Inheritance 3

Name: _____

Class: _____

Date: _____

Time: **85 minutes**

Marks: **78 marks**

Comments:

1. The polar bear is a mammal that lives in arctic habitats.

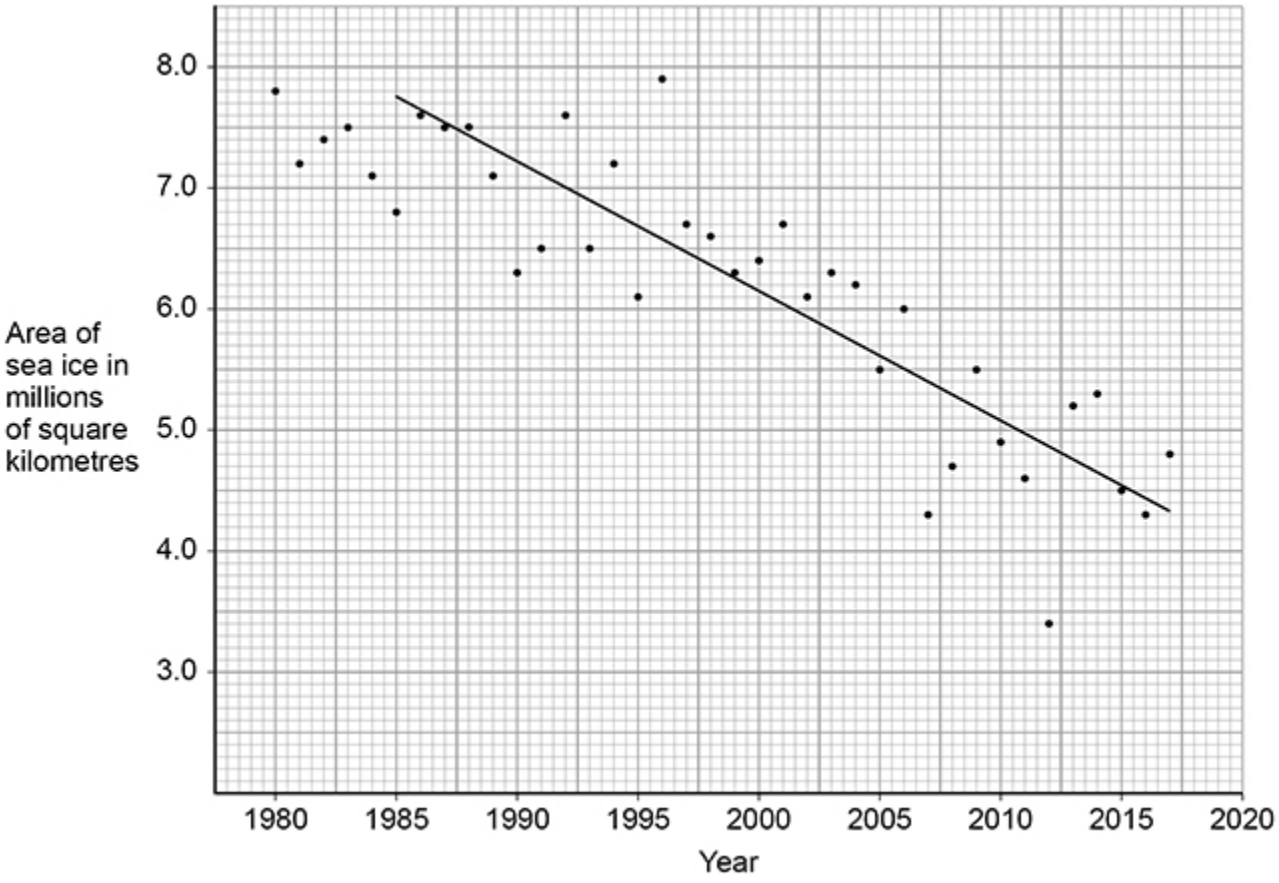
(a) Complete the table below for the classification of the polar bear, *Ursus maritimus*.

Classification group	**Name**
Domain	
Kingdom	
	chordata
Class	mammalia
Order	carnivora
	ursidae
Genus	Ursus
Species	maritimus

(2)

Scientists have been measuring the area of sea ice in the Arctic since 1980.

The figure below shows the area covered by sea ice every September.



(b) Determine the annual rate of loss of sea ice between 1985 and 2017.

A trend line has been drawn on the figure above to help you.

_____

_____

_____

_____

Rate of loss = _____ million square kilometres per year

(3)

The total number of polar bears living on the arctic ice is not known.

The hunting of polar bears has been banned or reduced in some areas.

In some populations the average mass and height of polar bears has decreased.

Polar bears eat seals. Seals live on the sea ice in winter and raise their pups there in early spring. In the summer seals live mainly in the sea catching fish to eat.

Polar bears spend much of the year hunting seals on the sea ice and in the sea nearby. The sea ice area is at its lowest each year in September at the end of summer. The polar bears feed mainly in early spring, and again in autumn to build fat stores to survive the next winter.

During the winter of 2017 scientists measured the metabolic rates of nine female polar bears and found them to be much higher than expected. Cameras attached to the female polar bears showed they had to swim long distances to find seals to eat.

(c) Suggest why polar bears find it harder to catch seals in autumn than in spring.

_____

_____

_____

_____

(2)

(d) Evaluate what might happen to the population of polar bears in the Arctic in the future.

(4)

(Total 11 marks)

2. A human body cell contains 46 chromosomes.

(a) How many chromosomes does a human sperm cell contain?

Tick (✓) **one** box.

22 ☐ 23 ☐ 46 ☐

(1)

(b) Draw **one** line from each word to the meaning of that word.

Word	Meaning
Gene	A small ring of DNA in the cytoplasm
Genome	All the genetic material of an organism
Nucleus	A small section of DNA which codes for a protein
	A structure which contains chromosomes

(3)

Some plants contain a harmful chemical called PTC.

Some people can taste PTC.

(c) Suggest **one** advantage of being able to taste PTC.

_____

_____

(1)

Only people with a dominant allele **T** can taste PTC.

People with **only** the allele **t** cannot taste PTC.

(d) A person has the genotype **Tt**.

What word describes the person's genotype?

Tick (✓) **one** box.

Heterozygous	☐
Phenotype	☐
Recessive	☐

(1)

(e) Give the genotype of a person who **cannot** taste PTC.

_____

(1)

(f) A woman and a man plan to have a child.

The woman and the man both have the genotype **Tt**.

Complete the figure below to show the possible genotypes of the child.

		Woman: T	Woman: t
Man	T	T T	
Man	t		

(2)

(g) What is the chance of the child being able to taste PTC?

Use the figure above.

Tick (✓) **one** box.

25% ☐ 50% ☐ 75% ☐ 100% ☐

(1)

(Total 10 marks)

3. **Figure 1** shows one species of bird on a bird feeder.

Figure 1

The birds use their beaks to reach nuts inside the bird feeder.

Cats sometimes eat the birds.

(a) Give the food chain for the birds, cats and nuts.

_____

(2)

(b) Which organism in the food chain you gave in part (a) is the primary consumer?

_____

(1)

(c) Cats are one biotic factor that affects the size of the bird population.

Which **two** of the following are **biotic** factors?

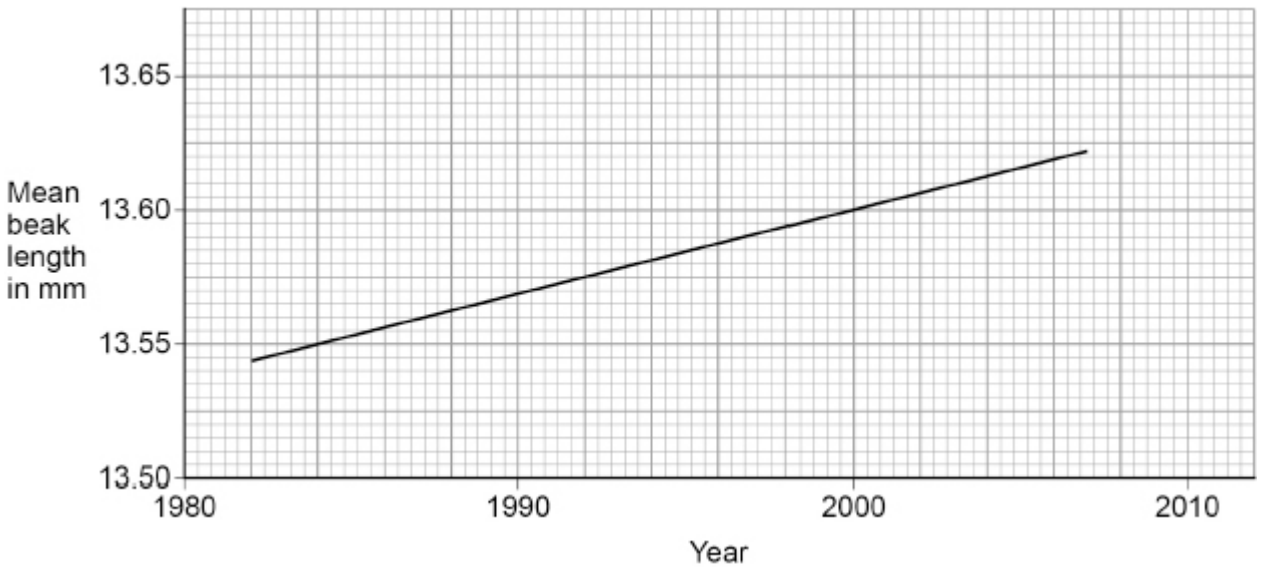
Tick (✓) **two** boxes.

Food	☐
Pathogens	☐
Sunlight	☐
Temperature	☐
Water	☐

(2)

Figure 2 shows the mean beak length of this species of bird from 1982 to 2007.

Figure 2



(d) What was the mean beak length in 2000?

Mean beak length = _____ mm

(1)

(e) What type of adaptation is beak length?

Tick (✓) **one** box.

Behavioural	☐
Chemical	☐
Structural	☐

(1)

Figure 2 shows evidence of evolution in this species of bird.

(f) Scientists have concluded that beak length in this species of bird is increasing.

Complete the sentences about the evolution of this species of bird.

Choose answers from the box.

excretion	**generation**	**mutation**
reproduction	**respiration**	**variation**

The difference in beak length in the bird population
is called _____.

A change in a gene affects the beak length.
Change in a gene is called _____.

The birds with the longest beaks get more food.
Getting more food improves a bird's chances of
survival and _____.

This process of evolution takes place over more
than one _____.

(4)

(g) Birds of this species:

- live for about 3 years
- produce up to 24 eggs every year.

Why is evolution easier to study in birds than in humans?

Tick (✓) **one** box.

Birds breed less frequently than humans.	☐
Birds have a shorter life cycle than humans.	☐
Birds have fewer offspring than humans.	☐

(1)

(h) Bacteria also provide evidence for evolution.

Which statement describes evidence for evolution?

Tick (✓) **one** box.

Bacteria can become resistant to antibiotics.	☐
Decomposition can be caused by bacteria.	☐
Some bacteria are pathogens.	☐

(1)

(Total 13 marks)

4. A fossil was found in rocks. The rocks were formed from mud.

The fossil is of the fungus *Ourasphaira giraldae*.

(a) What is the genus of the fungus?

Tick (✓) **one** box.

Giraldae ☐

Ourasphaira ☐

Ourasphaira giraldae ☐

(1)

(b) The mud around the fungus did **not** contain oxygen.

Which process did the mud around the fungus prevent?

Tick (✓) **one** box.

Decay ☐

Geological activity ☐

Photosynthesis ☐

(1)

(c) The fossilised fungus is estimated to be 890 000 000 years old.

What is 890 000 000 in standard form?

Tick (✓) **one** box.

8.9×10^6 ☐

8.9×10^7 ☐

8.9×10^8 ☐

8.9×10^9 ☐

(1)

(d) Traditional classification divided organisms into kingdoms.

Who developed the traditional system of classification?

Tick (✓) **one** box.

Carl Linnaeus ☐

Carl Woese ☐

Charles Darwin ☐

(1)

(e) More recent classification methods use a three-domain system.

What is the name of the domain the fungus *Ourasphaira giraldae* is classified in?

Tick (✓) **one** box.

Bacteria ☐

Eukaryota ☐

Plants ☐

(1)

(f) Why has classification changed over time?

Tick (✓) **one** box.

Electron microscopes allow more detail to be seen inside cells. ☐

Many more types of organisms have become extinct. ☐

Some fossils are buried so deep that they may never be discovered. ☐

(1)

(g) The fungus *Ourasphaira giraldae* is now extinct.

Give **two** possible causes of extinction.

1 _____

_____

2 _____

_____

(2)

(Total 8 marks)

5. A fossil was found in rocks. The rocks were formed from mud.

The fossil is of the fungus *Ourasphaira giraldae.*

(a) What is the genus of the fungus?

_____

(1)

(b) Why was the mud important during the formation of the fossil?

Tick (✓) **one** box.

The fungus completely decayed in the mud. ☐

The mud stopped oxygen reaching the fungus. ☐

There was water in the mud around the fungus. ☐

(1)

The estimated age of the fossil is in the range from 8.9×10^8 years old to 1.1×10^9 years old.

(c) Calculate the size of the range of the estimated age of the fossil.

_____

_____

_____

Size of range = _____ years

(1)

(d) Humans did **not** exist when the fungus was alive.

Suggest **one** other reason why an accurate estimation of when this species of fungus existed is not known.

_____

_____

(1)

Carl Woese developed the three-domain system of classification.

(e) Fungi are **not** in the domain Archaea.

Which domain are fungi classified in?

_____

(1)

(f) Which **two** characteristics are features of organisms in the domain Archaea?

Tick (✓) **two** boxes.

Can only survive in light	☐
Can survive in extreme environments	☐
Cells contain chloroplasts	☐
Cells do not have a cell wall	☐
Cytoplasm contains DNA	☐

(2)

(g) Carl Linnaeus lived in the 1700s.

Carl Linnaeus classified living things into groups depending on their appearance.

Give **three** types of evidence that are used **now** to classify living things.

Do **not** refer to appearance in your answer.

1 _____

_____

2 _____

_____

3 _____

_____

(3)

(Total 10 marks)

6. **Figure 1** shows one species of bird on a bird feeder.

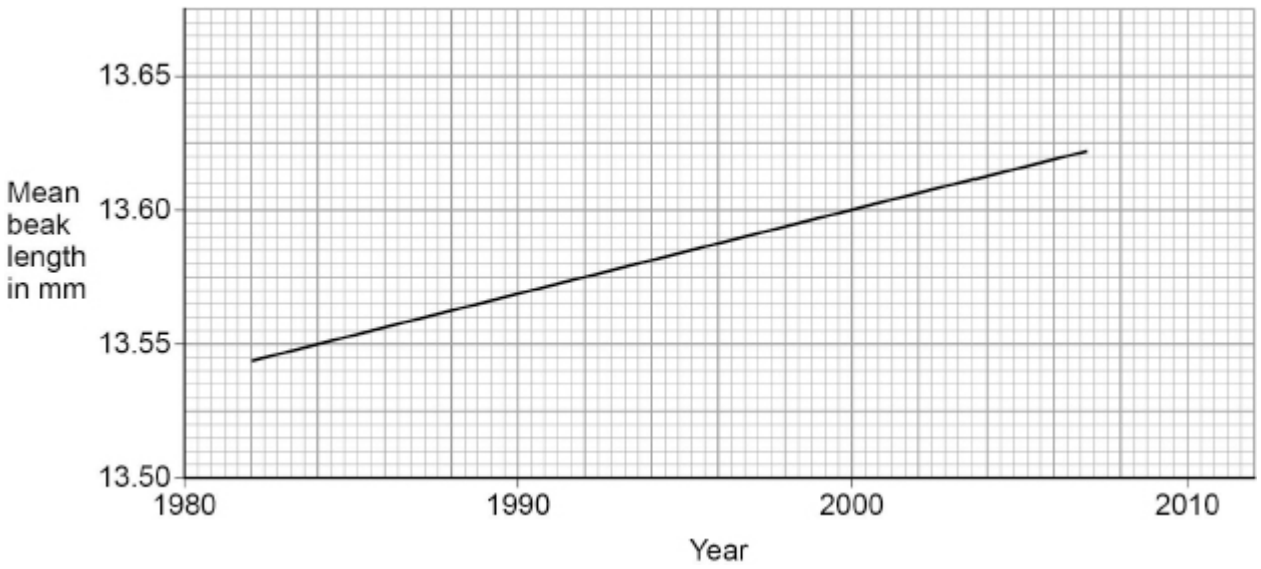
Figure 1

The birds use their beaks to reach nuts inside the bird feeder.

Figure 2 shows the mean beak length of this species of bird in the UK.

This species of bird often visits bird feeders.

Figure 2



(a) Determine the rate of change in beak length from 1984 to 2000.

Use **Figure 2**.

Rate of change = _____ mm/year

(3)

(b) Explain the process of evolution that could cause the trend in **Figure 2**.

(6)

(c) Birds of this species:

- live for about 3 years
- produce up to 24 eggs every year.

Explain why evolution is easier to study in this species of bird than in humans.

(3)

(d) Birds of this species are found in different parts of the world.

Describe evidence that would show two individual birds are the same species.

(3)

(Total 15 marks)

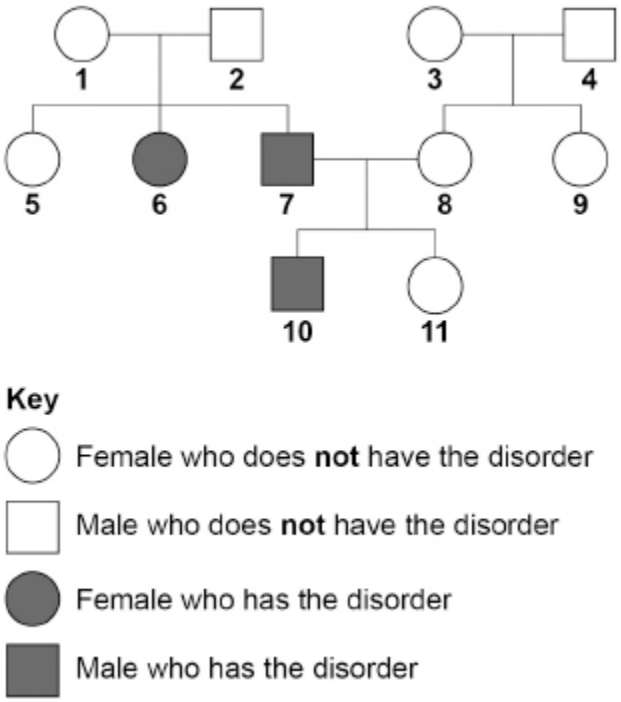
7. This question is about genetic disorders.

(a) Some people are heterozygous for a genetic disorder.

Define the term ‘heterozygous’.

(1)

(b) The figure below shows the inheritance of a genetic disorder in a family.



Person **7** and person **8** plan to have another child.

Determine the probability that the child will be a **male** who has the disorder.

You should:

- draw a Punnett square diagram
- identify the genotype of person **7** and the genotype of person **8**
- identify the phenotype of each offspring genotype
- use the symbols:

  H = dominant allele

  h = recessive allele

Probability of having a male child with the disorder = _____

(6)

(c) Polydactyly is a different inherited disorder.

Two parents do **not** have any alleles for polydactyly in their ordinary body cells.

These parents produced a child with polydactyly.

Explain how polydactyly suddenly occurred in this family.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 11 marks)

1. (a)

	eukaryote / eukaryota
	animal(ia)
phylum / phyla	
family	

2 *marks for all 4 correct*

1 *mark for 2 or for 3 correct*

ignore italics and upper / lower case letters

2

(b) **View with the graph**

two readings from graph

7.75 **and** 4.32

allow in range of 7.7 to 7.8 ***and*** *4.3 to 4.4*

allow two readings from two identified points on the line, allowing a tolerance of ± ½ a small square

1

calculation of gradient

$\frac{3.43}{32}$

allow calculation of gradient using correct readings from graph, $\frac{dy}{dx}$

1

correct answer

0.1(071875)

allow correct answer using student's correct readings from graph

1

(c) any **two** from:

in autumn

- no / fewer seals left on ice
  or
  all / most seals are in the sea

  ignore seals are in the sea unqualified

- seals are adults / older so swim faster

- more <u>competition</u> between polar bears

2

(d) **Level 2:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

3–4

Level 1: Some logically linked reasons are given. There may also be a simple judgement.

1–2

No relevant content

0

Indicative content

may decrease because:

- global warming is melting sea ice
- less sea ice each year so less habitat / hunting area
- as ice / habitat disappears seals will decrease in number
- having to swim longer distances to find seals, wastes energy
- increased metabolic rate means more food is required
- not building up fat stores in the autumn means fewer will survive each winter
- decrease in mass / height may reduce hunting ability / strength
- hunting in some / most areas continues
- less likely to find mates
- eventually the species may become extinct

may increase / maintain numbers if:

- more laws put in place to stop hunting **or** laws to stop hunting will allow bears to reproduce
- quotas introduced to reduce hunting
- nations / people work to reduce carbon dioxide emissions to halt global warming
- (feeding / hunting) behaviour of polar bears changes

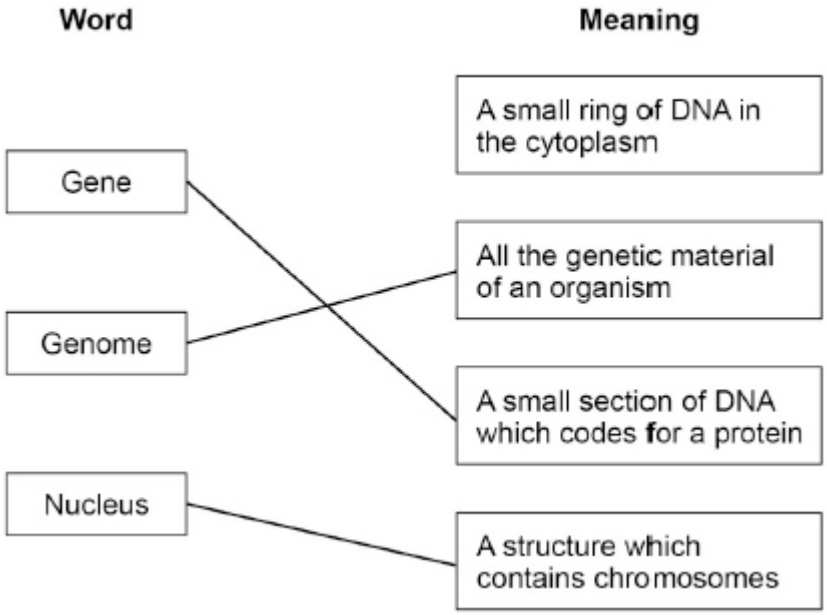
For Level **2** both increase / maintenance **and** decrease of the polar bear population must be considered

[11]

2. (a) 23

1

(b)



additional line from a box on the left negates the mark for that box

1
1
1

(c) any **one** from:

- to survive

  allow to protect them
- so you do not eat the plants
- to stop you being harmed / poisoned

  allow stop you getting ill / dying

1

(d) heterozygous

1

(e) tt

allow homozygous recessive

1

(f)

		Woman	
		T	**t**
Man	**T**	**T T**	Tt
	t	Tt	tt

allow 1 or 2 genotypes correct for **1** mark

2

(g) 75%

*allow **only** a probability consistent with student's derivation*

*if no answer to question **(f)***

allow 75%

1

[10]

3. (a) nut(s) → bird(s) → cat(s)

*allow **1** mark for organisms in correct order (left to right) but arrows incorrect or missing*

*allow **2** marks for cat(s) ← bird(s) ← nut(s)*

*do **not** accept cat(s)bird(s) nut(s)*

*do **not** accept cat(s) →bird(s) →nut(s)*

2

(b) <u>birds</u>

*answer must be consistent with food chain given in question **(a)***

*if no answer to question **(a)***

allow bird(s)

1

(c) food

1

pathogens

1

(d) 13.60 (mm)

allow 13.6 (mm)

1

(e) structural

1

(f) variation

1

mutation

1

reproduction

1

generation

must be in this order

1

(g) birds have a shorter life cycle than humans

1

(h) bacteria can become resistant to antibiotics

1

[13]

4. (a) Ourasphaira

1

(b) decay

1

(c) 8.9×10^8 years old

1

(d) Carl Linnaeus

1

(e) eukaryota

1

(f) electron microscopes allow more detail to be seen inside cells

1

(g) any **two** from:

- drought
- ice age
- global warming

if none of these, allow climate change for 1 mark

ignore weather

- volcanic activity
- asteroid collision

*if neither of these, allow catastrophic event **or** natural disaster for **1** mark*

- (new) predators

allow named example

allow hunters

- (new) disease / pathogen

allow named example

- competition for food

allow lack of food

- competition for mates

allow lack of mates

ignore competition unqualified

- lack of habitat **or** habitat change

ignore environment change

ignore isolation

ignore pollution

2

[8]

5. (a) *Ourasphaira*

ignore italics

ignore capitalisation

*do **not** accept Ourasphaira giraldae*

1

(b) the mud stopped oxygen reaching the fungus

1

(c) any **one** from:

- 2.1×10^8 (years)
- 210 000 000 (years)

1

(d) any **one** from:

- fossil(s) of the fungus may have been destroyed (by geological activity)

  ignore some destroyed
- fossil(s) of the fungus may not have been found (yet)

  ignore some not found (yet)
- dating methods are not precise / accurate
- the time at which an organism / fungus evolves from ancestors is difficult to pinpoint

  allow point of speciation is not known

1

(e) eukaryota

allow eukaryote(s)

1

(f) can survive in extreme environments

1

cytoplasm contains DNA

1

(g) any **three** from:

- studies of internal / cell structures with light microscopes
- studies of internal / cell structures with electron microscopes

  allow organelles for internal / cell structures

  *if neither mark awarded allow studies of internal / cell structures (with microscopes) for **1** mark*

- chemical analysis
- comparison of biochemical processes
- DNA / genetic analysis
- studies of evolution(ary relationships)

3

[10]

6. (a) 13.55 (mm) **and** 13.60 (mm)

1

$$\frac{13.60\ (\text{mm}) - 13.55\ (\text{mm})}{2000 - 1984}$$

allow

$$\frac{0.05}{16}$$

allow correct working from other pairs of readings

1

0.003125 (mm/year)

or

3.125×10^{-3} (mm/year)

allow correct answer from other pairs of readings

allow a correct answer given to any number of significant figures

1

(b) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

- there is variation in beak length (in this bird population)
- variation is due to mutations

- beak length is controlled by gene(s)

- birds with longer beaks can reach more nuts / food **or** birds with longer beaks can fight with **or** outcompete birds with shorter beaks
- therefore have more energy from food
- so can produce more offspring **or** reproduce more

- those offspring that inherit the long beak allele more likely to survive
- which is natural selection
- pass allele ***I*** gene (for long beak) on
- repeated over many generations

- birds are evolving to have longer beaks

For **Level 3** detail of process of evolution must be linked to beak length **and** implication of several generations is required.

(c) shorter life cycle / span

allow converse if clearly referring to human evolution

ignore shorter life

1

more offspring

1

(so) the genetics of the population changes faster

*allow effect of mutations seen sooner / faster **or** humans can see evolution in birds during the course of a human life(time)*

allow more fossil evidence

1

(d) similar / same phenotype

1

similar genotype / DNA (profile)

1

(can reproduce / breed and) produce fertile offspring

1

[15]

7. (a) any **one** from:

- (having two) different alleles for a gene / trait / characteristic / disorder

  ignore examples such as Hh

  ignore having two different alleles unqualified
- (having) the dominant **and** recessive allele for a gene / trait / characteristic / disorder

1

(b) father / person 7 **hh**

1

mother / person 8 **Hh**

*allow **hh** and **Hh** parental genotypes with each parent unidentified **or** reversed for **1** mark*

1

(possible offspring correctly derived)
hh (× 2)
Hh (× 2)

allow correctly derived offspring from incorrect parental genotype(s)

1

(each different phenotype identified)
hh = has the disorder
Hh = does not have the disorder

allow from incorrectly derived offspring

*if incorrectly have **HH** = does not have the disorder*

1

0.5

*allow 50% **or** ½ **or** 1:1 **or***

*1 out of 2 **or** 1 in 2*

*do **not** accept 1:2*

allow probability of having disorder correctly derived from incorrect parental genotypes

1

(probability of male with disorder)
0.25

*allow 25% **or** ¼ **or** 1:3 **or***

*1 out of 4 **or** 1 in 4*

*do **not** accept 1:4*

allow probability of male with disorder correctly derived from incorrect probability of having the disorder

1

(c) caused by mutation

*allow description, for example change in the genetic code **or** change in base sequence*

1

during meiosis

allow in (germ) cells prior to meiosis

allow in (the formation of) gametes / egg / sperm

allow during mitosis between fertilisation and birth

1

causing a change in amino acid sequence

1

causing a different (specific) protein to be produced

or

causing none of a (specific) protein to be produced

causing a different (specific) enzyme to be produced

or

causing none of a (specific) enzyme to be produced

allow polydactyly is caused by a dominant allele so if child has one / the allele (with the mutation) they will have the disorder

*if no other mark awarded allow parents used donated egg / sperm for **1** mark*

1

[11]