

Answer Questions 1 and 2 in the spaces provided.

1. (a) Yeast (*Saccharomyces cerevisiae*) is a single-celled fungus, which may be found growing naturally on the surface of fruits, including grapes. These yeast cells are diploid and reproduce by budding, forming a clone of cells. Under certain conditions, however, these diploid cells may undergo meiotic division. Each diploid cell forms four haploid cells, which are also capable of reproducing by budding.

Haploid yeast cells exist in two strains, known as mating types *a* and α . An *a* cell and an α cell may fuse to form a diploid cell, with 32 chromosomes, which then continues to reproduce by budding.

- (i) State the number of chromosomes present in an α cell.

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(1)

- (ii) Suggest why it might be advantageous for yeast to reproduce by budding.

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(3)

- (iii) Yeast mating types *a* and α recognise each other by producing small protein molecules, which bind to the cell surface membrane of the opposite mating type. Suggest how the structure of the yeast cell surface membrane is related to this function.

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(b) Yeast cells are normally able to carry out aerobic respiration and produce ATP from the oxidation of glucose and other substrates. Mutation may occur in yeast, giving rise to cells known as petite mutants. These cells have abnormal mitochondria which lack many of the proteins involved in the electron transport chain. Petite mutant cells grow very slowly compared with normal yeast cells.

(i) State the location of the electron transport chain within a mitochondrion.

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(1)

(ii) Suggest why petite cells grow slowly compared with normal yeast cells.

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(c) DNA has been extracted from both the nuclei and mitochondria of normal yeast and petite mutants. These samples of DNA have then been analysed to determine their densities, as shown in the table below.

DNA sample	DNA density / arbitrary units
Normal nuclear	1.700
Normal mitochondrial	1.684
Petite nuclear	1.700
Petite mitochondrial	1.680

What do these results suggest about the cause of the petite phenotype in yeast?

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(1)

Q1

(Total 12 marks)



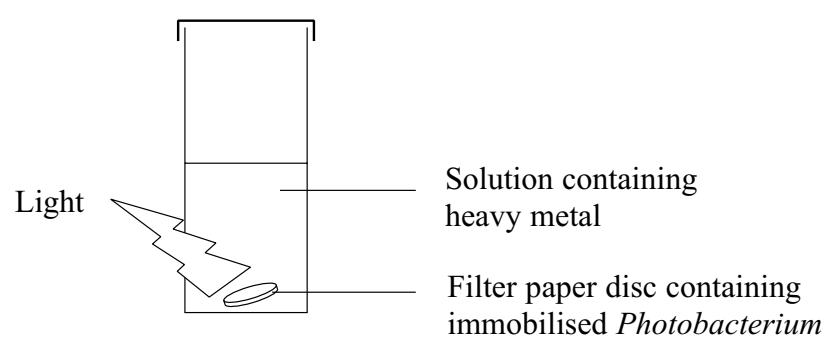
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2. The term bioluminescence means the production of light by living organisms, as a result of their metabolic activity. Substances that adversely affect metabolism will cause a decrease in the production of light, or stop it completely.

One species of luminescent bacterium, *Photobacterium*, has been used to investigate the effect of heavy metals on bioluminescence. This method depends on finding the time taken for a solution containing the metal to completely stop the production of light by these bacteria.

In this investigation, small discs of filter paper were prepared, containing an immobilised culture of *Photobacterium*. The discs were then placed in separate bottles containing solutions of mercury chloride, cadmium chloride and nickel chloride, as shown in the diagram below.



The bottles were then kept in the dark at a constant temperature and examined after 30 minutes and then four more times until five hours after the start. The emission of light from the filter paper discs was observed and recorded. The results are shown in the tables below. In the tables, + indicates light emission; – indicates that no light was emitted.

Mercury chloride

Time / h	Concentration of mercury chloride solution / mg dm ⁻³				
	0.05	0.10	0.50	1.0	10.0
0.5	+	+	+	+	–
1.0	+	+	+	+	–
2.0	+	+	+	–	–
3.0	+	+	–	–	–
5.0	+	–	–	–	–



Cadmium chloride

Time/ h	Concentration of cadmium chloride solution / mg dm ⁻³				
	0.05	0.10	0.50	1.0	10.0
0.5	+	+	+	+	+
1.0	+	+	+	+	+
2.0	+	+	+	+	+
3.0	+	+	+	+	-
5.0	+	+	+	+	-

Nickel chloride

Time/ h	Concentration of nickel chloride solution / mg dm ⁻³				
	0.05	0.10	0.50	1.0	10.0
0.5	+	+	+	+	+
1.0	+	+	+	+	+
2.0	+	+	+	+	+
3.0	+	+	+	+	+
5.0	+	+	+	+	-

(a) Suggest reasons for each of the following.

(i) The bacteria were immobilised in the filter paper discs.

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(ii) The bottles were kept at a constant temperature during the investigation.

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(4)

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(b) Describe the effect of mercury chloride concentration on the emission of light by *Photobacterium*.

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(2)

(c) Which metal was the most toxic to *Photobacterium*? Give an explanation for your answer.

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(2)

(d) Suggest how this method could be used to investigate whether a sample of water from a river had been polluted with heavy metals.

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(3)

(Total 11 marks)

Q2

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Write an essay on ONE of the following topics.

Put a cross in the box below indicating the question you have chosen (☒). If you change your mind, put a line through the box (☒) and then put a cross in the other box (☒).

Chosen question number: Question 3 ☒

Question 4B ☒

Question 5H ☒

For Biology you should choose EITHER Question 3 OR Question 4B.

3. Digestion and absorption of carbohydrates and the regulation of blood glucose. (15 marks)

4B. The uptake, transport and roles of mineral ions in flowering plants. (15 marks)

For Biology (Human) you should choose EITHER Question 3 OR Question 5H.

3. Digestion and absorption of carbohydrates and the regulation of blood glucose. (15 marks)

5H. Humans as primates and the adaptations of humans to life at high altitudes. (15 marks)

Marks will be awarded for scientific content, coverage of the topic, and the quality of written communication. You should include in your answers any relevant information from the whole of your course. You may include diagrams if you wish, but make sure that they are relevant to your essay and add extra information to it.

Write your answer including any plan here.

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(Total 15 marks)

TOTAL FOR PAPER: 38 MARKS

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