Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 30 minutes

Paper reference **WBI12/01**

Biology

International Advanced Subsidiary/Advanced Level
UNIT 2: Cells, Development, Biodiversity and Conservation

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- **Show all your working out** in calculations and **include units** where appropriate.

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 7 1 8 5 7 A 0 1 3 2

Pearson

Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Woese classified organisms into a system with three domains.

(a) How many of the domains contain prokaryotic organisms?

(1)

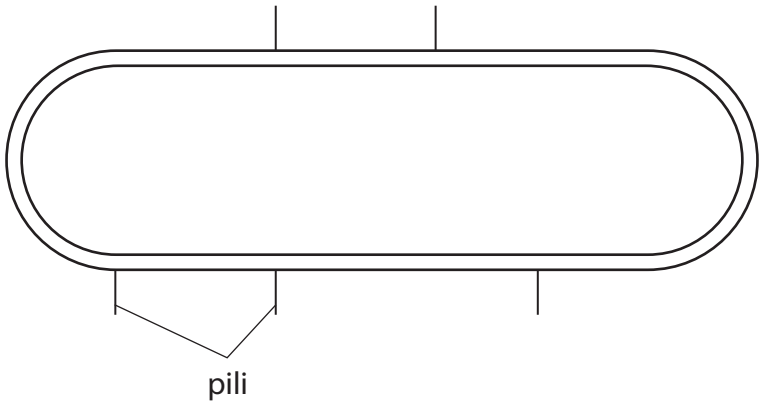
☒ **A** none

☒ **B** one

☒ **C** two

☒ **D** three

(b) The diagram shows part of a prokaryotic cell, as drawn by a student.



(i) Complete the diagram by drawing and labelling a flagellum and a plasmid.

(2)

(ii) State the function of a plasmid.

(1)

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(c) (i) The ribosomes in prokaryotic cells are different from the ribosomes in eukaryotic cells.

Give **one** difference between prokaryotic ribosomes and eukaryotic ribosomes.

(1)

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(ii) How many of the following statements about eukaryotic ribosomes are correct?

- ribosomes are located on the surface of both types of endoplasmic reticulum
- ribosomes are located inside chloroplasts and mitochondria
- ribosomes are involved in the process of transcription

(1)

☒ **A** none

☒ **B** one

☒ **C** two

☒ **D** three

(Total for Question 1 = 6 marks)

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2 The photograph shows water lilies in a river in Thailand.



(Source: © Igor Prahin/Alamy Stock Photo)

(a) One water lily leaf has a diameter of 305 cm.

Which of the following shows the upper surface area of this leaf?

Assume the leaf is circular.

Use the formula πr^2.

(1)

☒ **A** 7.3 m^2

☒ **B** 29.22 m^2

☒ **C** 730.6 cm^2

☒ **D** 2922.5 cm^2

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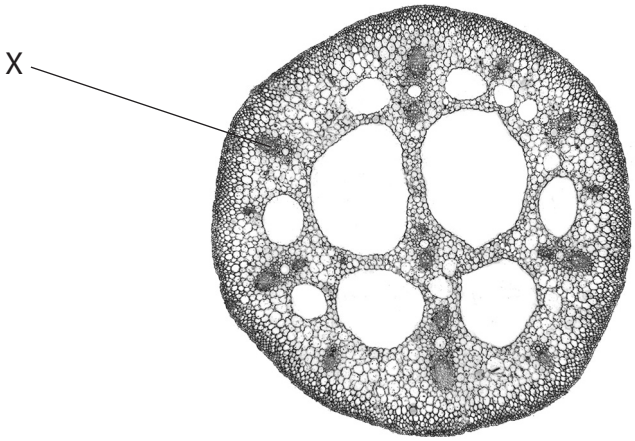
(b) The photograph shows a cross-section of the stem of a water lily.



(Source: © Scenics & Science/Alamy Stock Photo)

The structure labelled X contains xylem vessels and phloem.

How many of the following statements are correct?

- both xylem vessels and phloem transport dissolved substances
- only phloem transport dissolved substances in one direction
- only the walls of xylem vessels contain both cellulose and lignin

(1)

☒ **A** none

☒ **B** one

☒ **C** two

☒ **D** three

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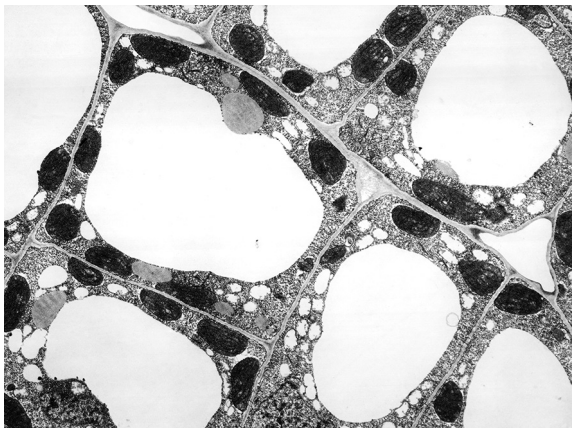
(c) The leaves of the water lilies contain several types of tissues and cells.

The photograph shows a group of leaf mesophyll cells, as seen using an electron microscope.



Magnification × 7 800

(Source: © DR. JEREMY BURGESS/SCIENCE PHOTO LIBRARY)

(i) Label one permanent vacuole on this photograph.

(1)

(ii) Give two functions of a vacuole.

(2)

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(Total for Question 2 = 5 marks)

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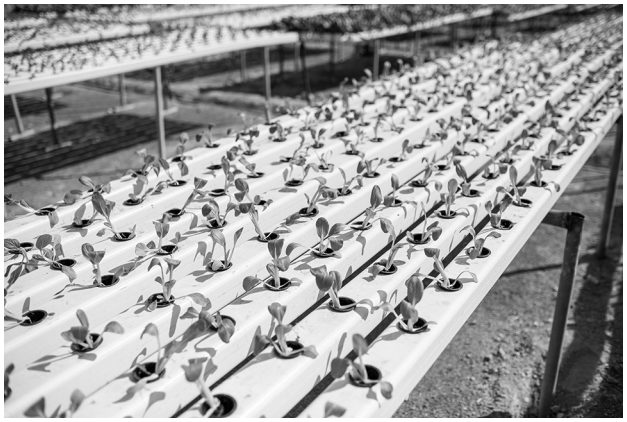
3 The photographs show plants growing in vertical and horizontal systems.

In both of these systems, the plants grow in nutrient solutions instead of in soil.



vertical system

(Source: © Lano Lan/Alamy Stock Photo)



horizontal system

(Source: © RossHelen editorial/Alamy Stock Photo)

(a) (i) The nutrient solutions contain magnesium ions and nitrates.

Describe the roles of these inorganic ions in the plants.

(2)

Magnesium ions .....

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Nitrates .....

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(ii) Suggest **one** advantage of the vertical system over the horizontal system.

(1)

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(b) Fruits contain cells.

The effect of calcium ion concentration on the firmness of fruits was investigated.

Cherry plants were treated once, twice or three times, with two different concentrations of calcium chloride solution. The firmness of the cherry fruits from these plants was then measured.

The table shows the effect on the mean fruit firmness of these treatments and a control.

Number of treatments	Mean fruit firmness / N cm^{-2}	
	Plants treated with a calcium chloride solution of 950 mg dm^{-3}	Plants treated with a calcium chloride solution of 3 800 mg dm^{-3}
0 (control)	4.03	4.03
1	4.08	4.18
2	4.09	4.28
3	4.19	4.61

(i) Which is the percentage increase in mean fruit firmness between the cherries from the control plants and those from plants treated three times with the higher calcium chloride concentration?

(1)

☒ **A** 3.72%

☒ **B** 3.97%

☒ **C** 6.20%

☒ **D** 14.39%

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(ii) Give **one** conclusion for this investigation.

(1)

(iii) Explain the effect of calcium ion concentration on the firmness of cherry fruits.

(3)

(Total for Question 3 = 8 marks)

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4 Boards used for chopping fruit and vegetables can be made from wood or oil-based plastics.

The photograph shows some chopping boards.



(Source: © Dorling Kindersley ltd/Alamy Stock Photo)

(a) (i) Bacteria can grow on the surfaces of chopping boards.

Explain the conditions that would result in the greatest bacterial growth on the surface of a chopping board.

(3)

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(ii) Explain why boards made from oil-based plastics are not considered sustainable.

(2)

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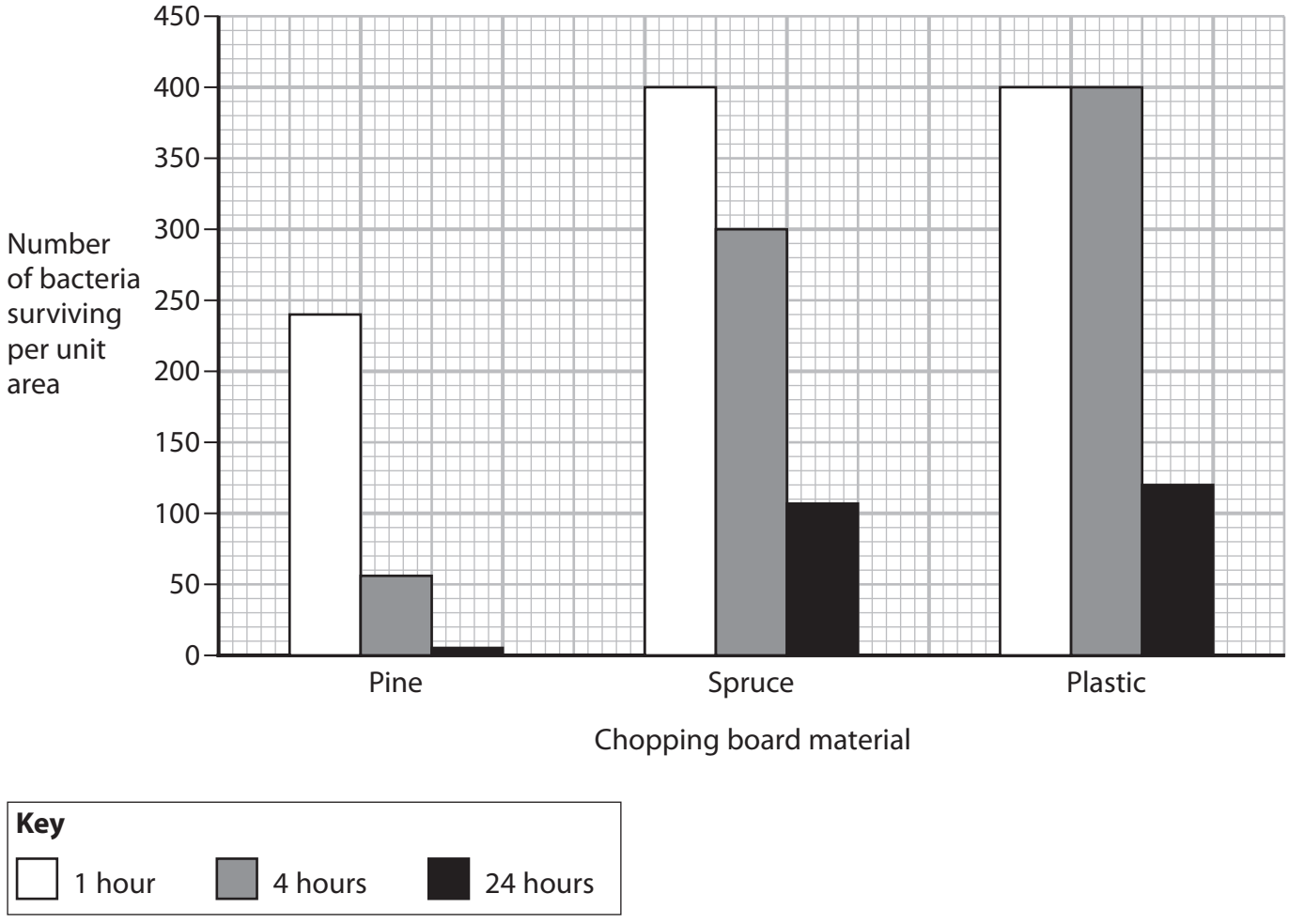
(b) The number of bacteria surviving on boards made from different materials was investigated.

Identical bacterial cultures were placed on boards made of pine wood, spruce wood and plastic. The graph shows the number of bacteria surviving after bacteria were placed on the boards and kept in the same conditions.



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(i) Comment on the results of this investigation.

(3)

(ii) Suggest **one** reason for the difference in bacterial survival on the pine chopping board and on the plastic chopping board.

(1)

(Total for Question 4 = 9 marks)

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5 Some of the characteristics of an organism are due to polygenic inheritance.

(a) Every person has a Rhesus characteristic.

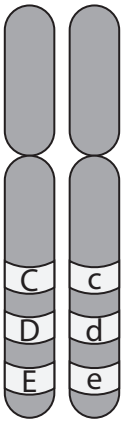
People who are Rhesus positive have one or more of three types of Rhesus antigen C, D or E, on the cell surface membrane of their red blood cells.

Each Rhesus antigen is coded by a dominant allele of gene C or gene D or gene E.

People who are Rhesus negative for one of these genes will have two recessive alleles.

For example, a person who is Rhesus D negative will have inherited two recessive d alleles.

The diagram shows the loci of these three genes on a pair of chromosomes.



(i) State what is meant by the term **allele**.

(1)

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(ii) Which of the following is the genotype of a person who is Rhesus negative for all three genes?

(1)

☒ **A** ccddee

☒ **B** ccddEe

☒ **C** CcDdEe

☒ **D** CCDDEE

(iii) Rhesus antigens are glycoproteins.

Describe how a Rhesus antigen would be produced from its polypeptide chain and transported to the cell surface membrane.

(5)

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(b) Seed colour in wheat is an example of polygenic inheritance. There are three genes thought to affect seed colour (A, B, C). Each gene has a dominant and recessive allele.

A cross between two heterozygous plants (AaBbCc) was carried out.

The seed colour of the offspring was recorded.

The table below shows the phenotype of the wheat seed colour, the number of recessive alleles and the frequency of seed colour in the offspring.

Colour of wheat seed	Number of recessive alleles	Frequency of seed colour
White	6	1
Very light red	5	6
Light red	4	15
Intermediate red	3	20
Red	2	15
Moderate red	1	6
Dark red	0	1

Explain this variation in the colour of wheat seeds.

(3)

(Total for Question 5 = 10 marks)

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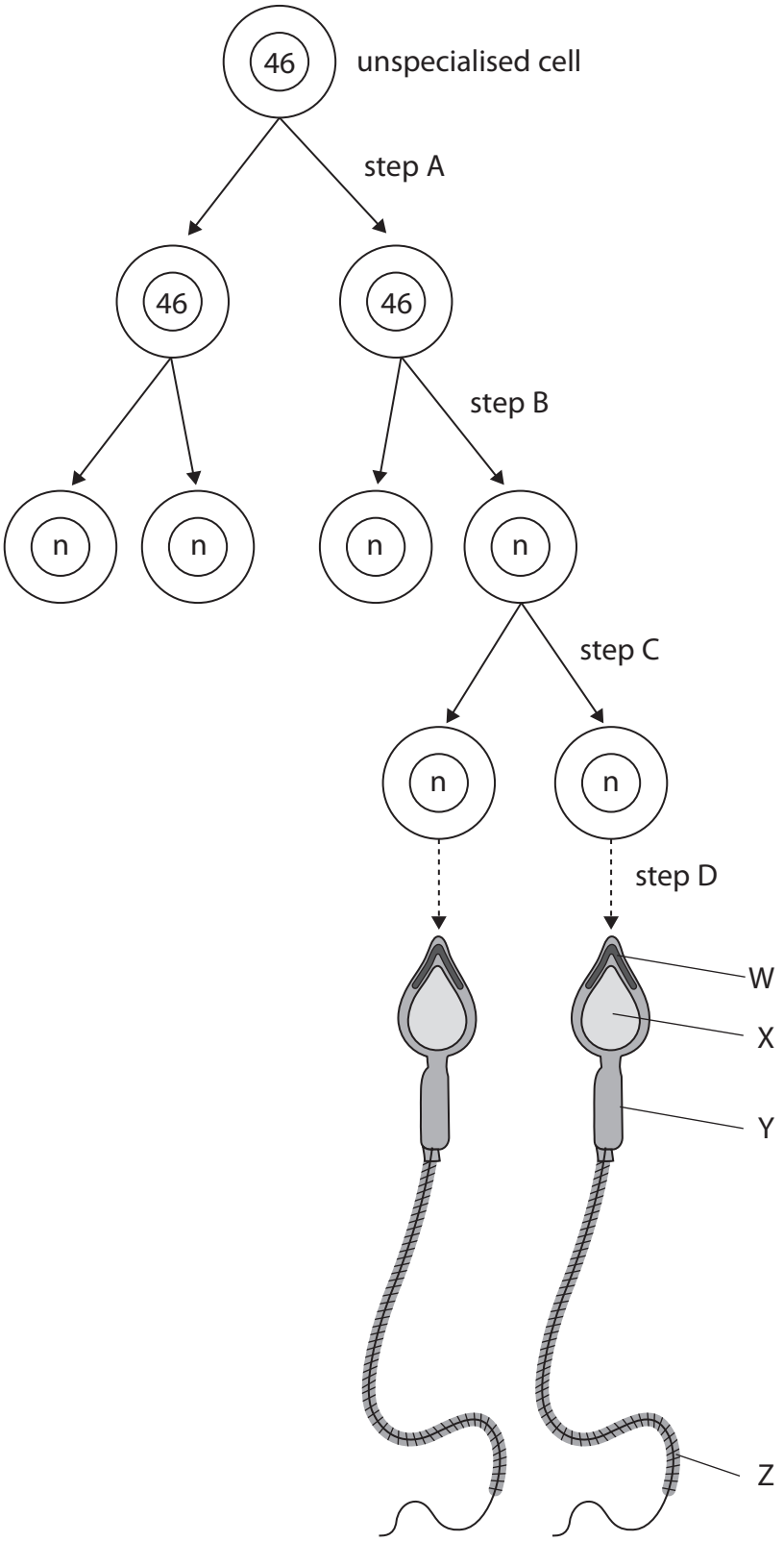
6 The diagram shows some of the steps involved in the production of human sperm cells from an unspecialised cell. This process involves both mitosis and meiosis.



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(a) (i) The unspecialised cell is diploid.

State the types of division occurring at step A and step B.

(2)

step A .....

step B .....

(ii) Which part of the sperm cell contains enzymes that are released to break down the zona pellucida?

(1)

☒ **A** W

☒ **B** X

☒ **C** Y

☒ **D** Z

(b) A sperm cell is a specialised cell.

Explain what happens at step D for the cell to become a specialised sperm cell.

(5)

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(c) The nucleus of a sperm cell fuses with the nucleus of an egg cell to form a zygote. The zygote develops into a blastocyst.

(i) Draw a diagram to show the arrangement of the cells of a blastocyst.

(2)

(ii) The blastocyst contains some pluripotent stem cells.

Which of the following describes these pluripotent stem cells?

(1)

☒ **A** adult stem cells that can give rise to most types of cell in the body, including totipotent cells

☒ **B** adult stem cells that can give rise to most types of cell in the body, excluding totipotent cells

☒ **C** embryonic stem cells that can give rise to most types of cell in the body, including totipotent cells

☒ **D** embryonic stem cells that can give rise to most types of cell in the body, excluding totipotent cells

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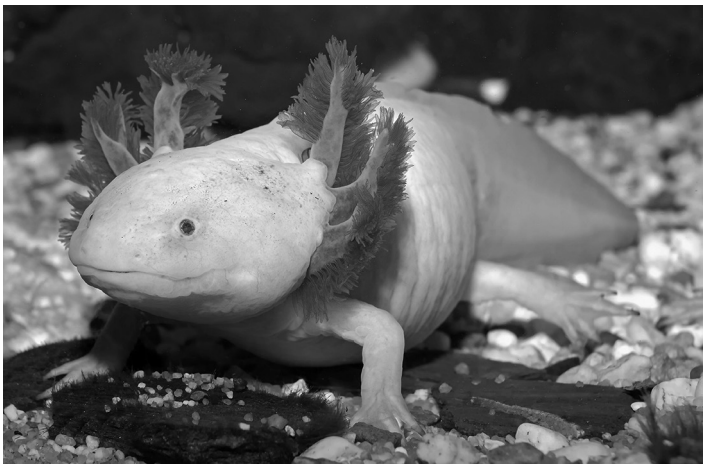
(d) The photograph shows a Mexican salamander.



(Source: © Imagebroker/Alamy Stock Photo)

Salamanders can regenerate damaged limbs and organs throughout their lives.

An ethics committee has approved the use of stem cells taken from salamanders.

Suggest why the use of stem cells taken from salamander embryos was approved.

(2)

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(Total for Question 6 = 13 marks)

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7 Great lakes and crater lakes can be found in Nicaragua, a country in Central America. These two types of lake differ in their species richness.

(a) State what is meant by the term **species richness**.

(1)

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*(b) Lake Nicaragua and Lake Managua are great lakes.

Crater lakes were formed from the craters of volcanoes.

The photographs show a great lake and a crater lake in Nicaragua.



Great lake

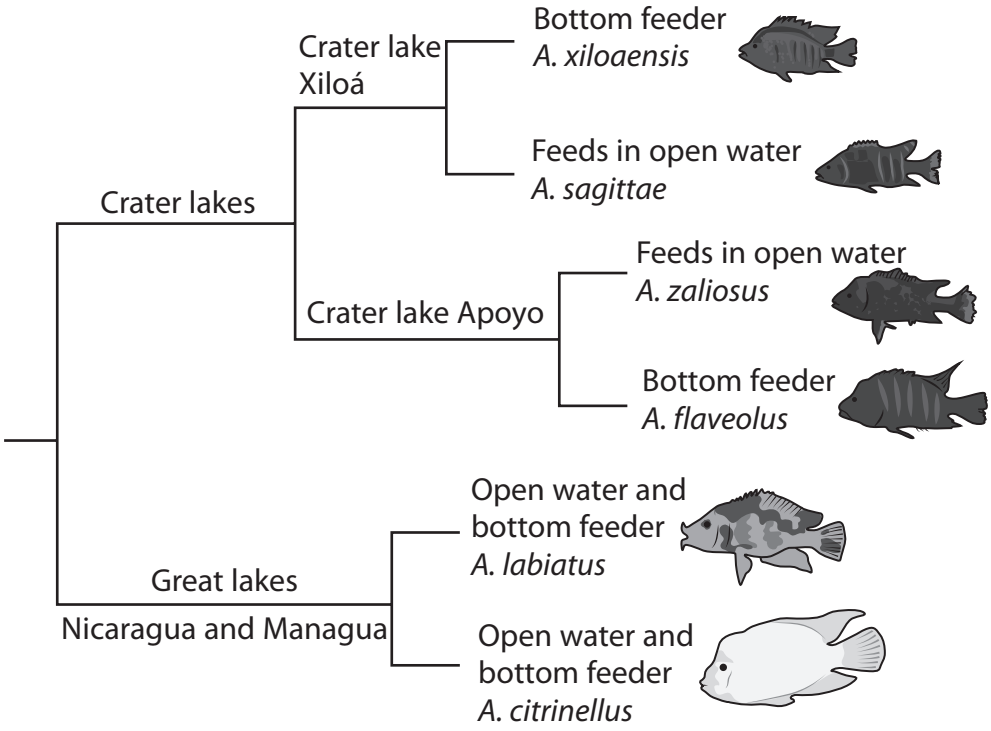
(Source: © mauritius images GmbH/Alamy Stock Photo)



Crater lake

(Source: © John Mitchell/Alamy Stock Photo)

The diagram shows a proposed relationship for some species of cichlid fish and the location of the lakes they inhabit.



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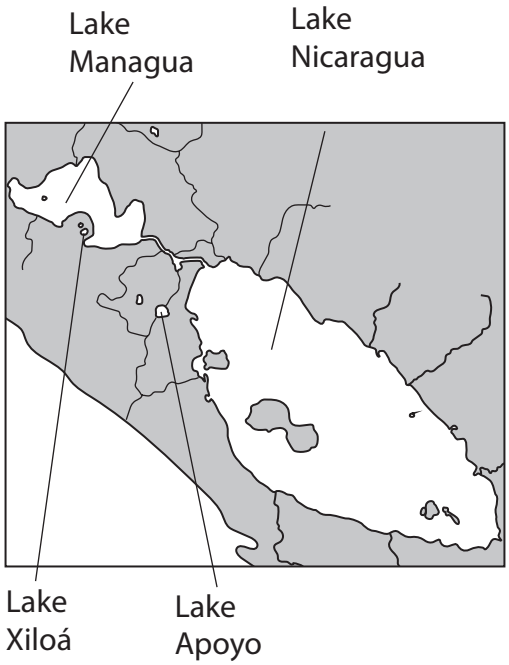

The table shows the estimates of when cichlid fish species first inhabited the crater lakes and when speciation occurred.

Crater lake	First inhabited / number of years ago	First speciation occurred / number of years ago
Apoyo	4700	3700
Xiloá	4300	2700

Describe how new cichlid species may have been formed in these four lakes and how the scientists would have determined that these cichlids were six different species.

Use the information in the question and your own knowledge to support your answer.

(6)

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(c) A study compared the diversity of cichlid species in two crater lakes.

The index of diversity (D) for Lake Xiloá was 2.8.

The table shows the data obtained from Lake Apoyo.

Species	Number of individuals (n)	n(n – 1)
A. astorquii	156	24 180
A. chancho	45	1 980
A. flaveolus	78	6 006
A. globosus	8	56
A. supercilius	17	272
A. zaliosus	12	
	N = 316	$\sum n(n-1) =$

An index of diversity (D) is calculated using the formula:

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

Determine which of the lakes has the higher biodiversity of cichlids.

Use the table and the formula to help you.

(4)

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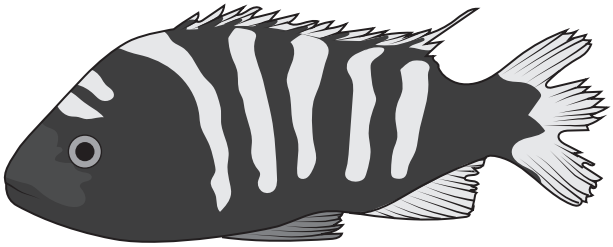
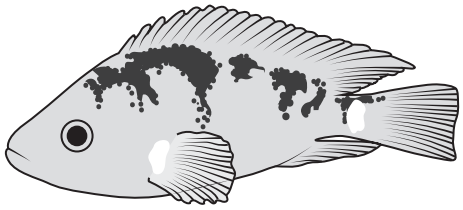
(d) The drawing shows two *A. citrinellus* cichlids.



melanic phenotype –
black with white stripes



gold phenotype –
orange with black mottling

The gold phenotype is caused by inheriting a dominant allele and the melanic phenotype is caused by two recessive alleles at the same locus.

A scientist studied the change in allele frequencies in the *A. citrinellus* population over time.

In the first study, the allele frequencies in the population were $p = 0.6$ and $q = 0.4$.

In a later study, 672 fish of this species were gold and 128 were melanic.

Determine if the allele frequencies have changed, using the equations:

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

$$p + q = 1$$

(3)

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(Total for Question 7 = 14 marks)

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8 Mitosis and the cell cycle are involved in producing new cells.

(a) Describe the role of the cell cycle in producing new cells.

(3)

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(b) Uncontrolled cell division can result in the formation of a tumour.

The RB gene is a tumour suppressor gene.

The RB protein produced from this gene inhibits tumour growth.

Lung cancer can occur when this gene has increased methylation compared with the RB gene in normal lung cells.

Explain why increased methylation of this gene could cause the growth of a tumour.

(4)

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(c) The cell cycle can be affected by various chemicals.

One drug, used to treat various types of cancer, prevents the shortening of spindle fibres.

Explain how preventing the shortening of spindle fibres affects mitosis.

(2)

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*(d) Paclitaxel is a drug used to treat some tumours.

In one study, the effect of paclitaxel on the cell cycle in human lung tumours was investigated.

The table shows the results of this study.

Concentration of paclitaxel / nmol dm^{-3}	Duration of mitosis / hours	Mitotic index of cancerous cells in lung tissue (%)
0	1	2
10	4	17
100	9	38
1 000	21	48
10 000	24	59

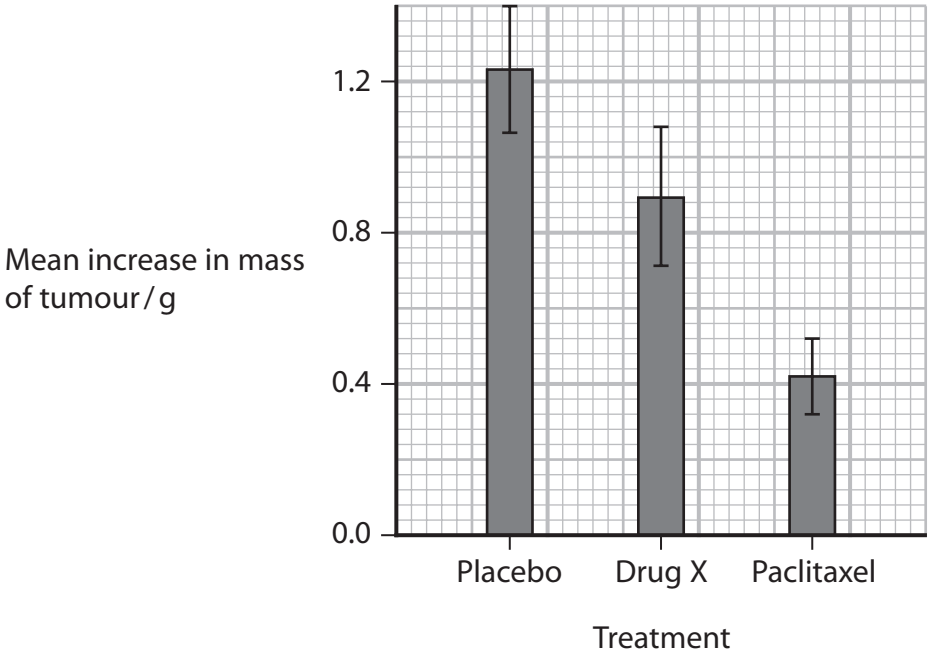
In another study, the effect of paclitaxel on the growth of breast tumours in mice was investigated. The effect of paclitaxel was compared with drug X and with a placebo.

For each group the increase in mass of the tumour was measured 21 days after starting treatment.

Three groups of mice with breast tumours were given the following treatments:

- Group 1 received a placebo
- Group 2 received drug X
- Group 3 received paclitaxel.

The graph shows the results from this study.



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Evaluate the effectiveness of paclitaxel.

Use the information given to support your answer.

(6)

(Total for Question 8 = 15 marks)

TOTAL FOR PAPER = 80 MARKS

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