Surname	Centre Number	Candidate Number
First name(s)		0

wjec cbac

GCSE

S23-3430UD0-1

3430UD0-1

TUESDAY, 16 MAY 2023 – MORNING

SCIENCE (Double Award)
Unit 4 – BIOLOGY 2
HIGHER TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**10**	
2.	**5**	
3.	**7**	
4.	**8**	
5.	**6**	
6.	**8**	
7.	**11**	
8.	**5**	
Total	**60**	

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ADDITIONAL MATERIALS

In addition to this paper you may require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Question **5** is a quality of extended response (QER) question where your writing skills will be assessed.

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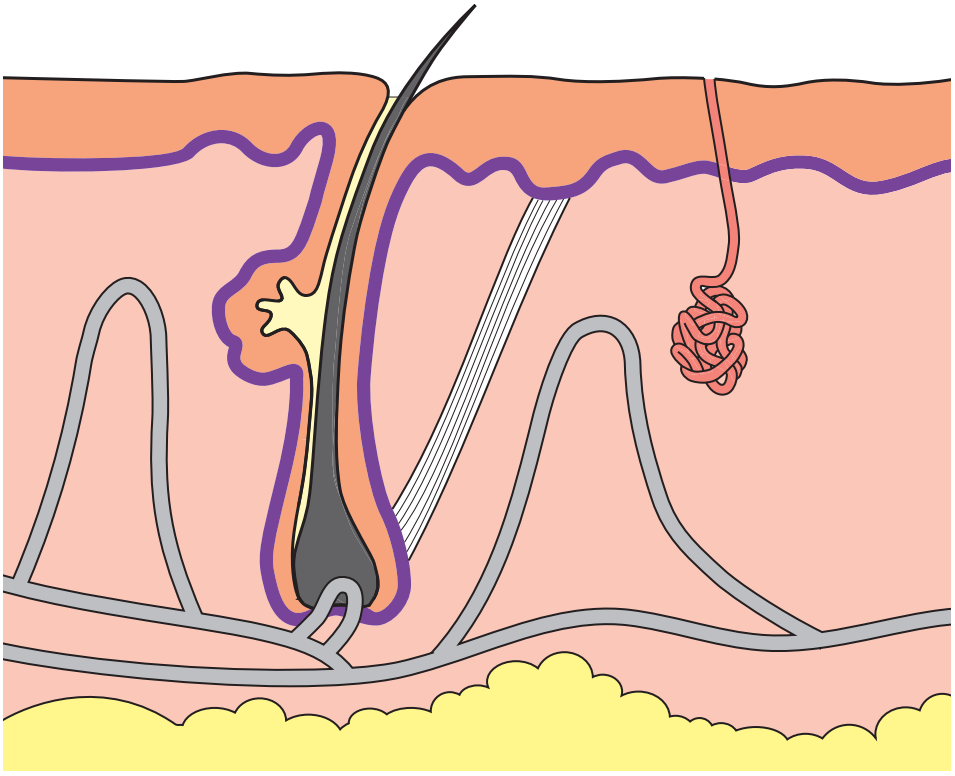
Answer **all** questions.

1. **Image 1.1** shows a section through human skin.

Image 1.1



(a) On **Image 1.1**, **use arrows to label**: [2]

I. the sweat duct
II. a blood vessel

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(b) Scientists investigated the effect of air temperature on both the skin temperature and core body temperatures of five volunteers. Core body temperature is the temperature of the internal organs of the body.

- The five volunteers were placed in a temperature controlled laboratory at −20 °C.
- The volunteers wore bathing suits and were kept at the temperature for 5 minutes after which their skin and core temperatures were recorded.
- The experiment was then repeated at other air temperatures over the next six days, each day at a different air temperature.

The skin temperatures at different air temperatures are shown in **Table 1.2**. The mean core body temperatures are shown on **Graph 1.3**.

Table 1.2

Air temperature (°C)	Skin temperature of volunteers (°C)					Mean skin temperature (°C)
	Volunteer number					
	1	2	3	4	5	
−20	21.4	22.0	22.6	21.8	21.5	21.9
−10	23.3	23.2	22.8	22.9	23.0	23.0
0	23.8	24.2	24.4	23.5	23.9	24.0
10	25.7	25.3	25.9	25.2	25.2	25.5
20	28.3	28.1	28.5	27.9	27.8	28.1
30	33.0	32.3	32.7	32.4	32.2	32.5
40	38.5	40.2	39.3	40.2	39.1	.....

(i) **Complete Table 1.2** by calculating the mean skin temperature of the five volunteers at a temperature of **40 °C**. [1]

(ii) I. Plot the **mean skin temperature** against the **left-hand** y-axis on **Graph 1.3**. The first two points have been plotted for you. [2]

II. **Join the plots with a ruler**. [1]

The mean core body temperature is already plotted against the right-hand y-axis.

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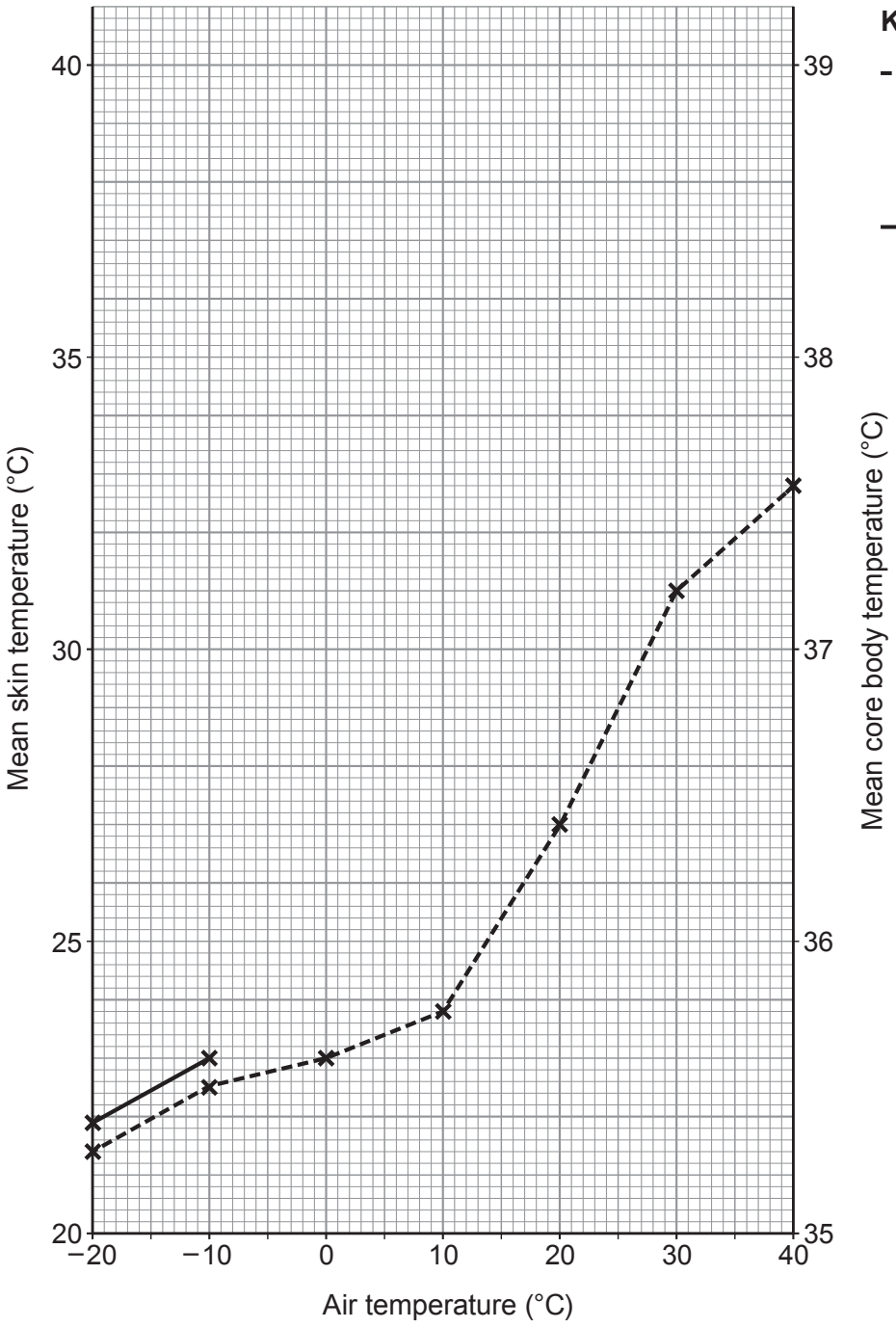
Graph 1.3



III. **From Graph 1.3** determine the mean core body temperature when the air temperature **is 25 °C**. [1]

Mean core body temperature when air temperature is 25 °C = ... °C

IV. From **Graph 1.3** state the relationship between the skin temperature and the core body temperature. [1]

.....

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(c) (i) Place a tick (✓) in **one** of the boxes below to show the processes which occur in the skin when air temperature is **low**. [1]

- ☐ blood vessels constrict, sweating reduces, hairs lowered on skin surface, shivering occurs
- ☐ blood vessels dilate, sweating reduces, hairs raised on skin surface, shivering occurs
- ☐ blood vessels constrict, sweating reduces, hairs raised on skin surface, shivering occurs
- ☐ blood vessels constrict, sweating increases, hairs raised on skin surface, shivering occurs

(ii) Place a tick (✓) in **one** of the boxes below to show the processes which occur in the skin when air temperature is **high**. [1]

- ☐ blood vessels dilate, sweating increases, hairs lowered on skin surface, shivering occurs
- ☐ blood vessels dilate, sweating increases, hairs lowered on skin surface, no shivering
- ☐ blood vessels constrict, sweating increases, hairs lowered on skin surface, no shivering
- ☐ blood vessels dilate, sweating decreases, hairs lowered on skin surface, no shivering

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2. (a) State the meaning of the term biological control. [1]

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(b) Many species of moths destroy food crops. The global effect of these pest species results in the loss of many billions of dollars per year. The stage in the life cycle of moths that causes the damage is the caterpillar, which eats the plant crop.

The simplified life cycle of most moths is shown in **Image 2.1**:

Image 2.1

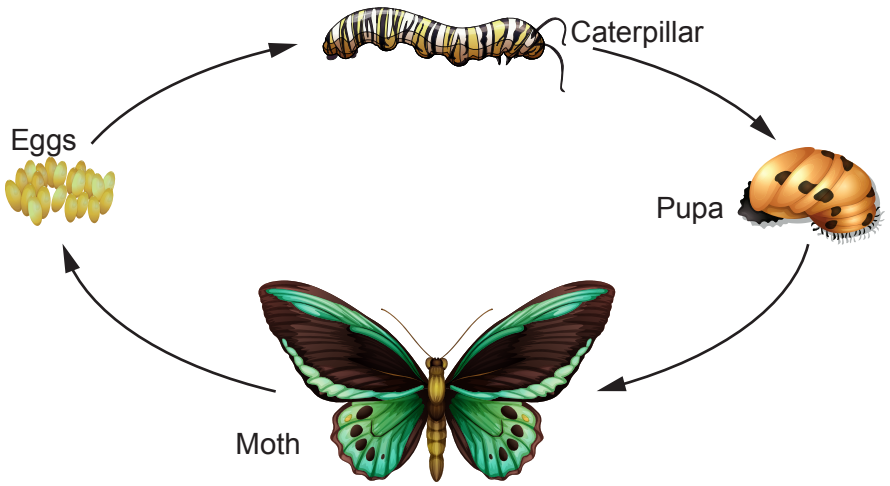

Table 2.2 shows five species of small wasps (*Trichogramma*) used as biological control agents. It also shows the stage in the moth life cycle they attack and the area of farmland in different countries where these biological control agents are already used successfully.

Table 2.2

Species of wasp	Stage of moth life cycle attacked by wasp	Food crops damaged by moth caterpillars	Region where wasp is used	Area of farmland where the wasp is used successfully (million hectares)
Trichogramma pretiosum	eggs	potatoes	China	2.0
Trichogramma platneri	caterpillars	corn, sugar cane	Mexico	1.5
Trichogramma acacioi	caterpillars	avocado and other fruit crops	Brazil	1.0
Trichogramma japonicum	caterpillars	rice, potatoes	South East Asia	0.3
Trichogramma ostriniae	caterpillars	corn	Europe	0.1

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As an advisor for the United Nations you are asked to advise the Government of Peru on the use of a biological control agent to prevent moth damage in potato crops.

(i) Using all the information given, suggest the best species of *Trichogramma* to use and give the reason for your choice. [2]

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(ii) State **one** factor that would need to be investigated before *Trichogramma* is released into the environment in Peru. [1]

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(iii) Suggest why it is not possible to conclude, from the information in the table, that the percentage of crops damaged by moths is less in China than it is in Europe. [1]

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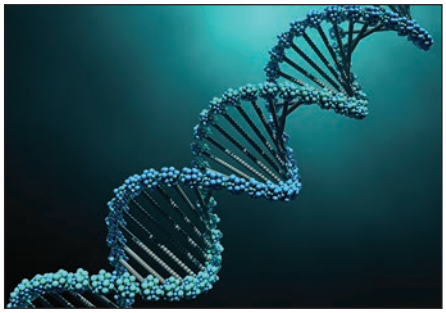
3. In the human genome, 99.9% of DNA is common in all individuals. The remaining 0.1% of the genome consists of DNA that is unique to individuals. During genetic profiling it is this unique 0.1% of the DNA that is separated and examined.

Image 3.1



Many online companies have websites that allow people to trace their ancestors and to build family trees. As part of this process they sell home DNA testing kits. Each kit contains a swab to remove cells from the inside of the user's cheek. The swab is placed in a container and sent to a laboratory where the DNA is extracted from the swab and processed for genetic profiling.

Image 3.2

(a) In **Image 3.2**, a swab is being used to remove cheek cells. The process is being carried out by another person and not by the person whose cheek cells are being collected. State why it is important for genetic profiling that the person using the swab is wearing gloves. [1]

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(b) State what has to happen to DNA before it can be separated into bands during genetic profiling. [1]

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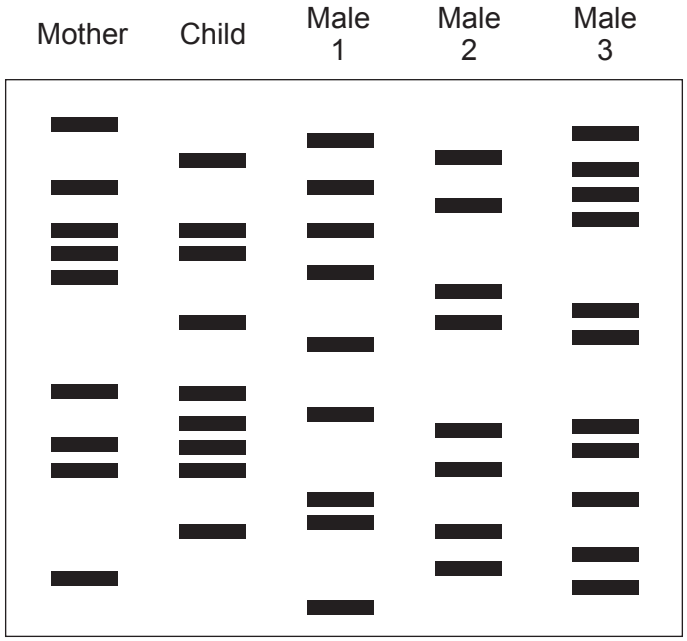
(c) Genetic profiles can be used in cases of disputed paternity. The genetic profile of both the mother and the child must be known. Any DNA band found in the genetic profile of the child that is not found in the genetic profile of the mother must be present in the genetic profile of the father for paternity to be confirmed.

Image 3.3 shows 5 genetic profiles, those of the mother and child, together with the profiles of three males who are disputing paternity of the child.

Image 3.3



(i) Using **Image 3.3**, state which male is the father of the child. [1]

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(ii) Support your answer by **circling three** DNA bands, on the profile of the father in **Image 3.3**, that proves your answer. [2]

(d) Apart from disputed paternity and tracing ancestors, give **two** other uses of genetic profiling. [2]

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4. The North American black bear *(Ursus americanus)* is widespread through the USA and Canada. In British Columbia a form of the North American black bear is found which is white or cream in colour. This form of the North American black bear is known as the Kermode or spirit bear. This is shown in **Image 4.1**. [This is not the same species as the polar bear *(Ursus maritimus)*.]

Image 4.1

Kermode or spirit bear

The white or cream colour of the Kermode bear is due to a recessive allele.

(a) (i) Two heterozygous North American black bears were mated. Using the letters **B** and **b**, complete the Punnett square below to show this cross. [2]

	Gametes	.....	.....
F1	.....	.....	.....
	.....	.....	.....

(ii) In the Punnett square **draw a circle** around the genotype of a Kermode bear offspring. [1]

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(iii) North American black bears reproduce every two years and produce 2–3 offspring at a time. Explain why, if they only produce 2–3 offspring at a time, the Punnett square contains boxes for four offspring. [2]

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(b) Explain why scientists use the scientific names *Ursus americanus* and *Ursus maritimus* when describing bears rather than the common names North American black bear and polar bear respectively. [1]

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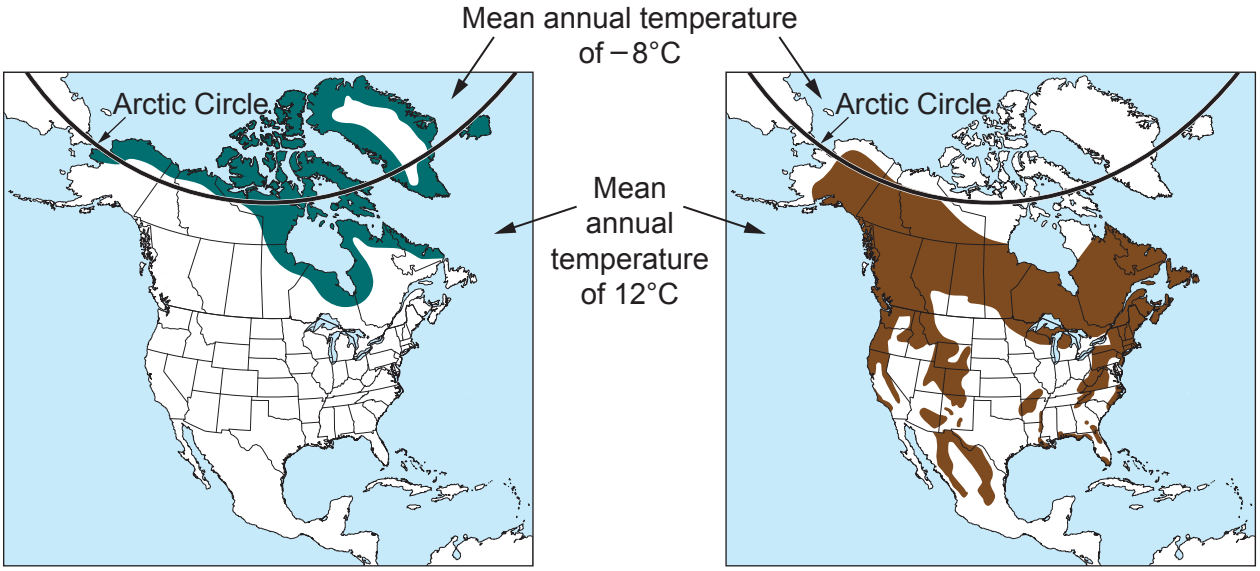
(c) Adult male polar bears have a mass of up to 450 kg. The male North American black bear is much smaller with a maximum mass of 158 kg. The shaded areas on the maps in **Image 4.2** show the range of these two bears in North America.

Image 4.2



Polar bear range in North America

North American black bear range

Use the maps in **Image 4.2**, and your own knowledge, to suggest a reason why the mass of an adult male polar bear is nearly three times as great as that of an adult male North American black bear. [2]

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5. Longworth traps are used to capture small mammals alive. They are baited with oats and supplied with a source of water. After being examined the mammals are released unharmed. Longworth traps must be checked at least once a day. **Image 5.1** shows a field vole and **Image 5.2** shows a Longworth trap.

Image 5.1

Field vole

Image 5.2

Longworth trap

Describe how you would estimate the population size of the field vole *(Microtus agrestis)* in a field of grass using the capture-recapture technique and Longworth traps.
You have 10 Longworth traps set at the same coordinates in the field for the whole time of the investigation and a pair of small scissors to clip 1 cm^2 of hair from the backs of the voles.

Population size can be estimated using the following equation:

$$\text{Population size} = \frac{\text{number in 1}^{st}\text{ sample} \times \text{number in 2}^{nd}\text{ sample}}{\text{number in 2}^{nd}\text{ sample previously marked}}$$

(NB **quadrats are not required** in this investigation.) [6 QER]

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6. The bacterium, *Bacillus thuringiensis*, commonly known as Bt, occurs naturally in the soil. Some strains of Bt produce poisonous proteins that kill certain insects.

Strains of Bt are effective against the caterpillars of European corn borer moths. Bt is not harmful to humans, other mammals, birds, fish, or beneficial insects. **Image 6.1** shows a european corn borer.

Image 6.1

European corn borer

In an attempt to control European corn borer damage in sweetcorn *(Zea mays)* scientists cut out the gene from the DNA of Bt which codes for the poisonous protein. This gene was then inserted into the DNA of a sweetcorn seed. The seed then grew into an adult plant. When this plant reproduced, all of its offspring contained the Bt gene. Sweetcorn that has been genetically modified by scientists to contain the Bt gene is known as Bt corn.

(a) Explain why, when the sweetcorn seed germinated and grew into the adult plant, every cell would contain the Bt gene. [2]

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(b) State why the Bt gene is described as a selective agent against the European corn borer. [1]

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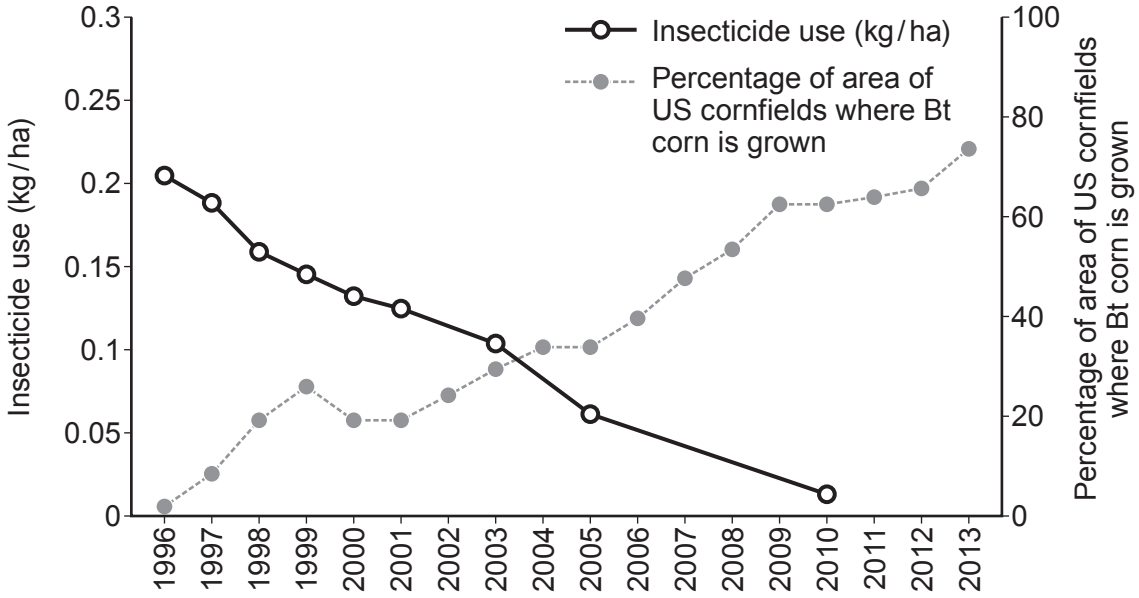
(c) An alternative to using Bt corn, is to use chemical sprays called insecticides which kill insect pests. **Graph 6.2** shows the percentage area of US cornfields where Bt corn is grown. It also shows insecticide use in kg / ha.

Graph 6.2



(i) Use **Graph 6.2** to **explain** the trend in the use of insecticide. [2]

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(ii) Since 2010 there has been an increased use of insecticide sprays in Bt cornfields in the US. Suggest a reason for this. [1]

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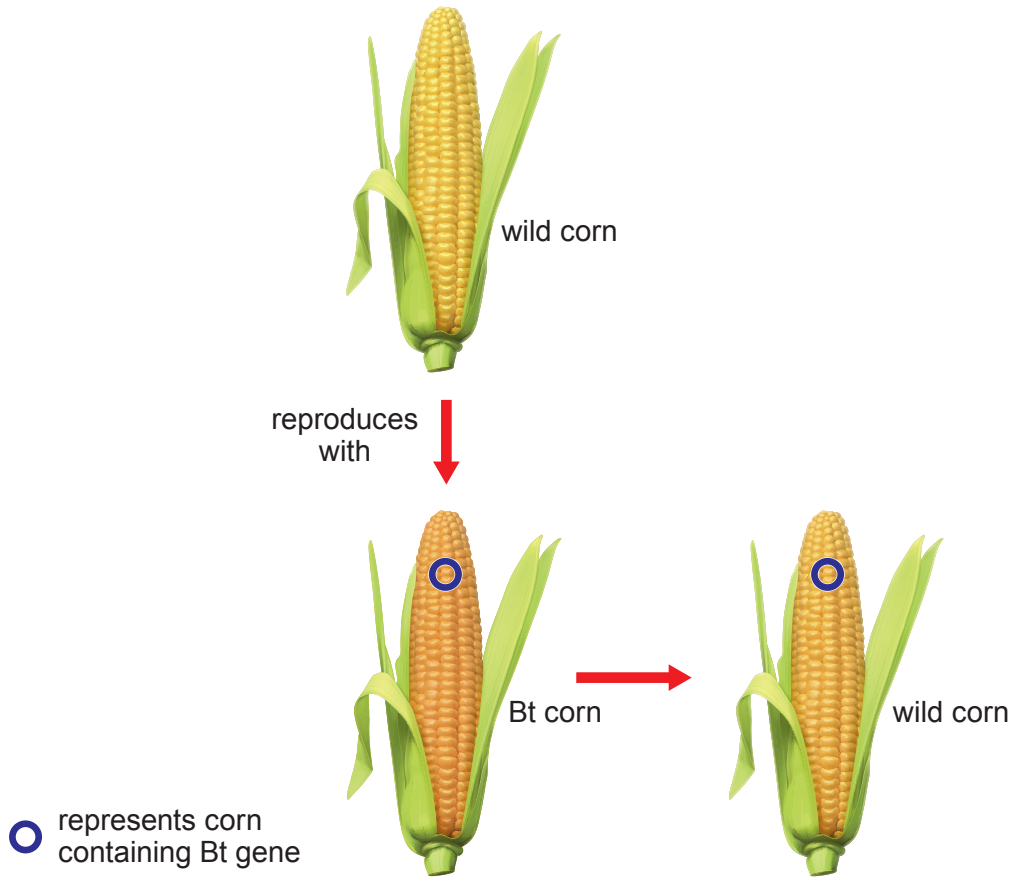
(d) **Image 6.3** illustrates one of the potential disadvantages of GM technology.

Image 6.3



Use **Image 6.3** to identify the potential danger of GM technology. [2]

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7. (a) State the meaning of the term hormone. [2]

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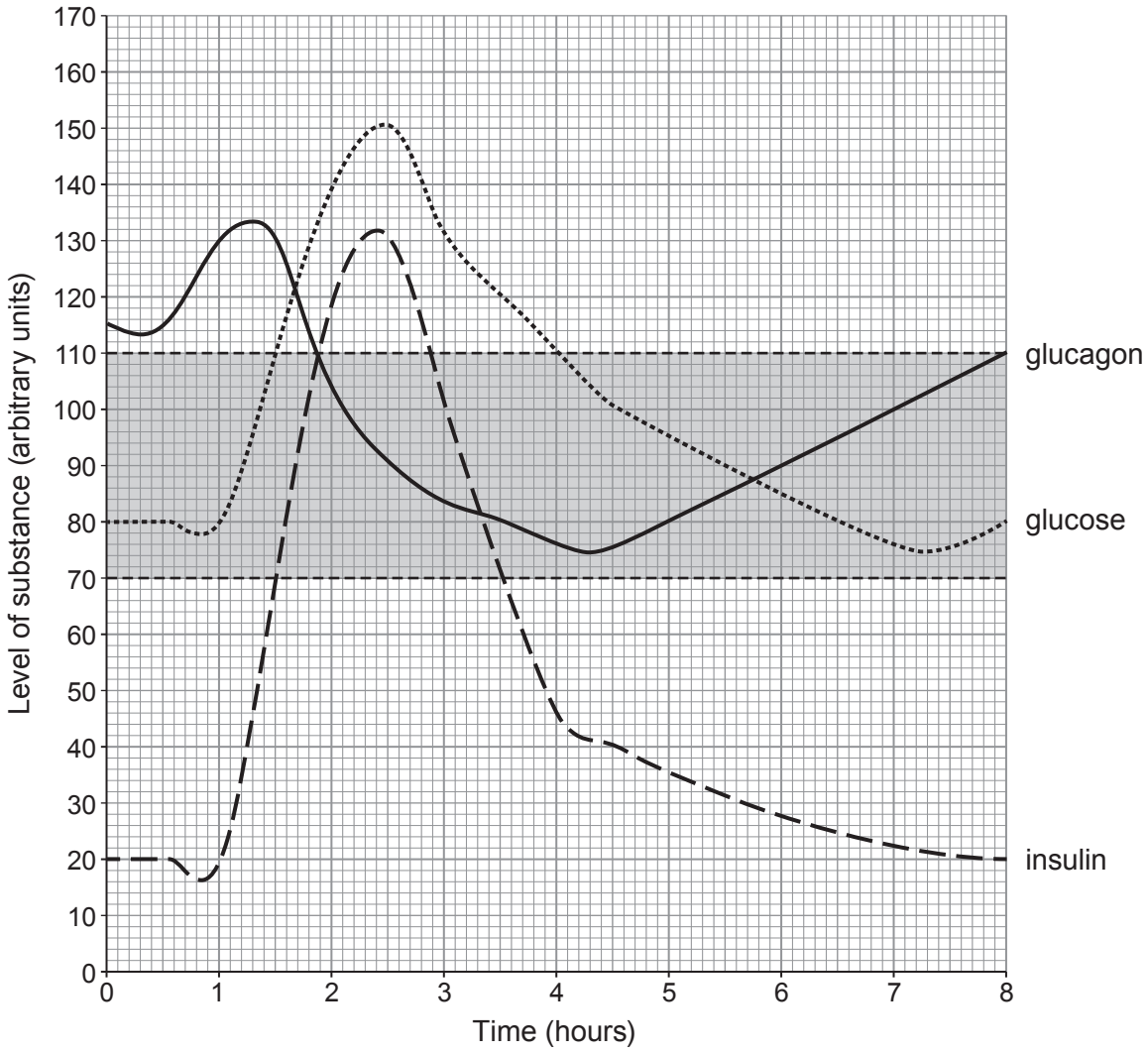
(b) The glucose, insulin and glucagon levels in the blood of a non-diabetic were monitored over an 8 hour period. **Graph 7** shows the results.

Graph 7



(i) Suggest what the band running across **Graph 7** between 70 and 110 arbitrary units represents. [1]

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(ii) I. Use **Graph 7** to describe the relationship between the level of insulin and glucose in the blood. [1]

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II. Name the homeostatic mechanism, occurring in the body, which maintains this relationship. [1]

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(iii) Explain why the glucagon level rises during the 1st hour of the monitoring. [3]

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(iv) A high carbohydrate meal was eaten during this investigation. Use **Graph 7** to identify the time at which the meal was eaten. Tick (✓) **one** box below to indicate your answer. [1]

At:

☐	1 h	☐	5 h
☐	2 h	☐	6 h
☐	3 h	☐	7 h
☐	4 h	☐	8 h

(v) The results for a Type 1 diabetic would be different to those shown in **Graph 7**. **Add labelled lines** to **Graph 7** to show how each of the following would appear in a **Type 1 diabetic**. **Your lines must stay between the hours indicated below.** [2]

I. the glucose line between **2–4** hours

II. the insulin line between **1–4** hours

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8. (a) **Complete the table** by writing in **true** or **false** against each of the following pairs of statements about antibiotics and vaccines. [2]

Statements	**True** or **False**
Antibiotics are produced from fungi. Vaccines are produced from dead or non-active pathogens.	.....
Antibiotics are used to prevent infection. Vaccines are used to treat infection.	.....
Antibiotics can cure infection caused by bacteria. Vaccines cannot cure infection caused by bacteria.	.....

(b) Smallpox was an infectious disease caused by a virus. An estimated 300 million people worldwide died from smallpox during the 20th Century. The last naturally occurring case was diagnosed in October 1977 and the World Health Organization certified the global eradication of the disease in 1980.

The global eradication was considered to have occurred because the smallpox vaccine was very effective and the programme of vaccination was thorough and worldwide.

However, some authorities dispute the claim that eradication was due to vaccination. They stated that deaths from smallpox were already decreasing in unvaccinated populations and that only 10% of the World's population were vaccinated.

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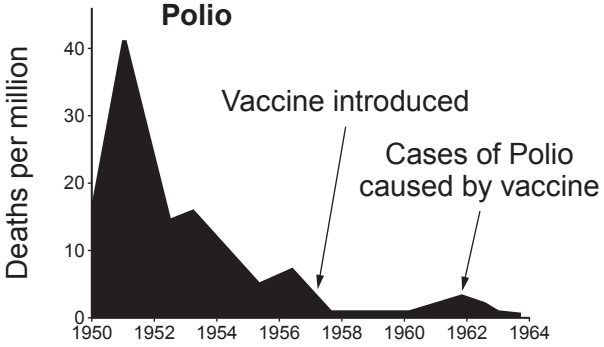
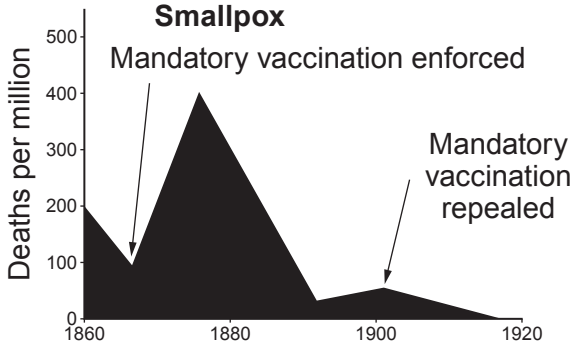
Graphs 8.1, **8.2**, **8.3** and **8.4** show data for four diseases that caused deaths in the UK in the 19th and 20th Centuries. They also show the dates at which vaccines for three of these diseases were introduced.

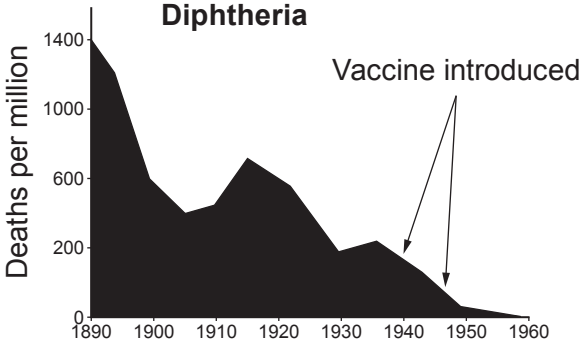
Graph 8.1



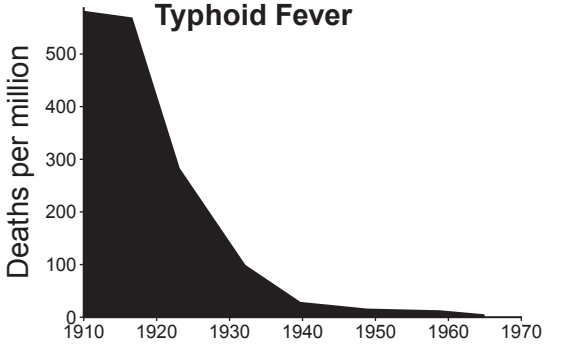
Graph 8.2



Graph 8.3



Graph 8.4



Note: **Mandatory vaccination enforced** means that by law people had to be vaccinated against smallpox.
Mandatory vaccination repealed means that people were no longer legally required to be vaccinated against smallpox.

Using **only** the information in **Graphs 8.1**, **8.2**, **8.3** and **8.4**, explain how they could be used as evidence both **for** and **against** the use of vaccination. [3]

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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