

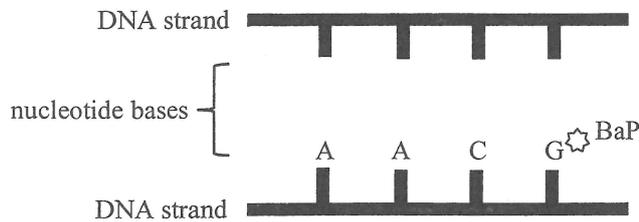
SECTION B

Answer **ALL** questions. Write your answers in the spaces provided.

1. Fill in the table below to compare the characteristics of nervous and hormonal controls. (3 marks)

		<i>Nervous control</i>	<i>Hormonal control</i>
(a)	Signalling molecule		
(b)	Transmission pathway		
(c)	Comparison of the time taken to induce responses		

2. BaP is a carcinogenic chemical which is commonly found in grilled meats. It can attach randomly to the nucleotides of DNA molecules. When it is attached to guanine (G), this G will be misread as thymine (T). The diagram below shows part of nucleotide sequence of one strand of a DNA molecule with BaP attached to a G:



- (a) On the above diagram, write down the nucleotide sequence found in the opposite strand of the DNA when misreading happens. (1 mark)
- (b) Suggest *one* reason why this type of mutation may *not* affect the functioning of the protein formed. (1 mark)

- (c) If this type of mutation accumulates over time in the DNA molecules, there is a chance that it will affect the functioning of the protein formed and subsequently lead to tumour formation. Suggest which cellular process this protein controls. (1 mark)

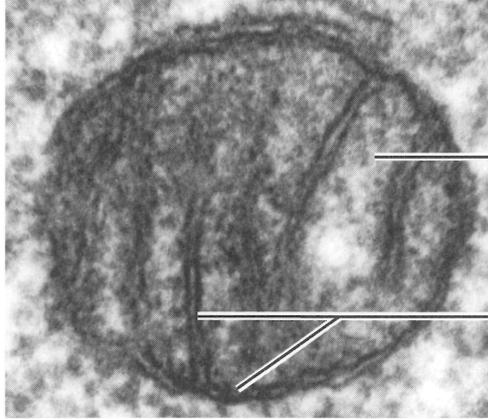
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3. The diagram below shows an electron micrograph of a mitochondrion:



50 nm

- (a) Label X in the above diagram. (1 mark)
- (b) Describe *one* observable feature of Y and explain how this feature is related to the functioning of mitochondria. (2 marks)

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- (c) Chemical Z can inhibit an enzyme found in X.
- (i) Which key process of respiration would be inhibited? (1 mark)

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- (ii) If chemical Z is added to a plant cell culture, how would this affect the respiratory pathway? (3 marks)

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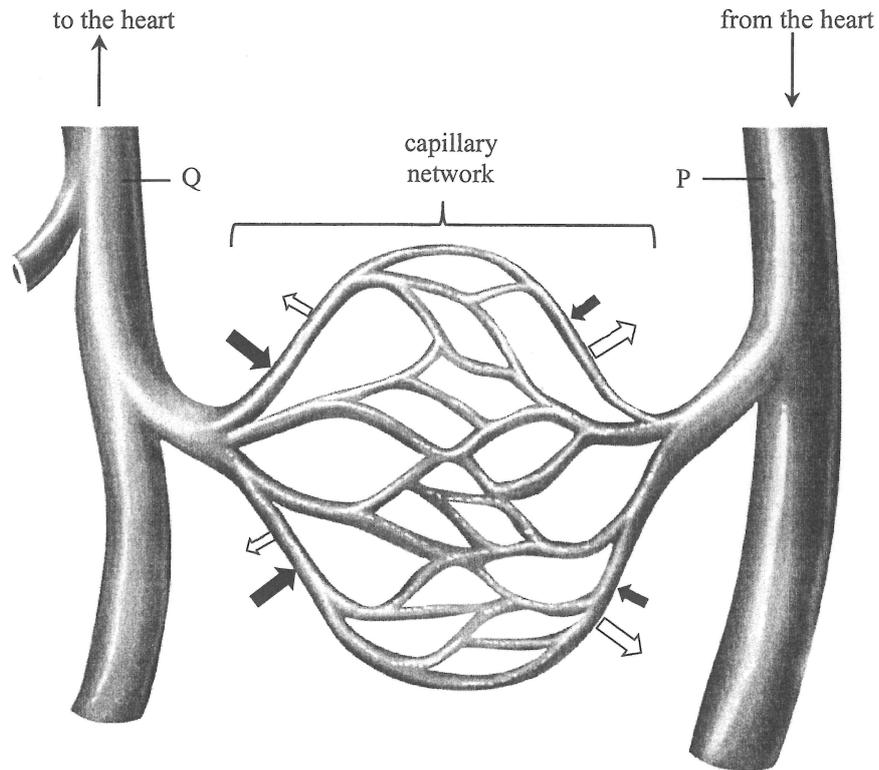
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4. The schematic diagram below shows the arrangements of some blood vessels:



(a) The two types of arrows (black and white) represent two factors which govern the movement of fluid into or out of the capillary network. Identify these two factors. (2 marks)

➡ :

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⇨ :

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(b) The sizes of the arrows in the above diagram represent the magnitudes of the factors. Explain the change in the factors denoted by ⇨ as the blood flows from P to Q. (3 marks)

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- (c) The capillary network is the location where exchange of materials occurs between the blood and tissue fluid. When the blood flows through the capillary network of a particular organ, some substances will be taken up into the blood.

Complete the table below to show the organ where the capillary network is found. Provide your explanation. (3 marks)

	<i>Organ</i>	<i>Substance taken up into the blood</i>	<i>Explanation</i>
(i)		insulin	Insulin is secreted from the organ in response to the change of the blood glucose level.
(ii)		urea	

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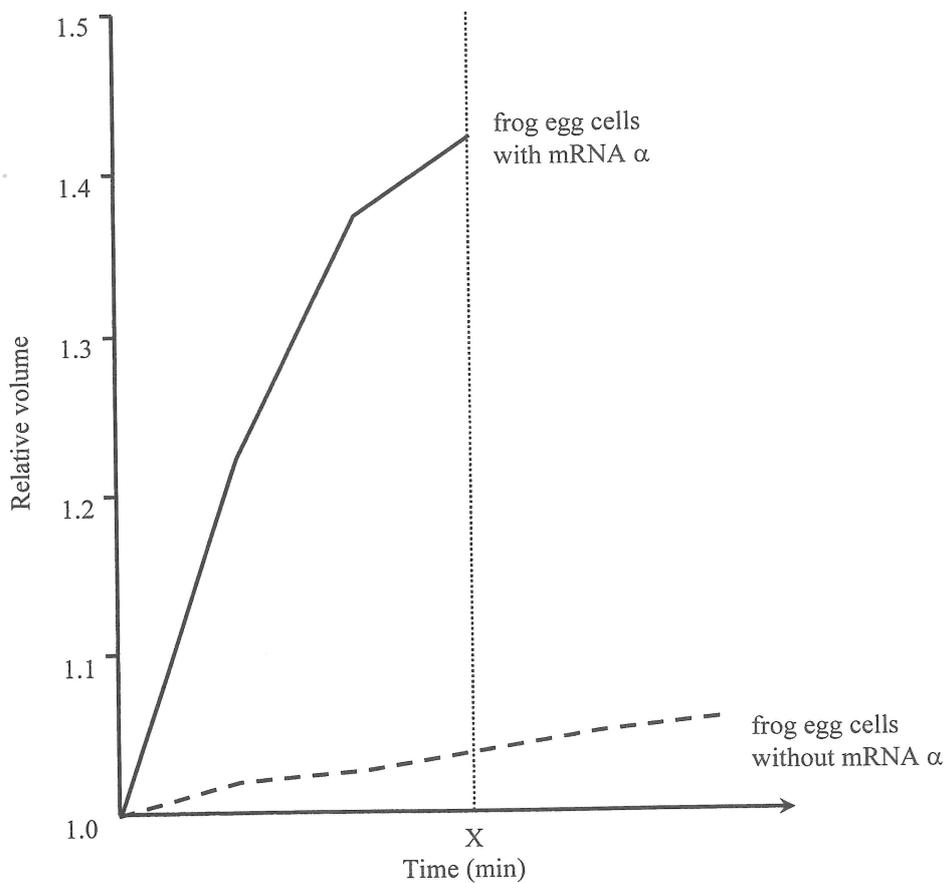
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5. In an experiment, mRNA α was isolated from a mammalian cell and then injected into a frog egg cell. The expression of mRNA α eventually led to the presence of protein α on the cell membrane of the frog egg.

(a) Describe how the injected mRNA α led to the presence of protein α on the cell membrane of the frog egg. (3 marks)

(b) In another experiment, frog egg cells received an injection of a fixed amount of water with or without mRNA α . After that, these two types of frog egg cells were transferred to pure water. The changes in the relative volumes ($\frac{\text{new volume}}{\text{original volume}}$) of these two types of frog egg cells are shown in the graph below:



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- (i) Explain why there was an increase in the relative volume of the frog egg cells without mRNA α after they were transferred to pure water. (2 marks)

- (ii) Based on the difference shown in the results of the two types of frog egg cells, deduce the function of protein α on the cell membrane. (3 marks)

- (iii) Suggest why no data were obtained from frog egg cells with mRNA α after X minutes. (1 mark)

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6. Shirley came across an article about some beans containing an amylase inhibitor as a defence against insects. She wondered if the amylase inhibitor would also work in the human body and if it did, whether it could be used as a food supplement for weight management. She discussed the idea with her classmate Johnson. They had different ideas:

Shirley: I think we should test if the bean extract can inhibit pancreatic amylase.

Johnson: Perhaps we can use salivary amylase instead of pancreatic amylase.

- (a) With reference to the process of digestion, which amylase would produce more valid results for developing a food supplement that targets weight management? Explain your answer. (3 marks)

- (b) The table below shows the reaction mixtures prepared for the investigation:

<i>Solution</i>	<i>Volume of solution used in each set-up (mL)</i>	
	<i>Set-up I</i>	<i>Set-up II</i>
1% starch solution	15	15
Amylase solution	5	5
Bean extract	0	5
Buffer solution (to maintain the pH)	5	5
Water	5	0

- (i) Explain the purpose of adding water to set-up I. (2 marks)

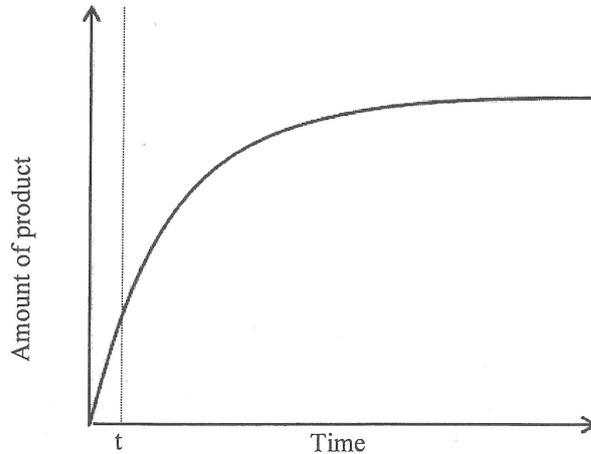
- (ii) Suggest *one* method to determine the rate of starch digestion and state clearly the measurement taken to show the rate of starch digestion. (2 marks)

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(c) The graph below shows the amount of product formed over time when amylase is working normally:



The experiment was repeated with the addition of bean extract at time t . If the bean extract can inhibit the amylase being studied, what will be the change in the amount of product formed? On the above graph, sketch a line to show the results. (1 mark)

(d) Shirley and Johnson shared their ideas with their professor. Their professor suggested that they should conduct an *in vivo* experiment using mice with the control group fed with starchy food and the experimental group fed with a mixture of starchy food and bean extract.

(i) Explain why the result of an *in vivo* experiment is more valid than that of *in vitro* experiment in this case. (1 mark)

(ii) Apart from monitoring the change in body weight of the mice, their professor suggested that they should take blood samples from the mice after the meals for analysis. Which component of the blood should they monitor? What would be the expected results of the control group and the experimental group if their ideas actually worked? (2 marks)

(e) Suggest how the amylase inhibitor helps the bean defend against insects. (1 mark)

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7. The following photograph was generated by an artificial intelligence programme using the following sentence:

'A photograph capturing Hong Kong students on a field trip to a rocky shore, studying the distribution and abundance of organisms along the shore.'



- (a) The photograph does not truly reflect the requirement in the sentence because two pieces of essential equipment are missing.

- (i) List the *two* pieces of essential equipment for the study. (1 mark)

- (ii) How could you use the equipment listed in (i) to collect the data needed for the study? (2 marks)

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- (b) In a field trip to a rocky shore, a student found a thin brown sheet lying on a rock. The student suspected that it was an alga. A small piece of the sample was taken back to school for further study.



5 cm

Using apparatus and reagents available in a school laboratory, design a set-up which can be used to show whether the sample of this thin sheet can undergo respiration. In the space below, draw a simple labelled diagram of this set-up. (3 marks)

Title: A set-up for demonstrating if respiration occurs in the sample

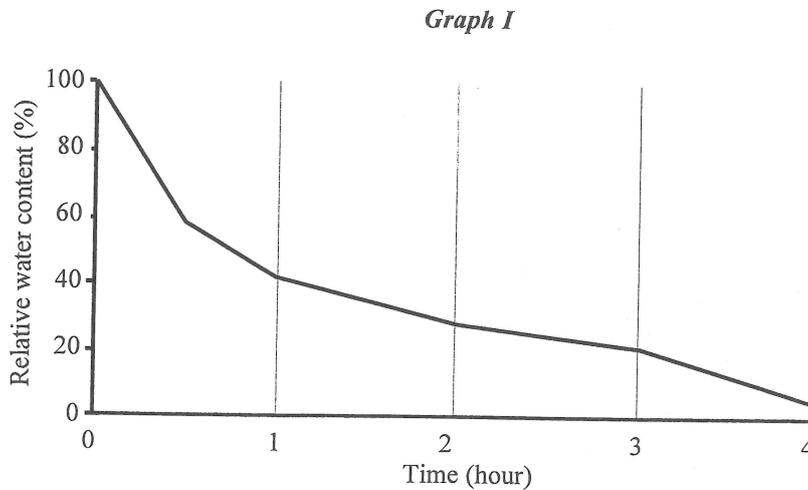
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- (c) Under normal circumstances, the level of free radicals in algal tissues is kept at a certain level as a result of homeostasis. In response to dehydration, algal tissues will be stimulated to produce free radicals which can cause damage to the cell components if there is an accumulation.

Graph I shows the change in relative water content of algal tissue samples during a period of four hours of dehydration:



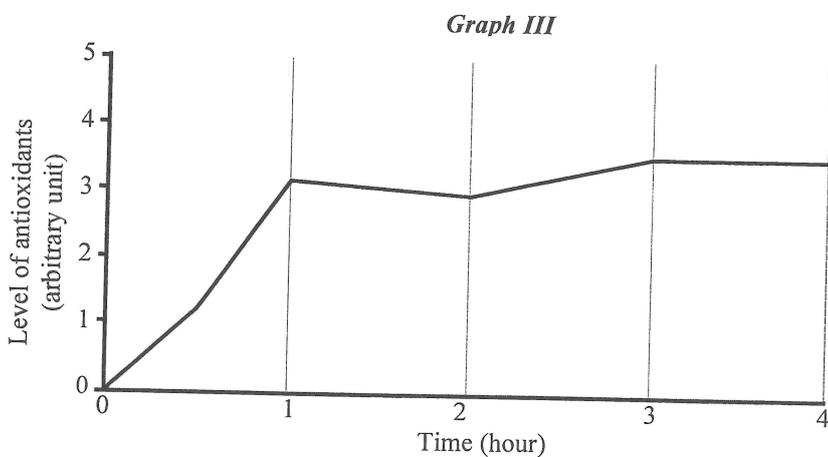
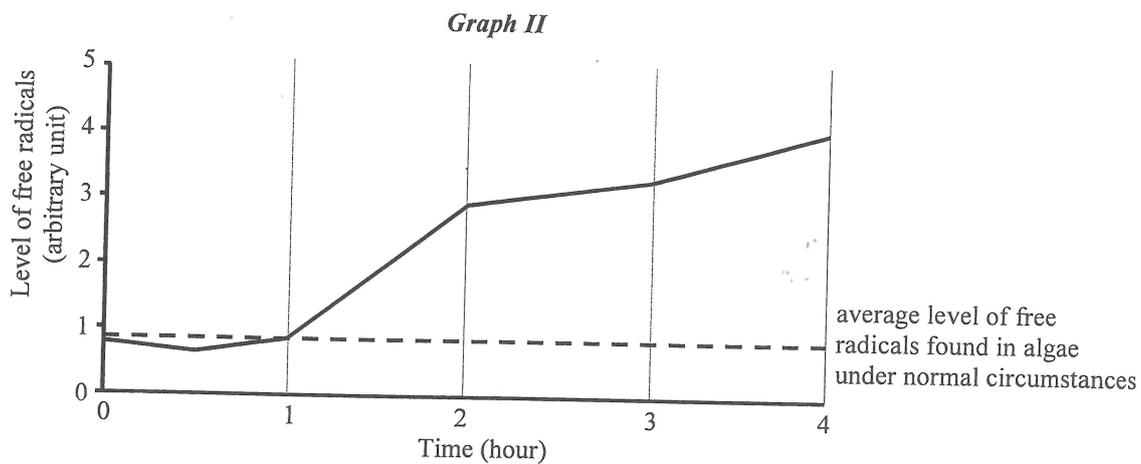
With reference to Graph I, what would be the expected change in the level of free radicals found in the algal tissue samples during the four hours of dehydration? (1 mark)

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- (d) Graph II and Graph III respectively show the actual change in the level of free radicals and the change in the level of antioxidants found in the algal tissue samples of the alga during the same period of dehydration:



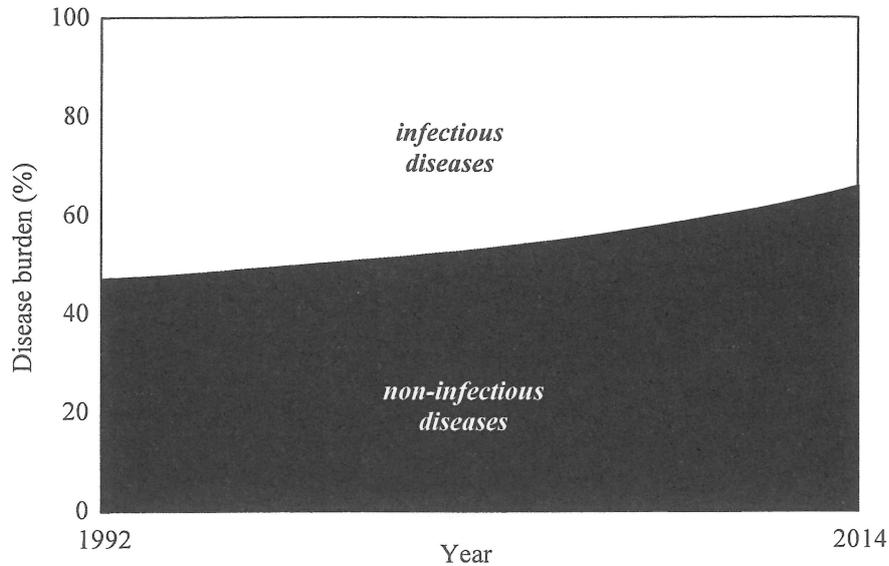
Based on your answer in (c) and the data shown in Graph II and Graph III, suggest the role of antioxidants in helping the algae to cope with the dehydration. Give *two* pieces of evidence from the data shown. (3 marks)

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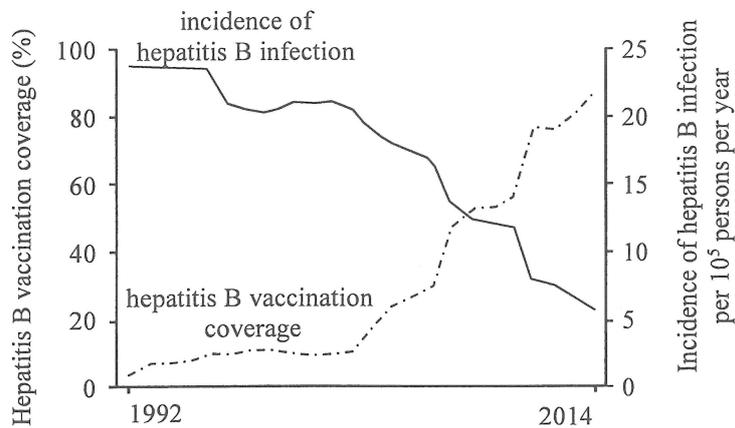
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8. Disease burden is a measure of population health that aims to quantify the potential loss of lifespan and health outcomes due to illness as compared to the ideal of living to a ripe old age and in good health. The graph below shows the percentage share of disease burden caused by infectious diseases and non-infectious diseases in Country X from 1992 to 2014:



- (a) Describe the change in the percentage shares of the disease burden of Country X from 1992 to 2014. (1 mark)

- (b) The graph below shows the impact of hepatitis B vaccination on the incidence of hepatitis B infection in Country X from 1992 to 2014:



- With reference to the principle of vaccination, explain the relationship shown in the above graph. (4 marks)

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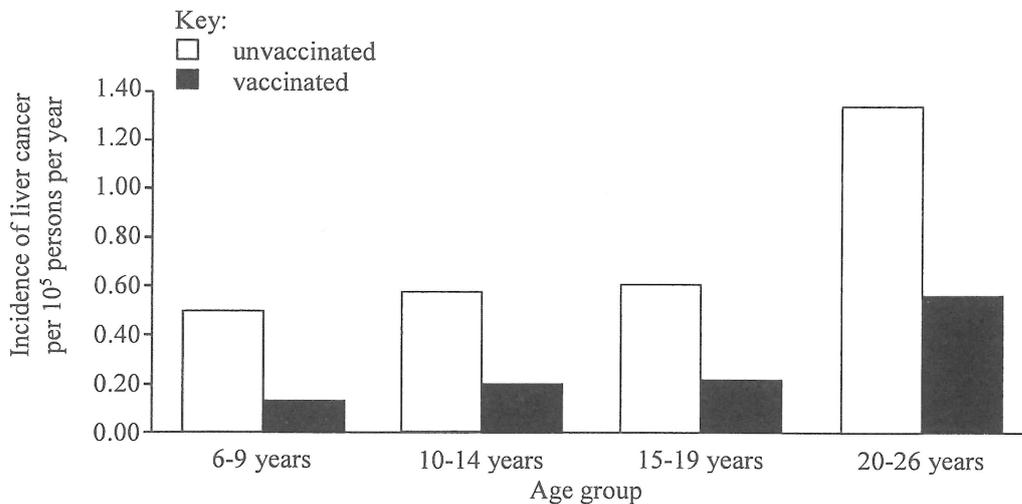
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- (c) With reference to the information from (a) and (b), suggest the role of vaccination in the change of disease burden in Country X. (1 mark)

- (d) The graph below shows the incidence of liver cancer among different age groups who have or have not been vaccinated against hepatitis B in Country X:



What can you conclude about the relationship between hepatitis B and liver cancer? Support your answer with evidence from the graph. (2 marks)

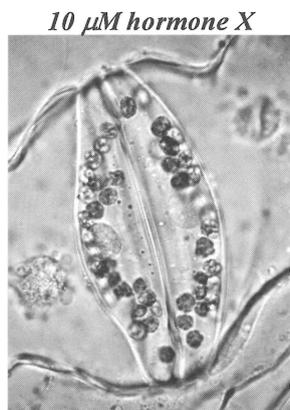
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9. Hormone X is a plant hormone which is produced in leaves of plant P when water supply is inadequate. A student detached some leaves from plant P and placed them in either water or a 10 μM solution of hormone X. After two hours, the student examined the lower epidermis of the leaves under a light microscope. The photomicrographs below show the images obtained:



(a) Based on the above information, explain the importance of hormone X to the drought tolerance in plant P. (2 marks)

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(b) In nature, there are varieties of plant P which produce different amounts of plant hormone X in response to drought stress. The student measured the fresh leaf masses of two different varieties (A and B) of plant P after drought treatment for two weeks. The results are shown in the table below:

<i>Plant variety</i>	<i>Treatment</i>	<i>Leaf fresh mass (g)</i>
A	Control	0.20
	Drought	0.18
B	Control	0.21
	Drought	0.08

Which variety will have a higher level of hormone X produced? Explain your answer. (3 marks)

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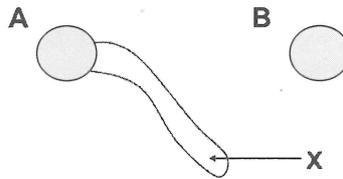
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10. In an investigation, pollen grains collected from a single flower were cultured in an artificial medium. After 48 hours incubation, they were observed under a light microscope. Two types of pollen grains with different appearances were observed, as shown in the diagram below:



(a) The number of each type of pollen grains is approximately the same. It is known that the formation of structure X is controlled by a single gene. Deduce the genotype of the parent plant producing these two types of pollen grains. (4 marks)

(b) If these two types of pollen grains land on a stigma of the flower of the same species, which type of pollen grains will lead to formation of seed? Explain your answer. (3 marks)

(c) 100 seeds were collected from the parent plant in (a) after self-pollination. According to your answer in (b), complete the following table to show the proportion of genotypes in these seeds. (1 mark)

Genotype	Homozygous dominant	Heterozygous	Homozygous recessive
Proportion (%)			

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