

1)

The phenotype of an organism is affected by its genotype and its environment.

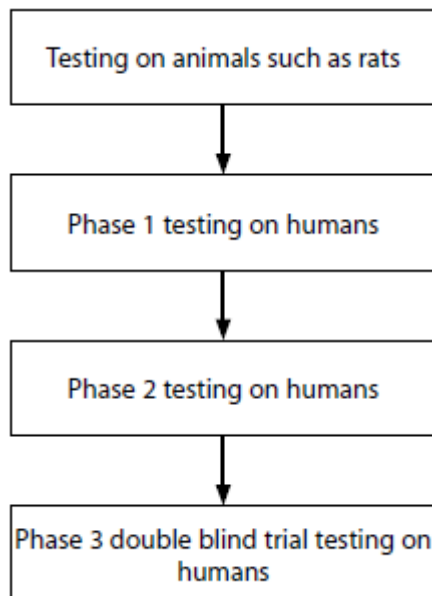
(a) The table below shows the mean difference in two phenotypes, height and mass, from a study on several human identical twins and non-identical twins. Each pair of twins was brought up together.

Phenotype	Type of twins	
	Identical	Non-identical
Mean height difference / cm	1.7	4.4
Mean mass difference / kg	1.9	4.6

Explain how the data in the table show the effects that genotype and the environment have on the phenotypes.

(3)

(b) When a drug is being developed, it goes through a series of different test stages. Some of these are shown below.



(i) Suggest why a drug can be tested on rats before testing on humans.

(2)

(ii) State what is done during each of the following phases of testing on humans.

(3)

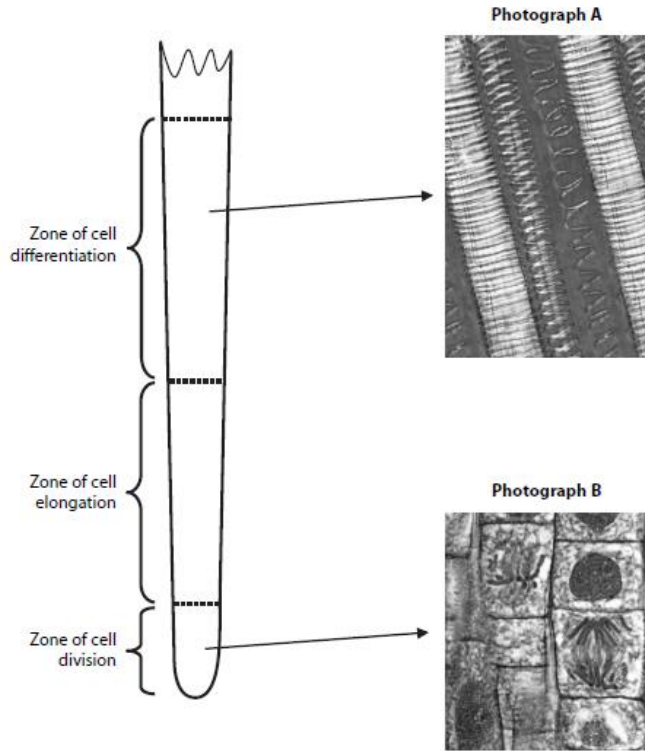
Phase 1

Phase 2

2)

In the roots of plants, cell division, cell elongation (growth) and cell differentiation occur in different zones near the root tip.

The diagram below show the three different zones in a root. Photographs **A** and **B** show some of the tissues present in two of these zones.



(a) (i) Name the specialised tissue shown in photograph **A**.

(1)

*(ii) Describe and explain how this tissue is adapted for the transport of water and support in a plant.

(4)

(b) Explain how differential gene expression could result in the specialisation of cells.

(3)

(c) Only one of the two tissues shown in the photographs **A** and **B** is totipotent. Describe how you could use a plant tissue culture technique to show which of the two tissues is totipotent.

(4)

3)

The diversity of ant species in a habitat can be used as an indicator of environmental conditions and conservation status.

(a) A study of the effect of high copper levels on ant diversity was undertaken in Brazil. Ants were collected in the same way at three different sites in one habitat. The number of different species at each site was recorded. Site 1 and Site 2 were near a copper mine and had high levels of copper present. Site 3 had normal levels of copper. The amount of vegetation present at each site was also recorded.

The results are shown in the table below.

Site	Number of ant species found	Amount of vegetation present
1	14	Very little
2	16	Little
3	45	Rich and dense

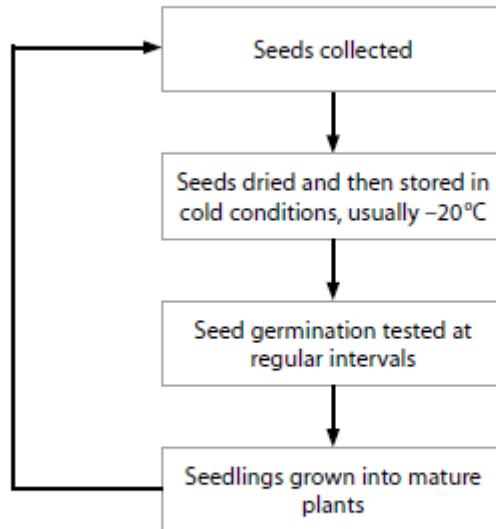
(i) Using the information in the table, what is the evidence that ant diversity can be used as an indicator of environmental conditions?

(1)

(ii) It has been suggested that there is no **direct** effect of copper on ants. Suggest how the data in the table support this suggestion.

(2)

(b) Seedbanks have been set up around the world to help conserve rare plant species. The process for storing seeds includes the following stages.



(i) Suggest **two** reasons why the seeds need to be dried and then stored in cold conditions. (2)

(ii) Suggest why seed germination is tested at regular intervals. (2)

(c) One of the aims of both seedbanks and zoos is to conserve endangered species. Give **two** ways in which zoos help to conserve endangered species. (2)

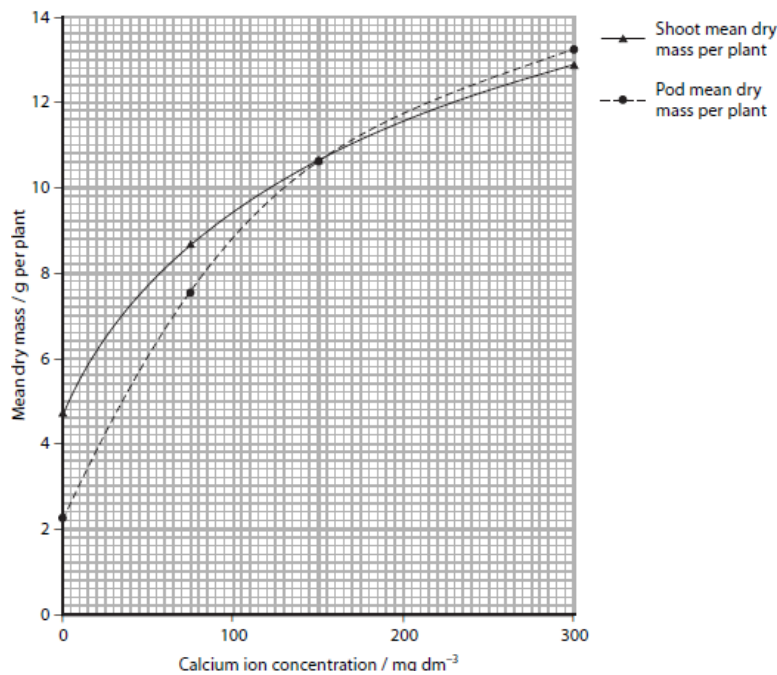
4)

A study was undertaken to investigate the effect of calcium ion concentration on the mass of shoots and the mass of pods of bean plants.

Two bean plants were grown in a pot and watered regularly with a solution containing all the required mineral ions except calcium. When the plants had produced mature bean pods, the shoots and the pods were dried and the mean dry masses were recorded.

This experiment was repeated three times, each with a different calcium ion concentration added to the watering solution.

The results are shown in the graph below.



- (a) (i) Using the information in the graph, compare the effect of calcium ion concentration on the mean dry mass of shoots and the mean dry mass of pods in bean plants. (3)
- (ii) Suggest how calcium ions contributed to the change in mass in the shoot of the bean plant. (1)
- (b) During this investigation, it was found that there was a relationship between calcium ion concentration in the watering solution and total nitrogen uptake by the bean pods. The data are shown below.

Calcium ion concentration in the watering solution / mg dm ⁻³	Total nitrogen uptake by the bean pods / mg
0	70
75	220
150	290
300	350

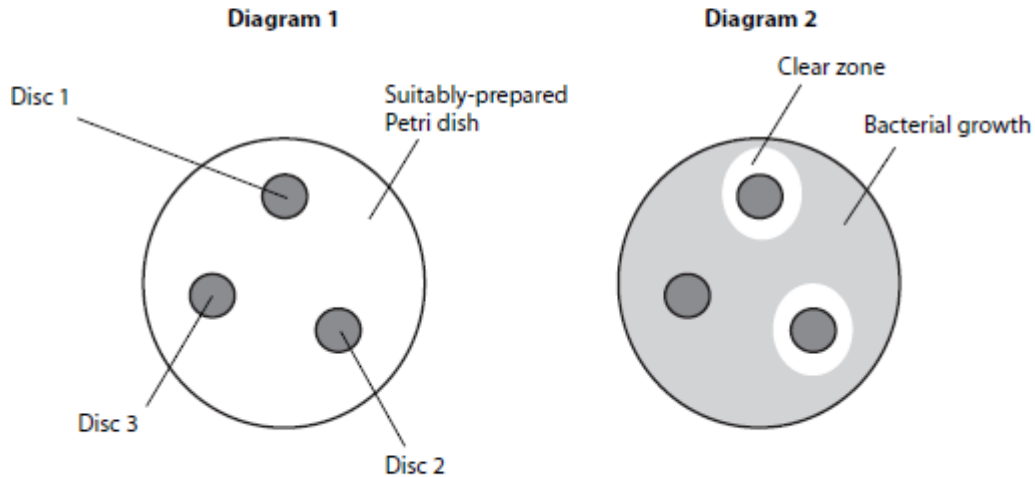
- (i) Describe the relationship between calcium ion concentration and total nitrogen uptake by the bean pods. (2)
- (ii) Suggest the form in which the nitrogen was supplied in the watering solution. (1)
- (iii) Suggest how the protein content of the bean pods from plants grown in the watering solution containing a calcium ion concentration of 300 mg dm⁻³ would differ from those watered with a lower calcium ion concentration. Give an explanation for your answer. (3)

5)

A student investigated the antimicrobial properties of tea tree oil.

She cut three identical discs of blotting paper. She soaked disc 1 in 100% tea tree oil, disc 2 in 50% tea tree oil and 50% vegetable oil and disc 3 in 100% vegetable oil. She then placed all three discs onto a single suitably-prepared Petri dish as shown in diagram 1.

She incubated the Petri dish at 25 °C for 24 hours. The results of the incubation are shown below in diagram 2.



- (a) Suggest what is meant by the phrase **suitably-prepared Petri dish**. (2)
- (b) (i) Describe the function of disc 3. (1)
- (ii) Explain why clear zones are found around disc 1 and disc 2. (2)
- (iii) The clear zone around disc 1 is not a circle. Suggest how you would calculate the mean diameter of this clear zone. (2)
- (c) The mean diameters of the clear zones around disc 1 and disc 2 were found to be the same. This suggests that both strengths of tea tree oil had equally effective antimicrobial properties.
- Describe how you would determine the minimum strength of tea tree oil that would be as effective as the 100% tea tree oil. (3)
- (d) Suggest **one** reason why it was good safety practice to incubate the Petri dish at 25 °C rather than at 37 °C. (2)

6)

In the 1990s, a scientist called Woese suggested a new way of grouping organisms into domains.

(a) The table below shows Woese's three domains and gives some of the characteristics of each domain.

Domain	Some characteristics of each domain
P	True nucleus absent Small (70S) ribosomes present Smooth endoplasmic reticulum absent RNA polymerase made up of 14 subunits
Q	True nucleus present Large (80S) ribosomes present Smooth endoplasmic reticulum present RNA polymerase made up of 14 subunits
R	True nucleus absent Small (70S) ribosomes present Smooth endoplasmic reticulum absent RNA polymerase made up of 4 subunits

(i) Place a cross ☒ in the box which shows the two domains which are most **distantly related**.

- A P and Q (1)
- B P and R
- C Q and R

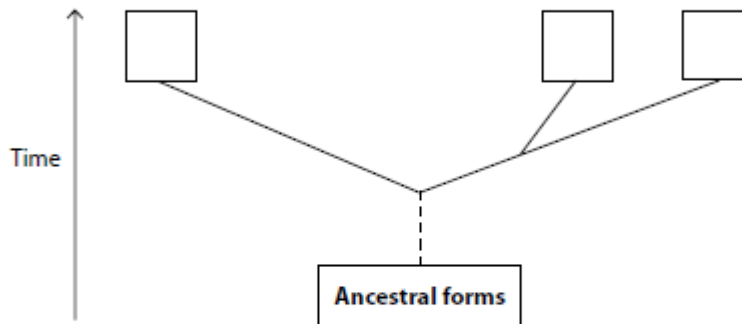
(ii) Place a cross ☒ in the box which shows the domain that represents eukaryotic organisms.

- A P (1)
- B Q
- C R

(iii) The diagram below represents the phylogenetic tree for the three domains.

Place a cross (×) in the box on the diagram that correctly identifies the eukaryotic domain.

(1)



(iv) Give the name of **one** of the other two domains.

(1)

b) One domain includes the plants and these have cells with a cell wall.

* (i) Describe the structure of a plant cell wall.

(4)

(ii) A student studied the cell wall arrangement between two adjacent plant cells. He noticed several features which he could not name. Two of these are described in the table below.

Complete the table by writing in the name of each feature described.

(2)

Feature described	Name of feature
Site where there was no cell wall and the cytoplasm linked the two adjacent cells	
Dark line that is the boundary between one cell and the next cell	

7)

Biodiversity, including both species richness and genetic diversity, is an important concept to be considered when organising captive breeding programmes.

(a) Explain what is meant by each of the following terms.

(3)

Niche

Species richness

- (b) One way to measure genetic diversity is to find the percentage of genes that have different alleles.

The table below shows the percentage of genes that have different alleles in four types of cat.

Type of cat	Percentage of genes with different alleles (%)
Cheetah	4
Domestic cat	23
Lion	12
Ocelot	21

- * (i) Using the information in the table above and your own knowledge, suggest why the cheetah is the cat at most risk if the environment changes. (3)
- (ii) Cheetahs are unusual amongst the big cats.



Cheetah and cub
Dr P. Marazzi / Science Photo Library

A female cheetah often mates with several different males and gives birth to two or three cubs at a time, each having a different father.

Suggest why this may be advantageous to cheetahs.

(2)

- (c) Rafa was a male cheetah involved in breeding programmes in several zoos. The table below shows some data from Rafa's studbook.

Name of zoo housing Rafa	Event	Date of event
WINSTON	Birth of Rafa	24 Dec 1974
SD-WAP	Transfer	26 Nov 1980
LAGUNA HI	Transfer	9 Apr 1982
SD-WAP	Transfer	5 Dec 1984
BATON ROUGE	Transfer	11 Feb 1986

Suggest what effect transferring Rafa from one zoo to another had on genetic diversity in this species.

(2)

- (d) Place a cross in the box to the right of the statement that correctly describes an endemic animal.

(1)

Statement	
Ducks that migrate from one continent to another	<input type="checkbox"/>
House fly that is found in all continents except Antarctica	<input type="checkbox"/>
Cheetahs that are exclusive to one continent	<input type="checkbox"/>