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A Level Biology A
H420/02 Biological diversity
Sample Question Paper

Date – Morning/Afternoon
Time allowed: 2 hours 15 minutes

You may use:
- a scientific or graphical calculator

SPECIMEN

First name	
Last name	
Centre number	
Candidate number	

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION
- The total mark for this paper is **100**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **28** pages.

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SECTION A

You should spend a maximum of 20 minutes on this section.

Answer **all** the questions.

1 If a person is bitten by a venomous snake, the immediate treatment is normally to inject the person with the appropriate antibodies.

This is an example of which type of immunity?

A artificial active immunity

B artificial passive immunity

C natural active immunity

D natural passive immunity

Your answer ☐ **[1]**

2 What is an operon?

A The binding site for a repressor protein.

B Any group of genes responsible for the metabolism of lactose in prokaryotes or eukaryotes.

C A cluster of genes under the control of a promoter.

D A regulatory gene.

Your answer ☐ **[1]**

3 Which statement correctly describes a difference between somatic and germ line gene therapy?

A Germ line therapy involves the use of liposomes; somatic therapy involves use of viral vectors.

B Somatic therapy can target specific tissues in need of treatment, germ line therapy cannot.

C Somatic therapy is most successful when targeting single gene defects, but germ line therapy can target multiple defects.

D Long term success is theoretically more likely with somatic cell therapy than germ line therapy.

Your answer ☐ **[1]**

SPECIMEN

4 Selection pressure can affect homozygous individuals. The effect can be investigated using a model gene pool.

A large gene pool is necessary to ensure that

A genetic drift can occur if frequency is higher.

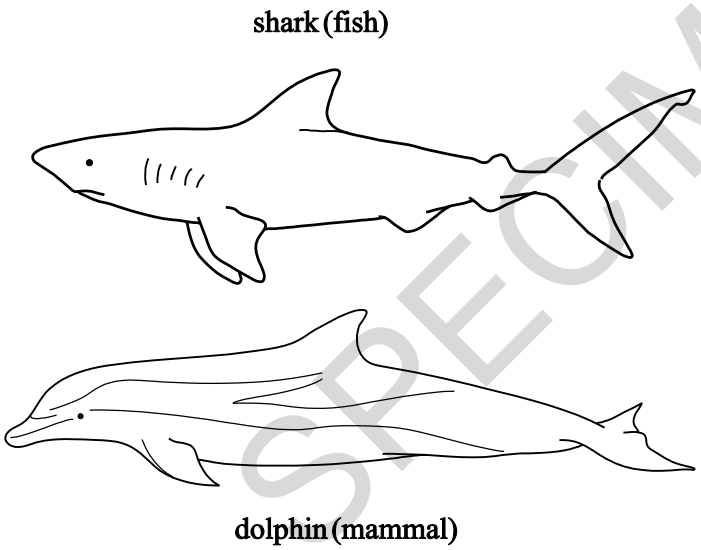
B homozygous individuals are present in high frequency.

C the effect of chance variations in gene frequencies are minimised.

D Hardy–Weinberg equilibrium is achieved.

Your answer ☐ **[1]**

5 These two organisms show very similar anatomical adaptations but are classified in different taxonomic groups.



What is this an example of?

A convergent evolution

B divergent evolution

C disruptive selection

D stabilising selection

Your answer ☐ **[1]**

SPECIMEN

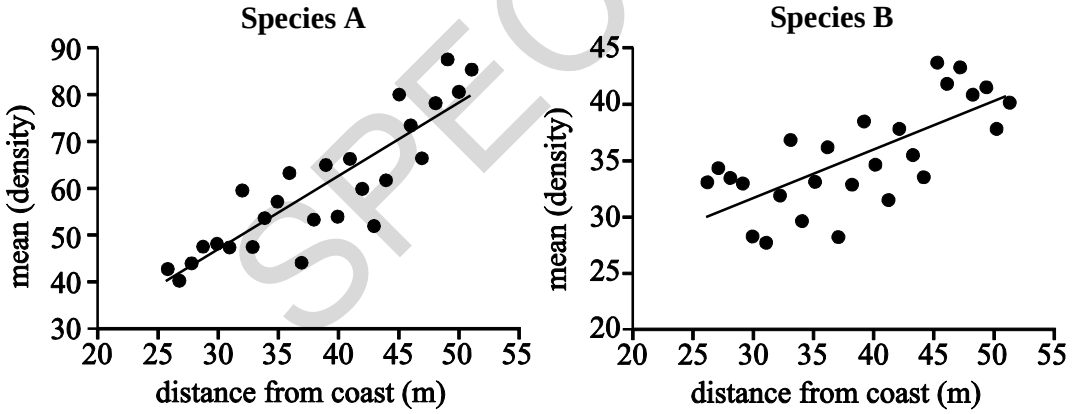
6 A range of microscopes are available for scientific research. Each type of microscope has a different use.

Select the row that shows the correct uses for all the types of microscope.

	Type of microscope and what it is used to observe			
	Light microscope	**Transmission electron microscope**	**Scanning electron microscope**	**Laser scanning confocal microscope**
A	an object at a certain depth within a cell	organelles	cell surfaces	whole cells and tissues
B	cell surfaces	an object at a certain depth within a cell	whole cells and tissues	organelles
C	whole cells and tissues	organelles	cell surfaces	an object at a certain depth within a cell
D	organelles	an object at a certain depth within a cell	whole cells and tissues	cell surfaces

Your answer ☐ **[1]**

7 The graphs below show the density of two different plant species as proximity to the coast changes.



Which of the following statements correctly describes one aspect of the technique used to collect these data?

A Quadrats were randomly placed using a random number generator and coordinates.

B Larger quadrats were required for **species A** because their mean density was higher.

C A belt transect has been used to allow calculation of density.

D Abiotic factors were measured at every point of quadrat sampling.

Your answer ☐ **[1]**

SPECIMEN

8 Immobilised enzymes can be produced by which of the following methods?

A binding enzyme to a soluble matrix

B intermolecular hydrogen bonding of enzymes

C absorbing enzymes onto the surface of a gel

D enclosing enzymes within a partially permeable membrane

Your answer ☐ **[1]**

9 Which of the following statements describes an organelle which is **not** membrane bound?

A contains cristae

B modifies and packages proteins

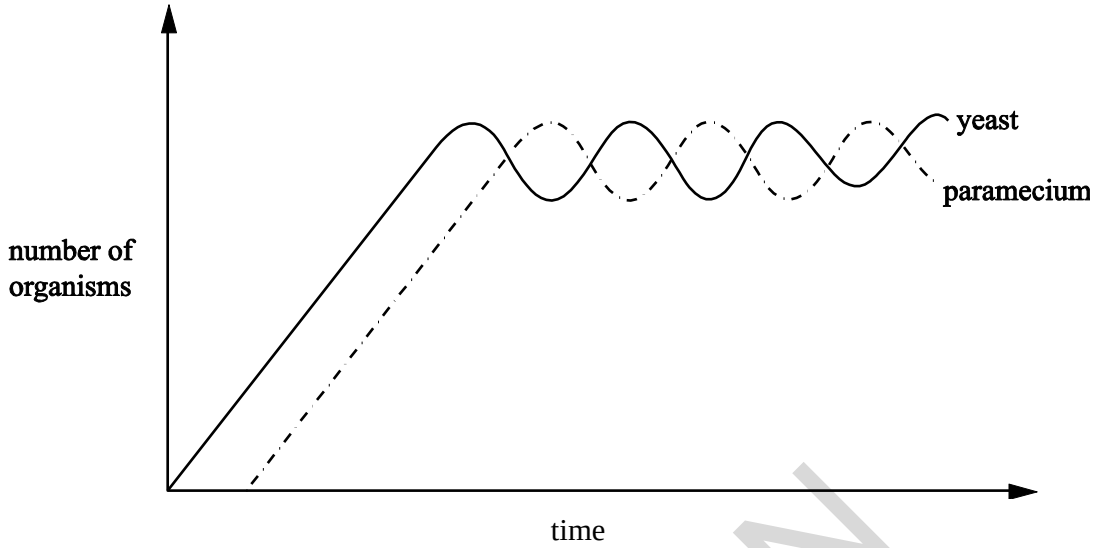
C contains digestive enzymes

D is made of rRNA and protein

Your answer ☐ **[1]**

SPECIMEN

10 The graph shows a population of yeast and a unicellular organism, *Paramecium*, grown in a fermentation chamber.



Which **one** of the following statements best describes the relationship between the two organisms?

A The *Paramecium* and yeast populations are complementary to each other.

B The yeast thrives in the relationship at the expense of the *Paramecium* population.

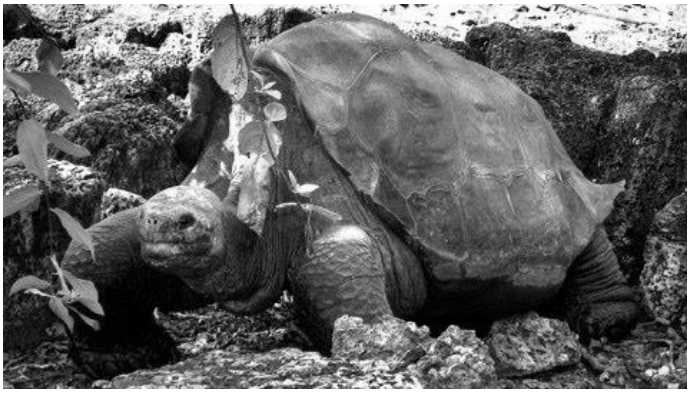
C The *Paramecium* feeds on the yeast and reduces the number in the yeast population.

D The two populations are in equilibrium and stable due to a type of negative feedback.

Your answer ☐ **[1]**

SPECIMEN

11 The last giant Galapagos tortoise died in 2012. Scientists froze some of the tortoise's cells.



The following statements describe processes involved in potential cloning of the giant Galapagos tortoise using the cells. They are **not** in the correct order.

1 A donor egg is enucleated.

2 The embryo develops into a mature egg, which is incubated.

3 A somatic cell from the tortoise is defrosted and the nucleus is removed.

4 Electrofusion of the host cell and new nucleus.

5 The somatic cell nucleus is inserted into the enucleated oocyte.

6 The transformed egg divides *in vitro*.

Which option states the correct order for producing a clone of the giant Galapagos tortoise?

A 1, 3, 4, 5, 6, 2

B 3, 5, 1, 4, 2, 6

C 1, 6, 3, 5, 4, 2

D 3, 1, 5, 4, 6, 2

Your answer ☐ **[1]**

SPECIMEN

12 A number of events occur for a new species to emerge in a population.

Which of the following statements correspond to events that are involved in the formation of a new species?

Statement 1: Gene mutation.

Statement 2: Selection pressure.

Statement 3: A change in the environment.

A 1, 2 and 3

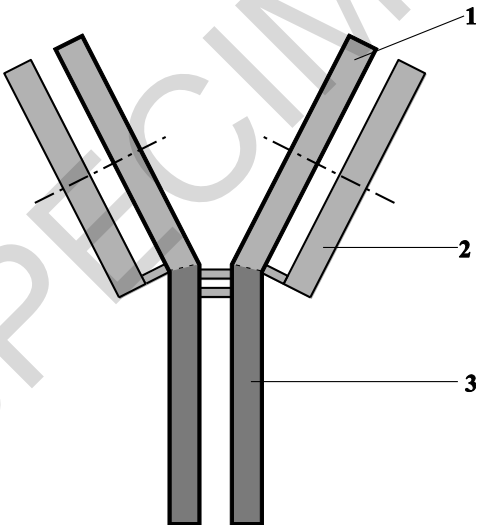
B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

13 The diagram represents the general structure of an antibody.



Which of the following numbered part(s) of the diagram represent the part of the antibody that has the same sequence of amino acids in all antibodies?

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

SPECIMEN

14 The following statements are about the structure of DNA.
Which of the following statement(s) is/are true?

Statement 1: Purine bases pair with pyrimidine bases.

Statement 2: Phosphodiester bonds link adjacent nucleotides.

Statement 3: There are always equal amounts of adenine and guanine.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

15 Deep sea vents on the ocean floor are surrounded by unusual organisms such as chemosynthetic bacteria and eyeless shrimp.

Which of the following statement(s) about these ecosystems is/are true?

Statement 1: The temperature of the vents influences the organisms that live there.

Statement 2: A predatory octopus would affect the balance of these organisms.

Statement 3: The number of eyeless shrimp found at each vent is constant.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

SPECIMEN

SECTION B

Answer **all** the questions.

16 There will be outbreaks of new infectious diseases in the future. They will arise from mutations in the genomes of existing organisms. The mutating organisms may not at present be pathogenic, or they may be animal pathogens that mutate to become able to infect humans.

(a) What feature of a pathogen such as *Mycobacterium tuberculosis* could be altered by a mutation, making a vaccine ineffective?

……

…… **[1]**

(b) **(i)** Outline the processes that lead to the production of antibodies against an unfamiliar bacterium.

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…… **[3]**

(ii) Explain how helper T cells act to speed up these processes.

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…… **[2]**

SPECIMEN

(c) **Fig. 16.1** shows the concentration of new antibodies in the blood of a person infected for the first time by a pathogen, on day 0. This is their 'primary response'.

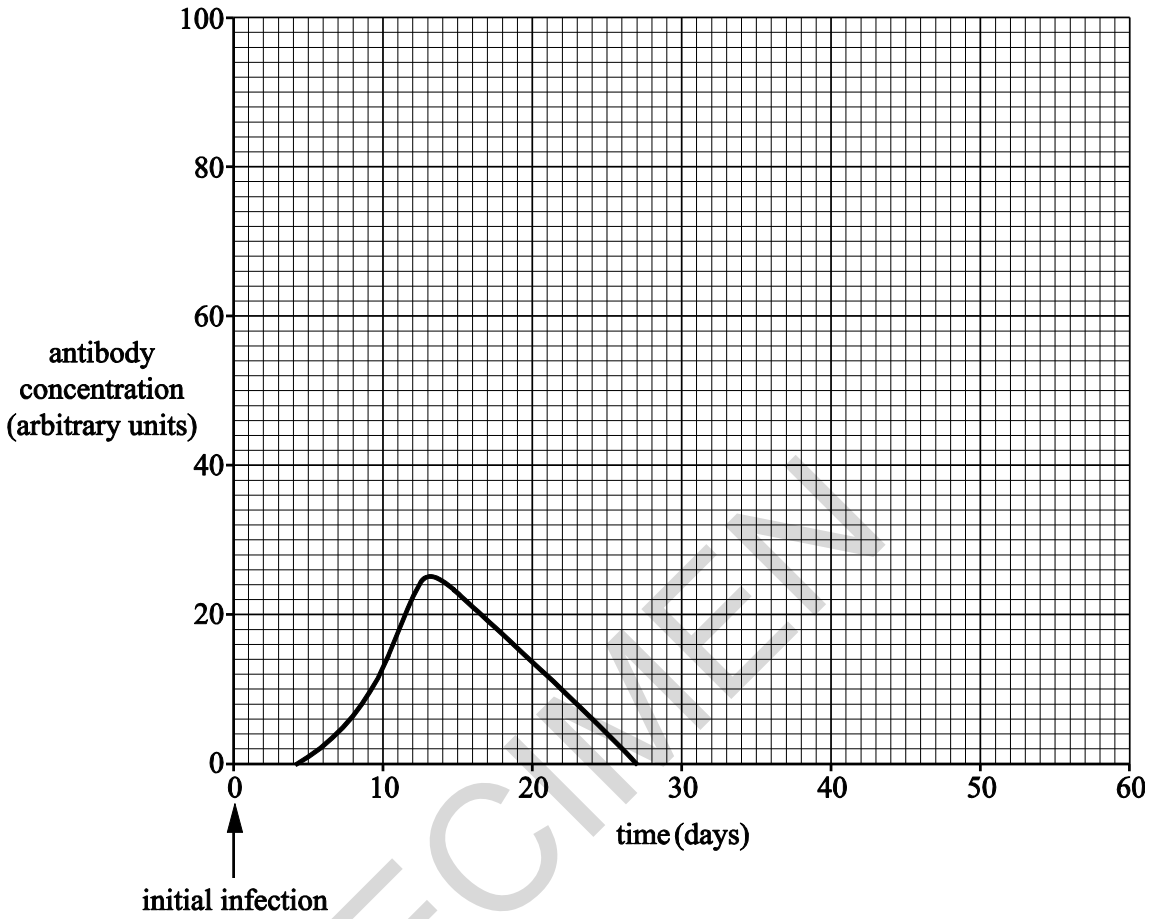


Fig. 16.1

(i) On day 30, this individual was again infected with the same pathogen. Sketch a line **on Fig. 16.1** to show the antibody concentration from day 30 onwards.

[2]

(ii) Explain how memory cells caused the differences between the two lines on the graph.

……...

……...

…… **[2]**

SPECIMEN

(d) **(i)** It takes time for an effective vaccine to be prepared in quantity for a new strain of bacterium.

List two vulnerable groups of people for whom you would advise doctors to prescribe antibiotics although they are **not** yet showing symptoms of the new disease.

……...

……. **[2]**

(ii) Discuss the implications of the over-use of antibiotics when people do not show symptoms.

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……. **[4]**

SPECIMEN

17 Domesticated pigs are descended from *Sus scrofa,* sometimes called the 'wild boar'.

(a) (i) In **Table 17.1**

- number the levels in the correct sequence and
- complete the name column.

Sequence of levels	Level	Name
.....	Order	Artiodactyla
.....	Species	.....
.....	Family	Suidae
1	Kingdom	.....
.....	Genus	.....
.....	Phylum	Chordata
.....	Class	Mammalia

Table 17.1

[4]

(ii) We now have DNA evidence of how organisms are related to each other. This evidence has helped biologists to construct a second classification viewpoint: the Domain system.

Explain what such developments show about the nature of scientific knowledge.

.....

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

SPECIMEN

(b) In domesticated, farmed pigs, the following two traits have been studied:

- The allele for curly tail, **T**, is dominant to the allele for straight tail, **t**.
- The allele for pink skin (dermis), **D**, is dominant to the allele for black skin, **d**.

(i) Draw a genetic diagram to show the results of crossing pigs that are heterozygous for both traits, tail and skin. Use the letters given above.

parental genotypes …… ……..

gametes …… ……..

F_1 offspring genotypes

……...

offspring phenotypes

……...

phenotype ratio

……...

[5]

(ii) Describe in words how this phenotypic ratio might be different if the two genes were autosomally linked.

……...

…… **[1]**

SPECIMEN

(c) A pig farmer crossed one group of pigs, heterozygous for both traits, with another group homozygous recessive for both traits. The farmer expected to get roughly equal numbers of each of the four possible mixtures of tail and skin phenotype.
The results that actually occurred are shown in **Table 17.2**.

Phenotype	**Observed, *O***	**Expected, *E***			
curly pink	20	26			
curly black	30	26			
straight pink	21	26			
straight black	33	26			

Table 17.2

(i) The farmer thought from these results that the two genes might be autosomally linked.

Calculate χ^2. (You may wish to use **Table 17.2** to write figures for steps in your calculation process.)

$$x^2 = \sum \frac{(O-E)^2}{E}$$

Answer**……** **[3]**

(ii) The farmer had concluded that the genes are linked.

Use your calculation and **Table 17.3** to justify whether the farmer's conclusion can be supported or not.

Degrees of freedom	**Probability**							
	0.95	**0.90**	**0.75**	**0.50**	**0.25**	**0.10**	**0.05**	**0.01**
1	0.004	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.103	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.352	0.584	1.212	2.366	4.11	6.25	7.81	11.34
4	0.711	1.064	1.923	3.357	5.39	7.78	9.49	13.28
5	1.145	1.610	2.675	4.351	6.63	9.24	11.07	15.09

Table 17.3

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…… **[1]**

SPECIMEN

18 Milk contains lactose. Lactose cannot be absorbed in the small intestine. The intestinal cells of mammalian infants produce lactase, an enzyme that splits lactose into glucose and galactose. These monosaccharides can pass into the blood.

Fig. 18.1 shows a molecule of the disaccharide lactose and the products of its breakdown in digestion.

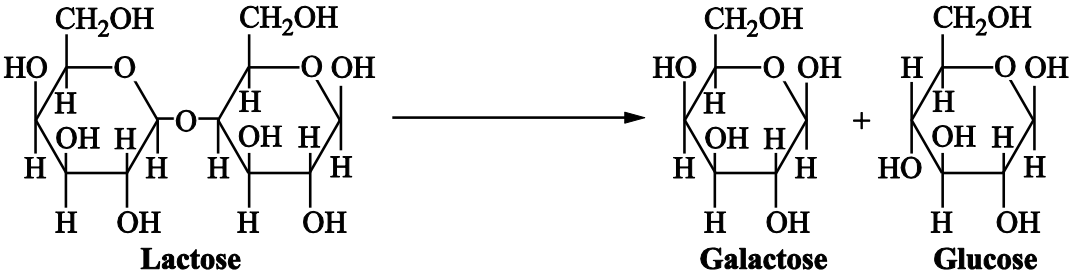


Fig. 18.1

(a) **(i)** Suggest why galactose and glucose cannot pass through the plasma membrane into intestinal cells by simple diffusion through the phospholipid bi-layer.

……. **[1]**

(ii) What two substances are required to break the glycosidic bond in lactose?

1……

2……

[1]

(b) A gene codes for the production of lactase. This gene is normally switched off after an infant moves to adult food. Almost all adult mammals are unable to digest lactose. They are said to be **lactose intolerant**. Humans are an exception.

Most humans have a genetic mutation that prevents the shutdown of lactase production.

State what structural detail of a polypeptide is altered by gene mutations.

…… **[1]**

(c) Some humans are lactose intolerant. Milk can be treated with lactase to reduce the concentration of lactose present. Fresh milk is passed over lactase molecules immobilised on a suitable matrix.

Give two **economic** advantages of immobilising enzymes for large-scale production.

1…….

2…….

[2]

SPECIMEN

(d) The mean levels of human lactose intolerance vary in different parts of the world.

Table 18.1 shows the contrasting levels of lactose intolerance in two ethnic groups from different parts of the world.

Population	**Frequency of lactose intolerance *phenotype***
Europeans	0.05
Australian aborigines	0.97

Table. 18.1

The Hardy–Weinberg principle states that:

$$p + q = 1$$

$$p^2 + 2pq + q^2 = 1$$

Where ***p*** is the frequency of the dominant allele and ***q*** is the frequency of the recessive allele in the genotypes of a population.

The lactose intolerance allele is recessive to the mutant allele, which **prevents** lactose intolerance.

Calculate the frequency of the heterozygous genotype in the Australian aborigine population. Show your working.

SPECIMEN

Frequency = **…….** **[2]**

(e)* Read the following five statements.

Mutations preventing lactose intolerance have occurred in humans at various times in the prehistoric past, and in all human races.

The domestication of large lactating mammals like goats and cattle arose in Europe and parts of Africa 5 000 to 10 000 years ago.

The lowest levels of lactose intolerance are found in areas that European populations colonised, like North America.

The ability of agricultural populations to digest the milk, as well as the meat, of animals, is advantageous. It adds to their general nutrition.

Until recent times the Australian aborigines had been isolated on their island continent for around 50 000 years.

Suggest how the lactose intolerance phenotype came to be present in only 5% of a population like the Europeans, but came to be present in 97% of the Australian aborigines. Use the information given above and knowledge of Darwin's theory of evolution by natural selection.

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SPECIMEN

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…… **[9]**

(f) An Iron Age farm was excavated by archaeologists. Some DNA was recovered from the tooth of an animal thought to be a type of domesticated milk cow.

A farmer keeps rare breed cows similar to those farmed on the Iron Age farm. DNA from the cows was obtained.

What technique would you plan to use, to compare digested and amplified fragments from the two DNA samples?

…… **[1]**

SPECIMEN

19 Laboratory techniques are used by workers in various professions, and by scientists.

(a) A patient has been coughing blood, and it is suspected that bacteria will be found in the blood.

A medical technician cultures the blood on an agar plate. What measures should the technician take to keep the agar plate culture sterile?

……

……

…… **[2]**

(b) Tissue traces from a crime scene often need to be identified. DNA from the tissue is 'amplified' by the polymerase chain reaction (PCR) to get samples large enough for further analysis.

Modern PCR technique uses DNA polymerase from the bacterium *Thermus aquaticus*. Why is this enzyme chosen?

……

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…… **[2]**

(c) Valine, citrulline, hydroxyproline and glutamic acid are amino acids that are normally found in considerable amounts in urine. Following certain diets can result in a change in the amino acids present in the urine of some people.

Plan a method to compare the amino acids present in the urine of a person who has been following one of these diets with that of a person who has not.

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…… **[3]**

SPECIMEN

20 The European corn borer moth, *Ostrinia nubilalis*, is a pest of agriculture. Its larvae develop inside maize stems and eat the contents, weakening the stems so that the plants collapse.

The bacterium *Bacillus thuringiensis* ('Bt') produces a protein that poisons the larvae of moths and butterflies. This protein can be isolated from cultures of Bt and packaged in fluids to be sprayed on the surface of plants.

The gene coding for the toxic protein has also been isolated. It has been incorporated into a genetically modified strain of maize called Bt corn. This makes the plant tissues poisonous to the corn borer moth.

(a) Consider the statement:

> '***Genetically modified plants and animals should be classed as new species***'**.**

Outline **one** experiment or investigation that would provide evidence to support or contradict the statement.

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…… **[3]**

(b) A farmer wants to increase the yield of maize.

A friend recommends planting genetically-modified Bt corn as it would be more effective against European corn borer larvae rather than spraying unmodified corn with Bt toxin.

Which method would you recommend to the farmer? Justify your answer.

……

…… **[1]**

SPECIMEN

(c)* Some students investigated the different ways of protecting maize plants against the corn borer moth. In each of **three** separate but close-together square plots, in the same field, they planted several hundred maize seedlings.

Plot A: untreated (control).

Plot B: sprayed daily with Bt toxin.

Plot C: the seedlings planted were genetically modified Bt corn.

On the first day of each week, one student would walk around the edge of a plot and count the number of maize plants that had collapsed in that plot. Each plot had a student responsible for counting. The results are shown in **Table 20.1**.

	Number of maize plants collapsed since the last weekly count		
Week number	**Plot A**	**Plot B**	**Plot C**
1	0	0	1
2	0	0	0
3	18	22	21
4	0	0	0
5	5	1	0
6	14	11	12
7	5	2	1
8	12	0	1
9	17	1	0
10	30	6	0
11	32	13	1
12	41	17	0
13	38	26	1
14	47	31	1
15	50	44	2
16	49	47	0

Table 20.1

The students' tutor raised a number of concerns about the investigation. In summary:

- **The methods were not a valid test of what was being investigated.**
- **The results may not be accurate.**
- **Some variables were not controlled.**

Explain why these concerns are justified and suggest improvements to the investigation.

SPECIMEN

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…… **[6]**

(d) Many plants can produce natural clones of themselves. Gardeners and farmers take advantage of this natural process by taking cuttings.

When a genetically modified plant is created, it may be cloned into many plantlets in the process called micropropagation.

Compare the equipment and techniques of taking cuttings with those used for micropropagation.

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…… **[2]**

SPECIMEN

21 This Question is about ecosystems in the Southern (Antarctic) Ocean.

(a) Observe the food chain:

phytoplankton (producers) → krill (shrimps etc.) → small fish → large fish → seals

Table 21.1 shows the transfers of energy and the quantities of energy stored as biomasses for the food chain. Magnitudes are given in kilojoules per square metre of sea surface per year.

	Phyto-plankton	**Krill**	**Small fish**	**Large fish**	**Seals**
Energy input, by photosynthesis or feeding ($kJ\ m^{-2}\ y^{-1}$)	900	80	11	1.4	
Energy lost to surroundings by respiration ($kJ\ m^{-2}\ y^{-1}$)	180	64	8.8	1.2	1.05
Energy input converted to biomass ($kJ\ m^{-2}\ y^{-1}$)	720	16	2.2	0.2	0.05
Biomass energy lost to other consumers or decomposers ($kJ\ m^{-2}\ y^{-1}$)	640	5	0.8	0.09	0.05

Table 21.1

(i) For larger and less numerous organisms, such as the seal, it is more appropriate to record energy flows per square kilometre.

Calculate the energy input to the seal population from large fish. Record your answer in kilojoules per square **kilometre** of sea surface per year.

Answer…… **[2]**

(ii) Calculate the percentage of energy stored in large fish biomass converted to energy in seal biomass. Show your working.

Answer…… **[2]**

SPECIMEN

(b) (i) The biomass of large fish in the Southern Ocean is a food resource for humans. It is increasingly harvested by powerful, long-distance trawlers. If over-exploited, the Southern Ocean ecosystem may be permanently altered.

- Suggest two measures that an international treaty might impose, to prevent fishing from causing permanent damage to the Southern Ocean.
- Identify the practical difficulties that might prevent your two measures from being effective.

First measure……

……

Difficulty……

……

……

Second measure……

……

Difficulty……

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……

[4]

(b) (ii) Krill can also be harvested as a human food source.
The fishing industry aims to harvest large fish.
Some environmentalists say that krill harvesting should be increased.

Use this information and **Table 21.1** to put forward arguments for and against harvesting krill instead of large fish as a human food source.

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……. **[2]**

SPECIMEN

22 A small, permanent pond is the habitat for a climax community of producers (aquatic plants and algae) and consumers (bacteria, protoctista, worms, snails, arthropods and small vertebrates like newts and fish).

(a) Why might ecologists call this a 'climax community'?

……

…… **[1]**

(b) The protoctist *Paramecium caudatum* is usually between 200 and 300 μm in length. An accurate measurement would help in the correct identification of a specimen from this pond.

What laboratory equipment would you select to make an accurate measurement of the length of *Paramecium caudatum*?

……

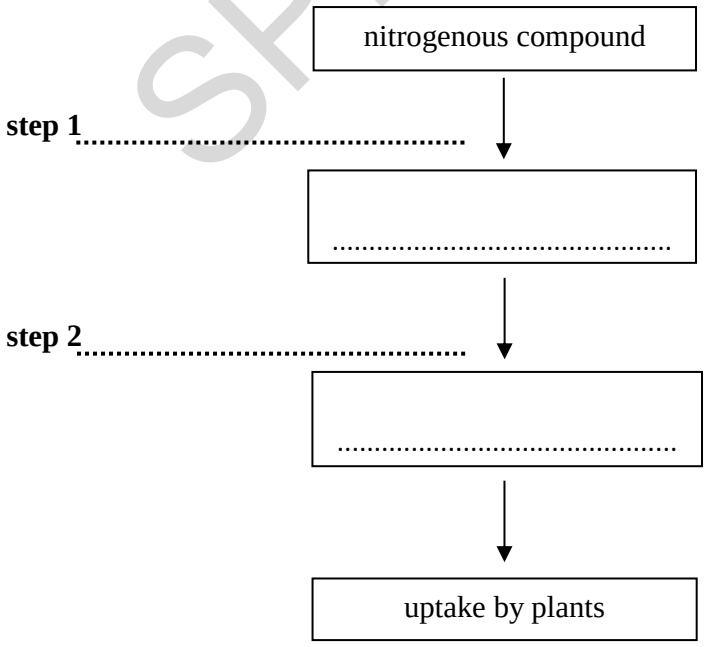
…… **[2]**

(c) An animal fell into the pond. It drowned and decayed. Within a year the biological compounds in its body had been completely recycled.

(i) What nitrogenous excretory molecule from the decomposers would pass to the next stage of the nitrogen cycle?

…… **[1]**

(ii) Complete the flow chart to show what happens to this nitrogenous compound, and name the groups of bacteria involved at steps 1 and 2, as it is converted to a form that plants can take up and use.



[4]

END OF QUESTION PAPER

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