Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Thursday 25 May 2023

Morning (Time: 1 hour 30 minutes)

Paper reference **8BN0/02**

Biology A (Salters Nuffield)

Advanced Subsidiary

PAPER 2: Development, Plants and the Environment

You must have:
Calculator, HB pencil, ruler

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.
- **Show all your working out** in calculations and **include units** where appropriate.
- Answer the questions in the spaces provided – *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- You may use a scientific calculator.
- 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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Answer ALL questions. Write your answers in the spaces provided.

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 Plant cells and animal cells have similarities and differences.

(a) Which of the following groups of organelles are found in both animal and plant cells?

(1)

☐ **A** amyloplasts, chloroplasts and Golgi apparatus

☐ **B** amyloplasts, Golgi apparatus and rough endoplasmic reticulum

☐ **C** cell wall, Golgi apparatus and mitochondria

☐ **D** Golgi apparatus, mitochondria and rough endoplasmic reticulum

(b) Plant and animal cells both undergo the process of mitosis.

Which of the following happens during the process of mitosis?

(1)

☐ **A** the cell divides

☐ **B** the cell membrane breaks down

☐ **C** the nucleus divides

☐ **D** the organelles multiply

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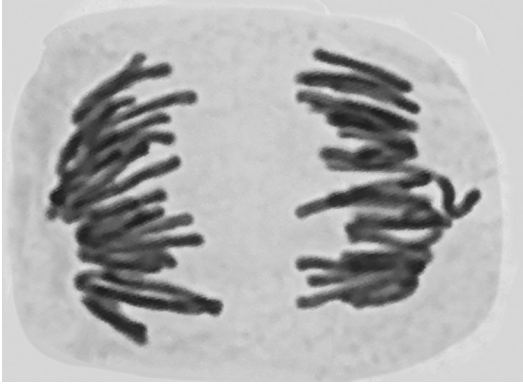
(c) Mitotic division in the common sunflower, *Helianthus annuus*, was investigated.

Several samples of 1 000 root tip cells were examined and the stage of the cell cycle recorded for each cell.

The photograph shows a single root tip cell.



© STEVE GSCHMEISSNER/SCIENCE PHOTO LIBRARY

(i) Which stage of mitosis is shown in this cell?

(1)

☒ **A** anaphase

☒ **B** metaphase

☒ **C** prophase

☒ **D** telophase

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(ii) The results of five root tip samples are shown in the table.

Sample	Number of cells in each stage of the cell cycle				
	Interphase	Prophase	Metaphase	Anaphase	Telophase
1	888	100	7	3	2
2	872	114	10	2	2
3	879	102	15	2	2
4	879	72	25	22	2
5	848	132	10	10	0
Mean	873	104	13	8	2

Which is the approximate ratio of the number of cells not in mitosis to the number of cells in mitosis?

(1)

☒ **A** 9 : 1

☒ **B** 9 : 2

☒ **C** 7 : 1

☒ **D** 7 : 2

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(iii) Describe what happens in the cell during the telophase stage of mitosis.

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(Total for Question 1 = 8 marks)

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2 The photograph shows a pea plant, *Pisum sativum*, growing in a pot.

These plants are usually grown in fields.

The pea plant contains bacteria called *Rhizobia* inside their roots. These bacteria produce nitrate ions using nitrogen gas from the air.

© Pefkos/Shutterstock

(a) Describe the importance of nitrate ions to plants.

(3)

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(b) Pea plants also require magnesium ions.

(i) Which of the following molecules found in plants contains magnesium ions?

(1)

☒ **A** amylose

☒ **B** calcium pectate

☒ **C** cellulose

☒ **D** chlorophyll

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(ii) Devise a laboratory experiment to measure the effect of magnesium ion concentration on the growth of pea plants.

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3 Natural selection involves changes to allele frequencies within a population.

The Hardy–Weinberg equation can be used to determine changes in allele frequencies over time.

The equation can be written as $p^2 + 2pq + q^2 = 1$

(a) (i) Which part of the equation shows the proportion of heterozygotes in a population?

(1)

☒ **A** p^2

☒ **B** $2pq$

☒ **C** q^2

☒ **D** 1

(ii) Which is the value for q^2 if $p^2 = 0.49$?

(1)

☒ **A** 0.09

☒ **B** 0.30

☒ **C** 0.51

☒ **D** 0.70

(b) The photograph shows a blonde hedgehog.

© ECOSTOCK/Shutterstock

The light-coloured spines are a result of a recessive allele. Blonde hedgehogs are homozygous for this allele.

In the 1960s, a small group of blonde hedgehogs was released on the island of Alderney.

There are now 500 hedgehogs on the island of Alderney.

It has been found that 60% of this population are blonde hedgehogs.

(i) Use the Hardy–Weinberg equation to calculate the number of hedgehogs in this population that are heterozygous for the blonde allele.

$$p^2 + 2pq + q^2 = 1.0$$

(3)

Answer .....

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(ii) Before the 1960s, all of the hedgehogs on this island were dark coloured.

It has been suggested that the blonde hedgehogs are less likely to be killed by cars at night.

Explain the role of natural selection in the increase in the number of blonde hedgehogs on the island of Alderney.

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4 Some phenotypes are affected by polygenic inheritance.

Polygenic inheritance involves genes at many loci.

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

(1)

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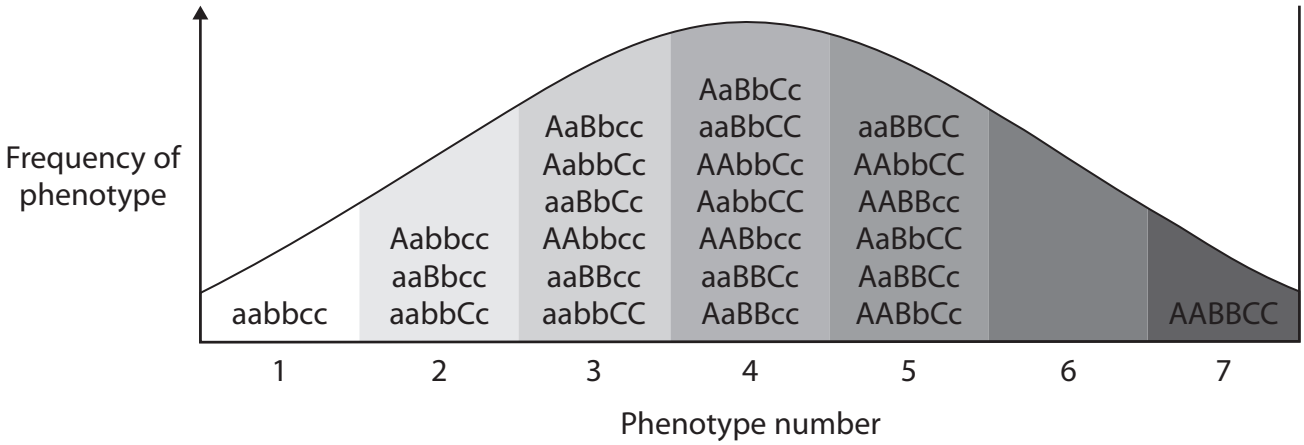
(b) In polygenic inheritance, alleles of the genes involved can have a cumulative effect.

An example of a polygenic trait is grain colour in wheat. In some varieties of wheat, the grain colour is controlled by three gene loci: A, B and C.

The presence of at least one dominant allele results in the production of a pigment.

The diagram shows the frequency of different phenotypes from grain with no pigment (phenotype 1) to very dark grain (phenotype 7).



(i) Deduce which **three** genotypes would give phenotype 6.

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(ii) Explain why the frequency of phenotype 7 is different from the frequency of phenotype 3.

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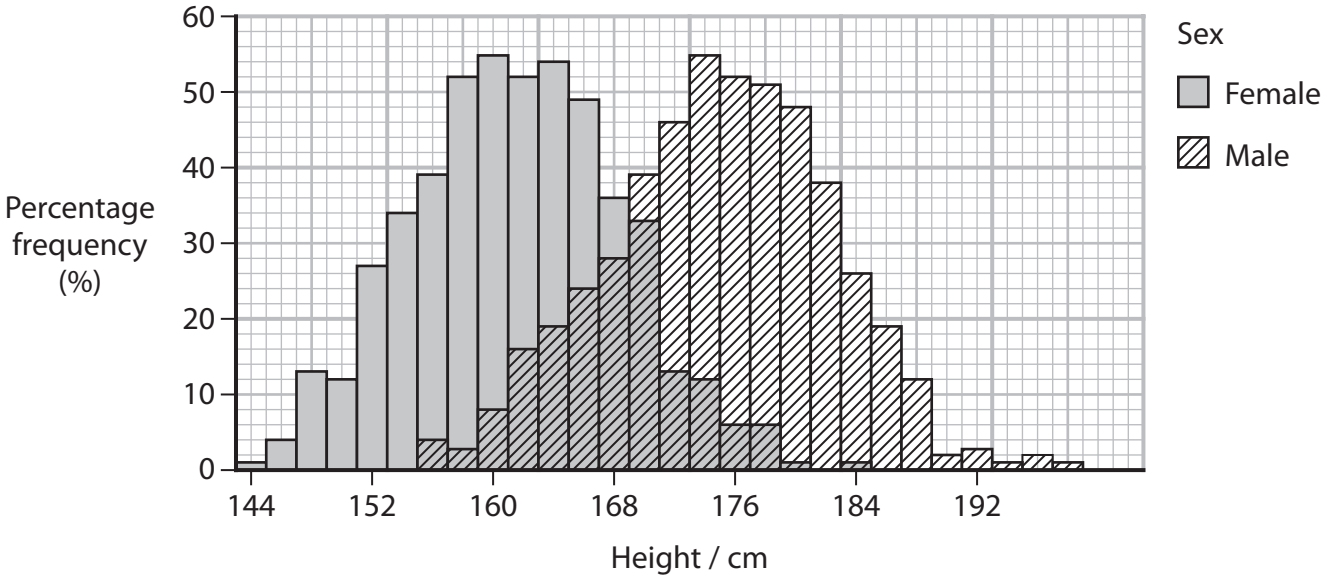
(c) Human height is another phenotype affected by polygenic inheritance.

The graph shows the frequency of height for two groups of adults.



(i) State the **mode** for height in males.

(1)

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(ii) The data show that there are more adults at the lower end of the range for height than at the higher end of the range for both females and males.

Explain how the interaction between environment and genotype can account for this difference.

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(Total for Question 4 = 8 marks)

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5 Smoking is an environmental factor that can cause lung cancer.

Smoking can cause epigenetic changes to the AHRR gene.

People who smoke cigarettes have less DNA methylation of this gene than non-smokers.

(a) Explain how DNA methylation can modify the activation of a gene.

(3)

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(b) The AHRR gene is involved in regulation of cell growth and differentiation.

(i) Explain how differential gene expression allows cells to become specialised.

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(ii) Deduce the reasons why reduced DNA methylation of the AHRR gene can increase the risk of lung cancer.

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6 Plants have been used as sources of medicine for thousands of years.

(a) The antimicrobial properties of a range of plant extracts were studied.

Extracts were produced by grinding plant material in water or ethanol.

The effectiveness of these extracts was tested against the bacteria *Staphylococcus aureus* grown in agar jelly in Petri dishes.

The table shows the results of this investigation.

Plant extract	**Diameter of zone of inhibition / mm**	
	Extract made with water	**Extract made with ethanol**
Cardamom	8.0	12.0
Cinnamon	6.0	10.0
Cloves	6.0	14.0
Cumin	6.0	11.5
Lemongrass	8.0	12.5

(i) The area of the zone of inhibition for lemongrass extract made with water was 50.3 mm^2.

Calculate the difference in the areas of the zones of inhibition for the lemongrass extract made with water and the lemongrass extract made with ethanol.

Give your answer to one decimal place.

(2)

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(ii) Describe how valid results could have been obtained for this investigation.

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(b) Some natural antimicrobial medicines can be harmful to patients.

Any new drugs have to be tested before they can be given to patients.

These drugs are tested using a set of protocols.

(i) Explain the pre-clinical trials that will be carried out when testing a new drug.

(2)

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(ii) A double-blind trial was used to determine the effectiveness of an antimicrobial drug.

Explain what is meant by the term **double-blind trial**.

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(iii) The table shows the percentage of trials that progress to the next stage.

Percentage of trials that progress from one stage to the next (%)		
Stage I to Stage II	**Stage II to Stage III**	**Stage III to Approval**
70.1	58.3	75.3

Deduce the reasons for the higher percentage of trials progressing from Stage I to Stage II than the percentage progressing from Stage II to Stage III.

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7 The photograph shows a greater flamingo. This is a species of bird that lives in coastal areas where the water has a high concentration of salt.

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(a) Flamingos have bright pink feathers.

The colour of their feathers is affected by biotic factors in their environment. These factors include their diet and microorganisms in the water.

(i) The pink colour is partly caused by the presence of prokaryotic microorganisms living in the feathers. These organisms contain a red pigment.

Name **two** structures inside the cells of these microorganisms that are found in prokaryotic cells and **not** in eukaryotic cells.

(2)

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(ii) Scientists tested the RNA of these microorganisms and discovered that they belonged to the domain Archaea.

Explain how molecular phylogeny could be used to identify the microorganisms as Archaea and **not** Bacteria.

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(b) Warm coastal waters in the United Arab Emirates provide a natural habitat for greater flamingos. The greater flamingos occupy a niche within this habitat.

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

(1)

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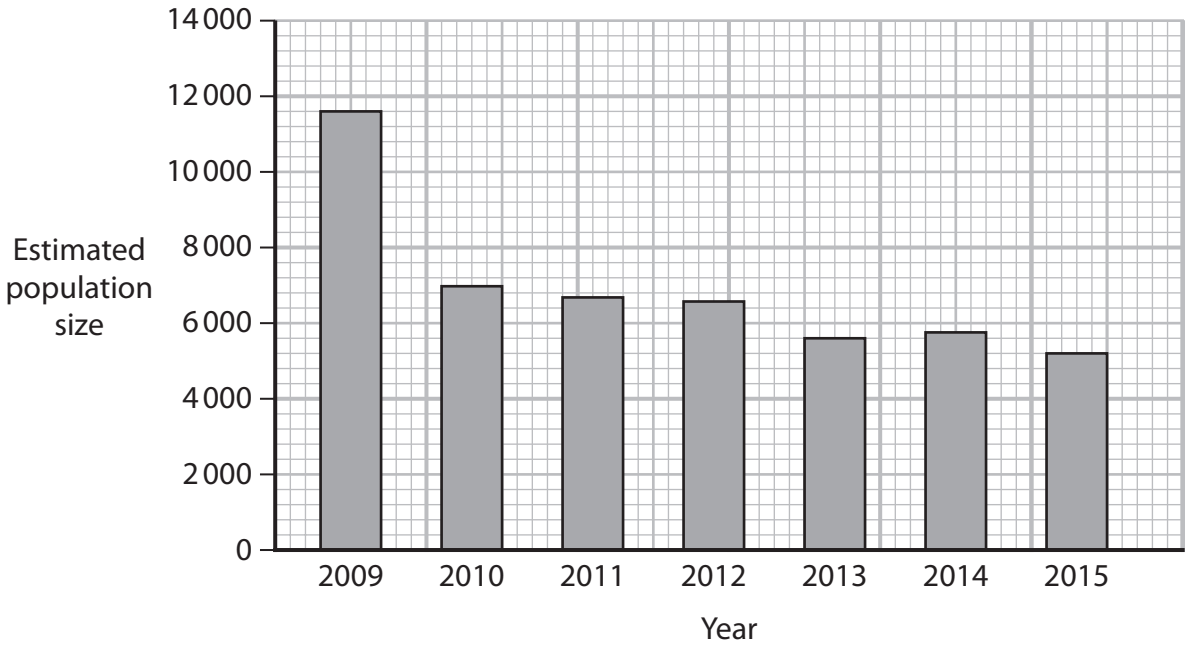
(ii) Some of this habitat has been lost as the human population has grown and land has been developed.

The graph shows the estimated population size of the flamingos from 2009 to 2015 in one study.



Calculate the percentage decrease in the estimated size of the flamingo population from 2009 to 2015.

Give your answer to **three** significant figures.

(3)

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(iii) Captive breeding programmes can be used to increase the number of flamingos.

Flamingos kept in zoos are given food containing carotene pigments to make their feathers stay pink.

Discuss the factors that need to be taken into account when zoos carry out captive breeding and reintroduction programmes for the greater flamingo.

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8 Stem cells can be used to treat a number of medical conditions.

Stem cells can be totipotent or pluripotent.

Stem cells used to treat medical conditions are usually taken from the tissues of adults (the donors).

(a) The cells in the early stages of embryo development are totipotent.

(i) Describe the properties of totipotent stem cells.

(2)

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(ii) Following the fertilisation of an egg cell, the zygote divides to become an embryo.

The embryo develops into a fetus.

Compare and contrast the structure of an unfertilised egg cell with that of a zygote.

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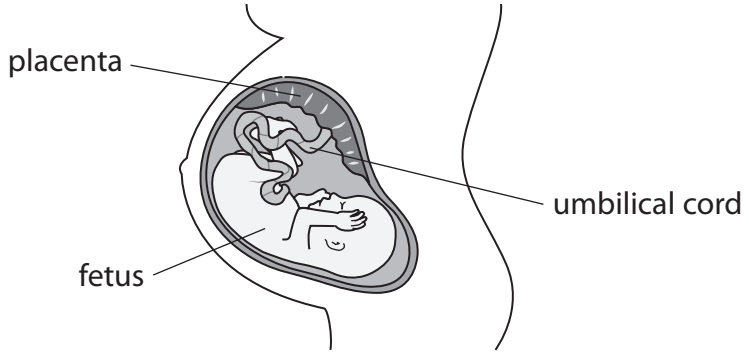
(b) Stem cells are also found in the umbilical cord.

The diagram shows how the umbilical cord connects the developing fetus to the placenta.



(i) Cells in the umbilical cord are genetically identical to the cells of the fetus.

Which of the following explains why the cells in the umbilical cord are genetically different from the cells of the mother?

(1)

☒ **A** the cells in the umbilical cord are produced by meiosis

☒ **B** the fetus contains genes from both parents

☒ **C** the fetus contains pluripotent stem cells

☒ **D** the umbilical cord is produced by the mother

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*(ii) In 2019, stem cell transplants were given to 1714 people in the UK.

Stem cell transplants require a matching donor to provide the stem cells.

Stem cells from umbilical cord tissue can give rise to every type of cell in the blood.

Stem cells from donated bone marrow can also give rise to all types of blood cell.

Parents may be given the option to store umbilical cord tissue as a bank of stem cells for future use.

Stem cells are used to treat children with blood disorders. These could be blood cancers, such as leukaemia, or genetic diseases.

Discuss the issues concerning the use of stem cells from the following sources:

- embryos
- bone marrow from donors
- stored umbilical cord tissue.

(6)

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