Name: _____

Class: _____

Date: _____

Inheritance, Variation and Evolution part 9 AQA Triple Biology

Time: **90 minutes**

Marks: **84 marks**

Comments:

1. The Galapagos Islands are located in the Pacific Ocean.

Several species of birds called finches live on the Galapagos Islands.

These finches are very similar to each other.

Figure 1 shows two modern species of Galapagos finch and their classification.

Figure 1

Medium ground finch

Small ground finch

Classification group	**Medium ground finch**	**Small ground finch**
Kingdom	*Animalia*	*Animalia*
	Chordata	*Chordata*
Class	*Aves*	*Aves*
	Passeriformes	*Passeriformes*
	Thraupidae	*Thraupidae*
Genus	*Geospiza*	*Geospiza*
	fortis	*fuliginosa*

(a) Complete **Figure 1** to give the names of the missing classification groups.

(2)

(b) Give the binomial name of the medium ground finch.

Use information from **Figure 1**.

_____

(1)

In each species of finch, there is a variation in beak depth.

Figure 2 shows how beak depth is measured.

Figure 2

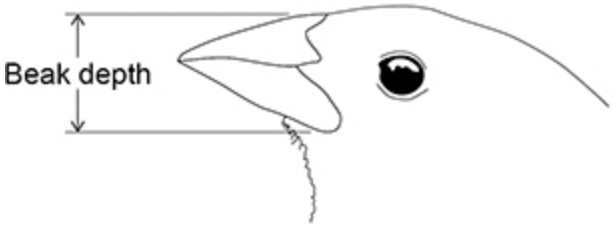
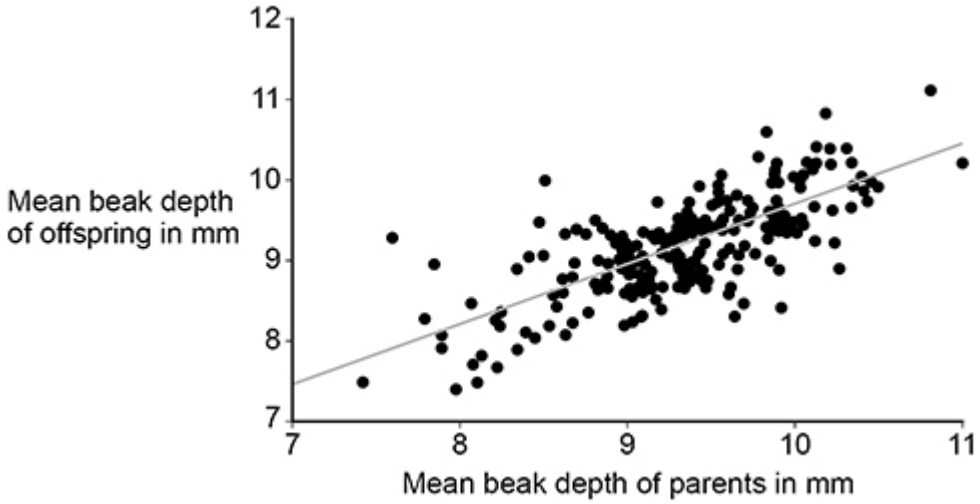


Figure 3 shows the relationship between the beak depth of parent birds and the beak depth of their offspring.

Figure 3



(c) Give evidence from **Figure 3** that beak depth is an inherited characteristic.

_____

_____

(1)

(d) Scientists suggested that more than one gene controls beak depth.

Give evidence from **Figure 3** to support the scientists' suggestion.

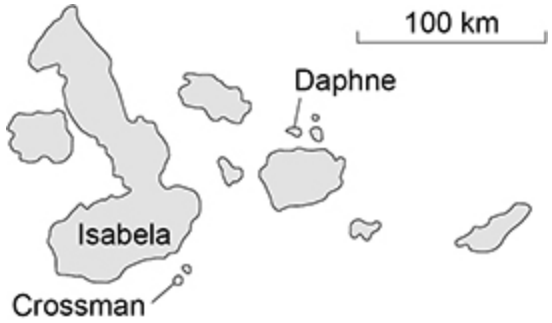
_____

_____

(1)

Figure 4 is a map of the Galapagos Islands.

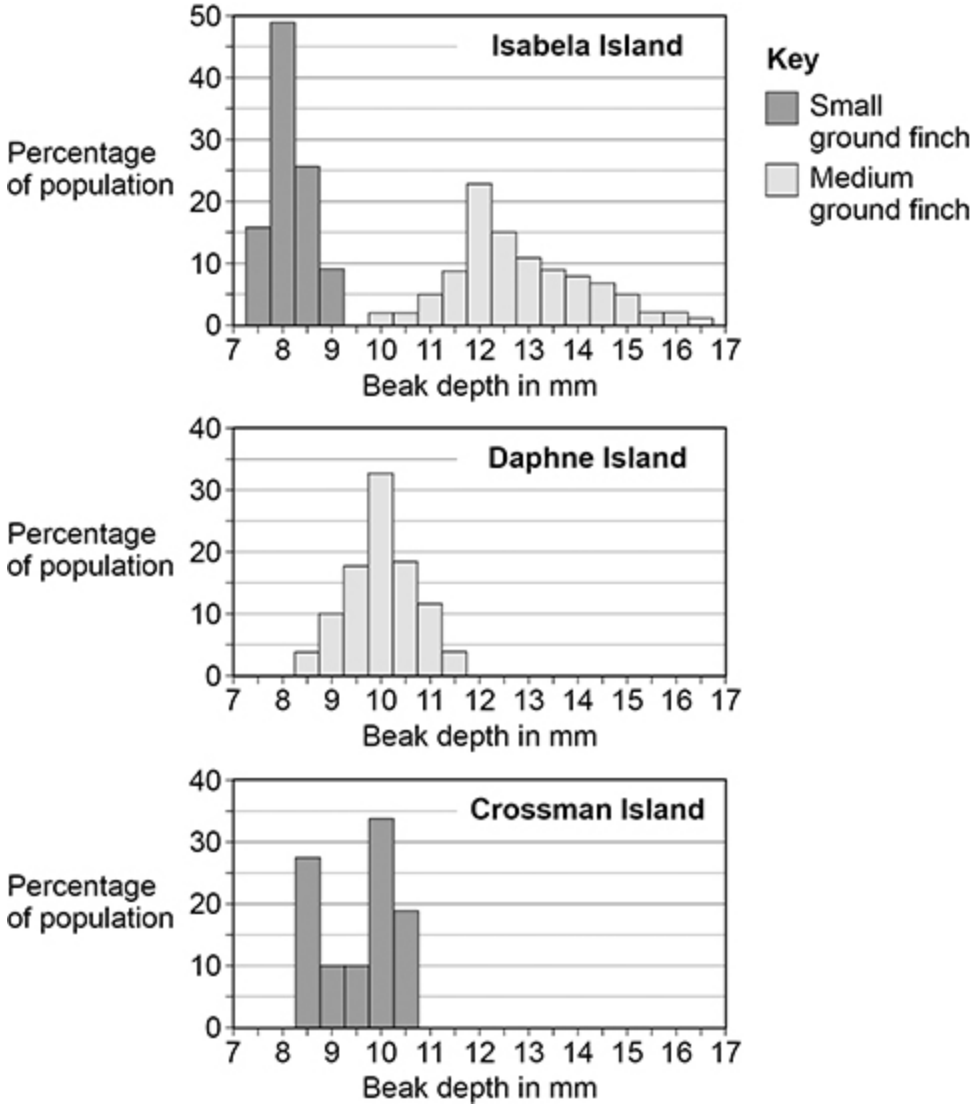
Figure 4



On Isabela Island, the medium ground finch **and** the small ground finch are found.
On Daphne Island, only the medium ground finch is found.
On Crossman Island, only the small ground finch is found.

Figure 5 shows how the beak depth of each species varies on each island.

Figure 5



The medium ground finch and the small ground finch both feed on seeds.

The size of seeds eaten by each bird depends on the depth of the bird's beak.

(e) The range of beak depth of **medium ground finches** on Isabela Island is different from the range on Daphne Island.

Explain what might have caused this difference.

(6)

(f) **Figure 5** shows:

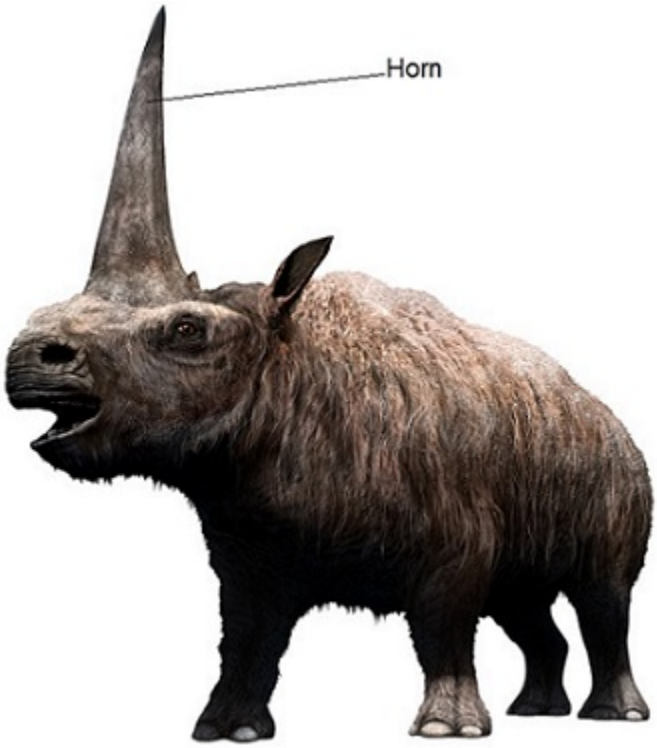
- the **two** species of finch live on Isabela Island
- only **one** of the species lives on Daphne Island
- only **one** of the species lives on Crossman Island.

Suggest why both species of finch are able to live on Isabela Island.

(2)

(Total 13 marks)

2. The image below shows what the extinct Siberian rhinoceros (*Elasmotherium sibiricum*) might have looked like.



(a) What is the genus of the Siberian rhinoceros?

Tick (✓) **one** box.

Elasmotherium ☐

Elasmotherium sibiricum ☐

sibiricum ☐

(1)

The 'three-domain system' of classification places all living organisms in one of three domains.

(b) Which domain was the Siberian rhinoceros in?

Tick (✓) **one** box.

Archaea ☐

Eukaryota ☐

Prokaryota ☐

(1)

(c) Who developed the 'three-domain system' of classification?

Tick (✓) **one** box.

Carl Woese ☐

Charles Darwin ☐

Gregor Mendel ☐

(1)

(d) The horn of the Siberian rhinoceros is estimated to have been 150 cm long.

Suggest **one** advantage of this adaptation to the Siberian rhinoceros.

_____

_____

(1)

(e) The only parts of the Siberian rhinoceros that have been found are fossilised bones.

Give **one** reason why **only** the bones of the body of the Siberian rhinoceros became fossils.

_____

_____

(1)

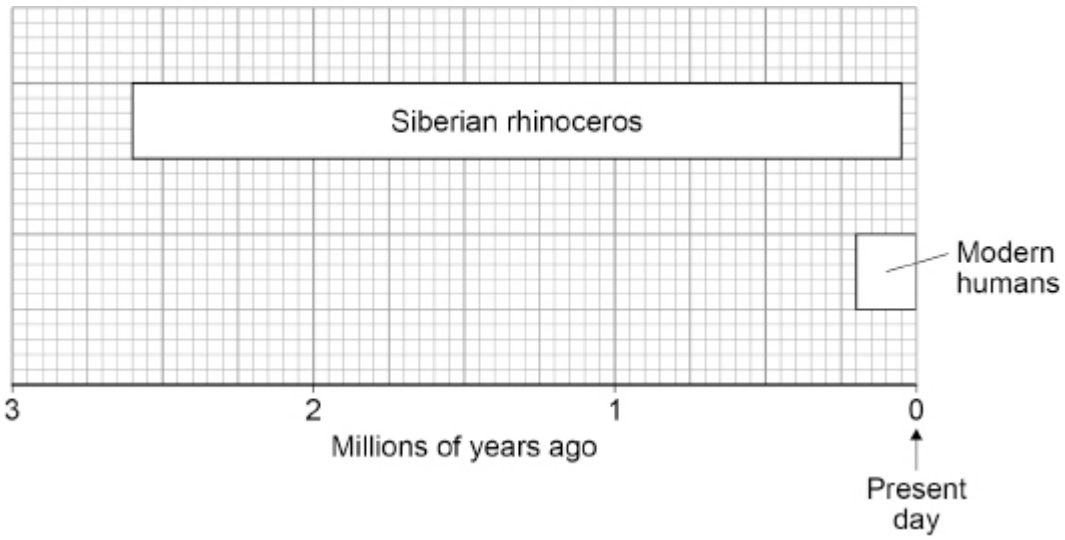
(f) Suggest how scientists can estimate when the Siberian rhinoceros was alive.

_____

_____

(1)

The below diagram shows when the Siberian rhinoceros existed and when modern humans existed.



(g) How many million years ago did the Siberian rhinoceros become extinct?

_____ million years ago

(1)

(h) Determine the time in years when both the Siberian rhinoceros and modern humans existed together.

Use the diagram above and your answer to Question (g).

_____

_____

_____

_____

Time = _____ years

(3)

(i) Suggest **two** factors that may have caused the extinction of the Siberian rhinoceros.

1 _____

_____

2 _____

_____

(2)

(Total 12 marks)

3. Sperm cells and egg cells are formed by meiosis.

(a) During meiosis a cell divides twice.

How many sperm cells are formed when a cell divides by meiosis?

_____

(1)

(b) Human body cells contain 46 chromosomes.

How many chromosomes are in each human egg cell?

_____

(1)

Dupuytren's is a disorder that affects the hands.

One form of Dupuytren's is caused by a dominant allele (**D**).

The allele for **not** having Dupuytren's is recessive (**d**).

(c) What is an allele?

Tick (✓) **one** box.

A different form of a chromosome ☐

A different form of a gamete ☐

A different form of a gene ☐

(1)

(d) A man with Dupuytren's has the genotype **Dd**.

Which word describes the man's genotype?

Tick (✓) **one** box.

Heterozygous ☐

Homozygous ☐

Phenotype ☐

(1)

The man with Dupuytren's (**Dd**) and a woman who does **not** have Dupuytren's (**dd**) plan to have a child.

(e) Complete the genetic diagram in the figure below to show the possible genotypes of the child.

		Woman	
		d	**d**
Man	**D**	Dd	
	d		

(2)

(f) Draw a ring around the genotype of a child in the figure above who will have Dupuytren's.

(1)

(g) What is the chance of the child having Dupuytren's?

Tick (✓) **one** box.

25% ☐

50% ☐

75% ☐

100% ☐

(1)

(h) A genetic disorder develops as a result of a change in a gene.

What scientific term describes a change in a gene?

_____

(1)

(i) People with a family history of some genetic disorders are offered embryo screening.

Suggest **one** way embryo screening can help people with a family history of a genetic disorder.

_____

_____

(1)

(Total 10 marks)

4. This question is about DNA.

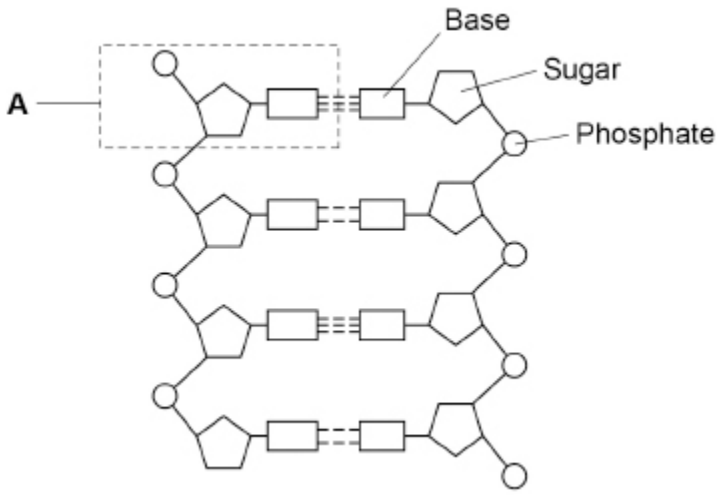
(a) Describe the shape of a DNA molecule.

_____

_____

(2)

The below diagram shows part of a DNA molecule.



(b) DNA codes for a sequence of amino acids.

Which part of DNA forms the code for a particular amino acid?

Tick (✓) **one** box.

Bases ☐

Phosphates ☐

Sugars ☐

(1)

(c) Which substance is produced when amino acids are joined together?

Tick (✓) **one** box.

Carbohydrate ☐

Fat ☐

Protein ☐

(1)

(d) DNA is made of repeating units. One of the units is labelled **A** in the diagram above.

What is the name of the repeating unit labelled **A**?

Tick (✓) **one** box.

Chromosome ☐

Enzyme ☐

Nucleotide ☐

(1)

(e) The DNA in one human body cell is the length of 6 000 million repeating units (part **A**).

Each repeating unit is 0.34 nanometres (nm) long.

Calculate the length of the DNA in the cell in millions of nanometres.

_____

_____

_____

Length = _____ million nm

(2)

(f) Give your answer to question (e) in metres.

1 metre = 1×10^9 nanometres

_____

_____

Length = m

(1)

(g) DNA analysis can show people which alleles they have.

Patients who have certain types of cancer can be offered DNA analysis.

The family of the patient can also be offered DNA analysis.

Suggest **one** advantage of having DNA analysis.

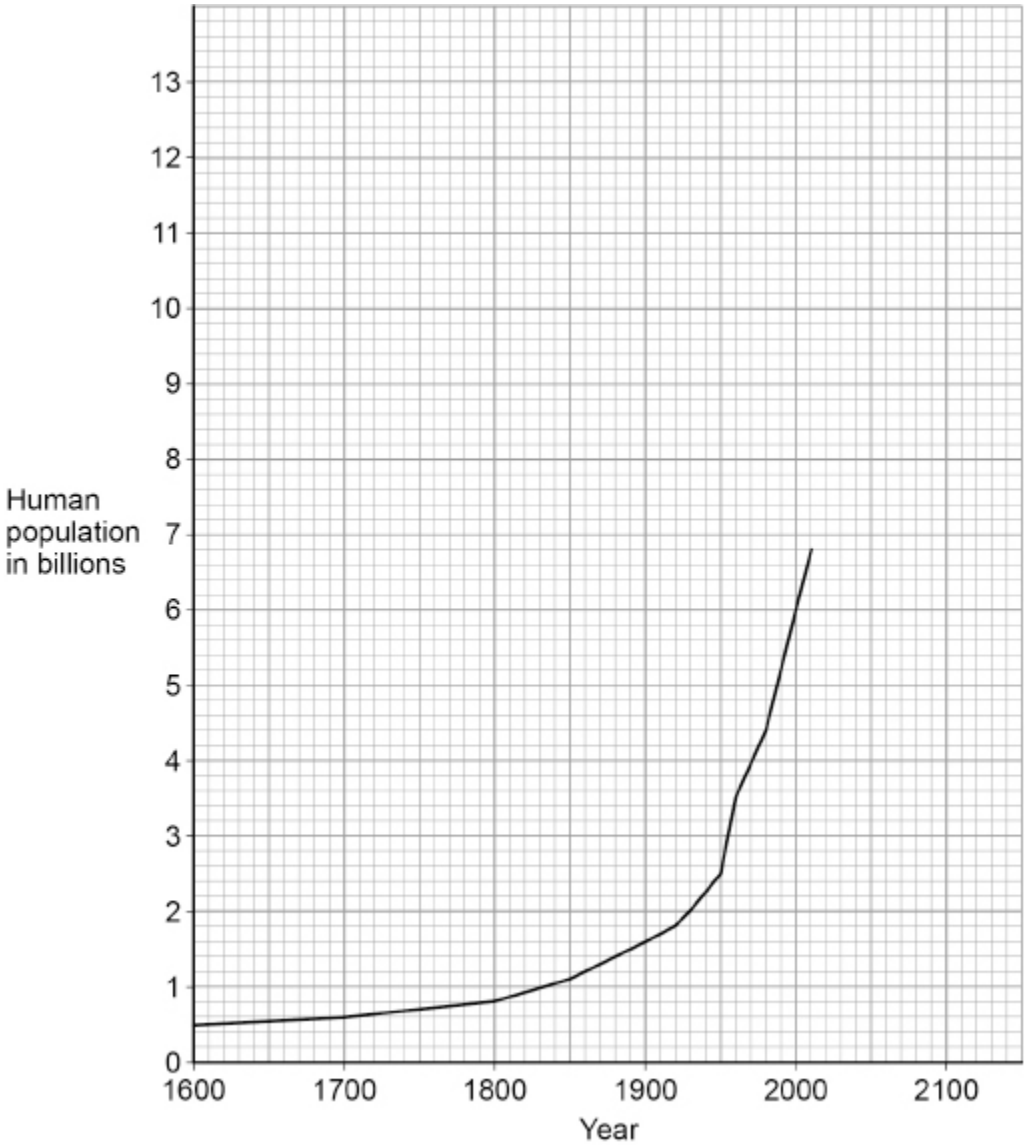
_____

_____

(1)

(Total 9 marks)

5. The graph below shows the human population from 1600 to 2010.



In 1900 the human population was 1.6 billion.

(a) Calculate how many times greater the human population was in the year 2000 compared with the year 1900.

_____

_____

_____

Number of times greater = _____

(2)

(b) In 1950 the human population was 2.5 billion.

Calculate the mean annual increase in the human population between 1900 and 1950.

_____

_____

_____

Mean annual increase = _____ billion per year

(2)

(c) Predict the human population in 2050 if the current rate of population increase continues.

You should draw an extrapolation line on the graph above.

_____

_____

_____

Predicted human population = _____

(2)

(d) The increasing human population has caused a decline in fish stocks.

Describe how fishing quotas can help to return fish stocks to a sustainable level.

_____

_____

_____

_____

(2)

(e) Farming techniques have changed in recent years.

Describe:

- why more land is being used for farming
- how increased farming has decreased biodiversity.

(6)

(f) Genetic modification of crop plants can help meet the demands of the increasing human population.

Golden rice is a genetically modified (GM) crop.

What is the advantage of golden rice compared with non-GM rice?

Tick (✓) **one** box.

Golden rice contains protein-rich mycoprotein ☐

Golden rice has improved nutritional value ☐

Golden rice produces human insulin ☐

(1)

(g) Suggest **one** reason why some people are concerned about the use of golden rice.

_____

_____

(1)

(Total 16 marks)

6. DNA is a polymer of nucleotides.

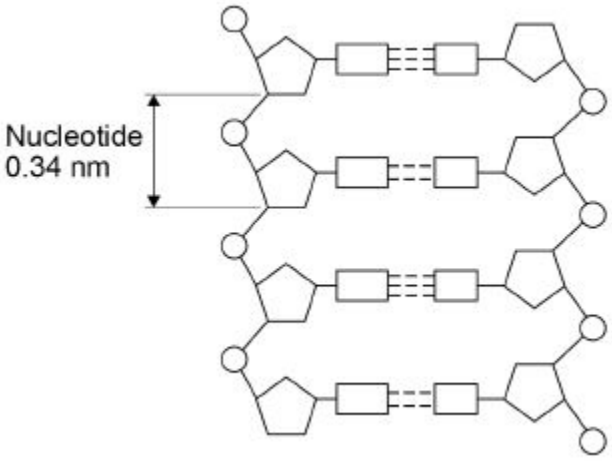
(a) Why is DNA described as a polymer?

_____

_____

(1)

The diagram below shows part of a DNA molecule.



(b) Describe the structure of a nucleotide.

(4)

(c) The length of a DNA double helix increases by 0.34 nm for every pair of nucleotides.

The total number of nucleotides in a human body cell is 1.2×10^{10}.

Calculate the total length of double helix in a human body cell.

Give your answer in metres. Use information from the diagram.

Total length = _____ m

(5)

(d) Some parts of DNA do **not** code for proteins.

Describe how non-coding parts of DNA can affect the expression of genes.

_____

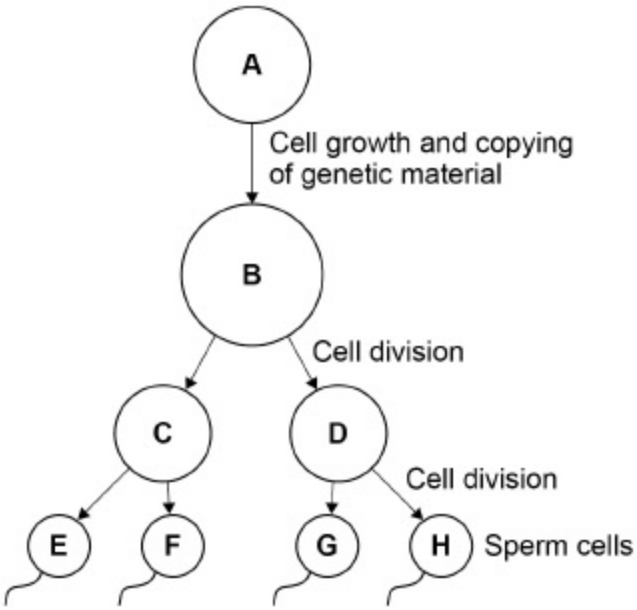
_____

(1)

(Total 11 marks)

7. **Figure 1** shows the production of sperm cells in humans.

Figure 1



(a) Cell **A** is a normal body cell.

How many chromosomes are there in cell **A**?

Tick (✓) **one** box.

23 ☐ 46 ☐ 48 ☐ 92 ☐

(1)

(b) What is the mass of DNA in cell **E**?

Tick (✓) **one** box.

A quarter of the mass of the DNA in cell **A** ☐

Half the mass of the DNA in cell **A** ☐

The same mass as the DNA in cell **A** ☐

Twice the mass of the DNA in cell **A** ☐

(1)

(c) What type of cell division produces sperm cells?

Tick (✓) **one** box.

Binary fission ☐

Differentiation ☐

Meiosis ☐

(1)

(d) Sometimes there are errors in copying the genetic material.

What term describes an error in the genetic material?

Tick (✓) **one** box.

Absorption ☐

Fertilisation ☐

Mitosis ☐

Mutation ☐

(1)

(e) A woman has three children, aged 4, 6 and 9 years.

Why are the children **not** genetically identical?

_____

_____

_____

_____

(2)

In sexual reproduction, a sperm cell fuses with an egg cell to form a new single cell.

An embryo develops from the single cell.

The cell divides three times to produce the embryo.

(f) How many cells are there in the embryo after three cell divisions?

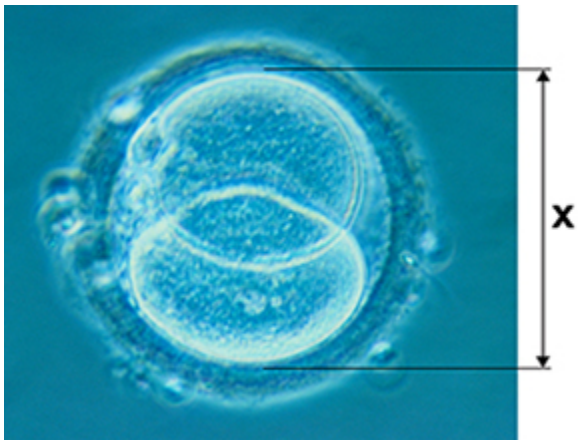
Tick (✓) **one** box.

3 ☐ 6 ☐ 8 ☐ 9 ☐

(1)

Figure 2 shows a different human embryo.

Figure 2



(g) Measure image length **X** on **Figure 2**.

Give your answer in millimetres (mm).

X = _____ mm

(1)

(h) The image in **Figure 2** has been magnified × 500

Calculate the real length of the embryo.

Use the equation:

$$\text{real length of the embryo} = \frac{\text{image length}}{\text{magnification}}$$

Give your answer in micrometres (µm).

1 mm = 1000 µm

_____

_____

_____

_____

Real length of the embryo = _____ µm

(3)

(i) The embryo may **not** implant in the lining of the uterus.

The embryo will then be lost from the woman's body several days later.

Explain why the woman may **not** notice this has happened.

_____

_____

_____

_____

(2)

(Total 13 marks)

1.

(a)

Classification group
Kingdom
Phylum
Class
Order
Family
Genus
Species

*all 4 correct = **2** marks*

*2 or 3 correct = **1** mark*

*0 or 1 correct = **0** marks*

2

(b) Geospiza fortis

ignore underlining or attempted italics or upper and lower case letters

1

(c) offspring have similar beak depths to parents

ignore same beak depths

ignore positive correlation / described

1

(d) parents of a given beak depth produce offspring with several beak depths

allow spread of results for a given parental beak depth about line of best fit

allow range of phenotypes for a given parental beak depth

1

(e) colonisers of Isabela have a range of beak depths

allow colonisers of Daphne have a range of beak depths

1

due to different combinations of alleles of several genes
or
due to different alleles of one gene
or
due to mutation

1

large range of (sizes / species of) seeds / food (on Isabela)
or
large(r) seeds (on Isabela)

allow small range of (sizes / species of) seeds / food on Daphne

or

allow small(er) seeds on Daphne

1

more competition for seeds / food (on Isabela)

allow less competition for seeds / food on Daphne

ignore competition unqualified

1

birds with larger beaks get enough food to (survive and) reproduce (on Isabela)

allow birds with smaller / medium beak sizes get enough food to (survive and) reproduce on Daphne

1

(survivors) pass on (beneficial) alleles to offspring

allow pass on genes / mutation ignore pass on chromosomes / characteristics

1

(f) Isabela is a large island with more species of plants
or
Isabela is a large island with more variety in seed / food sizes
or
Isabela is a large island with more plants / seeds / food

1

less competition for seeds / food
or
enough seeds / food for both bird species

1

[13]

2. (a) *Elasmotherium*

1

(b) eukaryota

1

(c) Carl Woese

1

(d) any **one** from:

- fighting / competing for mates / food / territory
- to kill predators / prey

allow for defence / protection

1

(e) (bones **or** hard tissues) did not decay

*allow soft tissues decayed **or** were eaten*
allow other parts decayed or were eaten
allow horn could be damaged / lost in fighting

1

(f) any **one** from:

- compare to other fossils of known age

allow compare with the fossil record

- by the age of the rocks (where fossil was found)

allow depth underground (where fossil was found)
allow (radio)carbon / isotope dating
allow DNA analysis

1

(g) 0.05 (million years ago)

1

(h) 0.2 – 0.05

allow 0.05 × 3
allow ecf from question (g)

1

0.15

1

150 000 (years)

allow 0.15 million (years)

1

(i) any **two** from:

ignore pollution

- drought
- ice age / global warming
- volcanic activity

allow earthquakes / tsunami

- asteroid / meteor collision
- (new) predators

allow hunters / poachers / eaten

- (new) disease

allow named pathogen

- competition for food

allow lack of food

- competition for mates

*allow isolation **or** lack of mates*

- lack of habitat **or** habitat change

*if no other marks awarded allow natural disaster **or** climate change **or** catastrophic event for **1** mark*

2

[12]

3.

(a) 4 / four

1

(b) 23 / twenty three

*do **not** accept 23 pairs*

1

(c) a different form of a gene

1

(d) heterozygous

1

(e)

		Dd/dD
	dd	**dd**

*allow 2 correct for **1** mark*

2

(f) ring around any **Dd**

allow ecf from question (e)

1

(g) percentage must match answer given to questions (e) and (f)

if no answer in question (e) allow 50 %

1

(h) mutation / mutated

*do **not** accept mutant*

1

(i) any **one** from:

- to help them prepare
- to inform whether to consider having an abortion
- to find out if they have passed on the disorder

allow to see if the child / embryo has the disorder

allow answers referring to genetic disorders, or specific example such as Dupuytren's / cystic fibrosis

1

[10]

4.

(a) any **two** from:

- double

allow two strands

- helix

allow twisted / spiral / coiled

- long / thin

2

(b) bases

1

(c) protein

1

(d) nucleotide

1

(e) 0.34 × 6 000

1

2040 (million nm)

1

(f) answer from question (e) correctly converted

if no answer to question (e), allow 2.04 (m)

1

(g) any **one** of:

- to determine if the cancer is genetic (or caused by lifestyle factors)
- to inform / help treatment
- to allow embryo screening to ensure allele is not passed on
- to inform relatives if they have inherited (affected) gene / allele
- to detect cancer early **or** before symptoms show
- to understand cause of the cancer

1

[9]

5. (a)

$$\frac{6.0}{1.6}$$

allow a range of 5.9 to 6.1 for 6.0

1

3.75

*do **not** accept if a unit is given*

*if no other marks awarded, allow a correct answer using a value of 5.8 or 6.2 for **1** mark*

1

(b)

$$\frac{2.5 - 1.6}{50}$$

allow

$$\frac{0.9}{50}$$

1

0.018 (billion per year)

1

(c) suitable extrapolation line drawn on the graph.

allow straight extrapolation

1

reading taken at 2050 from student's line

allow a tolerance of ± ½ small square

*allow **1** mark for 10 billion if no extrapolation drawn*

1

(d) fewer fish caught **or** limit the number of fish caught

*allow a method of doing this, eg increase mesh size **or** do not catch young fish*

1

(remaining fish) can reproduce

allow more fish (survive to) reproduce

1

(e) **Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.

4–6

Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.

1–3

No relevant content

0

Indicative content

human land use

- increasing population requires more food
- crops / livestock for food
- farming crops for biofuels
- peat use as compost
- peat use as fuel
- increased use of pesticide / insecticide / herbicide / fertilisers
- use of free-range / organic methods increases land use (for same yield)

link to biodiversity

- deforestation
- monocultures
- loss of hedgerows to make fields larger
- loss of habitat
- consequence of loss of habitat e.g. (change in) migration
- fertiliser run off polluting water
- use of pesticide / insecticide / herbicide reduces insects / plants which damages food chains
- more soil erosion

link to atmospheric pollution

- more carbon dioxide (from farm animals / machinery)
- more methane (from cows)
- climate change **or** global warming
- example of impact on biodiversity
- acid rain
- desertification

Answers referring to only land use or only biodiversity are level 1

(f) golden rice has improved nutritional value

1

(g) any **one** from:

- gene may contaminate / enter other breeds / species
- reduction / extinction of population of wild / traditional rice
- reduction / extinction of population of flowers / insects
- high cost of seeds

  allow decrease in biodiversity
- may have too much vitamin A (in diet)

  allow decrease in gene pool
  allow may harm (human) health
  allow may cause side effects (on humans)
  ignore references to religious beliefs
  ignore may harm humans unqualified

1

[16]

6. (a) many (joined) nucleotides **or** monomers

allow (long) molecule / chain made of repeating units

1

(b) phosphate

1

(phosphate attached to a) sugar

1

(which has 1 of 4) base(s) (attached to sugar)

ignore phosphorus

allow deoxyribose / pentose

*allow **2** marks if position of sugar / phosphate / base is incorrect*

1

(bases) are A, C, G **and** T

*allow bases are adenine, cytosine, guanine **and** thymine do **not** accept thiamine / adenosine*

allow description of a pair of nucleotides

1

(c) 0.34 × 12 000 000 000

an incorrect answer for one step does not prevent allocation of marks for subsequent steps

1

4 080 000 000

1

$$\frac{4\ 080\ 000\ 000}{1\ 000\ 000\ 000}$$

allow conversion from nm to m at any point in the calculation

1

4.08 (m)

1

2.04 (m)
(divided by 2 due to base pairs)

allow division by 2 at any point in the calculation

1

(d) (non-coding parts) can switch genes on / off

1

[11]

7. (a) 46

1

(b) half the mass of the DNA in cell **A**

1

(c) meiosis

1

(d) mutation

1

(e) any **two** from:

- different egg / sperm each time
- genes from two parents
- each gamete / egg / sperm has different alleles / genes / DNA / genetic information

ignore different chromosomes

ignore the children have different genes / alleles

2

(f) 8

1

(g) 40

allow in range 39 to 41

1

(h)

*an answer of 80 scores **3** marks*

*allow ecf from part (g) for **3** marks*

*an answer of 0.08 scores **2** marks*

$\frac{40}{500}$

allow $\frac{\text{answer to part } \mathbf{(g)}}{500}$

1

× 1000

1

80

*an answer from mp1 but not × 1000 scores **2** marks*

1

(i) embryo is (very) small

1

(so) embryo not seen / felt

or

lost in normal menstrual flow

ignore not noticed

1

[13]