



(d) Describe how DNA controls the structure of a protein.

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(2)

(e) Polydactyly and cystic fibrosis are both inherited disorders caused by faulty DNA.

- Polydactyly is caused by a dominant allele.
- Cystic fibrosis is caused by a recessive allele.

Mother **A** has polydactyly.

Mother **B** has cystic fibrosis.

Mother **A** is more likely to have a child with polydactyly than Mother **B** having a child with cystic fibrosis.

Explain why.

Assume the fathers of the children have no alleles for polydactyly or cystic fibrosis.

You may use genetic diagrams in your answer.

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(3)

(Total 13 marks)

2

Fall armyworms are native to America.

Fall armyworms eat corn plants.

(a) The binomial name for fall armyworms is *Spodoptera frugiperda*.

Fall armyworms belong to an order of insects called Lepidoptera.

The table shows a classification table for the fall armyworm.

Complete the table.

Classification group	Name
Kingdom	
	Arthropoda
	Insecta
Order	Lepidoptera
Family	Noctuidae
	<i>frugiperda</i>

(2)

Fall armyworms have been found in Africa.

By 2016 they had spread rapidly destroying corn crops.

(b) Suggest **one** reason why the fall armyworms are spreading so rapidly in Africa.

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(1)

(c) Fall armyworms:

- are **not** worms (annelids)
- are the caterpillars of moths (arthropods).

Describe **one** way scientists could tell if a new 'worm' they found should be classified as an annelid or as an arthropod.

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(1)

- (d) In parts of Africa, aeroplanes have been used to spray insecticide on crops, to kill the worms.

Explain the advantages and disadvantages of spraying insecticide on the corn crops.

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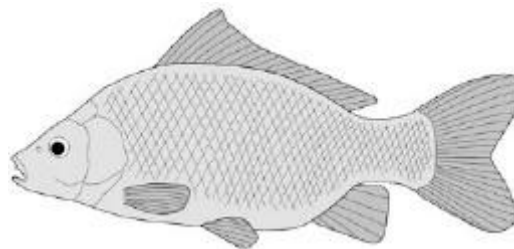
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(4)

(Total 8 marks)

- 3 The figure below shows a carp.



- (a) A mutation causes a blue colour in some carp.

What is a mutation?

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(1)

- (b) Suggest how a mutation could cause a different colour in carp.

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(1)

(c) Two alleles control the body colour of carp:

- brown (**B**)
- blue (**b**).

The brown allele is dominant to the blue allele.

Two carp that are heterozygous for colour are crossed and produce  $2.6 \times 10^5$  offspring.

Approximately how many of the offspring are expected to be blue?

Draw a genetic diagram to explain your answer.

Give your answer in standard form.

Number of offspring expected to be blue = \_\_\_\_\_

(5)

(d) A scientist wanted to find out whether a brown carp has the genotype **BB** or **Bb**.

Describe what genetic cross a scientist could do to determine this.

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(2)

(Total 9 marks)

**4** Different antibiotics destroy bacteria in different ways.

- Some antibiotics disrupt the bacterial cell membrane.
  - Some antibiotics disrupt the bacterial cell wall.
- (a) Antibiotics that disrupt the bacterial cell membrane often cause more side effects in humans compared with antibiotics that disrupt bacterial cell walls.

Suggest why.

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(1)

(b) Some antibiotics prevent ribosomes functioning.

Suggest how this damages the bacterium.

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**(1)**

(c) Drug manufacturers are spending less on research into new antibiotics.

One reason why is because new antibiotics are rarely prescribed.

Some people think that governments should pay drug manufacturers to develop new antibiotics.

Suggest why.

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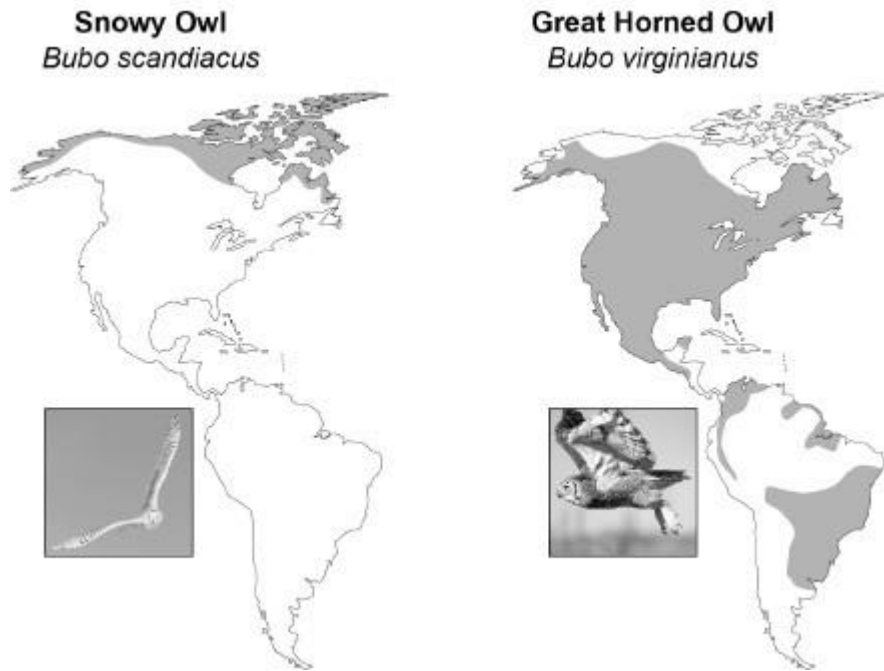
**(3)**

**(Total 5 marks)**

5

There are several species of owl alive today.

The image shows where two species of owl breed in North America.



(a) What is the genus name of the snowy owl?

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(1)

(b) The snowy owl and the great horned owl are different species.

Define the term 'species'.

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(1)







(d) The protein in the milk has to be extracted and purified before it can be used as a vaccine.

Scientists are improving the process so the protein will work as a vaccine **without** needing to be extracted and purified.

Give **two** possible advantages of producing goat's milk that contains an effective malaria vaccine.

1. \_\_\_\_\_  
\_\_\_\_\_

2. \_\_\_\_\_  
\_\_\_\_\_

**(2)**

(e) Malaria affects many people across the world.

Describe how the white blood cells might respond to an infection of the malaria pathogen.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**(3)**

**(Total 12 marks)**

## Mark schemes

- 1 (a) glucagon  
*correct spelling only* 1
- (b) if glucose too high (insulin causes) glucose to enter liver / muscle cells  
**or**  
glucose to be converted to glycogen 1
- so blood glucose levels fall 1
- when glucose gets too low (glucagon causes) glycogen breakdown in liver / muscle cells  
*allow ecf from part (a)* 1
- so glucose enters blood and raises level again 1
- this is called negative feedback 1
- (c) any **two** from:  
• polymer  
• made of two strands  
• (twisted) in a double helix  
*allow:*  
• *backbone of strands contains sugar and phosphate groups*  
• *(cross) linked by pairs of bases*  
• *correct names of four bases or base pairs* 2
- (d) contains a code 1
- for a sequence of amino acids which forms a specific protein 1

(e) mother **A** (polydactyly)

50% / half of children will have polydactyly if parent is heterozygous as it only takes one allele to show the disorder and half the sperm / ova / gametes will have faulty allele.

1

(and) all / 100% will have polydactyly if parent is homozygous as faulty gene will always be passed on

1

(but) for mother **B** (cystic fibrosis) none / 0% of children will have cystic fibrosis as it would need a second allele from the other parent before the disorder would be present

*allow genetic diagram(s) if correct and offspring ratio clearly indicated.*

1

[13]

2

(a)

	Animalia	}
Phylum		
Class		
Genus	<i>Spodoptera</i>	}
Species		

1

1

(b) any **one** from:

- no / few natural predators
- no / few pathogens / diseases
- more favourable climate
- plentiful food as corn crops grown over wide areas in Africa

1

(c) any **one** from:

- compare the structural features with those of annelids and arthropods  
*allow named structural features eg is it a segmented worm, does it form a pupa, does it turn into an adult with legs.*
- carry out DNA analysis and compare with known annelids and arthropods
- carry out electron microscopy of internal parts to see fine structure and compare with known annelids and arthropods

1

(d)

<b>Level 2:</b> Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	3-4
<b>Level 1:</b> Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	1-2
No relevant content	0
<b>Indicative content</b> <b>advantages</b> <ul style="list-style-type: none"><li>• killing worms will mean more corn / food for African people</li><li>• so food security or no famine</li><li>• it will stop the spread of the worms</li><li>• so stop it reaching other countries and causing food shortages there</li><li>• it will remove an invasive species</li><li>• and so restore the natural ecosystem balance in the area</li></ul> <b>disadvantages</b> <ul style="list-style-type: none"><li>• insecticide will kill other (pollinating) insects</li><li>• so will stop fertilisation of crops and lead to poor yields</li><li>• insecticide will kill other insects</li><li>• and upset the ecological balance in the area or reduce biodiversity in the area</li><li>• insecticide may be toxic to humans</li><li>• causing illness if they ingest it</li><li>• insecticide may build up in the food chain</li><li>• and poison / kill organisms further up the chain</li></ul> (ignore cost as it could be argued either way)	

4

[8]

3

(a) a change in the DNA / gene

1

(b) produces a different protein / enzyme that is responsible for colour

1

(c) parents genotype both Bb

*allow correctly derived gametes*

1

offspring genotypes correctly derived 1

bb identified as blue  
*allow ring around bb only* 1

65 000  
*allow ecf or  $260\ 000 \times 0.25$*  1

$6.5 \times 10^4$  1

(d) cross with **bb** / blue carp  
*allow annotated Punnett square diagram(s) of cross with **bb** carp* 1

if any offspring are blue, the parent was **Bb** / heterozygous  
*allow converse* 1

*allow cross with known **Bb** carp*  
*if any offspring are blue, other parent was **Bb** / heterozygous*

[9]

4 (a) human cells have cell membrane  
**or**  
human cells have no cell wall 1

(b) can no longer synthesise proteins 1

(c) antibiotics are being developed at a slower rate than emergence of new resistant strains 1

resistant strains mean we cannot treat (common) infections 1

reduce (future) cost of antibiotic resistant infections 1

[5]

5 (a) *Bubo* 1

(b) (individuals of one species) can interbreed to produce fertile offspring  
*allow converse if clearly stated* 1

- (c) owls have become geographically isolated from each other  
**or**  
 arctic ice / temperature in different areas have separated the original population 1
- northern area is much colder and has snow / ice  
*allow examples – biotic (eg food / predators) or abiotic* 1
- genetic variation / mutations in each population  
*allow gene(s) / mutation* 1
- (natural selection occurs so) better adapted survive to reproduce 1
- passing on their favourable allele(s) 1
- until individuals of the two populations can no longer interbreed (to produce fertile offspring) 1

**[8]**

- 6** (a) gene for the malarial protein is removed from the malarial pathogen  
*allow gene for the malarial protein is removed from the malarial protist* 1
- goat DNA / chromosome is cut open 1
- using an enzyme 1
- goat and malarial DNA are combined (and put back into the goat cell) 1
- (b) only females produce milk  
*allow males don't produce milk* 1
- (c) ensure all the offspring are female (to produce milk) 1
- ensure all goats will have the malarial protein gene  
**or**  
 all will produce the malarial protein / vaccine 1

(d) any **two** from:

- everyone who drinks milk will get the vaccine
- no need for storage / refrigeration of the vaccine
- cheaper production of the vaccine
- less risk of infection from injections
- no needles which some people are scared of

2

(e) pathogens are engulfed (destroyed) via phagocytosis

1

antibodies are produced to kill the pathogens

1

(and) antitoxins are made (to stop the symptoms of malaria)

1

**[12]**