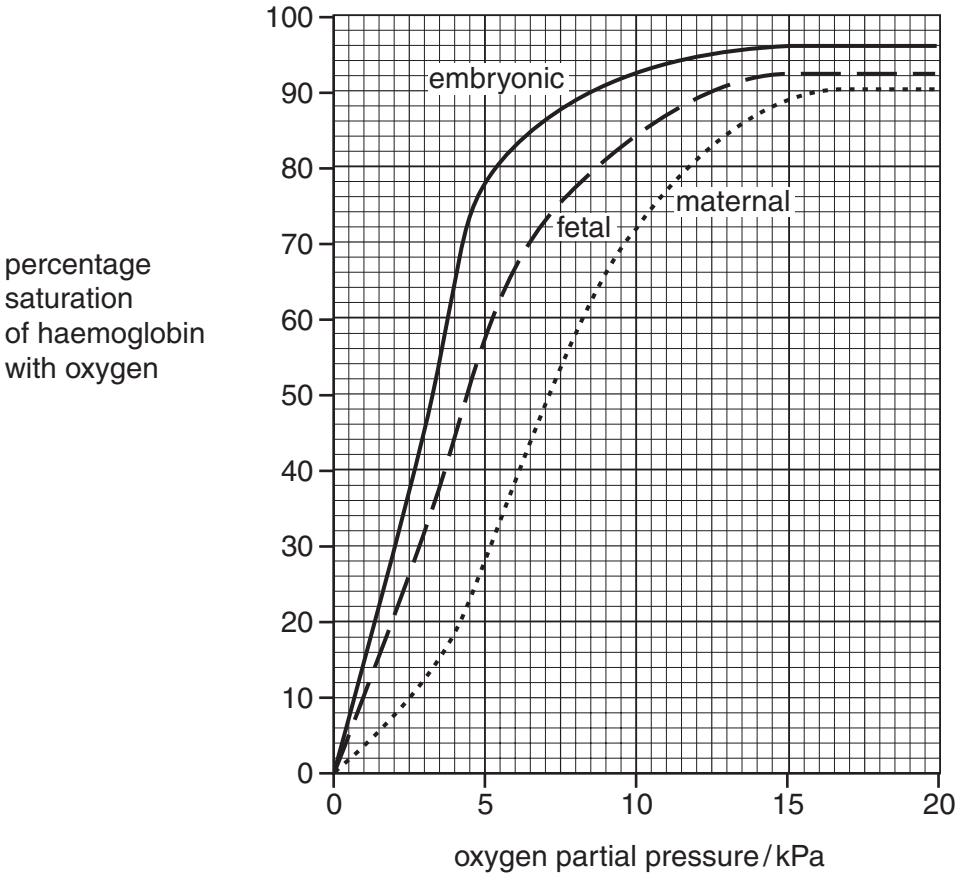


Fig. 1.2

With reference to Fig. 1.2,

(i) explain how fetal haemoglobin carries and releases oxygen efficiently;

.....

.....

.....

.....

.....[4]

(ii) compare the dissociation curve for fetal haemoglobin with that for maternal haemoglobin;

.....

.....

.....

.....[3]

(iii) explain why the curves for fetal and maternal haemoglobin are different;

.....

.....

.....

.....[2]

(iv) suggest **one** reason why the curve for embryonic haemoglobin is steeper than the curve for fetal haemoglobin.

.....

.....[1]

[Total : 15]

2 Fig. 2.1 shows stages in the germination of the garden pea, *Pisum sativum*, and of the french bean, *Phaseolus vulgaris*.

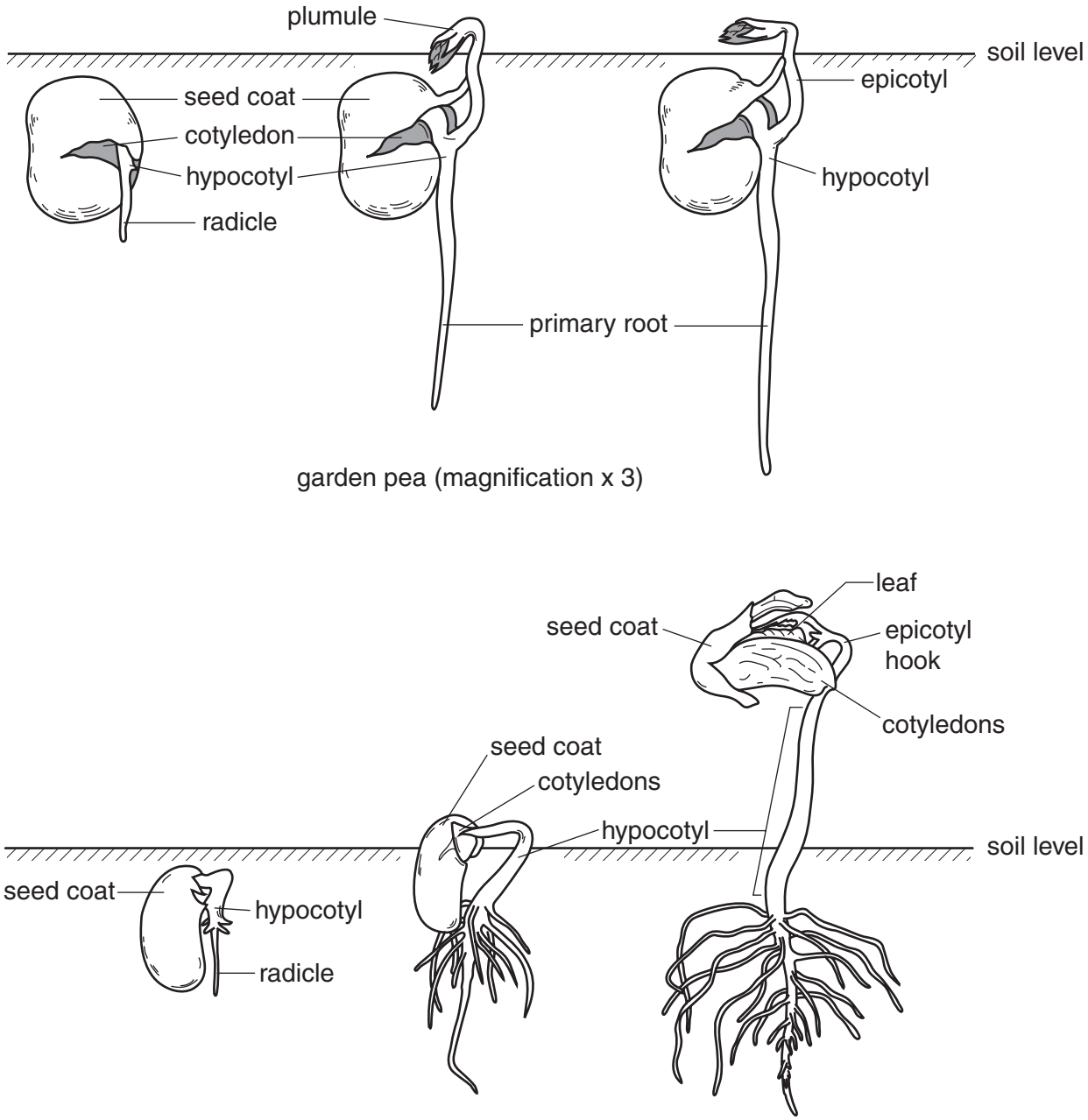


Fig. 2.1

(a) With reference to Fig. 2.1 **only**, state three ways in which the germination of a garden pea differs from that of a french bean.

garden pea	french bean
1.	.....
.....	.....
2.	.....
.....	.....
3.	.....
.....	.....[3]

Question 2 continues on the next page.

[Turn over

For Examiner's Use

(b) French beans were sown at similar densities in three experimental plots, **A**, **B** and **C**. Plot **A** was used as a control, plot **B** had nitrate added at 30 kg hectare^{-1} and plot **C** had phosphate added at 27 kg hectare^{-1}.

At harvest, ten bean plants were removed from each plot and the yield, expressed as dry mass (g) of beans produced by each plant, determined. The results, the mean, $\overline{x}$, and the standard deviation, s, are given in Table 2.1.

Table 2.1

dry mass of beans / g		
plot **A** (control)	plot **B** (+ nitrate)	plot **C** (+ phosphate)
40 41 41 39 42 40 41 38 41 40	39 41 42 37 41 38 39 41 40 37	48 47 48 50 43 49 47 48 48 49
$\overline{x}$ = 40.3 s = 1.16	$\overline{x}$ = 39.5 s = 1.80	$\overline{x}$ = 47.7 s = 1.89

(i) Describe how the dry mass of the beans was determined.

.....

.....

.....

.....

.....

.....[3]

(ii) With reference to Table 2.1, describe the effects of added nitrate and phosphate on the yield of beans.

nitrate .....

.....

.....

phosphate .....

.....

.....[4]

(iii) With reference to Table 2.1, suggest explanations for the effects of the added nitrate and phosphate.

nitrate .....

.....

.....

phosphate .....

.....

.....[5]

[Total : 15]

3 Either

(a) (i) Outline the main cellular changes associated with growth and development. [8]

Describe the changes of the uterus that are caused by

(ii) oestrogen and [6]

(iii) progesterone [6]

during the menstrual cycle.

[Total : 20]

Or

(b) (i) Outline how flowering is induced in a short-day plant. [8]

Describe

(ii) the interactions of plant growth regulators in controlling seed dormancy and [7]

(iii) their use in fruit maturation. [5]

[Total : 20]

[Turn over

OPTION 4 – APPLICATIONS OF GENETICS

1 **(a)** State the two major factors that contribute to phenotypic variation in a plant species.

1. .....

2. .....[2]

The genetic diversity of the Mexican wild grass, teosinte, has been reduced by selective breeding to produce cultivated maize. Maize now differs markedly from teosinte in having cobs. The main genetic difference between the two plants involves a gene called *teosinte branched 1 (tb1)*. The maize variant of this gene results in the characteristic short side branches bearing cobs.

(b) **(i)** Outline the principles of selective breeding.

.....

.....

.....

.....[3]

(ii) Explain briefly why selective breeding tends to reduce genetic diversity.

.....

.....

.....

.....[3]

(c) Describe how a seed bank of teosinte seeds could be maintained.

.....

.....

.....

.....

.....

.....[4]

(d) The nucleotide sequence of the gene *tb1* was determined in four subspecies of maize from both North and South America and in teosinte to compare the genetic diversity of the two species. The results are shown in Table 1.1.

Table 1.1

	genetic diversity as a percentage of that in teosinte	
region of gene	teosinte	maize
DNA of transcribed region	100	39
DNA of regulatory region	100	3

With reference to Table 1.1,

(i) assess the evidence that selective breeding reduces genetic diversity;

.....

.....

.....[2]

(ii) suggest an explanation for the differences in diversity in the different regions of the maize gene.

.....

.....[1]

[Total : 15]

2 **(a)** Describe how antibiotic resistance

(i) arises in a bacterium;

.....

.....

.....[2]

(ii) spreads through a population of bacteria.

.....

.....

.....

.....[3]

A survey was made of the proportion of antibiotic-resistant gut bacteria in wild populations of bank voles and wood mice in a part of England. The sample sites were so positioned that it was thought that the animals would have had minimal contact with antibiotics or with domesticated animals routinely treated with antibiotics. Bacteria were cultured from the faeces of the animals and their resistance to various antibiotics determined. Table 2.1 shows the percentage of colonies of five species of bacteria, **1** to **5**, resistant to four broad-spectrum antibiotics, **A** to **D**. Antibiotics **C** and **D** have a similar molecular structure. Bacterial species **2** is closely related to species **3** and species **4** is closely related to species **5**.

Table 2.1

	percentage of colonies resistant to antibiotic			
bacterial species	**A**	**B**	**C**	**D**
1	14	0	95	100
2	63	0	97	90
3	50	0	94	67
4	39	0	92	77
5	50	0	100	90

(b) With reference to Table 2.1, suggest why

(i) all five species of bacteria are relatively resistant to antibiotics **C** and **D**;

.....

.....

.....

.....[3]

(ii) species **1** shows less resistance than the other species to antibiotic **A**;

.....

.....

.....[2]

(iii) none of the species of bacteria shows resistance to antibiotic **B**.

.....

.....

.....[2]

(c) It is often assumed that restricting the use of antibiotics will prevent the spread of antibiotic resistance in bacteria.

With reference to Table 2.1, comment on this assumption.

.....

.....

.....

.....[3]

[Total : 15]

3 Either

(a) (i) Describe the techniques used in embryo transplantation. [7]

(ii) Describe the process of cloning plants from tissue culture. [7]

(iii) Explain the advantages of using these two procedures in selective breeding. [6]

[Total : 20]

Or

(b) (i) Describe how Down's syndrome arises in humans. [7]

(ii) Describe how genetic screening is carried out. [7]

(iii) Explain the need for genetic counselling after genetic screening has detected a disorder. [6]

[Total : 20]

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