Genes, inheritance and selection – 2022 GCSE Gateway Biology A

1. June/2022/Paper_J247/03/No.24

Fig. 24.1 shows how stem cells in bone marrow differentiate into red blood cells.

Fig. 24.2 shows how the concentration of RNA and haemoglobin changes as the stem cell differentiates and the area of the nucleus changes.

Fig. 24.1

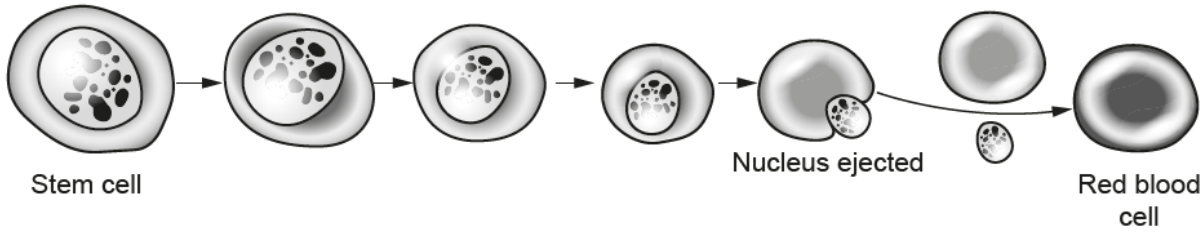
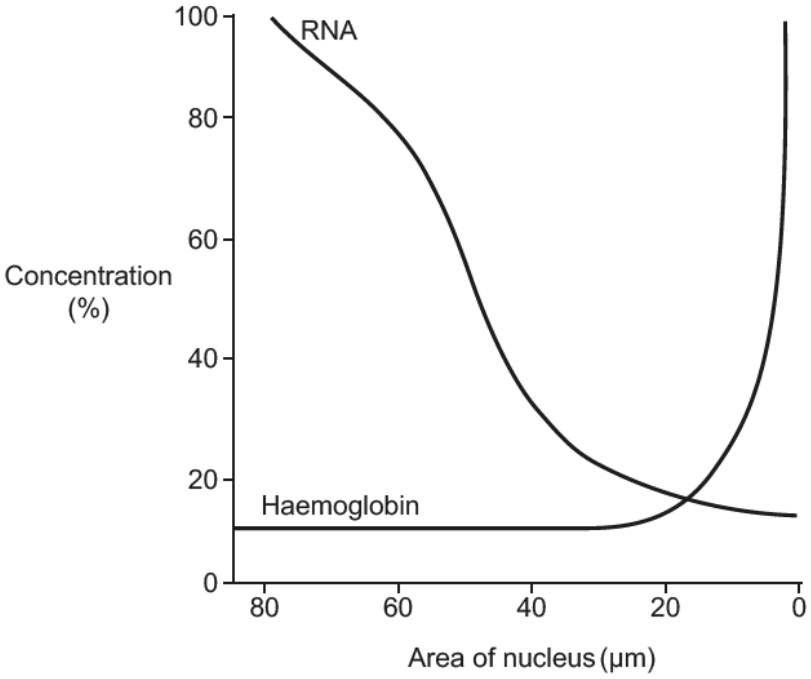


Fig. 24.2

Red blood cell development



(a)* Use **Fig. 24.1**, **Fig. 24.2** and your knowledge of cell differentiation to describe and explain the formation of red blood cells.

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..... **[6]**

(b) A male has:

- 4.7 million red blood cells per microlitre of blood.
- 4.5 litres of blood.

(1 litre = 1 000 000 microlitres)

Calculate how many red blood cells are in his blood.

Give your answer in standard form.

Number of red blood cells = ... **[3]**

2. June/2022/Paper_J247/04/No.3

What is phylogenetics?

A Classification using behavioural characteristics

B Classification using evolutionary links

C Classification using physical characteristics

D Classification using species name

Your answer ☐ **[1]**

3. June/2022/Paper_J247/04/No.9

Charles Darwin and Alfred Wallace were both involved in the development of the theory of evolution by natural selection.

How were they involved?

A Darwin first suggested the theory and Wallace developed it a hundred years later.

B They both travelled together on a ship called the Beagle.

C They worked together writing a book called 'On the Origin of Species'.

D They wrote scientific papers separately but then presented them together.

Your answer ☐ **[1]**

4. June/2022/Paper_J247/04/No.12

Errors in experiments can be random or systematic.

- A student investigates the effect of fertilisers on the dry mass of seedlings.
- They use pots of seedlings, solutions of fertilisers and a mass balance.

Which of these would produce a systematic error in the student's results?

A Some of the seedlings receive more light than others.

B Some of the seedlings are infected by a fungus.

C The student's mass balance is not calibrated correctly.

D The temperature in the classroom changes during the experiment.

Your answer ☐ **[1]**

5. June/2022/Paper_J247/04/No.18

The diagram shows a tulip plant. Many gardeners like to grow tulip plants.

(a) Tulips can be grown from seeds produced from sexual reproduction.

They can also be grown from bulbs that are produced by asexual reproduction.

Explain why most gardeners choose to grow bulbs produced by asexual reproduction rather than seeds.

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..... **[2]**

(b) In 1637, tulip growers found that a small number of their tulip plants produced flowers with different coloured stripes.

Until recently, there were two possible theories that explained the colours of these tulips.

Theory **1** – The stripes are caused by a mutation in the gene that produced the chemical that coloured the flower.

Theory **2** – The stripes are caused by a pathogen that infects the plant and changes the production of the coloured chemical.

Put ticks (✓) or crosses (✗) in the table to show whether each theory would produce changes in the phenotype and in the genotype of the tulip plants.

	Theory 1	**Theory 2**
Changes the phenotype of the tulip plant		
Changes the genotype of the tulip plant		

[2]

(c) Scientists now know that the colour changes are caused by a virus which infects the tulip tissue.

- The virus is injected into the phloem of the tulip by feeding insects.
- Although the infected bulbs produce attractive flowers, the infected bulbs become weaker every year until they die.

(i) 2.0×10^9 tulips are grown in the Netherlands every year. This uses 14 200 hectares of land.

1.5% of all the tulips grown are infected.

Calculate how many infected tulips there are in one hectare of land.

Number of infected tulips = ... **[2]**

*(ii) Growers need to identify infected tulips as soon as possible.

This allows them to only spray a small area with insecticide.

Scientists have developed a machine that moves rapidly through the fields scanning for infected tulips.

The text box shows the results of a trial of the machine in a field containing 1000 tulips.

The results of a trial of the machine are:

Actual results:
- 15 tulips infected
- 985 tulips not infected

Machine results:
- All 15 infected tulips identified
- 14 not infected tulips identified as infected
- 971 not infected tulips identified as not infected

Discuss the advantage of early detection of infected tulips and how useful the machine may be in making this possible.

Use data from the text box in your answer.

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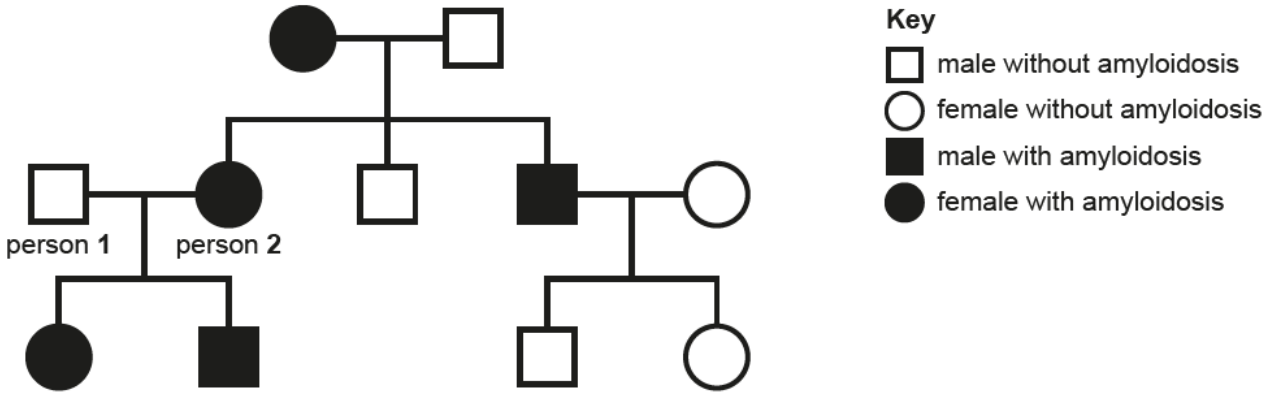
6. June/2022/Paper_J247/04/No.19

Amyloidosis is a group of inherited conditions that affect people's health.

The most common type of amyloidosis is caused by a dominant allele (**A**) of a gene.

(a) The diagram shows the inheritance of amyloidosis in a family.



(i) Complete the table about the family tree.

The first row has been done for you.

	Number of people in the family
males	6
people who are **homozygous recessive** for the gene	
people who are **homozygous dominant** for the gene	

[2]

(ii) Person **1** and person **2** are expecting another baby.

Complete the genetic diagram to find the probability that the baby will have amyloidosis.

	Person **1**		
Person **2**			

Probability = ... **[3]**

(b) Allele **(A)** codes for the production of a protein called amyloid.
Amyloid can block the blood vessels that leave the pancreas and the thyroid gland, preventing the release of hormones.

Complete the sentences to explain the symptoms that might be shown by person **2** in **(a)**.

Symptoms of person **2** can include:

- Being unable to control blood ..... due to a lack of the hormones ..... and ..... .
- Being unable to control ..... rate due to a lack of the hormone ..... .

[4]

(c) One treatment that doctors use for amyloidosis involves:

- Killing all the plasma cells in the body.
- Then giving the patient healthy stem cells.

Explain how this treatment could help people with amyloidosis.

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..... **[2]**

(d) Scientists are now developing a new treatment called gene silencing.
They have developed a drug that destroys the mRNA that codes for the amyloid protein.

Explain why this technique is called **gene silencing**.

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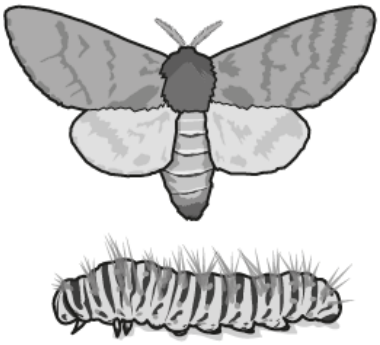
7. June/2022/Paper_J247/04/No.20

Pine processionary moths lay eggs that develop into larvae and then into caterpillars, as shown in the diagram.



moth

caterpillar

The caterpillars are a major pest, eating and killing pine trees.

The caterpillars are fed on by birds such as cuckoos. The caterpillars are also parasitised by fungi.

(a) Draw a labelled pyramid of biomass for these feeding relationships showing the organisms at each level.

[2]

(b) The caterpillars have long hairs on their bodies that cause irritation to predators. Cuckoos have a special sticky membrane lining their guts that traps these hairs. This allows the cuckoos to eat the caterpillars.

Explain how natural selection may have resulted in all cuckoos having the sticky membrane.

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(c) Scientists are controlling the pine processionary moth to conserve pine trees.

They spray the caterpillar's eggs or larvae with fungal spores.

This has been successful when spraying different concentrations of spores:

- 1×10^6 spores / ml on the eggs
- 1×10^8 spores / ml on the larvae.

(i) Name this type of control method.

..... **[1]**

(ii) The concentration of spores used on the larvae is higher than the concentration used on the eggs.

By how many orders of magnitude is it higher?

..... **[1]**

(d) Scientists have also tried to use natural plant defence methods on the larvae.

The table shows the effects of two plant-based oils on the larvae in laboratory conditions and on the pine trees.

Type of oil	**Deaths per 1000 larvae**	
	In the laboratory	**On the pine tree**
Ginger	712	874
Rosemary	300	761
Control treatment	13	22

(i) Calculate the percentage increase in the death of larvae on the pine trees compared to in the laboratory for the control treatment.

Percentage change = ... % **[2]**

(ii) More larvae die in the natural environment of the pine trees than in the laboratory for all treatments.

Suggest **one** reason why.

..... **[1]**

(iii) Evaluate the use of the two plant oils in the control of the larvae.

Use data from the table.

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..... **[3]**

8. June/2022/Paper_J247/04/No.22

Read the text below about two different genetic disorders or syndromes.

> Human genes are found on chromosomes in the nuclei of cells.
>
> In body cells, there is the diploid number of chromosomes, and in gametes there is the haploid number.
>
> Sometimes a gamete is formed that has an extra chromosome.
>
> - If this is chromosome number 18, a child with Edward's syndrome can be born.
> - If it is chromosome 21, a child that has Down's syndrome can be born.

(a) (i) Explain the difference between haploid and diploid cells.

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..... **[2]**

(ii) Explain how meiosis usually makes gametes that will produce children without these genetic disorders.

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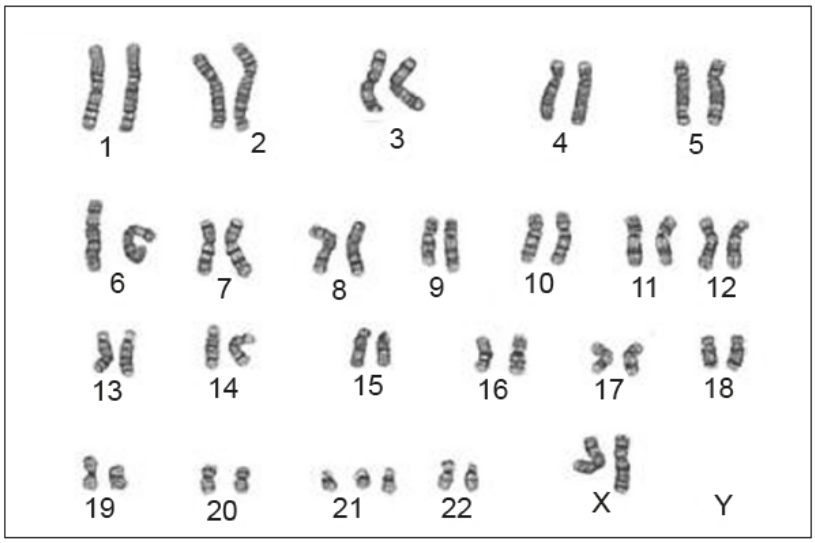
(b) The diagram shows the chromosomes found in a cell of a child.

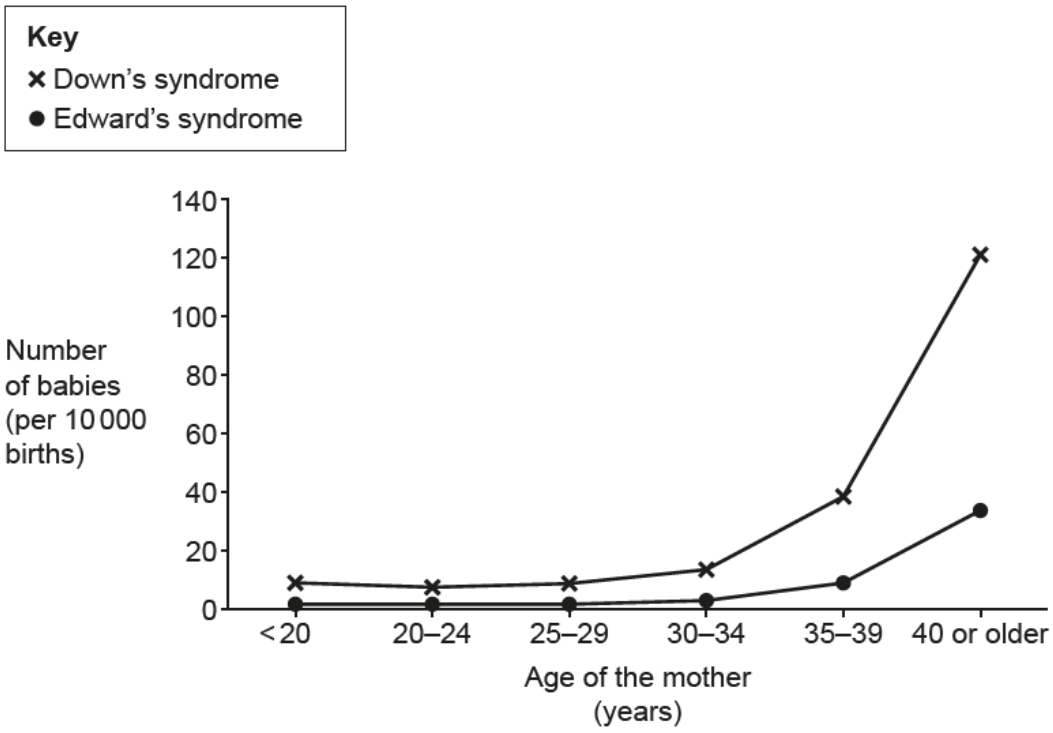


Write down **two** conclusions that can be made about this child from the diagram.

1.....

2..... **[2]**

(c) The graph shows how the number of babies born with Down's syndrome or Edward's syndrome varies with the age of the mother.



9. June/2022/Paper_J247/01/No.6

What word describes the amino acids that join to make a protein molecule?

A Enzymes

B Monomers

C Nucleotides

D Polymers

Your answer ☐ **[1]**

10. June/2022/Paper_J247/02/No.2

Which of these factors affect the phenotype of an organism?

A Only the environment of the organism.

B Only the organism's genes.

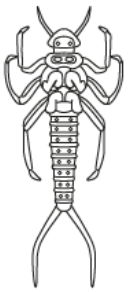
C The organism's genes and its environment.

D The organism's habitat and the habitat of its parents.

Your answer ☐ **[1]**

11. June/2022/Paper_J247/02/No.4

A student finds this organism in a pond:



The student uses this key to identify the organism.

1	3 pairs of legs	go to 3
	more than 3 pairs of legs	go to 2
2	curved body	freshwater shrimp
	straight body	water-louse
3	tail parts	go to 4
	no tail parts	water-boatman
4	2 tail parts	stonefly nymph
	3 tail parts	mayfly nymph

What is the name of the organism?

A Freshwater shrimp

B Mayfly nymph

C Stonefly nymph

D Water-louse

Your answer ☐ **[1]**

12. June/2022/Paper_J247/02/No.15

What is the definition of a genome?

A All the genes present in a community of organisms.

B All the genes present in a gamete.

C The entire genetic material of an organism.

D The genes inherited by an offspring from their mother.

Your answer ☐ **[1]**

13. June/2022/Paper_J247/02/No.17

Some farmers in Ireland want to start growing genetically modified (GM) wheat.

Growing GM wheat would mean that they need to spray less pesticides on their fields.

The table shows an estimate of the costs of growing non-GM wheat compared to GM wheat.

	Cost to farmer in euros per hectare (10 000 metres squared)	
Type of expense	**Non-GM wheat**	**GM wheat**
seeds	63	72
government charge	0	25
pesticide costs	165	113

(a) Use data from the table to suggest why the farmers want to start growing GM crops.

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..... **[2]**

(b) The wheat has been genetically modified.

Which type of chemical is inserted into the wheat cells to genetically modify them?

Put a (ring) around the correct answer.

DNA **fertiliser** **hormone** **pesticide**

[1]

(c) Some other farmers are concerned about growing GM wheat. They think that some people may not buy it.

Suggest **two** reasons why some people may **not** want to buy GM wheat.

1 .....

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2 .....

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[2]

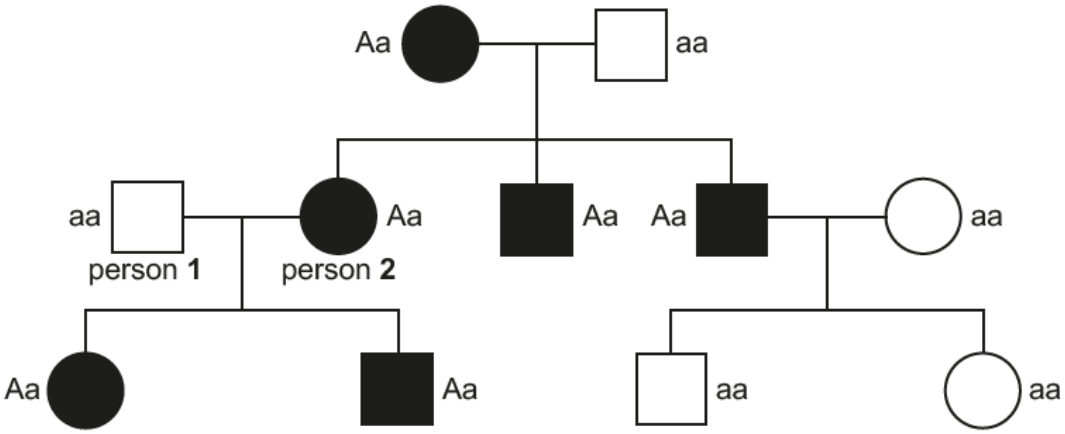
14. June/2022/Paper_J247/02/No.19

Amyloidosis is a group of inherited conditions that affect people's health.

The most common type of amyloidosis is caused by a dominant allele (**A**) of a gene.

The allele **A** codes for a harmful protein called amyloid.

(a) The diagram shows the inheritance of the allele in a family.



(i) Complete the table about the family tree.

The first row has been done for you.

	Number in the family
Number of males	**6**
Number of people who are homozygous recessive for the gene	
Number of people who have amyloidosis	

[2]

(ii) Person **1** and person **2** are expecting another baby.

Complete the genetic diagram to find the probability that the baby will have amyloidosis.

		Person **1**	
Person **2**	A		
	a		

Probability = ...

[2]

(b) Amyloid protein is made by blood cells called plasma cells.
Amyloid can stop the pancreas releasing insulin.
It can also prevent sensory neurones from working.

Explain why person **2** starts to develop symptoms of amyloidosis **and** suggest what these symptoms might be.

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..... **[3]**

15. June/2022/Paper_J247/02/No.20

Pine processionary moths lay eggs that develop into caterpillars, as shown in the diagram.

Moth

Caterpillar

(a) The caterpillars eat pine trees.
The caterpillars are eaten by birds such as cuckoos. The caterpillars are also parasitised by fungi.

Draw a food web to show these feeding relationships.

[2]

(b) The caterpillars have hairs on their bodies that cause irritation to predators.

Cuckoos have a special sticky membrane lining their guts that traps these hairs.

This allows the cuckoos to eat the caterpillars.

(i) Cuckoos evolved this sticky membrane by the process of natural selection.

The statements **A–E** show steps in this process.
They are **not** in the correct order.

A The gene for sticky membranes increases in the population.

B Cuckoos with sticky membranes reproduce and pass on the gene.

C Cuckoos with sticky membranes are more likely to survive.

D A change in a gene in the cuckoo produces a sticky membrane.

E Over many generations the cuckoos all have sticky membranes.

Write a letter in each box to show the correct order.
One has been done for you.

				E

[3]

(ii) Name the scientist who first published a book describing the theory of natural selection.

..... **[1]**

(c) Scientists use a fungus to kill the caterpillars to protect the pine trees.
The fungus is sprayed as spores which develop into the fungus.

Table 20.1 shows three treatments the scientists try.

Table 20.1

	Site of spraying	**Concentration of fungal spores used (million spores / ml)**	**How long the treatment lasts**
Treatment 1	on the tops of the pine trees	100	a few months
Treatment 2	on the soil around the pine trees	100 000	many years
Treatment 3	control (spraying with water)	0	

(i) Why is the use of the fungal spores an example of biological control?

..... **[1]**

(ii) How many times **more concentrated** are the spores in the spray used on the soil compared to the spray used on the tops of the pine trees?

Answer ..... **[1]**

(iii) **Table 20.2** shows the results of the scientists' spraying in one year.

Table 20.2

Site of spraying	Caterpillars killed (%)
on the tops of the pine trees	86.9
on soil	80.0
control (spraying with water)	3.7

The scientists made this statement:

> The fungal spores are an effective way to kill the caterpillars.
> The fungal spores should be sprayed on the soil not in the trees.

Discuss why the scientists are correct.
Use data from **Table 20.1** and **Table 20.2**.

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..... **[3]**