



GuideMyGrades

— YOUR GOALS. OUR EXPERTISE. —

EDEXCEL INTERNATIONAL GCSE BIOLOGY: QUESTIONS BY TOPIC

Reproduction and Inheritance (3)

International GCSE Biology Section 3

61 questions · 678 marks · Mark schemes included

Pearson Edexcel International GCSE (9–1) Biology 4BI1, Papers 1B, 1BR, 2B & 2BR, June 2019 - June 2025

 guidemygrades.com

 @Guidemygrades

 @Guidemygrades

 @Guidemygrades

 info@guidemygrades.com

 Piccadilly Business Centre, Unit C, Aldow Enterprise Park
Blackett Street, Manchester, M12 6AE

HOW TO USE THIS BOOKLET

Questions are grouped by specification sub-topic; within each sub-topic they run from the lowest mark tariff to the highest.

Click any sub-topic heading or question row below to jump straight to it.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

QUESTION	SOURCE	MARKS	PAGE
3(a) REPRODUCTION		26 questions · 288 marks	4
1. Q6	Paper 2BR June 2019	4	5
2. Q10	Paper 1B June 2025	6	6
3. Q1	Paper 1B January 2021	7	7
4. Q3	Paper 2BR January 2021	7	9
5. Q2	Paper 1B November 2020	8	11
6. Q1	Paper 1B January 2023	8	12
7. Q6	Paper 1BR January 2022	9	14
8. Q1 <i>also 5d</i>	Paper 1B November 2024	9	17
9. Q2	Paper 1B January 2022	10	20
10. Q7	Paper 1BR June 2023	10	22
11. Q8	Paper 1B November 2023	10	26
12. Q5	Paper 2B November 2020	11	29
13. Q5	Paper 2BR January 2023	11	31
14. Q5	Paper 2B June 2023	11	34
15. Q6	Paper 1B June 2019	12	37
16. Q10	Paper 1B January 2020	12	40
17. Q8	Paper 1BR January 2021	12	43
18. Q7 <i>also 3b</i>	Paper 1BR January 2023	12	46
19. Q5	Paper 1BR June 2025	12	49
20. Q5 <i>also 2d, 3b</i>	Paper 1BR November 2020	14	52
21. Q8	Paper 1B November 2021	14	55
22. Q2	Paper 2B November 2021	14	59
23. Q7	Paper 1B January 2021	16	62
24. Q1	Paper 2B June 2021	16	65
25. Q1	Paper 2BR January 2022	16	69
26. Q1 <i>also 5b</i>	Paper 2BR June 2025	17	73
3(b) INHERITANCE		35 questions · 390 marks	77
27. Q7	Paper 2B January 2020	6	78
28. Q3 <i>also 2j</i>	Paper 2B November 2020	7	80
29. Q1 <i>also 1b</i>	Paper 1B November 2020	8	82
30. Q7 <i>also 3a</i>	Paper 1B June 2021	8	85
31. Q4	Paper 2BR January 2023	8	87
32. Q5	Paper 2BR January 2020	9	89
33. Q5	Paper 1B January 2023	9	91



34.	Q4	<i>also 1b</i>	Paper 1BR January 2020	10	94
35.	Q6		Paper 2BR November 2020	10	96
36.	Q5		Paper 2B January 2021	10	97
37.	Q7	<i>also 2h</i>	Paper 1BR January 2022	10	99
38.	Q3		Paper 2B January 2023	10	101
39.	Q7		Paper 1BR June 2019	11	103
40.	Q5	<i>also 3a</i>	Paper 2B June 2019	11	105
41.	Q7		Paper 1B January 2020	11	108
42.	Q9		Paper 1BR January 2020	11	111
43.	Q4		Paper 2B January 2020	11	113
44.	Q9	<i>also 2h</i>	Paper 1B January 2021	11	115
45.	Q5		Paper 1BR January 2021	11	118
46.	Q7		Paper 1B November 2021	11	121
47.	Q2	<i>also 4d</i>	Paper 1BR June 2019	12	123
48.	Q5		Paper 2BR June 2019	12	126
49.	Q5		Paper 2BR June 2023	12	129
50.	Q5		Paper 1B June 2025	12	132
51.	Q9		Paper 1BR June 2025	12	134
52.	Q8		Paper 1B November 2020	13	137
53.	Q9		Paper 1BR November 2020	13	139
54.	Q6		Paper 2B January 2022	13	141
55.	Q4	<i>also 4d</i>	Paper 1B January 2023	13	145
56.	Q5		Paper 1B November 2023	13	148
57.	Q4		Paper 2B November 2023	13	151
58.	Q9		Paper 1B January 2022	14	154
59.	Q6		Paper 1B June 2023	14	157
60.	Q6		Paper 1B November 2024	15	160
61.	Q1	<i>also 2h</i>	Paper 2BR January 2021	16	164



QUESTIONS

61 questions · 678 marks · grouped by sub-topic



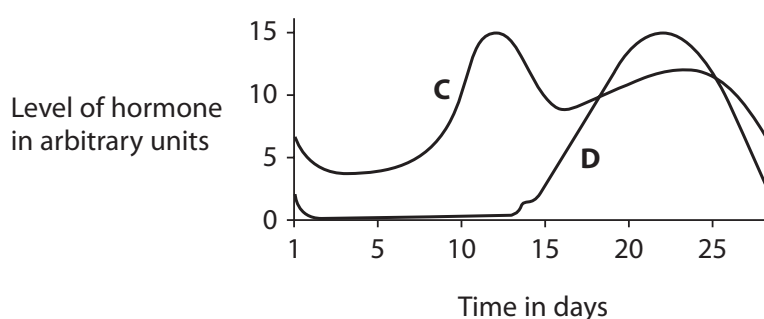
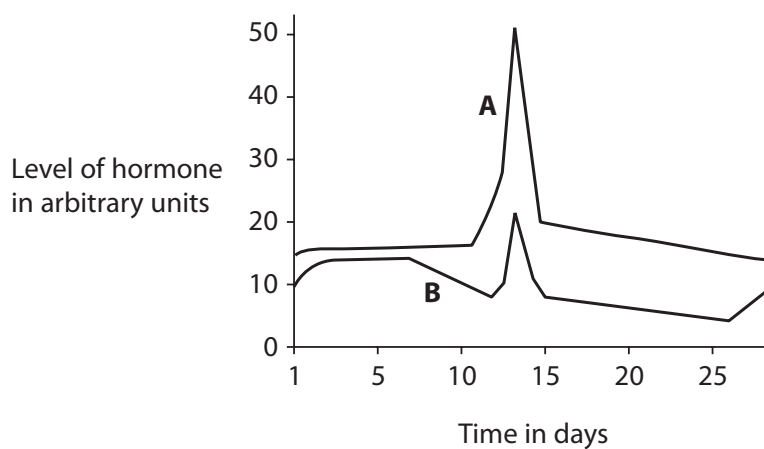
SUB-TOPIC 3(a)

REPRODUCTION

26 questions in this sub-topic · 288 marks · lowest tariff first



- 6 The graphs show changes in the levels of four hormones, A, B, C and D, that control the menstrual cycle.



- (a) Hormone A stimulates ovulation.

(i) Give the name of this hormone.

(1)

(ii) State what is meant by the term **ovulation**?

(1)

(b) Give the name of hormone D.

(1)

(c) State the source of hormones C and D.

(1)

(Total for Question 6 = 4 marks)



10 Some species of seed will only germinate after they have been exposed to light.

Design an investigation to determine if exposure to light affects germination.

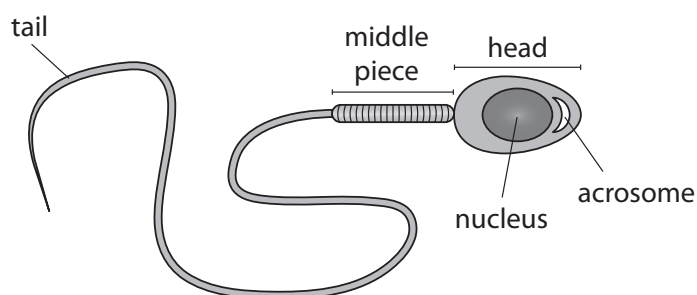
Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 10 = 6 marks)



1 The diagram shows a human sperm cell.



(a) What is the maximum number of X chromosomes found in the nucleus of a sperm cell?

(1)

- ☐ A 0
- ☐ B 1
- ☐ C 2
- ☐ D 23

(b) The middle piece of the sperm cell contains mitochondria.

Explain the function of these mitochondria.

(2)

.....

.....

.....

.....

(c) The acrosome contains digestive enzymes.

Suggest the function of the acrosome.

(2)

.....

.....

.....

.....

(d) Describe the route taken by a sperm cell from when it enters the woman's body to the site of fertilisation of the egg.

(2)

(Total for Question 1 = 7 marks)



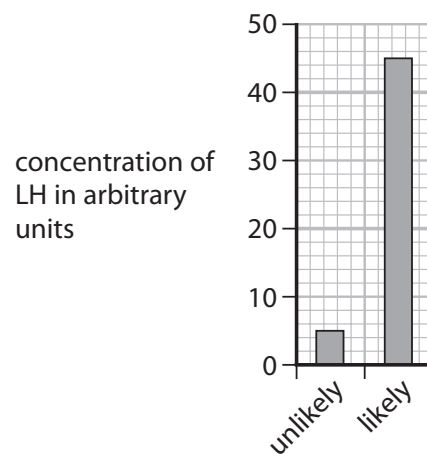
3 The hormones FSH and LH are involved in the regulation of the menstrual cycle.

(a) Which row gives the correct source for each hormone?

(1)

	Source of FSH	Source of LH
☐ A	ovary	pituitary
☐ B	ovary	ovary
☐ C	pituitary	pituitary
☐ D	pituitary	ovary

(b) The graph shows the concentration of LH in the blood of a woman when she is unlikely to become pregnant and when she is likely to become pregnant.



Calculate the percentage increase in concentration of LH in the blood from when the woman is unlikely to become pregnant to when the woman is likely to become pregnant.

(2)

percentage increase = ... %



(c) Describe the roles of the hormones FSH and LH.

(4)

FSH.....

.....

.....

.....

LH.....

.....

.....

.....

(Total for Question 3 = 7 marks)



2 The passage describes reproduction in flowering plants.

Complete the passage by writing a suitable word in each blank space.

(8)

Flowers are organs that allow plants to carry out reproduction.

The male gamete is contained within the grains. These grains

are released from the , which is found on top of the filament.

These grains need to land on the , the female part of the flower.

Grains can be transferred by wind or by animals. These animals are often insects such as

..... or butterflies. The petals of insect-pollinated plants are often

..... and brightly coloured. After pollination, the grains

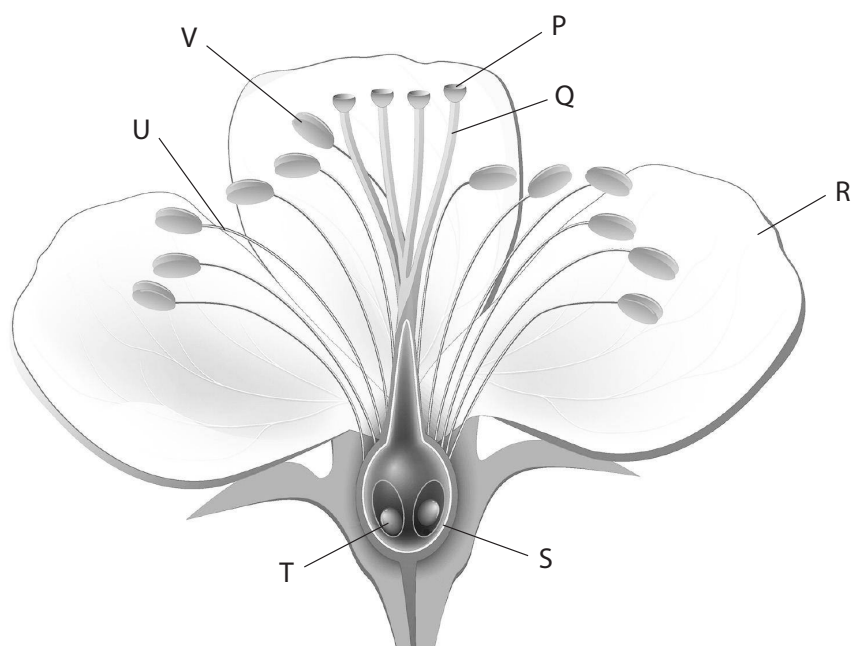
germinate and a tube grows down the to reach the ovary.

In the ovary, the gametes fuse. This process is known as

(Total for Question 2 = 8 marks)



- 1 The diagram shows a flower from an apple tree, with some structures labelled.



(Source: © Designua/Shutterstock)

- (a) (i) This apple tree is able to self-pollinate. Which is the correct transfer of pollen during pollination?

(1)

- ☐ A P to Q
- ☐ B P to T
- ☐ C V to P
- ☐ D V to S

- (ii) Which structure does the pollen tube grow down?

(1)

- ☐ A Q
- ☐ B U
- ☐ C V
- ☐ D R

(iii) Which structure develops into the seed?

(1)

☐ **A** P

☐ **B** S

☐ **C** T

☐ **D** V

(b) The flower from an apple tree is insect-pollinated.

Give three differences between the structure of this apple flower and the structure of a wind-pollinated flower such as grass.

(3)

1

.....

.....

2

.....

.....

3

.....

.....

(c) The seeds of many plants are surrounded by sweet-tasting fruit.

Suggest how this enables the plants to spread their seeds.

(2)

.....

.....

.....

.....

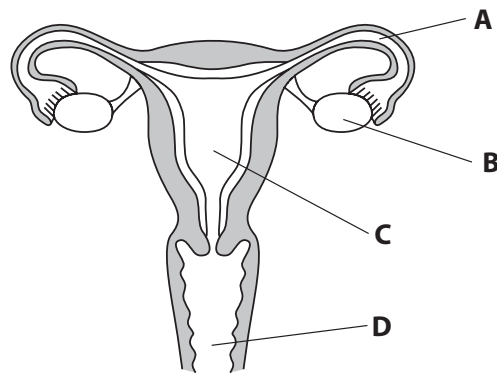
.....

.....

(Total for Question 1 = 8 marks)



6 The diagram shows the human female reproductive system.



(a) (i) Which label shows where ovulation occurs?

(1)

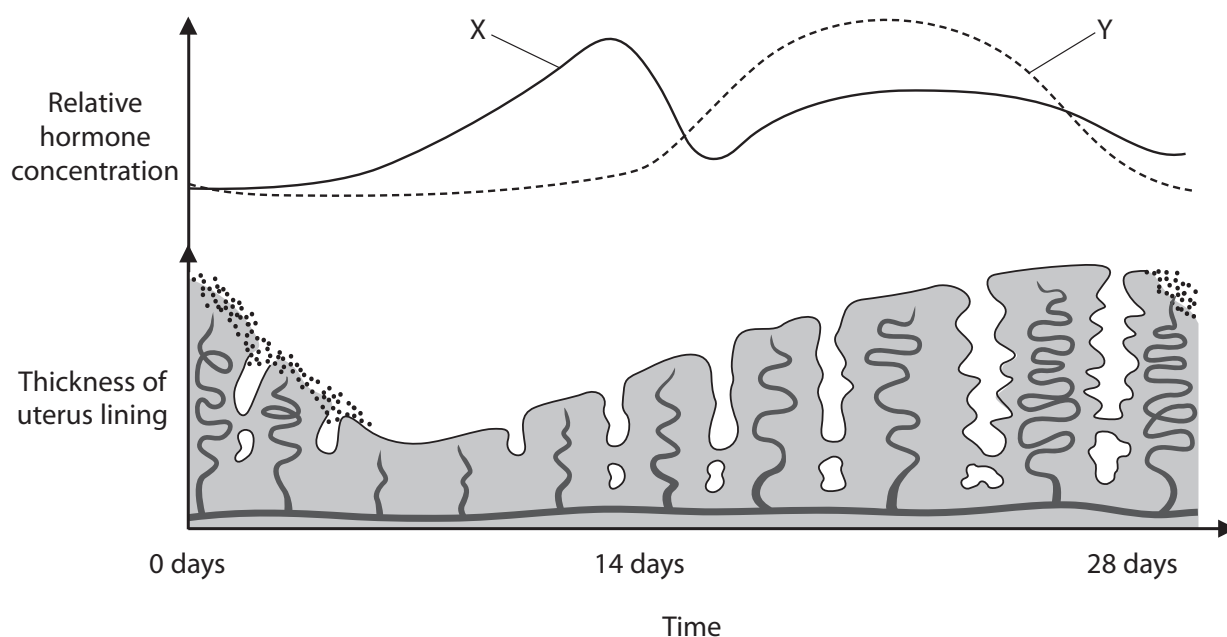
- ☐ A
- ☐ B
- ☐ C
- ☐ D

(ii) Which label shows where fertilisation usually occurs?

(1)

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(b) The diagram shows the changes in thickness of the uterus lining and levels of two hormones produced by the ovary during a menstrual cycle.



(i) Hormones X and Y are produced by the ovaries.

Name X and Y.

(2)

X

Y

(ii) Explain the function of hormone X during the menstrual cycle.

(2)

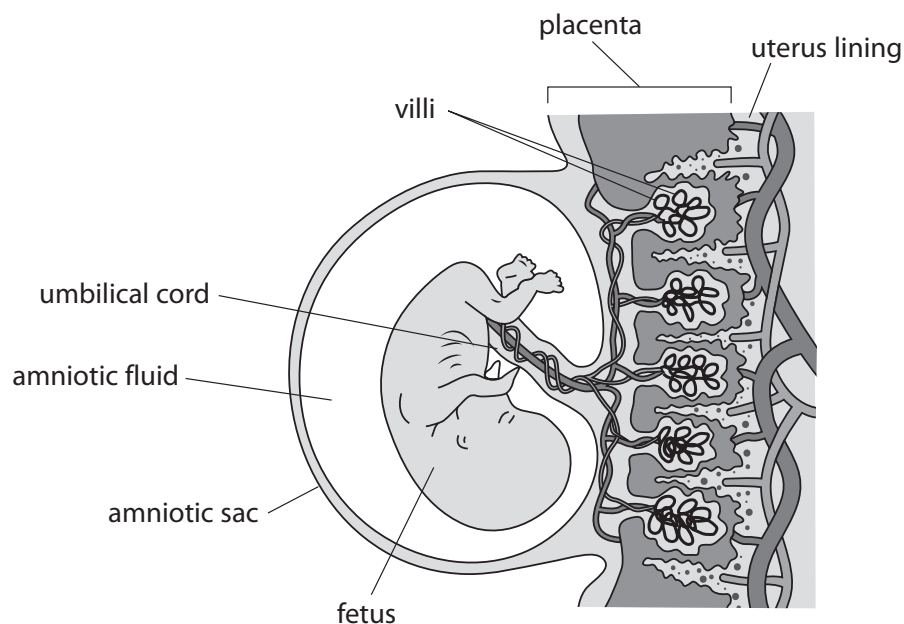
.....

.....

.....

.....

(c) The diagram shows a human fetus developing in the uterus.



Explain how the structure of the placenta enables the efficient exchange of substances between the fetus and the mother.

(3)

.....

.....

.....

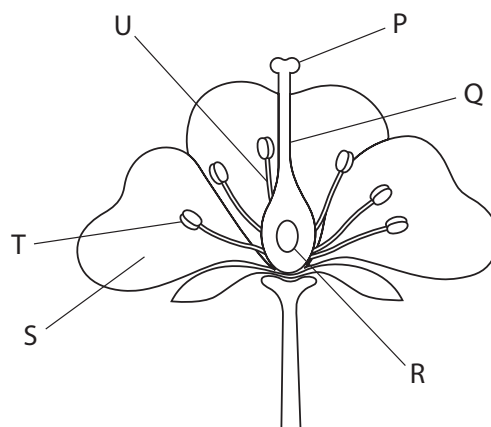
.....

.....

.....

(Total for Question 6 = 9 marks)

1 The diagram shows an insect-pollinated flower with some structures labelled.



(a) (i) Which structures are the male parts of the flower?

(1)

- ☐ A P and Q
- ☐ B P and R
- ☐ C S and T
- ☐ D T and U

(ii) On which structure does the pollen grain germinate?

(1)

- ☐ A P
- ☐ B R
- ☐ C S
- ☐ D T

(iii) Which structure becomes the seed after fertilisation?

(1)

- ☐ A P
- ☐ B Q
- ☐ C R
- ☐ D T

(b) The picture shows a strawberry plant.

This plant can reproduce sexually using its flowers, or asexually.



(Source: © Havryliuk-Kharzhevskia / Shutterstock)

(i) Describe how a strawberry plant reproduces asexually.

(2)

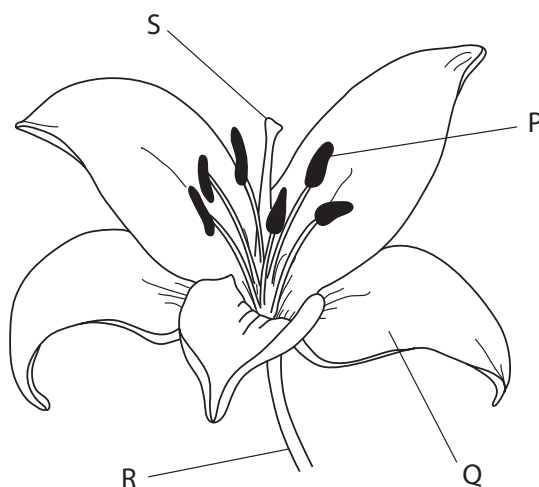
.....

.....

.....

.....

2 The diagram shows an insect-pollinated flower called a lily.



(a) (i) Which of these is the name of structure P?

(1)

- ☐ A anther
- ☐ B filament
- ☐ C stigma
- ☐ D style

(ii) Which of these is the name of structure Q?

(1)

- ☐ A leaf
- ☐ B petal
- ☐ C stem
- ☐ D style

(iii) On which structure do pollen grains germinate?

(1)

- ☐ A P
- ☐ B Q
- ☐ C R
- ☐ D S

(b) Describe how the structures of P, Q and S would differ in a wind-pollinated flower.

(3)

(c) Plants can also reproduce by asexual reproduction.

(i) Give one natural method that plants use to reproduce asexually.

(1)

(ii) Give one artificial method that a plant grower may use to reproduce a plant asexually.

(1)

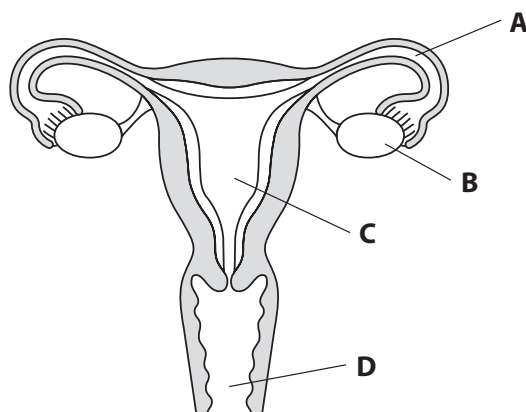
(iii) Suggest why a plant grower may choose to reproduce a plant asexually rather than allowing the plant to reproduce sexually.

(2)

(Total for Question 2 = 10 marks)



7 The diagram shows the human female reproductive system.



(a) (i) Where does fertilisation normally occur?

(1)

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(ii) State how oestrogen and progesterone affect structure C during the menstrual cycle.

(2)

oestrogen

.....

.....

progesterone

.....

.....

(b) *In vitro* fertilisation (IVF) is used to help some people have children.

Eggs are mixed with sperm in a laboratory.

Embryos are then transferred into a uterus.

(i) Describe how an embryo forms after the eggs and sperm have been mixed together.

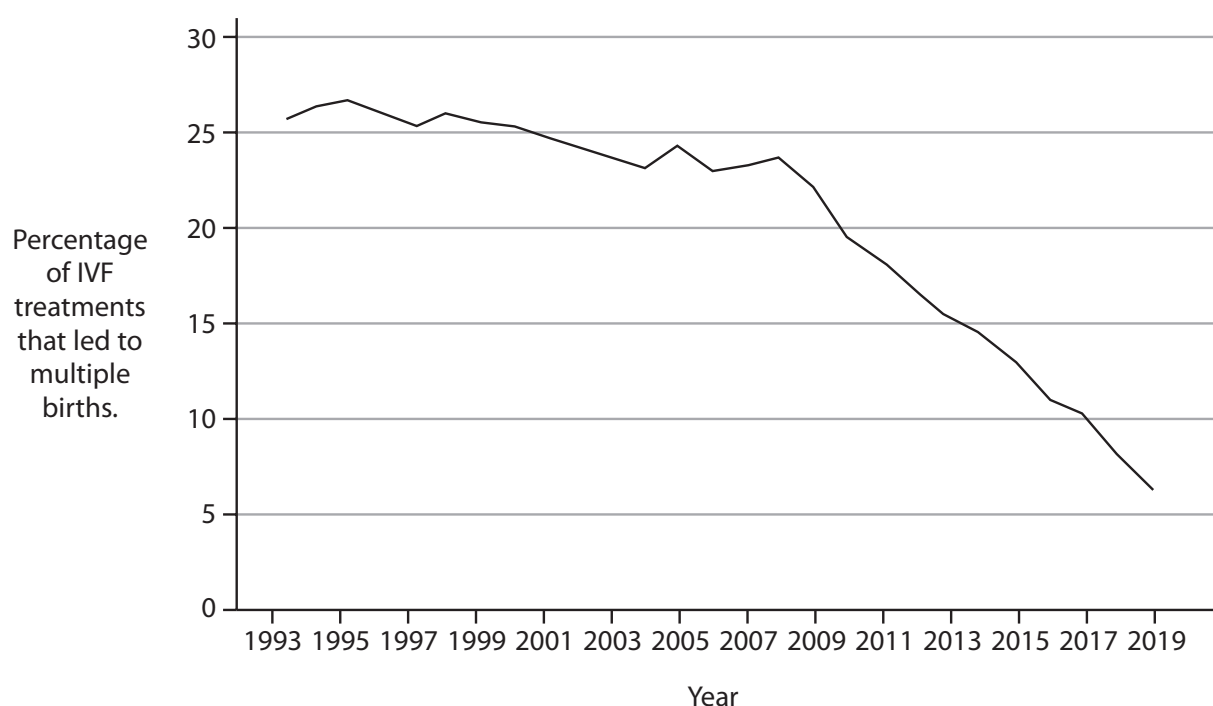
(2)

- (ii) If more than one embryo is transferred to a uterus, IVF can result in multiple births, such as twins or triplets. Pregnancies that produce more than one baby can be a health risk.

In the United Kingdom, since 2007, the recommendations for the number of embryos transferred are

- a person under 40 should have only one embryo placed into their uterus
- a person over 40 may have two embryos placed into their uterus

The graph shows the percentage of IVF treatments that led to multiple births from 1993 to 2019.



The table shows the success rates for IVF in the United Kingdom in 2019 for people of different age groups.

Age of person receiving embryo in years	Percentage of IVF treatments that produced a baby (%)
under 35	32
35 to 37	28
38 to 39	19
40 to 42	11
43 to 44	5
45 to 50	4

Discuss the effects of limiting the number of embryos transferred.

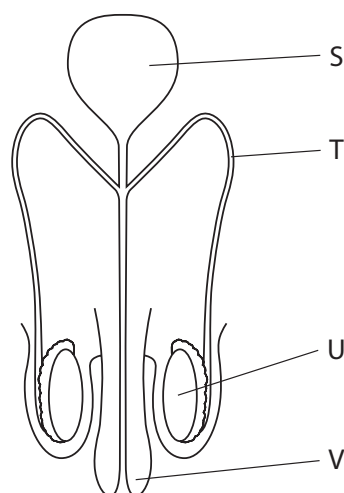
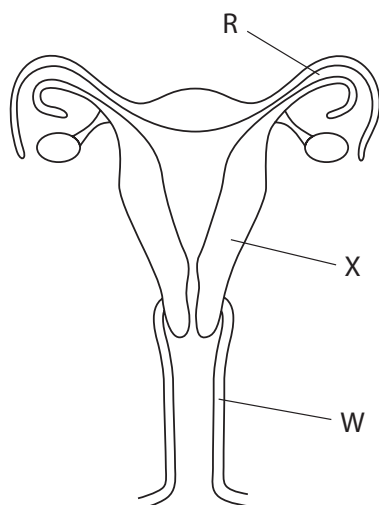
Use the information in the table and the graph to support your answer.

(5)

(Total for Question 7 = 10 marks)



- 8 The diagrams show the female reproductive system and the male reproductive system with some structures labelled.



- (a) (i) Which structure produces gametes?

(1)

- ☐ A R
☐ B S
☐ C U
☐ D X

- (ii) Which structure is the site of fertilisation?

(1)

- ☐ A R
☐ B S
☐ C W
☐ D X

- (iii) In which structure does the placenta usually develop?

(1)

- ☐ A R
☐ B S
☐ C W
☐ D X

- (b) Some males have an operation called a vasectomy. This means that they do not release sperm.

This involves cutting and sealing the sperm ducts (vas deferens) inside the man's scrotum.

- (i) On the diagram draw two lines to show where the cuts are made.

(1)

- (ii) Explain why this operation can be used as a permanent way of preventing pregnancy.

(2)

- 5 (a) The table gives information about some hormones involved in the menstrual cycle.
Complete the table by giving the missing information.

(6)

Hormone	Name of structure that secretes hormone	Functions of hormone
FSH		1..... 2 stimulates oestrogen secretion
.....	pituitary	1..... 2 stimulates development of corpus luteum
.....	ovaries	1 repairs lining of uterus 2 stimulates LH secretion
progesterone		1 maintains the lining of uterus 2 inhibits LH



(b) State what is meant by the term **menstruation**.

(1)

(c) A girl starts to ovulate at the age of 12 years and continues to ovulate until she reaches the age of 51 years.

[Assume her menstrual cycle is 28 days and she releases one egg per cycle.]

Estimate the maximum number of eggs she could release in her lifetime.

Give your answer to two significant figures.

(3)

number of eggs = ...

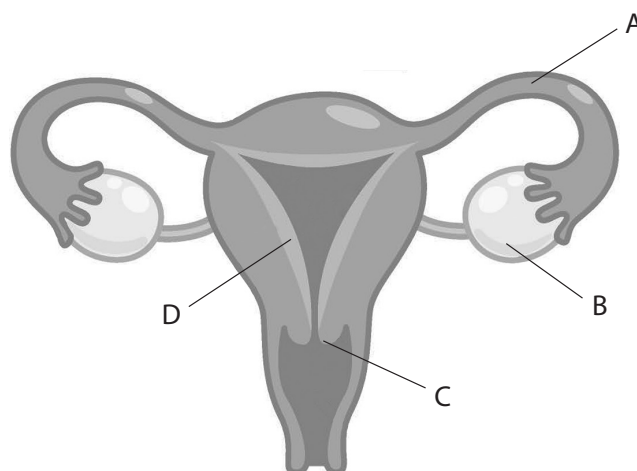
(d) Give a reason why a female does not produce as many offspring as the number of eggs she releases.

(1)

(Total for Question 5 = 11 marks)



- 5 The diagram shows part of the female reproductive system with some structures labelled.



(Source: © polikhay/Shutterstock)

- (a) Name the structures labelled A, B and C.

(3)

A.....

B.....

C.....

- (b) Describe the role of structure D in reproduction.

(2)

.....

.....

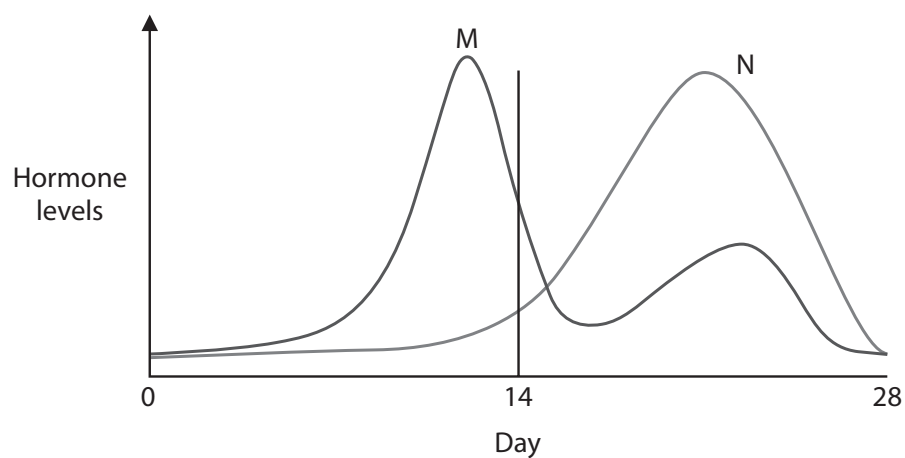
.....

.....

.....

.....

- (c) The graph shows the changes in the levels of hormones released from structure B during one menstrual cycle.



- (i) Explain the importance of the changes in hormone M and hormone N during the menstrual cycle.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Other hormones are involved in the menstrual cycle.

Describe the role of one other named hormone in the menstrual cycle.

(2)

(Total for Question 5 = 11 marks)

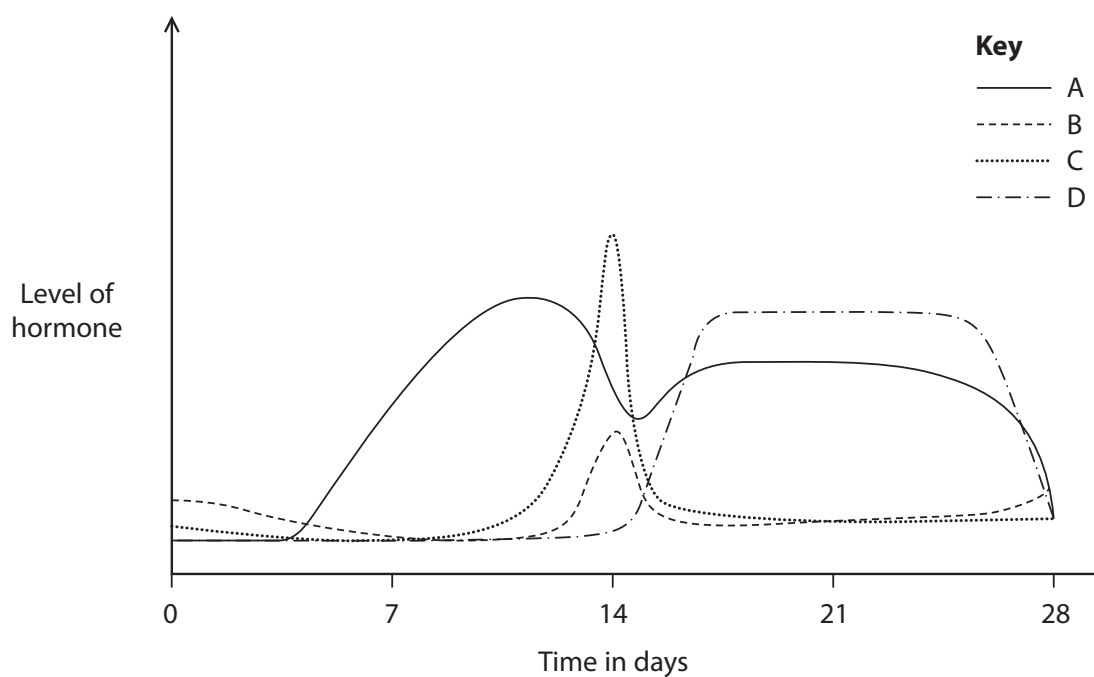


5 Hormones control the menstrual cycle.

(a) (i) Name the gland that produces FSH.

(1)

(ii) The diagram shows the changes in four hormones during the human menstrual cycle.



Which line represents the hormone progesterone?

(1)

- ☒ A
- ☒ B
- ☒ C
- ☒ D

(iii) Describe the roles of FSH and LH in the menstrual cycle.

(4)

FSH

LH

(b) Reproductive hormones can be used as contraceptives to prevent pregnancy.

The table gives information about three different methods of hormonal contraception.

Method	Description	Percentage effectiveness in preventing pregnancy (%)
oral tablets	tablets taken every day at same time	91 to 99
injection	- injection into muscle by medical professional - injection is repeated every 12 weeks	94 to 99
implant	- plastic rod containing hormones is surgically placed under skin of upper arm - can last for up to three years and then needs replacing	94 to 99

Discuss the advantages and disadvantages of the three methods of contraception shown in the table.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

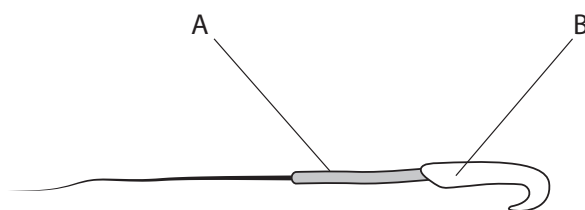
.....

.....

(Total for Question 5 = 11 marks)



6 The diagram shows a sperm cell from a rat.



(a) (i) Describe the role of a sperm cell.

(1)

(ii) Describe the structures found in part B.

(2)

(iii) Explain why part A contains many mitochondria.

(2)

(b) Nicotine is a chemical found in cigarettes.

A scientist investigates how nicotine affects sperm cells.

The scientist gives male rats different concentrations of nicotine.

He then calculates the percentage of damaged sperm cells in the semen produced by each rat.

The table shows his results.

Concentration of nicotine in mg per kg of rat	Percentage of damaged sperm cells (%)
0.0	6.4
0.5	16.8
1.0	24.8

- (i) The sample of semen from a rat given a nicotine concentration of 1.0 mg per kg contains 5.8×10^7 sperm cells.

Calculate the number of damaged sperm cells in this sample.

(2)

number = ...



(ii) The scientist concludes that cigarette smoking could make male humans infertile.

Discuss this conclusion.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

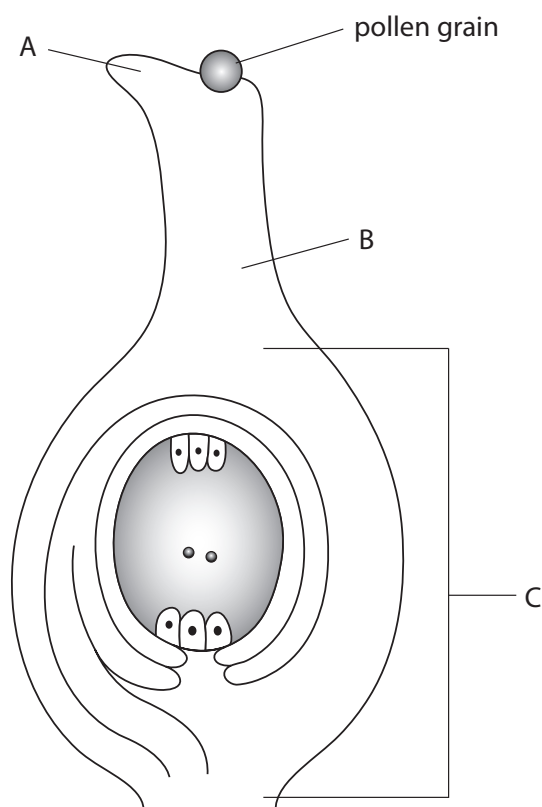
.....

.....

.....

(Total for Question 6 = 12 marks)

10 (a) The diagram shows some of the structures involved in fertilisation in a flowering plant.



(i) Name the parts labelled A, B and C.

(3)

A

B

C

(ii) On the diagram, draw the path the pollen tube takes after the pollen grain has germinated.

(2)

(iii) Describe what happens to the structures in part C after fertilisation.

(2)

.....

.....

.....

.....

.....

(b) A scientist investigates the effect of four different storage conditions on the germination of grass seeds.

She stores 500 seeds in each storage condition for two months.

She then counts the number of seeds that germinate when planted.

The table shows her results.

Storage condition	Number of seeds that germinate
wet and cold	476
dry and cold	444
dry and warm	440
wet and warm	432

(i) Calculate the percentage increase in the number of seeds that germinate in wet and cold conditions compared to the number of seeds that germinate in wet and warm conditions.

(2)

percentage increase = ...%



(ii) Suggest why fewer seeds germinate when they are stored in wet and warm conditions than in the other conditions.

(2)

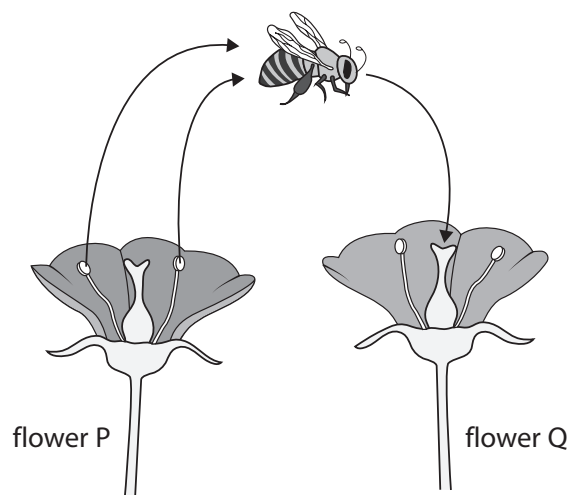
(iii) Give one observation that shows a seed has germinated.

(1)

(Total for Question 10 = 12 marks)



- 8 The diagram shows an insect transferring pollen grains from flower P to flower Q.



- (a) Which structure in flowers contains pollen grains?

(1)

- ☐ A anther
- ☐ B ovary
- ☐ C petal
- ☐ D sepal

- (b) (i) Pollen grains are deposited on the stigma and grow tubes down the style.

Suggest how style tissue helps the tube to grow.

(2)

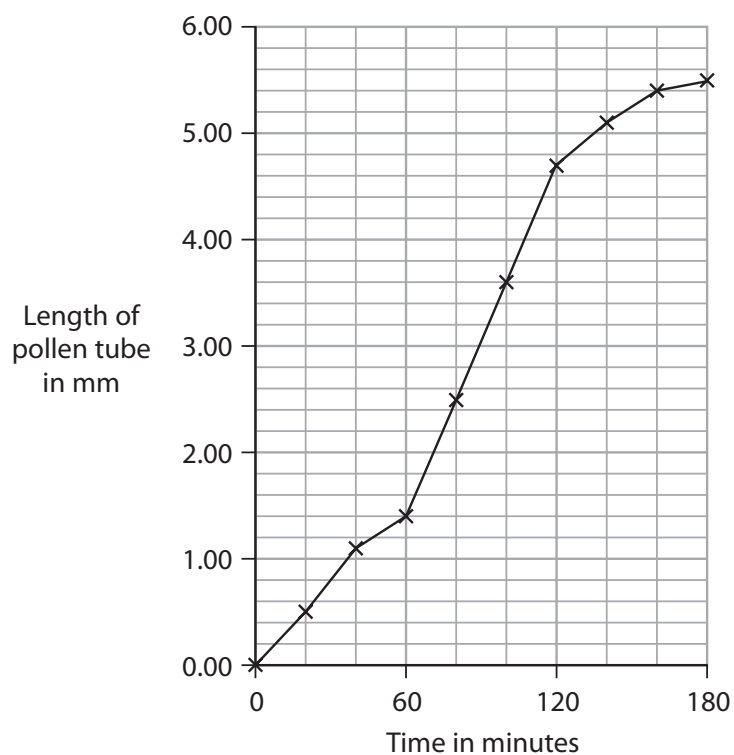
.....

.....

.....

.....

(ii) The graph shows the change in the length of a pollen tube over a 180 minute period.



Calculate the fastest rate of pollen tube growth in mm per minute.

(3)

fastest rate of growth: mm per minute

(c) A farmer grows apple trees.

The flowers on the apple trees must be pollinated by insects to produce an apple crop.

The farmer is concerned that the use of pesticides may affect the yield of apples.

Design an investigation to find out if pesticides reduce the yield of apples.

Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 8 = 12 marks)



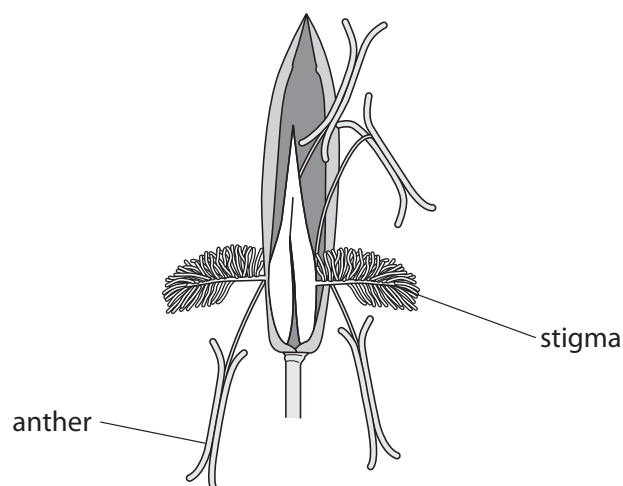
7 A species of grass has a diploid chromosome number of 12.

(a) Which row in the table shows the number of chromosomes in the nucleus of a pollen grain, and in the nucleus of a root cell, of this grass?

(1)

Number of chromosomes present		
	Pollen grain nucleus	Root cell nucleus
☐ A	6	6
☐ B	6	12
☐ C	12	6
☐ D	12	12

(b) The diagram shows a flower from the grass plant.



Explain two ways this flower is adapted for wind pollination.

(4)

1

.....

.....

.....

.....

2

.....

.....

.....

.....

(c) Scientists use this method to investigate self-pollination and cross-pollination in a species of grass plant.

- take pollen grains from the anther of a flower
- place some of the pollen grains on the stigma of the same flower
- after one day, count how many of the pollen grains grow a pollen tube

Repeat the method but place the pollen grains on the stigma of a flower of a different plant.

The table shows the scientists’ results.

Pollen transfer	Percentage of pollen grains that grow a pollen tube
pollen transferred to the stigma of same flower	5
pollen transferred to the stigma of a flower on a different plant	75

(i) State the dependent variable in this investigation.

(1)

(ii) Explain how the results of the investigation show that this species of grass plant is able to survive in a changing environment.

Use the information in the table to support your answer.

(3)

(d) Grass plants can also be produced by asexual reproduction.

New plants are produced from the roots of a parent plant.

(i) State the name of the type of cell division used to produce new plants by asexual reproduction.

(1)

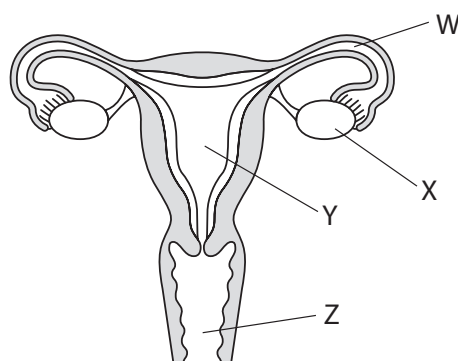
(ii) Describe why it is an advantage for commercial growers to produce plants by asexual reproduction.

(2)

(Total for Question 7 = 12 marks)



- 5 The diagram shows the human female reproductive system with some structures labelled.



- (a) (i) In which structure does ovulation occur?

(1)

- ☒ A W
☒ B X
☒ C Y
☒ D Z

- (ii) Explain the importance of progesterone in the menstrual cycle.

(2)

.....

.....

.....

.....

- (iii) Explain how the placenta enables a developing embryo to obtain nutrients.

(3)

.....

.....

.....

.....

.....

.....

(b) For fertilisation to occur, a sperm needs to reach an ovum.

(i) Which of these describes the number of chromosomes in the nucleus of a human sperm?

(1)

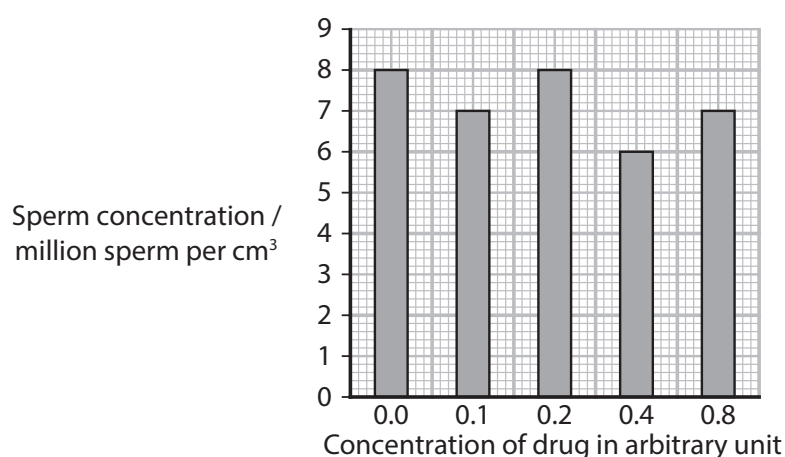
- ☐ **A** diploid number of 23 chromosomes
- ☐ **B** diploid number of 46 chromosomes
- ☐ **C** haploid number of 23 chromosomes
- ☐ **D** haploid number of 46 chromosomes

(ii) Scientists are developing a contraceptive drug to reduce fertility.

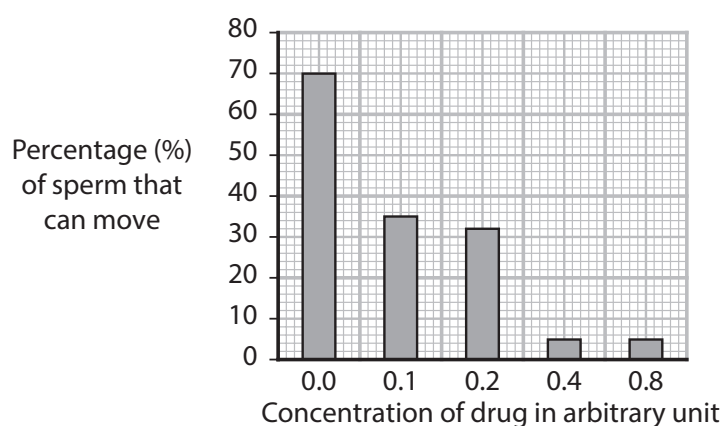
The drug is tested on 25 male mice.

Graph 1 shows the effect that different concentrations of the drug have on the mean concentration of sperm in semen.

Graph 2 shows the effect that different concentrations of the drug have on the percentage of sperm that can move.



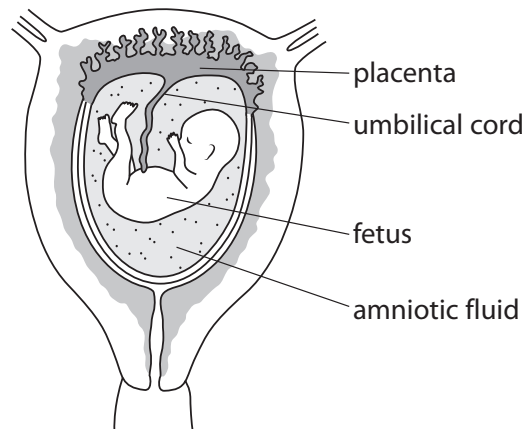
Graph 1



Graph 2



5 The diagram shows a fetus in the uterus of a woman.



The umbilical cord transports blood from the placenta to the fetus.

This blood contains molecules from the mother that are needed by the developing fetus.

- (a) (i) Explain how some of these molecules allow active transport to occur in cells of the fetus.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

- (ii) Explain how one type of molecule from the mother helps to protect the fetus from infection.

(2)

.....

.....

.....

.....

.....

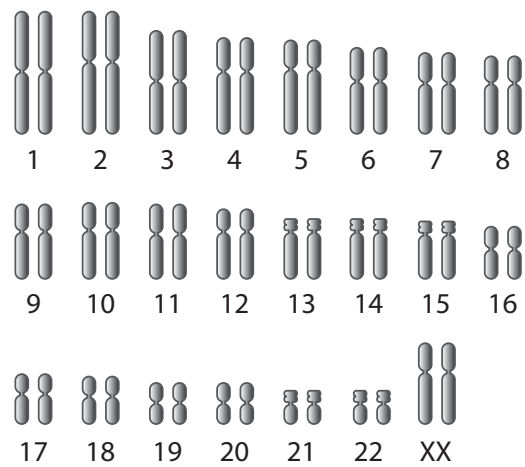
.....

(b) The amniotic fluid contains cells from the fetus.

It is possible to look at chromosomes in these cells.

A diagram of the chromosomes is called a karyotype.

The diagram shows the karyotype of a fetus cell.



Give two conclusions you can make from this karyotype.

(2)

- 1
- 2

(c) Doctors recommend that pregnant women obtain more of some dietary components than women who are not pregnant.

The table shows the recommended percentage increase of some dietary components in the diet of a woman who is pregnant compared to a woman who is not pregnant.

Component	Percentage increase of some dietary components in the diet of a woman who is pregnant compared to a woman who is not pregnant (%)
Energy in kJ	10
Calcium in g	71
Iron in mg	50
Protein in g	14
Vitamin D in µg	300

- (i) Explain why a woman who is pregnant requires more of each of the dietary components listed in the table.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (ii) The actual mass of additional iron needed by the pregnant woman was 9.0 mg per day.

Calculate the actual total mass of iron needed by the pregnant woman.

(3)

mass = ... mg per day

(Total for Question 5 = 14 marks)



8 All organisms carry out some form of reproduction such as asexual reproduction or sexual reproduction.

(a) Describe how asexual reproduction differs from sexual reproduction.

(3)

.....

.....

.....

.....

.....

.....

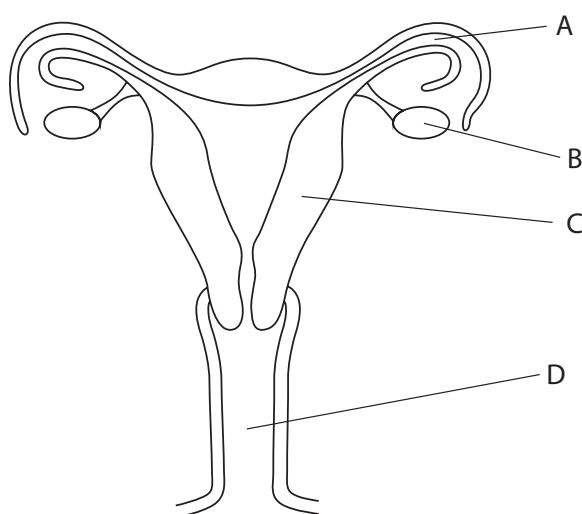
.....

.....

.....

.....

(b) The diagram shows the structure of the human female reproductive organs.



(i) What is the site of fertilisation?

(1)

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(ii) Where does the fetus usually develop?

(1)

☐ A

☐ B

☐ C

☐ D

(iii) Describe the role of the hormones produced by structure B.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) The male reproductive system in humans produces sperm in a liquid called semen.

The production of sperm changes with age.

A scientist investigates how age affects mean semen volume and sperm concentration in one ejaculation.

The table shows the results of the investigation.

In one ejaculation	Age in years						
	16–30	31–33	34–36	37–39	40–43	44–47	48–72
mean semen volume in cm ³	3.45	3.44	3.35	3.30	3.22	2.92	2.49
mean sperm concentration in millions per cm ³	61.5	64.2	64.1	61.1	62.1	62.4	56.9
mean number of sperm released in millions	212	221	215	202		182	142

(i) Calculate the mean number of sperm released in one ejaculation from men aged 40–43

(1)

mean number of sperm = ... million

(ii) Explain why mean number of sperm released is a better measure of fertility than either mean semen volume or mean sperm concentration.

(2)

.....

.....

.....

.....

.....

.....

(iii) Calculate the percentage decrease in mean number of sperm between men aged 37–39 and men aged 48–72

(2)

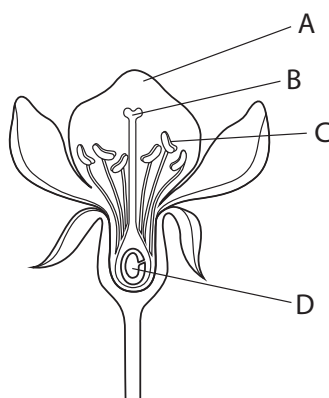
percentage change = ... %

(Total for Question 8 = 14 marks)



2 Flowers are involved in plant reproduction.

The diagram shows a section through a flower with parts labelled A, B, C and D.



(a) (i) Which part of the flower makes pollen grains?

(1)

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(ii) What part of the flower is the stigma?

(1)

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(b) After a pollen grain lands on the stigma of a flower, a pollen tube grows.

Explain the role of the pollen tube.

(3)

.....

.....

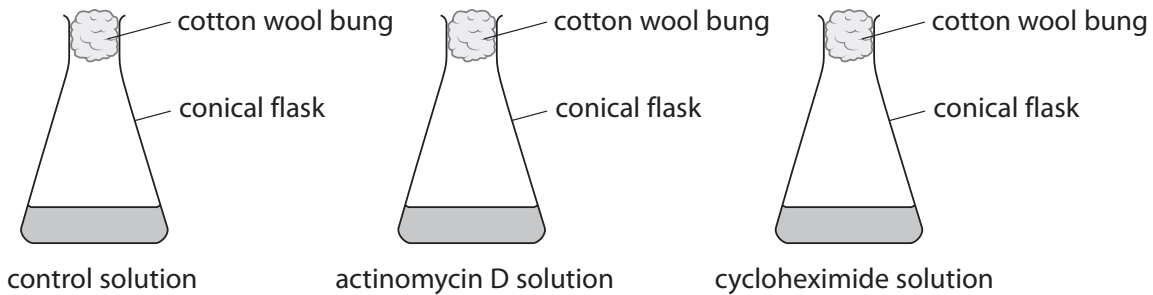
.....

.....

.....

.....

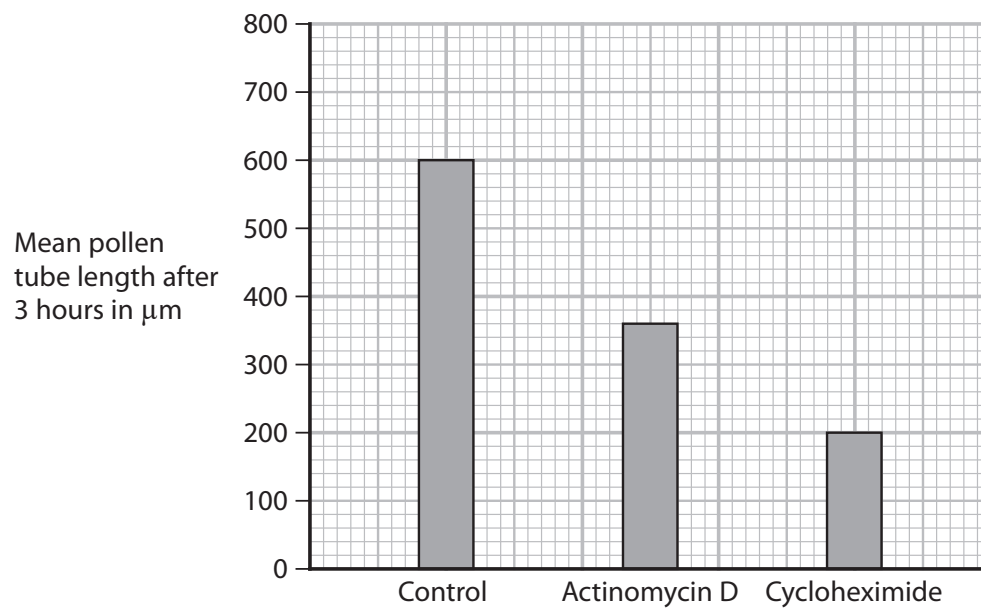
(c) A scientist investigates the effect of three different solutions on the growth of pollen tubes using this apparatus.



This is the scientist's method.

- place a different solution in three different flasks
- add pollen grains to the solution in each flask
- leave the grains in each solution for three hours
- take a sample of pollen grains from each solution
- measure the length of the pollen tubes in each sample

The graph shows the scientist's results.



- (i) Calculate the difference between the mean rate of pollen tube growth in the control solution and the mean rate of pollen tube growth in the actinomycin D solution.

Give your answer in μm per hour.

(2)

difference = ... μm per hour

- (ii) Actinomycin D prevents transcription and cycloheximide prevents translation.

Use this information and your own knowledge to explain the results of this investigation.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (d) Describe a method the scientist could use to observe pollen grains.

(3)

.....

.....

.....

.....

.....

.....

(Total for Question 2 = 14 marks)



- 7 Scientists investigate the effect of salt (NaCl) concentration on the germination of maize seeds.

Batches of seeds are watered with different concentrations of salt solution.

They count the number of seeds that germinate in each batch 12 days after sowing. They then determined the percentage germination.

- (a) (i) Describe how the scientists could tell if a maize seed had germinated.

(1)

.....

.....

- (ii) The scientists measured the germination after 12 days.

State two other abiotic variables that the scientists need to control in their investigation.

(2)

1

2

- (b) The table shows the scientists' results.

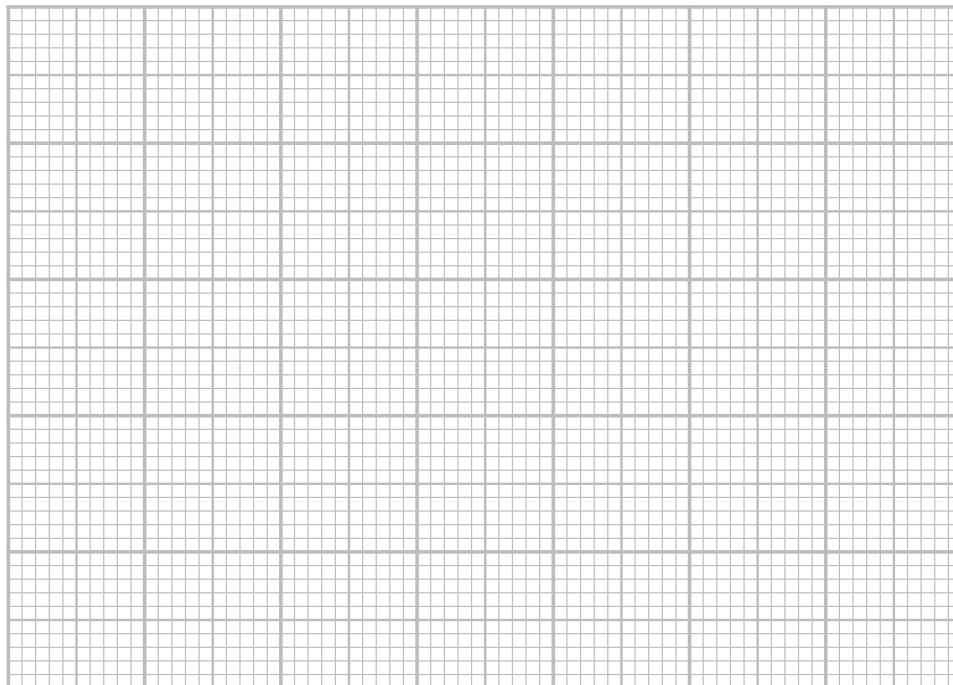
Concentration of salt solution in mmol	Percentage germination (%)
0	89
20	83
40	81
80	73
120	68
160	55
200	52
240	49
280	43
320	38



- (i) Plot a line graph to show the effect of concentration of salt solution on germination.

Use a ruler to join your points with straight lines.

(5)



- (ii) Explain the effect of increasing the concentration of salt solution on germination.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) As plants grow, they produce roots and stems.

(i) Compare the responses of roots and stems to gravity.

(2)

(ii) Compare the responses of roots and stems to light.

(2)

(Total for Question 7 = 16 marks)



- 1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Male contraception

Hormonal contraception has been used by women for many years to control their fertility. A recent study investigated a new contraceptive injection to be used by men.

- 5 The study was done in seven different countries: the United Kingdom, Australia, Germany, Italy, India, Indonesia and Chile. The researchers investigated a total of 320 healthy men aged between 18 and 45, all with female partners aged between 18 and 38.

- 10 All the men had normal sperm counts and produced sperm with no abnormalities in shape or movement. They had no sexually transmitted infections and no medical or mental health illnesses. Their female partners were healthy and did not intend to become pregnant within the next two years. They were willing to accept a low, but unknown, chance of becoming pregnant.

- 15 The study had two phases. These were the initial suppression phase lasting 26 weeks, followed by a contraceptive effectiveness testing phase lasting just over one year. In the suppression phase, the men were given injections of a drug called progestin and the hormone testosterone. This was repeated at 8, 16 and 24 weeks. Progestin inhibits sperm production and reduces the release of testosterone. Semen samples were collected every two weeks to monitor the sperm count. During this phase, couples had to use alternative barrier methods
20 of contraception, such as condoms.

- 25 When a man had produced two consecutive semen samples with a sperm count of less than one million per cm^3 , they began the contraceptive effectiveness testing phase. During this phase, the men continued to receive regular injections every eight weeks for just over one year. Semen samples were taken at the same time as each injection to monitor the sperm count. If the sperm count went above one million per cm^3 , the injections were stopped. At this point the men left the trial and other methods of contraception were resumed.

- 30 The contraceptive injections prevented pregnancies in the partners of 98.4% of the men. However, a number of men reported side effects. For example, just under half of the men developed acne (skin infections and irritation) and one in five reported mood disorders. In approximately 5% of the men, their sperm count had not returned to normal one year after stopping the injections. Despite the side effects, more than three-quarters of the men, and their partners, said they would be happy to continue to use this new method of
35 contraception.

The scientists concluded that this was a valuable early-stage trial that gave a good indication of the potential safety and effectiveness of the progestin and testosterone injections for male contraception.



- (a) Suggest why the men in the study had to be able to produce sperm with no abnormalities in shape or movement (lines 8 and 9).

(2)

- (b) (i) The contraceptive injection contained the drug progestin (lines 15 and 16).

Progestin is similar in structure and function to progesterone.

Describe the roles of progesterone in the human female body.

(2)

- (ii) Suggest why the injections also contain the hormone testosterone (lines 15 and 16).

(1)

- (iii) State where in the male body testosterone is produced.

(1)

- (c) (i) Give the purpose of the initial suppression phase of the study (line 13).

(1)



- (ii) State why the sperm count is monitored during the suppression phase (lines 18 and 19).

(1)

- (iii) State why alternative contraception was used during the suppression phase (lines 19 and 20).

(1)

- (d) Suggest why sperm count continues to be monitored during the testing phase (lines 25 and 26).

(1)

- (e) Calculate the number of men whose partners became pregnant during the study (lines 6 and 28).

(2)

number of men = ...



(4)

[illegible]

(Total for Question 1 = 16 marks)

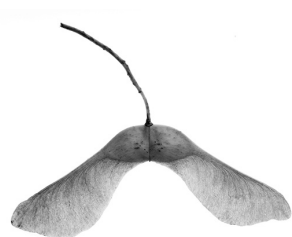


- 1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Moving plants

Flowering plants reproduce using different methods to transfer the pollen from plant to plant. This cross-pollination enables plants to produce offspring that show genetic variation. The transfer can be done by animals such as insects or by wind.

- 5 The reliance on animals and wind for reproduction does not end with pollination. Flowering plants also need a mechanism to disperse their fruits or the seeds they contain. This seed dispersal means that seeds producing new young plants will germinate away from the parent plant.



wings on a sycamore

(Source: © joanna wnuk/Shutterstock)



fluff on a dandelion

(Source: © Viktorija Reuta/Shutterstock)



spines on burdock

(Source: © Paulpixs/Shutterstock)

- 10 The simplest method of seed dispersal uses gravity. The seeds are within heavy fruit, which fall from the tree when they are ripe. Although some of the fruit may roll away from the parent plant, most remain close to the parent plant.

- 15 Animal dispersal is when plants rely on animals to transport their seeds to a different area. This may be because the seeds are surrounded by a brightly-coloured and sweet-tasting fruit. Examples of this are soft fruits such as raspberry and hard fruits such as apple.

- 20 Animals may also carry seeds in a different way. Many plants produce fruits or individual seeds covered in hooks or spines that attach the seeds to the animals' fur. The seeds are then carried away from the parent plant. Eventually, the seeds may fall off, or be rubbed off by the animal. Examples of plants using this form of dispersal are burdock and sea holly.

Some plants provide seed pods with a mechanism that ejects the seeds from the pod by force. All of these rely on the effect of evaporation of water in the seed pod, so this method of seed dispersal usually takes place in sunlight. Examples of plants using this form of dispersal are gorse bushes and lupins.

- 25 Wind is one of the main methods of seed dispersal. Some tall trees produce seed pods that have wings, which allow the seeds to travel long distances. Some seed pods have two wings such as the sycamore while others have one wing such as the ash.

- There are also lightweight adaptations that help seeds to be blown by the wind.
- 30 These include various sorts of fluff that increase the surface area of the seed, so that it can be picked up by the slightest breeze. Examples of plants using this form of dispersal are thistle and dandelion.

- The last method uses water. Trees found on tropical beaches often have their seeds carried away by the sea. The seeds have woody, waterproof coverings enabling
- 35 them to float in the water for long periods. Coconuts are a well-known example.

- (a) Explain how cross-pollination can lead to an increase in genetic variation.
(Lines 2–3)

(2)

- (b) (i) Explain the advantages of the seeds germinating away from the parent plant.
(Line 8)

(3)

- (ii) Give one advantage of a seed germinating close to the parent plant. (Line 11)

(1)



(c) Explain the conditions needed for seed germination.

(3)

(d) Explain why some seeds are surrounded by a brightly-coloured and sweet-tasting fruit. (Lines 13–14)

(2)

(e) Large numbers of tomato plants are often found growing along the sides of drains and settling beds on sewage farms.

Suggest a reason for this observation.

(1)

(f) Give the reason why sunlight is required for lupin seeds to be dispersed. (Lines 21–24)

(1)



(g) Describe an experiment you could carry out to investigate how the presence of fluff on dandelion seeds affects how fast they fall. (Lines 30–31)

(3)

(Total for Question 1 = 16 marks)



- 1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Pollination in fruit trees

Plants need to be pollinated to produce fruits and seeds. Some plants are self-pollinated and others are cross-pollinated.

- 5 Self-pollination is usually the transfer of pollen from flowers on the same tree. In fruit trees, self-pollination also includes the transfer of pollen from another tree of the same cultivar. A cultivar is a genetically identical group of trees produced by selective breeding. Self-pollinating plants need bees or other insects to transfer pollen. Examples of self-pollinated fruit trees are plum, apricot and peach that have sweet-tasting, soft fruits.



(Source: © freya-photographer/Shutterstock)



(Source: © Leena Robinson/Shutterstock)

- 10 Other fruit trees require cross-pollination and can only produce fruit by fertilisation from a different cultivar. Cross-pollination is the transfer of pollen from one cultivar to the flower of a different cultivar. Self-incompatibility prevents the same plant or cultivar from fertilising its own flowers. For example, the pollen from one cultivar of an apple tree will not fertilise trees of the same cultivar. Most hard fruit trees such as pear and apple require the presence of two different
15 compatible cultivars for pollination to result in fruit production.

Pollen can be transferred by wind, insects or birds. Many fruit trees are pollinated by insects. Nut trees are usually pollinated by wind.

- 20 After pollination the pollen grain must germinate to lead to fertilisation. The success of pollination and fertilisation depends on favourable environmental conditions. It also requires the right pollen grain reaching the right flower, as pollen can only fertilise specific, compatible flowers. For example, pollen from a peach flower will not pollinate apple flowers.

- 25 Cross-pollinating fruit trees should be planted no more than 60 m apart. This will ensure that bees visit the trees often enough to ensure pollination. Nut trees need to be planted no more than 15 m apart.

A further complication is that a few apple and pear cultivars, known as triploids, produce sterile pollen. Triploid cultivars have three sets of chromosomes within their cells. A triploid cultivar will require another cultivar for pollination, and the trees must flower at the same time.

- (a) Explain the differences between self-pollination and cross-pollination.
(lines 3 to 5 and 9 to 11)

(2)

- (b) Describe the sequence of events from pollen landing on a flower to fruit production.

(4)

(c) Fruit trees often produce sweet-tasting fruit containing sugars.

(i) Sugars are carbohydrates.

Name the three elements in carbohydrates.

(1)

.....

(ii) Suggest how production of sweet-tasting fruit may help spread the seeds of fruit trees. (lines 7 to 8)

(2)

.....

.....

.....

.....

(d) Explain how self-incompatibility prevents self-fertilisation. (lines 11 to 13)

(2)

.....

.....

.....

.....

(e) Describe how the structure of insect-pollinated flowers helps to achieve pollination. (line 16)

(3)

.....

.....

.....

.....

.....

.....

(f) Give a reason why nut trees need to be planted closer together than fruit trees. (lines 23 to 25)

(1)

.....

.....



(g) Explain why triploid cultivars produce sterile pollen. (lines 26 to 29)

(2)

(Total for Question 1 = 17 marks)



SUB-TOPIC 3(b)

INHERITANCE

35 questions in this sub-topic · 390 marks · lowest tariff first



- 7 Some mice have yellow hair and some mice have brown hair.

The gene for hair colour in mice has two alleles. The dominant allele is H and the recessive allele is h.

A scientist crosses a yellow-haired male mouse with a yellow-haired female mouse.

He predicts a 3:1 ratio of yellow to brown mice in the offspring.

- (a) Give the genotype of the yellow parent mice that would produce this 3:1 ratio.

(1)

- (b) The scientist then crosses three other pairs of male and female yellow mice.

The table shows his results.

	Number of offspring	
	yellow	brown
Cross one	7	3
Cross two	8	4
Cross three	6	3

Calculate the ratio of the total number of yellow to brown mice for these crosses.

(1)

ratio = ...



(4)

(Total for Question 7 = 6 marks)

3 The brain is part of the central nervous system.

(a) Name the other part of the central nervous system.

(1)

(b) Huntington's disease (HD) is caused by a mutation in the gene for making a protein called huntingtin.

This protein damages nerve cells in the brain.

HD is caused by a dominant allele.

A heterozygous parent and a homozygous recessive parent have a child.

(i) What is the probability of this child having HD?

(1)

- ☐ **A** 0.0
- ☐ **B** 0.25
- ☐ **C** 0.5
- ☐ **D** 1.0

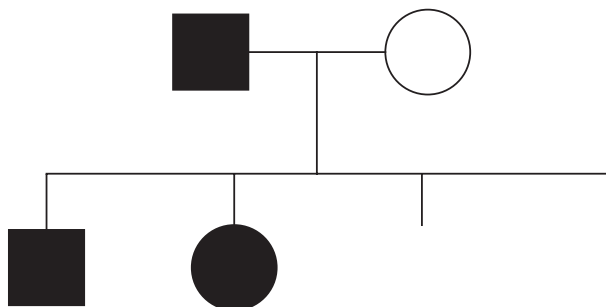
(ii) These parents have three more children.

The key shows the possible sex and phenotype of the individuals with or without HD.

Key	
female with HD	
female without HD	
male with HD	
male without HD	

The family pedigree gives the predicted sex ratio and the predicted phenotype ratio for two of the children. Complete the family pedigree by giving the predicted sex ratio and predicted phenotype ratio for the other two children.

(2)



(c) A drug can reduce the damage to nerve cells in the brains of people with HD.

The drug binds to messenger RNA produced by the mutated gene for huntingtin protein.

Suggest ways that this drug reduces damage to nerve cells in people with HD.

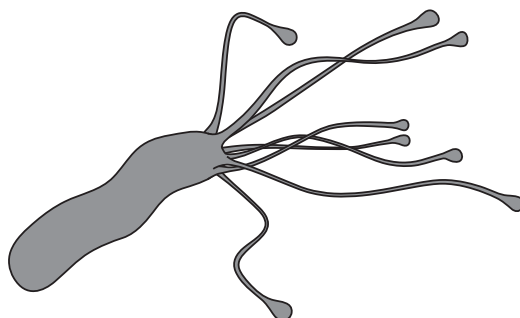
(3)

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(Total for Question 3 = 7 marks)

1 The bacterium *H. pylori* causes stomach ulcers.

(a) The diagram shows this bacterium.



(i) Which of these is found in this bacterium?

(1)

- ☒ A cellulose
- ☒ B chitin
- ☒ C cytoplasm
- ☒ D nucleus

(ii) The bacterium has evolved to release an enzyme called urease.

The action of the bacterium neutralises the acid in the stomach.

What is the pH changed to?

(1)

- ☒ A 1
- ☒ B 2
- ☒ C 7
- ☒ D 12

(iii) Use the theory of evolution by natural selection to explain how *H. pylori* bacteria could have evolved to produce urease.

(4)



(b) Probiotics are live microorganisms that can have health benefits when consumed.

Scientists investigate the ability of probiotics and cranberry juice to reduce the growth of *H. pylori*.

The scientists give various treatments to a group of people who have *H. pylori*.

The treatments are given daily for three weeks.

The scientists measure the mean percentage reduction of *H. pylori* for each treatment.

The table shows the scientists' results.

Treatment	Mean percentage (%) reduction in <i>H. pylori</i>
probiotics	14.9
cranberry juice	16.9
probiotics and cranberry juice	22.9
control	1.5

Give two conclusions from these results.

(2)

1

2

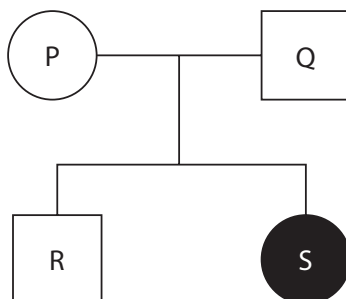
(Total for Question 1 = 8 marks)



- 7 Inherited conditions may be caused by a dominant allele (D) or by a recessive allele (d).

The diagram shows a family pedigree for an inherited condition.

The shaded circle shows a female with the condition.



- (a) Complete the table by giving the genotype of each individual.

One has been done for you.

(3)

Individual	Genotype
P	
Q	
R	Dd
S	

- (b) The parents have a third child.

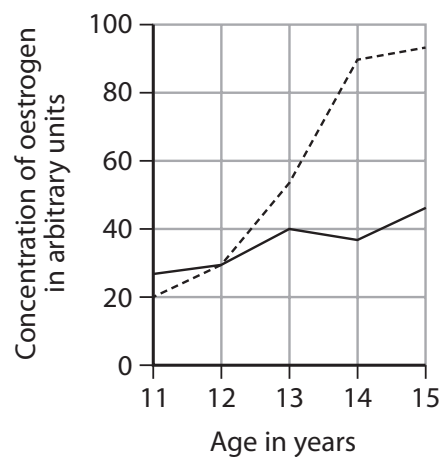
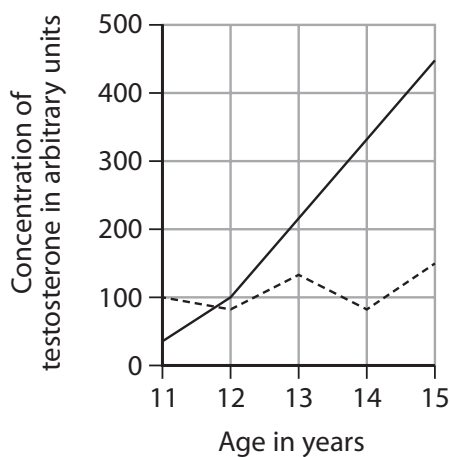
Calculate the probability that this third child is female and has the condition.

(1)

probability = ...



- (c) The graphs show changes in the concentrations of the hormones testosterone and oestrogen in child R and in child S between the ages of 11 to 15.



Key

— child R
 ---- child S

Explain how the changes in hormone concentrations affect the development of each child.

(4)

.....

.....

.....

.....

.....

.....

.....

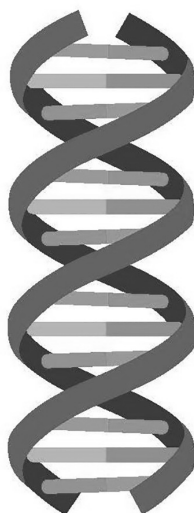
.....

.....

.....

(Total for Question 7 = 8 marks)

4 The diagram shows part of a molecule of DNA.



(Source: © ShadeDesign/Shutterstock)

(a) State what is meant by the term **genome**.

(1)

(b) Describe the differences between the structure of DNA and the structure of RNA.

(3)

(4)



5 The molecules RNA and DNA are both involved in inheritance and protein synthesis.

- (a) Give two differences between the structure of a DNA molecule and the structure of an RNA molecule.

(2)

1

.....

2

.....

- (b) This sequence shows the order of bases on a DNA strand.

CATCATCCTCATCTA

- (i) Give the sequence of bases in the mRNA that would be produced from this strand.

(1)

.....

- (ii) The sequence of bases in the mRNA is used to code for the amino acids in a protein.

Calculate the number of bases required to code for an amino acid chain of 1400 amino acids.

(1)

number of bases = ...



(c) A mutation results in a change in the sequence of bases in a DNA strand.

Discuss what effect a change in the sequence of bases could have on the functioning of the enzyme produced.

(4)

(d) Give one way that the incidence of mutation could be increased.

(1)

(Total for Question 5 = 9 marks)



- 5 The chromosomes in a human cell can be photographed and then arranged in pairs to show the karyotype.

White blood cells are often used to show the chromosomes in the karyotype.

The chromosomes in white blood cells are larger and easier to see when the white blood cells divide.

Diagram 1 shows a karyotype.

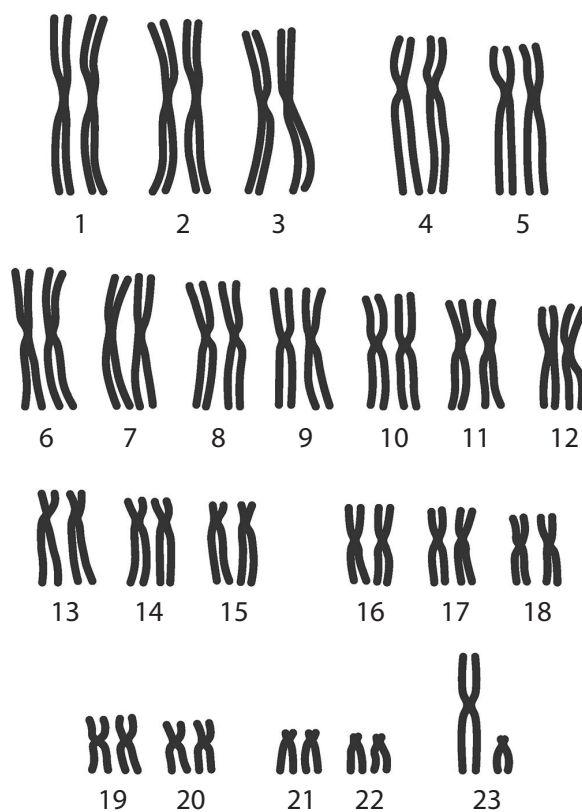


Diagram 1

(Source: © Dee-sign/Shutterstock)

- (a) (i) Explain why a red blood cell cannot be used to show a karyotype.

(2)

.....

.....

- (ii) State the type of cell division that occurs in white blood cells.

(1)

.....

(iii) The karyotype in diagram 1 is from a male.

State how this can be deduced from the diagram.

(1)

(b) Diagram 2 shows a karyotype from a white blood cell of another person.

The karyotype is from a female, and the person has a condition called Turner syndrome.

This condition affects the development of the ovaries so they may not produce normal quantities of sex hormones.

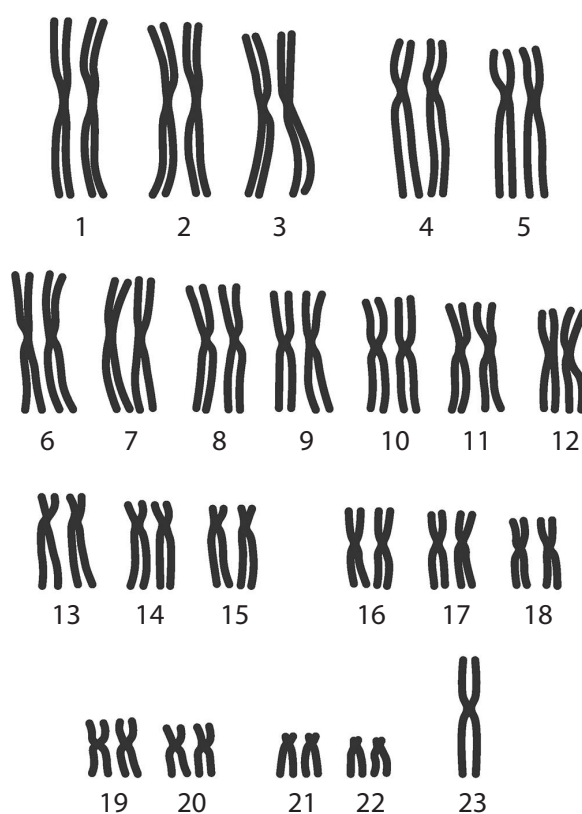


Diagram 2

(Source: © Dee-sign/Shutterstock)

- (i) Comment on the differences between the karyotypes shown in diagram 1 and diagram 2 and the effects Turner syndrome will have on the person.

Use information from the question and your own knowledge in your answer.

(4)

[illegible]

- (ii) Suggest how the difference in the chromosomes of people with Turner syndrome may have been produced.

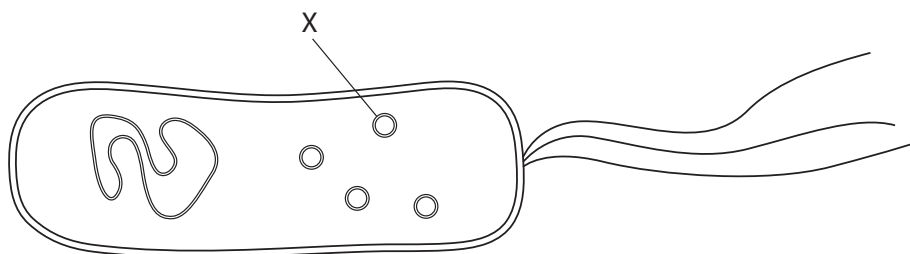
(1)

(Total for Question 5 = 9 marks)



- 4 Some bacteria are pathogenic and cause infections.

The diagram shows the structure of a pathogenic bacterium.



- (a) Name the part labelled X.

(1)

- (b) Antibiotics can be used to cure some infections.

Some bacteria are resistant to antibiotics.

Explain how resistance to an antibiotic occurs and increases in a population of bacteria.

(3)

- (c) The table shows the number of deaths in 2014 caused by bacteria that are resistant to antibiotics.

The table also shows the predicted number of deaths in 2050 caused by resistant bacteria.

Year	Number of deaths $\times 10^6$
2014	0.7
2050	10.0

- (i) Calculate the percentage increase in the predicted number of deaths in 2050 compared with the number of deaths in 2014.

(2)

percentage increase = ...

- (ii) A doctor claims that if he stops giving antibiotics to any patients who are ill, he can reduce the number of predicted deaths caused by resistant bacteria in 2050.

Comment on this claim.

(4)

(Total for Question 4 = 10 marks)



6 Variation in a population can have different causes.

(a) Which of these will **not** lead to an increase in genetic variation in a population of plants?
(1)

- ☐ A asexual reproduction
- ☐ B insect pollination
- ☐ C mutation
- ☐ D wind pollination

(b) Explain how a change in the DNA of a microorganism can reduce its ability to digest a substance.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Explain why a change in DNA may not affect the phenotype of an organism.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 6 = 10 marks)



5 (a) A DNA strand has this sequence of bases.

C A T T C A A T T C A T T T C

(i) How many amino acids does this sequence of bases code for?

(1)

☐ A 1

☐ B 3

☐ C 5

☐ D 15

(ii) Write down the complementary mRNA code for this sequence of bases.

(2)

(iii) A student reads that DNA codons are non-overlapping.

Suggest what is meant by the term non-overlapping.

You should refer to the sequence of bases in your answer.

(2)

.....

.....

.....

.....

.....

(b) Describe what happens in the translation stage of protein synthesis.

(4)

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.

(c) State what is meant by the genome of an organism.

(1)

(Total for Question 5 = 10 marks)



- 7 Hypertrophic myopathy is a heart condition that can affect some cats. It is caused by a dominant allele.

Hypertrophic myopathy causes the left ventricle wall of the heart to be less elastic.

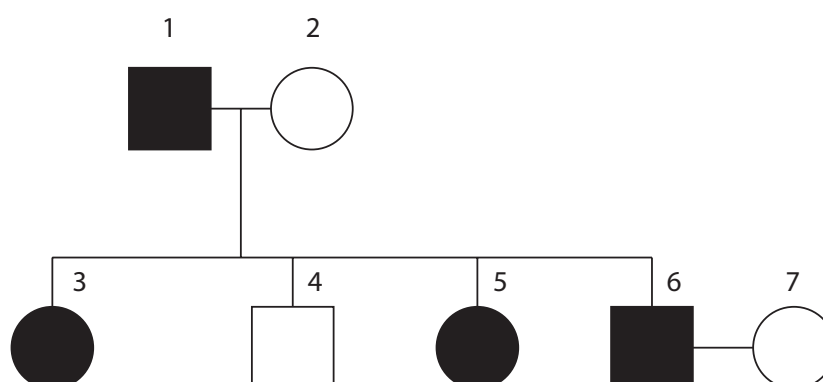
- (a) (i) Explain why cats with hypertrophic myopathy are unable to run quickly.

(2)

- (ii) State what is meant by a dominant allele.

(1)

- (iii) The diagram shows a family pedigree for cats with and without hypertrophic myopathy.



Key

-  male with hypertrophic myopathy
-  male without hypertrophic myopathy
-  female with hypertrophic myopathy
-  female without hypertrophic myopathy

Draw a genetic diagram to show the possible genotypes and phenotypes of the offspring produced by individuals 6 and 7.

Use **H** as the allele for hypertrophic myopathy and **h** as the allele for normal heart development.

(4)

- (iv) Calculate the probability that the next offspring produced by individuals 6 and 7 is male and has hypertrophic myopathy.

(1)

probability = ...

- (b) Cat breeders often try to remove harmful alleles from populations by selective breeding.

Suggest why it is more difficult to remove harmful recessive alleles from populations than harmful dominant alleles from populations.

(2)

.....

.....

.....

.....

(Total for Question 7 = 10 marks)



- 3 Hair colour in cattle is controlled by one gene with two alleles. The allele for white hair, C^W , is codominant with the allele for red hair, C^R .

Heterozygous cattle are a pale red colour called roan.

- (a) State what is meant by the term **gene**.

(1)

- (b) (i) Complete the table by giving the genotypes of red cattle, white cattle, and roan cattle.

(1)

Cattle hair colour	Genotype
red	
white	
roan	

- (ii) Two roan-coloured cattle are mated.

Determine the probability that the calf produced is a male calf with roan-coloured hair.

Include a genetic diagram in your answer.

(4)

probability = ...



- (c) (i) In a group of cattle, there are cattle with white-, red-, and roan- coloured hair. Height of cattle is also a genetically controlled characteristic. In the same group, there is a greater variation of heights compared with hair colour.

Explain why there is a greater variation in height of the cattle than there is in hair colour.

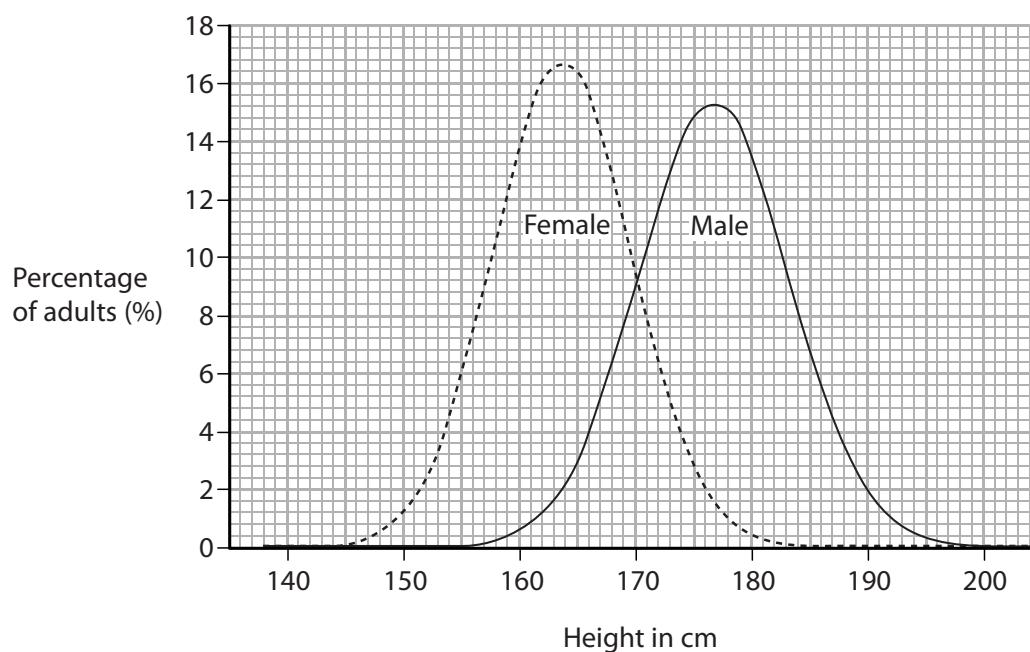
(2)

- (ii) Describe how a farmer could use selective breeding to increase the height of cattle.

(2)

(Total for Question 3 = 10 marks)

- 7 (a) The graph shows the height distribution in an adult population.



- (i) Human height is under polygenic control.

State the meaning of the term **polygenic**.

(1)

- (ii) Using the graph, determine the mode and median heights for males and females.

(2)

	Mode	Median
Females		
Males		

- (iii) Suggest two reasons why the mean height for males is greater than the mean height for females.

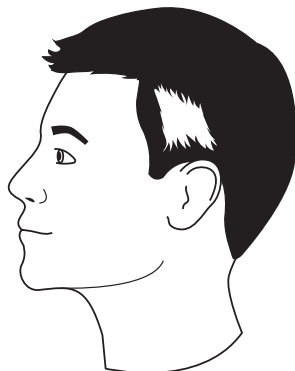
(2)

- 1
- 2

- (b) Some genetic characteristics show a different pattern of inheritance to height.

One example of this is piebaldism. In this condition, a person has a white patch of hair.

The diagram shows a person with piebaldism.



Piebaldism is controlled by a single dominant allele.

A man with a white patch of hair and a woman with a white patch of hair have two children.

The first child was born without a white patch of hair.

The second child was born with a white patch of hair.

- (i) Use your knowledge of genetics to explain the phenotypes of these children.

Use H to represent the allele for a white patch of hair and h to represent the allele for no white patch of hair.

(4)

- (ii) Another condition, called vitiligo, produces similar symptoms to piebaldism but is not genetically controlled.

Suggest how a doctor could diagnose whether a new patient has piebaldism or vitiligo.

(2)

.....

.....

.....

.....

.....

.....

(Total for Question 7 = 11 marks)

- 5** In humans, males are heterogametic because they have two different sex chromosomes. Females are homogametic because they have two similar sex chromosomes.

(a) Give the sex chromosomes in the body cell of a human male.

(1)

(b) In birds, females are heterogametic and have a Z chromosome and a W chromosome.

(i) What are the sex chromosomes in the body cell of a male bird?

(1)

☐ **A** XY

☐ **B** ZW

☐ **C** ZY

☐ **D** ZZ

(ii) A male and female bird have four offspring.

Calculate the probability that these offspring will all be female.

(2)

probability = ...



(c) Human females generally reach puberty between the ages of 11 and 16.

At puberty, hormonal changes occur that cause females to start ovulating.

- (i) The table lists the four hormones involved in controlling the menstrual cycle. It also shows the source of secretion and a function of each hormone.

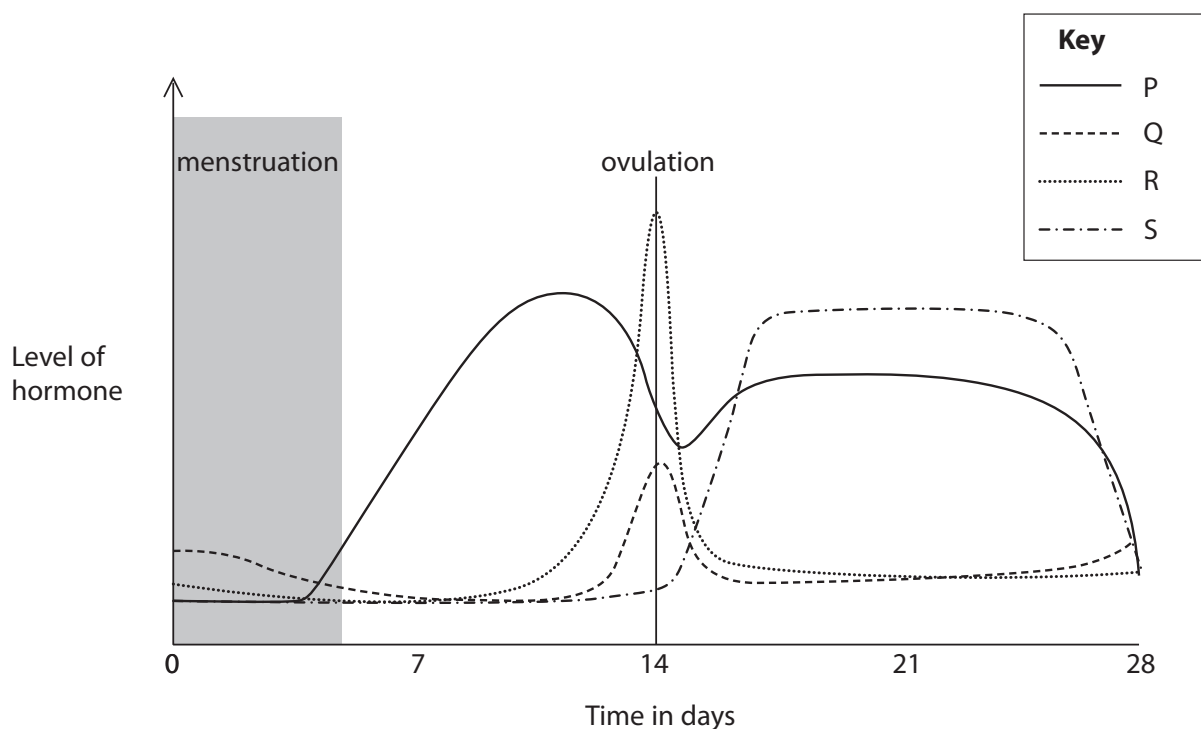
Complete the table by giving the missing information.

(4)

Hormone	Source	Function
FSH		stimulates follicle growth
LH	pituitary	
oestrogen		repairs the uterus lining
progesterone	ovary	



- (ii) The chart shows the changes in the levels of the four hormones during the menstrual cycle.



Each letter, P, Q, R and S, represents a different hormone.

Give the correct letter for each hormone.

(3)

FSH

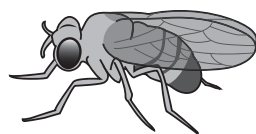
LH

Oestrogen

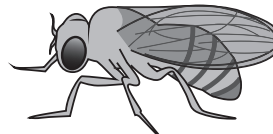
Progesterone

(Total for Question 5 = 11 marks)

- 7 The diagram shows a male fruit fly with long wings and a female fruit fly with long wings.



male



female

Wing length in these flies is controlled by a gene with two alleles.

The dominant allele (L) produces long wings and the recessive allele (l) produces short wings.

A male and a female fruit fly mate.

The table shows the number of male and female offspring with long wings and short wings.

Phenotype	Number of offspring
male with long wings	38
male with short wings	10
female with long wings	36
female with short wings	15

- (a) Which of these describes the genotypes of the parent fruit flies?

(1)

- ☒ A both are heterozygous
- ☒ B both are homozygous
- ☒ C both have long wings
- ☒ D one is heterozygous and one is homozygous

- (b) (i) Genetic diagrams are used to show how sex is inherited.

Complete the genetic diagram to show that equal numbers of male and female offspring are produced.

(2)

	X	Y

- (ii) Explain why the results of the cross might not produce exactly equal numbers of male and female offspring.

(2)

.....

.....

.....

.....

.....

.....

(c) Fruit flies feed on decomposing fruit.

The smell of the fruit attracts the fruit flies.

Design an investigation to find out if the smell of decomposing apples attracts fruit flies more than the smell of decomposing bananas.

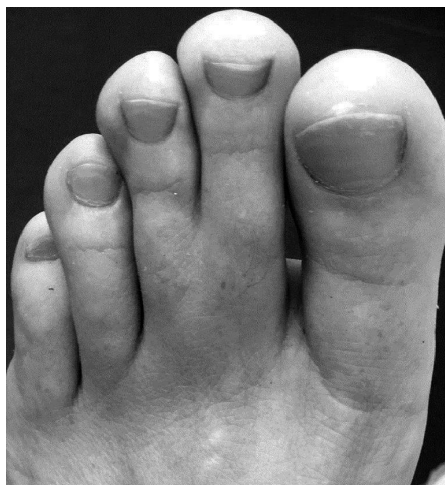
Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 7 = 11 marks)



- 9 Syndactyly is a condition where fingers and toes are not separated during development. The photograph shows the foot of someone with syndactyly.



One type of syndactyly is caused by a dominant allele that is inherited from the parents.

- (a) A man without syndactyly and a woman with syndactyly have a male child.

The child does not have syndactyly.

- (i) Use a genetic diagram to show the genotypes of the parents, the possible gametes and the genotype and phenotype of their child.

Use D to represent the dominant allele and d to represent the recessive allele.

(4)

- (ii) Determine the probability that the second child of these parents will be a girl with syndactyly.

(2)

probability = ...

- (b) Another type of syndactyly is caused by a recessive allele.

Explain the differences in the pattern of inheritance between a condition caused by a dominant allele and a condition caused by a recessive allele.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Syndactyly is controlled by a single gene that has two alleles.

Most other phenotypes are the result of a different sort of genetic control.

Describe the genetic control of most phenotypic features.

(2)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 9 = 11 marks)

4 DNA and RNA are involved in the processes of transcription and translation.

(a) State three ways in which the structure of a DNA molecule differs from the structure of an RNA molecule.

(3)

1

.....

2

.....

3

.....

(b) Describe the differences between the processes of transcription and translation.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....



(c) The DNA molecule codes for the amino acids used to make proteins.

There are four different bases in DNA and 20 amino acids used to make proteins.

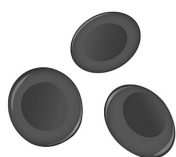
Use this information to show that a minimum of three bases on the DNA molecule is needed to code for each amino acid.

(3)

(Total for Question 4 = 11 marks)

- 9 Sickle cell anaemia is a condition in which some of the person's red blood cells develop abnormally.

The diagram shows red blood cells from a healthy person and red blood cells from a person with sickle cell anaemia.



cells from a healthy person



cells from a person with sickle cell anaemia

(Source: © solar22/Shutterstock)

- (a) A person with sickle cell anaemia often suffers pain as some of their blood vessels become blocked by the sickle cells.

- (i) Suggest why the person's blood vessels may become blocked.

(1)

- (ii) People with sickle cell anaemia have symptoms of tiredness and joint pain that get worse if they are exposed to cold temperatures and high altitudes.

Suggest why these symptoms get worse.

(3)

(b) Sickle cell anaemia is caused by a single recessive allele.

(i) State what is meant by the term **recessive**.

(1)

(ii) A man and a woman who are both heterozygous for the sickle cell allele have a child.

Calculate the probability that the child will be female and **not** have sickle cell anaemia.

(2)

probability = ...

(c) Sickle cell anaemia is more common in countries where malaria is found. This is because having an allele for sickle cell anaemia can reduce the likelihood of developing malaria.

Which type of organism causes malaria?

(1)

- ☐ **A** bacterium
- ☐ **B** fungus
- ☐ **C** plant
- ☐ **D** protocist

(d) What is the name of the pigment found in red blood cells?

(1)

- ☐ **A** chlorophyll
- ☐ **B** haemoglobin
- ☐ **C** iron
- ☐ **D** magnesium



(e) Give two differences in structure between red blood cells and white blood cells.

(2)

1

.....

2

.....

(Total for Question 9 = 11 marks)



- 5 The chromosomes found in human cells can be photographed and arranged in order to produce a karyotype.

The karyotype shown in Diagram 1 is from a normal human body cell.

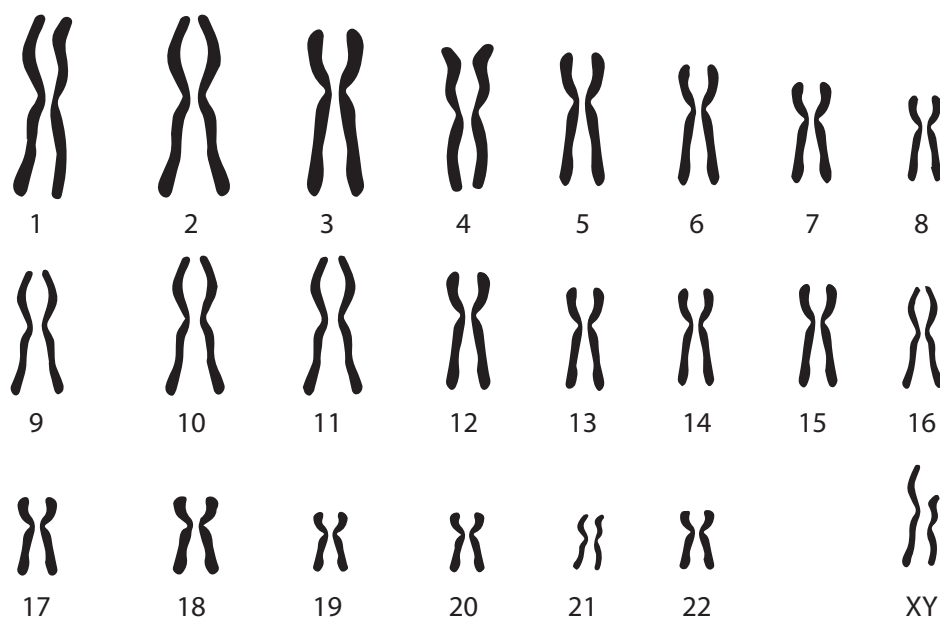


Diagram 1

- (a) (i) Explain how you can identify the sex of the person from the karyotype shown in Diagram 1.

(2)

.....

.....

.....

.....

- (ii) Cells can be described using the terms diploid or haploid.

Explain the difference between these two terms using the information in Diagram 1.

(2)

.....

.....

.....

.....

.....

.....

- (b) The karyotype shown in Diagram 2 is from a body cell of a person with a condition called Klinefelter syndrome.

This condition only affects males.

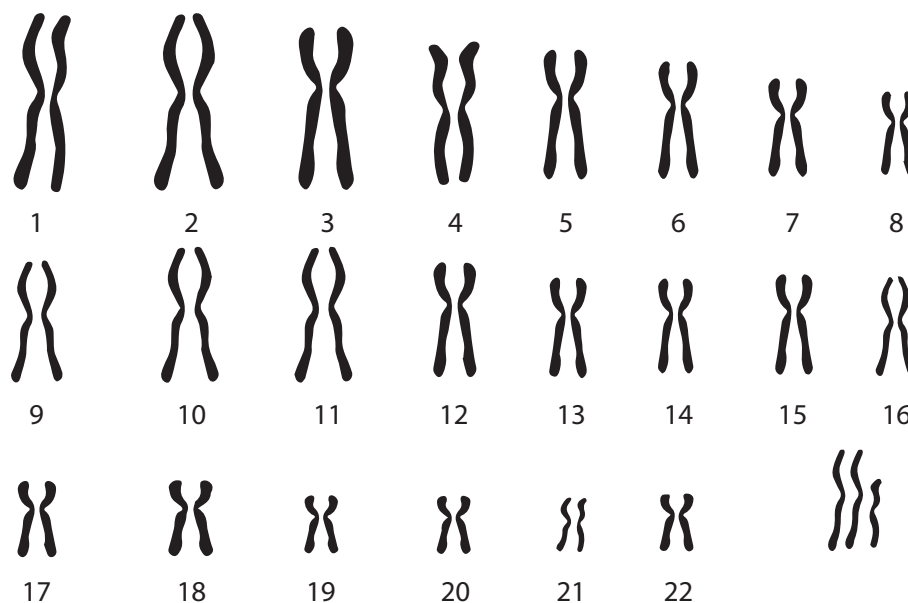


Diagram 2

- (i) Describe the differences between the karyotype in Diagram 1 and the karyotype in Diagram 2.

(2)

- (ii) Suggest how the karyotype in Diagram 2 may have been caused.

(2)

- (iii) The frequency of Klinefelter syndrome in the United Kingdom is 1 in every 660 males.

The population of the United Kingdom is 66 million, of which 49% are male.

Calculate the total number of males in the United Kingdom with Klinefelter syndrome. (2)

number of males = ...

- (iv) Suggest why females who are aged over 35 are more likely to give birth to a baby with the Klinefelter karyotype. (1)

.....

.....

(Total for Question 5 = 11 marks)

7 A scientist studies hair colour in mice.

Mice can have grey hair or white hair.

The hair colour is determined by a gene with two alleles.

In a first cross, a male mouse with white hair is mated with a female mouse with grey hair.

All the offspring have grey hair.

(a) (i) State what is meant by the term **gene**.

(1)

(ii) State the phenotype coded for by the dominant allele.

(1)

(b) A male mouse and a female mouse with grey hair were chosen from the offspring of the first cross. These mice are mated in a second cross.

Some of the offspring of this second cross have grey hair and some have white hair.

Use a genetic diagram to show the second cross.

You should give the genotypes of the parents and the gametes formed. You should also give the genotypes and ratio of phenotypes of the offspring.

(4)

- (c) The scientist concludes that a mouse with grey hair could have two possible genotypes.

Explain how the scientist could use a cross to determine the genotype of a mouse with grey hair.

(2)

- (d) Albino mice have white hair. These mice also have pink eyes as they do not have pigment in their irises.

They are also less likely to explore a new area when compared to mice with grey hair.

This is an example of one gene having many effects.

Describe how the genetic control of most phenotypic features differs from this example.

(3)

(Total for Question 7 = 11 marks)

2 Scientists investigate the effect of pollution on the growth of plant shoots.

This is their method.

- expose a sample of 500 seeds to pollution
- leave another sample of 500 seeds free from pollution
- allow the seeds to germinate and produce shoots
- after one day, squash 100 shoots from each sample
- using a microscope, count the number of cells in each shoot

The scientists squash 100 shoots from each sample every day for five days.

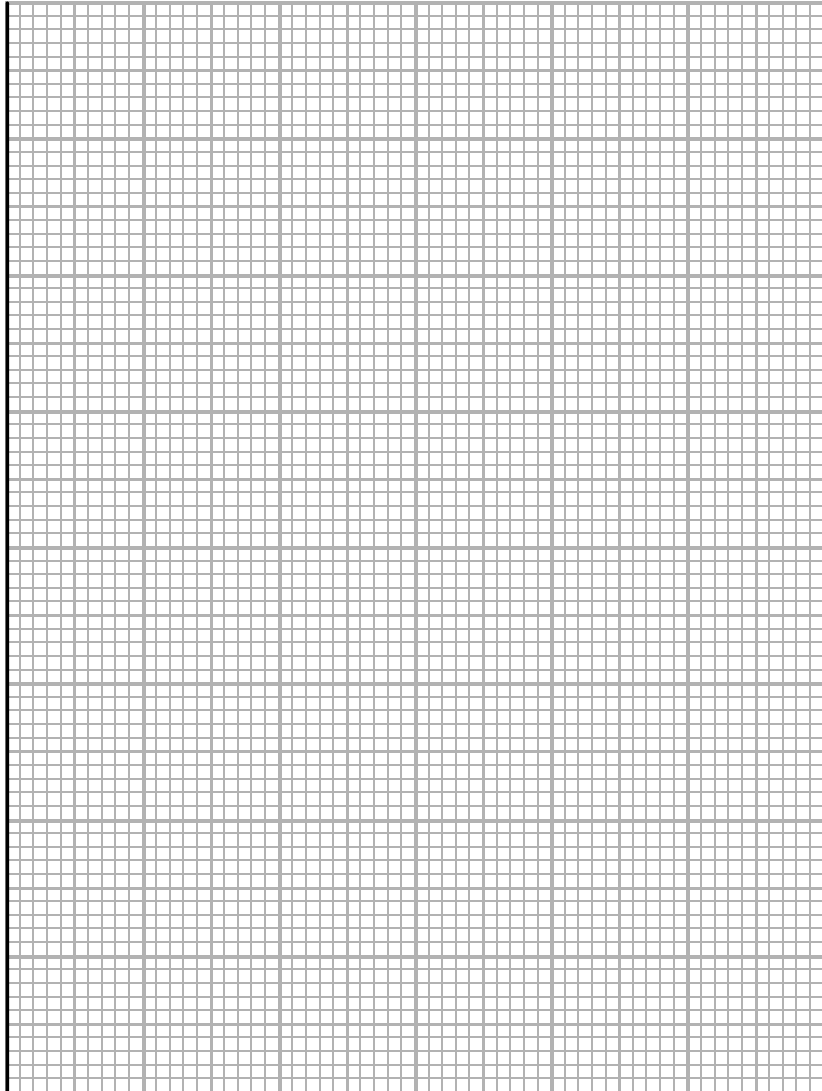
The table shows their results.

Time after germination in days	Mean number of cells in shoot tissue $\times 10^3$	
	Exposed to pollution	Free from pollution
1	45	45
2	38	120
3	40	150
4	38	140
5	42	145

(a) Plot a line graph of this data on the grid.

Use a ruler to join the points with straight lines.

(5)



(b) What is the dependent variable in this investigation?

(1)

- ☐ **A** germination rate
- ☐ **B** number of cells
- ☐ **C** pollution level
- ☐ **D** time after germination

(c) The scientists conclude that pollution reduces the growth of shoots by affecting cell division.

(i) Name the type of cell division affected by pollution in this investigation.

(1)

(ii) To make sure their conclusion is valid, the scientists control abiotic variables while the seeds are germinating.

Discuss two abiotic variables that the scientists control.

(4)

1

.....

.....

.....

2

.....

.....

.....

(iii) State one biotic factor that the scientists should control.

(1)

.....

(Total for Question 2 = 12 marks)

- 5 The photograph shows a breed of dog called an English Springer Spaniel.



(Source: © 2016–2018. Sherpa Multimedia, Inc)

Phosphofructokinase deficiency (PFK) is an inherited disease in this breed of dog.

The disease causes red blood cells to burst.

- (a) Explain why dogs with PFK find it difficult to exercise.

(2)

.....

.....

.....

.....

.....

.....

- (b) PFK is caused by a recessive allele.

The table lists the genotypes of some parents.

Complete the table by giving the percentage of offspring likely to have PFK for each set of parents.

The first one has been done for you.

(2)

Genotype of parents	Percentage of offspring likely to have PFK
both homozygous dominant	0
heterozygous x heterozygous	
heterozygous x homozygous recessive	

(c) A dog breeder is someone who breeds dogs and sells the offspring.

Explain the advantage for the dog breeder of using homozygous dominant dogs as parents.

(2)

(d) A dog breeder buys a healthy dog.

The dog shows no signs of PFK, but the breeder does not know its genotype.

Explain why the breeder mates this dog with a dog that has PFK.

(2)

(e) Part of the base sequence in the strand of DNA used to make the protein phosphofructokinase is CAGGTATGG.

(i) Which of these shows the base sequence of mRNA produced from this strand of DNA?

(1)

- ☐ **A** CAGGTATGG
- ☐ **B** CAGGUAUGG
- ☐ **C** GTCCATACC
- ☐ **D** GUCCAUACC

(ii) The mutated base sequence for the same strand of DNA is CAGTTATGG.

Explain why the mutated base sequence makes a different protein than the normal DNA.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 5 = 12 marks)

- 5 (a) Diagram 1 shows part of a DNA molecule.

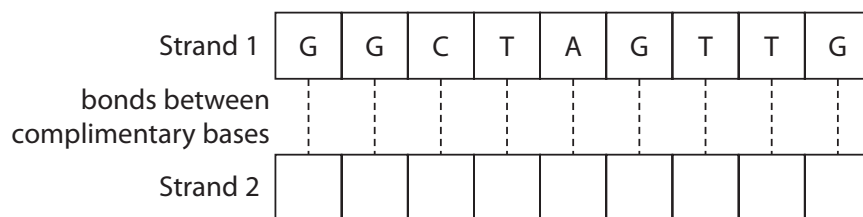


Diagram 1

- (i) Complete Diagram 1 by writing the letters of the missing bases in the empty boxes for strand 2.

(2)

- (ii) Give the maximum number of amino acids that are coded for by this DNA strand (strand 2).

(1)

- (iii) The original DNA strand is used to produce mRNA.

Complete the empty boxes in Diagram 2 to show the mRNA coded for by this DNA strand.

(2)



Diagram 2

(b) A length of DNA consists of 25 000 base pairs.

This makes a total of 50 000 bases.

In this length of DNA, 30% of the bases are adenine (A).

Determine the number of thymine (T) bases, cytosine (C) bases, and guanine (G) bases in this length of DNA.

(3)

number of thymine bases (T) = ...

number of cytosine bases (C) = ...

number of guanine bases (G) = ...



(4)

(Total for Question 5 = 12 marks)



5 (a) Inheritance involves genomes, genes and alleles.

(i) State what is meant by the term **genome**.

(1)

.....

.....

(ii) Explain the difference between a gene and an allele.

(2)

.....

.....

.....

.....

.....

.....

(b) In horses, black hair is caused by a dominant allele, B. The recessive allele, b, codes for brown hair.

A heterozygous black-haired male horse breeds with a heterozygous black-haired female horse.

(i) Draw a genetic diagram to show the genotypes of the parents, the gametes they can produce and the genotypes and ratio of phenotypes of their possible offspring.

(4)



- (ii) Calculate the probability that the first offspring will be male and have black hair.

(2)

probability = ...

- (c) In horses, eye colour is also controlled by a single gene with two alleles.

The dominant allele causes brown eyes and the recessive allele codes for blue eyes.

A farmer has a male horse with brown eyes.

Explain how the farmer could determine the genotype of this male horse.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 5 = 12 marks)



9 The ability of humans to taste a chemical called PTC is controlled by a single gene.

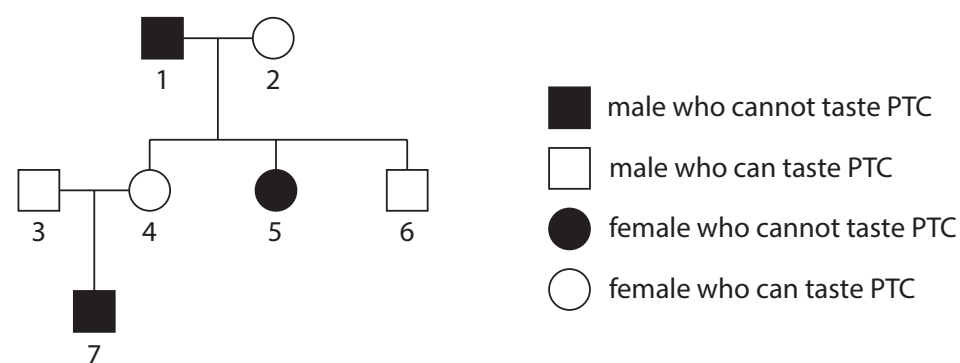
The ability to taste PTC is coded for by a dominant allele, **T**.

Not being able to taste PTC is coded for by a recessive allele, **t**.

(a) State what is meant by the term **recessive allele**.

(1)

(b) The pedigree diagram shows the individuals in a family who can taste PTC and those who cannot taste PTC.



(i) What are the genotypes of individuals 1 and 2?

(1)

- ☐ A TT and TT
- ☐ B Tt and TT
- ☐ C tt and Tt
- ☐ D tt and tt

- (ii) Determine the probability of individuals 3 and 4 having another child that can taste PTC and is male.

Use a genetic diagram to show your working.

(4)

probability



(c) People who can taste PTC say that it tastes bitter.

Many poisonous plants also taste bitter.

(i) Explain why there are many people who can taste PTC in areas where there are many poisonous plants.

Refer to natural selection in your answer.

(4)

(ii) People who can taste PTC often find the taste of vegetables very bitter.

Suggest why the recessive allele for not tasting PTC still exists in human populations.

(2)

(Total for Question 9 = 12 marks)

8 Cell division can be by meiosis or by mitosis.

(a) (i) Where are cells dividing by meiosis found in a human?

(1)

- ☐ A kidney
- ☐ B penis
- ☐ C skin
- ☐ D testis

(ii) Which part of a flowering plant is usually used to demonstrate cells dividing by mitosis?

(1)

- ☐ A anther
- ☐ B cotyledon
- ☐ C root tip
- ☐ D xylem

(b) The table lists features comparing the processes of meiosis and mitosis in human cells.

Complete the table by giving the missing information.

(6)

Feature	Meiosis	Mitosis
number of chromosomes in each original cell	46	
number of daughter cells produced from each original cell		2
number of chromosomes in each daughter cell		
ploidy level of daughter cells produced		diploid
genetic differences in daughter cells	present	
type of cell produced		body cell

(c) Cell division can cause variation in offspring.

(i) Describe other causes of variation in offspring.

(3)

(ii) Scientists investigating a drug treatment use rats that are homozygous for many genes.

Suggest the advantages of using rats that are homozygous for many genes.

(2)

(Total for Question 8 = 13 marks)



- 9 Cleft chin is a phenotype believed to be controlled by a single gene that has two alleles.

The dominant allele, N, codes for cleft chin and the recessive, n, allele codes for the absence of the cleft chin.

- (a) With reference to the example of cleft chin, state what is meant by the following terms

(i) phenotype

(1)

(ii) gene

(1)

(iii) allele.

(1)

- (b) A woman with a cleft chin has a child with a man who also has a cleft chin.

The child does not have a cleft chin.

- (i) Use a genetic diagram to show the genotypes of the parents, the gametes they can produce and all the possible genotypes and phenotypes of their children.

(4)

- (ii) The parents then have a second child. Calculate the probability that this child will be female and not have a cleft chin.

(2)

probability = ...

- (iii) Sometimes a cleft chin does not develop even if the individual inherits the dominant allele.

Suggest what might cause this.

(1)

- (c) Most inherited conditions are not controlled by a single gene, but by many genes.

Describe how a scientist could distinguish between a genetic condition in rats controlled by a single gene and one controlled by many genes.

(3)

(Total for Question 9 = 13 marks)

- 6 (a) The diagram shows one strand of DNA from a section of a gene.

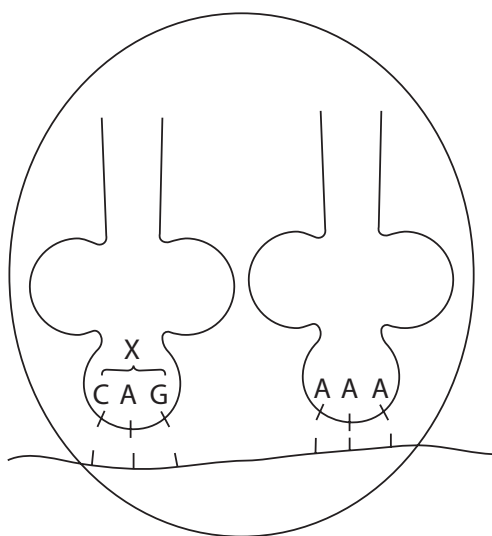
ATTCCGAGT

What would be the complementary sequence of bases on the messenger RNA produced from this strand of DNA?

(1)

- ☐ A TAAGGCTCA
- ☐ B ATTCCGAGT
- ☐ C UAAGGCUCA
- ☐ D AUUCCGAGU

- (b) The diagram shows a stage during protein synthesis.



Which row gives the correct names for the stage of protein synthesis shown and the sequence of bases labelled X?

(1)

	Stage of protein synthesis	X
☐ A	transcription	anticodon
☐ B	transcription	codon
☐ C	translation	anticodon
☐ D	translation	codon

(c) Explain how a mutation in a gene can affect the phenotype of an organism.

(3)



- (d) In an accident at a nuclear power station, radioactive material was released into the surrounding areas of land.

Scientists investigated the impact of this on a species of butterfly.



(Source: septembersun.123rf.com/PAL)

Samples of adult butterflies were collected from an area near the power station two months after the release of the radioactive material.

The percentages of butterflies with abnormalities were calculated.

The butterflies were then mated in the laboratory and the percentage of offspring with abnormalities calculated.

The experiment was repeated with butterflies collected from the same area, 10 months after the release of the radioactive material.

- (i) Describe how the scientists could have sampled the population of butterflies in the area.

(3)

.....

.....

.....

.....

.....

.....

.....

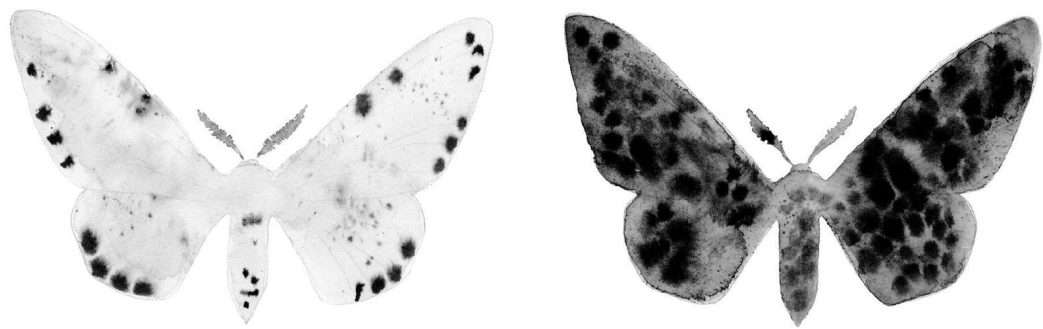
.....

.....

4 The peppered moth is found in many countries.

Two different forms of the peppered moth are a light-coloured moth and a dark-coloured moth.

The dark-coloured moth was first observed in cities when pollution, from burning coal, stained tree trunks black.



Light-coloured moth

Dark-coloured moth

(Source: © KBel/Shutterstock)

Scientists trapped moths in a city location from 1992 to 1998.

The table shows the scientists’ results.

Year	Number of light-coloured moths	Number of dark-coloured moths
1992	9	27
1993	11	18
1994	11	7
1995	5	1
1996	1	4
1997	8	1
1998	13	9

(a) Calculate the difference between the percentage of moths that are dark-coloured in 1992 and the percentage of moths that are dark-coloured in 1998.

(3)

difference = ...%

- (b) (i) Plot a line graph to show the number of light-coloured moths and the number of dark-coloured moths from 1992 to 1998.

Use a ruler to join the points with straight lines.

(5)



(ii) In the 1990s, many cities introduced laws that prevented the burning of coal.

Comment on the changes in the number of light-coloured moths and the number of dark-coloured moths between 1992 and 1998.

(5)

(Total for Question 4 = 13 marks)



- 5 Guinea pigs have either long hair or short hair. The hair length is controlled by one gene with two alleles.

The photograph shows a guinea pig with long hair and a guinea pig with short hair.



(Source: © Kallayanee Naloka/Shutterstock)

- (a) State what is meant by the term **allele**.

(1)

.....

.....

.....

(b) A breeder did the following crosses.

Cross 1 a male long-haired guinea pig with a female short-haired guinea pig,
this produces five offspring all with short hair

Cross 2 a male short-haired guinea pig with a female long-haired guinea pig,
this produces four offspring all with short hair

Cross 3 a male short-haired offspring from cross 1 with a female short-haired
offspring from cross 2, this produces some offspring with long hair and
some offspring with short hair

(i) Draw a genetic diagram to show the parents, gametes and all possible
genotypes and phenotypes of the offspring from cross 3.

(4)

(ii) Calculate the probability that the first offspring born from cross 3 is a male
with short hair.

(2)

probability = ...



(iii) Some short-haired guinea pigs are homozygous and some short-haired guinea pigs are heterozygous.

Explain how a breeder could use a cross to determine the genotype of a short-haired guinea pig.

(2)

.....

.....

.....

.....

.....

.....

(c) Guinea pigs stay completely still and do not move when they sense danger.

Describe how this behaviour has evolved by natural selection.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 5 = 13 marks)

(c) Scientists investigate the rate of spontaneous mutations in yeast.

They record the number of mutations per cell during mitosis and during meiosis.

They count the mutations in three different strains of yeast and repeat each count.

The mutation rates are counted per division per cell.

Yeast strain	Mutation rate $\times 10^8$ per division per cell	
	mitosis	meiosis
5160	6.53	45.4
	4.86	29.6
5207	5.90	132.6
	5.03	43.2
5209	0.21	2.20
	0.28	1.42

(i) Calculate the mean mutation rate for strain 5207 during meiosis.

(2)

mean rate = ... $\times 10^8$ per division per cell

(ii) Suggest why the mutation is calculated per division per cell rather than just per cell.

(1)

.....

.....

(4)

(Total for Question 4 = 13 marks)



9 Alkaptonuria is an inherited condition caused by the presence of recessive alleles.

(a) State what is meant by a recessive allele.

(1)

(b) Alkaptonuria is first diagnosed in children when it is noticed that they produce very dark urine that turns black when exposed to air.

A woman and a man do not have alkaptonuria. They have a child who has the condition.

The woman and the man are expecting a second child.

(i) Draw a genetic diagram to show the genotypes of the woman and the man, the gametes they produce and the possible phenotypes and genotypes of the second child.

(4)

(ii) Calculate the probability that the second child is male and does not have the condition.

(1)

probability = ...

(c) Alkaptonuria is caused by the body being unable to break down the amino acids tyrosine and phenylalanine.

This leads to a build-up of a toxin that causes damage to joints and tendons and can also lead to heart valve damage in later life.

A new drug treatment is being tested that can slow the damage to the joints and tendons.

Scientists selected 40 adults who all had alkaptonuria. They placed each patient into one of two groups. One group was given the drug treatment and the other group acted as a control.

The scientists then compared the symptoms of the patients in each group after three years.

(i) Describe what is meant by the control group.

(1)



- (d) Other scientists have suggested that eating fewer proteins that contain tyrosine and phenylalanine would reduce the symptoms of alkaptonuria.

Suggest why eating fewer of these proteins may be difficult.

(2)

(Total for Question 9 = 14 marks)



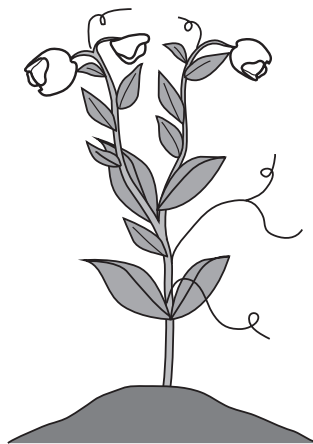
6 Many characteristics of pea plants are genetically controlled.

One of these characteristics is flower position.

Flower position can either be axial or terminal.



Axial



Terminal

In a first cross, scientists crossed pea plants with axial flowers with pea plants with terminal flowers.

This first cross produced 1120 offspring plants.

All of these offspring plants had axial flowers.

- (a) Use a genetic diagram to show the genotypes of the parent plants, the gametes they produce and the genotypes of the offspring plants.

(3)

(b) The scientists allowed the offspring from the first cross to self-fertilise.

This second cross produced 858 second generation plants. 608 of the plants had axial flowers and the other plants had terminal flowers.

(i) Calculate the ratio of plants with axial flowers to plants with terminal flowers.

Give your answer in the form $n : 1$

(2)

ratio = ... : 1

(ii) Explain why the ratio of plants with axial flowers to plants with terminal flowers is different from the expected ratio.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Scientists want to discover if plants with axial flowers produce more seeds than plants with terminal flowers.

Design an investigation to discover whether plants with axial flowers produce more seeds than plants with terminal flowers.

Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 6 = 14 marks)



- 6 This insect is the fruit fly *Drosophila melanogaster*. These flies are the most commonly used organisms for genetic research.

They have a life cycle of around 10 days and each female can produce hundreds of offspring.



(Source: © Nechaevkon/ Shutterstock)

- (a) Explain one reason why *Drosophila* are a popular choice for scientists to use in genetic studies.

(2)

.....

.....

.....

.....

- (b) Flies normally have long wings, but some flies have been found that have short wings.

In a first cross, a scientist mates 10 male flies with long wings with 10 female flies that have short wings.

They have 2810 offspring that all have long wings.

The scientist then sets up a second cross.

They mate a male offspring from the first cross with a female offspring from the first cross.

This second cross produces 241 offspring with long wings and 79 offspring with short wings.

- (i) Draw a genetic diagram to show the genotypes and phenotypes of the parents in the second cross and the ratio of phenotypes and genotypes of their offspring.

(4)

- (ii) Calculate the expected probability of a fly being male and having long wings in this second cross.

(2)

probability = ...



(c) Flies with short wings are not found in wild populations of *Drosophila*.

Explain this observation.

(3)

(Total for Question 6 = 15 marks)



- 1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Haemolytic disease

Haemolysis is the term used to describe the bursting of red blood cells. Haemolytic disease occurs when the red blood cells burst in the body of a foetus in a pregnant woman. The bursting of the red blood cells affects the development of the foetus into a baby.

- 5 The red blood cells burst when certain antibodies from the mother pass across the placenta. The antibodies attach to protein molecules called antigens. These antigens are on the surface of the foetal red blood cells. The protein antigen is called the rhesus factor and is made using the genetic code found on the dominant allele, D, during the production of red blood cells in bone marrow.
- 10 Homozygous dominant and heterozygous individuals have cells with the antigen. These individuals have the rhesus positive blood group. Homozygous recessive individuals have cells that do not have the antigen. These individuals have the rhesus negative blood group.
- 15 During the birth of a rhesus positive baby, some red blood cells may leak into the circulatory system of the mother. This happens as the placenta pulls away from the wall of the uterus. A rhesus negative mother will make antibodies that destroy rhesus positive red blood cells. This is not a problem for the child that has just been born. However, if the mother becomes pregnant again with another rhesus positive foetus, the antibodies will harm the foetus.
- 20 Haemolytic disease can be avoided by treating a rhesus negative woman at risk of having a second rhesus positive child. This treatment involves the mother having an injection during and after pregnancy. The injection destroys rhesus positive cells in the mother's blood before the cells can cause an immune response.
- 25 If the foetus is rhesus positive, the pregnancy is carefully monitored for signs of haemolytic disease. Monitoring includes regular ultrasound scans of the foetus and measuring the amount of antibody in the mother's blood. A change in the concentration of the antibody in the mother's blood, due to her secondary immune response, can lead to dangerous haemolysis. If a foetal blood test confirms a low number of red blood cells, a blood transfusion can be done
- 30 *in utero* to replace the burst foetal red blood cells.

- (a) Explain why bursting of red blood cells affects the development of a foetus (lines 3 and 4).

(2)

- (b) The dominant allele codes for the production of the protein that will act as an antigen.

Describe how the dominant allele leads to the production of RNA during protein synthesis (lines 7 to 9).

(3)

- (c) Give the reason why proteins cannot be made by red blood cells (lines 7 to 9).

(1)

- (d) Give one piece of evidence from the passage that shows that antibodies are smaller than red blood cells.

(1)

- (e) (i) A mother who is homozygous recessive for the rhesus factor has a child with a father who is heterozygous.

Give the genotypes of the mother, the father, their gametes and the possible genotypes of the child.

(3)

- (ii) Give the probability that the child will be rhesus positive.

(1)

- (f) Explain why the concentration of the rhesus antibody in the mother's blood rises quickly to harmful levels if she has a second child who is Rhesus positive (lines 16 to 19).

(3)

- (g) Suggest what is meant by the term *in utero* (line 30).

(1)



(h) A foetus with haemolytic disease can be given a blood transfusion.

Suggest the blood group of the source of the cells used for this transfusion
(lines 29 and 30).

(1)

(Total for Question 1 = 16 marks)



MARK SCHEMES

official Pearson Edexcel mark schemes



Question Number	Answer	Mark
6(a)(i)	LH / luteinising hormone (1)	1

Question Number	Answer	Mark
6(a)(ii)	release of <u>egg</u> / <u>ovum</u> / <u>ova</u> (1)	1

Question Number	Answer	Mark
6(b)	progesterone (1)	1

Question Number	Answer	Mark
6(c)	ovary / ovaries / corpus luteum / placenta / follicle (1)	1

Total 4 marks



Question Number	Answer	Additional guidance	Mark
10	C light and no light or different periods of light / light intensity / eq (1) O same species of seeds / same age / mass / eq (1) R repeat / (calculate mean) for each light / dark group / eq (1) M1 count number of seeds germinated / that have roots / shoots / split / eq (1) M2 after stated time period / eq (1) S1 same temperature / eq (1) S2 same water / same oxygen / same soil / eq (1)	Not just different light exposure unexplained Not repeat at different light periods / eq allow amount that have germinated ignore measure roots/shoots one day plus	6

Question Number	Answer	Mark
1(a)	The only correct answer is B 1 A is not correct as 0 is not the correct number of chromosomes C is not correct as 2 is not the correct number of chromosomes D is not correct as 23 is not the correct number of chromosomes	1

Question Number	Answer	Mark
1(b)	An explanation that makes reference to the following points: • energy / ATP / respiration /eq (1) • movement / swimming / tail movement/ eq (1)	2

Question Number	Answer	additional guidance	Mark
1(c)	An explanation that makes reference to two of the following points: • digest / break down egg membrane / eq (1) • allow (nucleus) to enter / penetrate egg (1) • fertilisation / fusion (1)	ignore wall / shell etc	2

Question Number	Answer	Additional guidance	Mark
1(d)	An answer that makes reference to 2 of the following points: • vagina • uterus / womb /cervix • oviduct / fallopian tube	two marks for all 3 in correct order one mark for 3 structures wrong order one mark for 2 structures in correct order vagina oviduct = 1 uterus vagina oviduct = 1 oviduct vagina = 0 uterus oviduct = 1 vagina uterus = 1 ign route after fertilisation	2

Total = 7 marks

Question Number	Answer	Mark
3(a)	The only correct answer is C as they are released from the pituitary A is not correct as they are not produced in ovary B is not correct as they are not produced in ovary D is not correct as they are not produced in ovary	1

Question Number	Answer	Additional guidance	Mark
3(b)	• $45 - 5 = 40$ • $40 \div 5 \times 100 = 800$ (2)	allow one mark for 40 award full marks for correct numerical answer without working	2

Question Number	Answer	Mark
3(c)	A description that makes reference to four of the following points: two from • FSH stimulates development / growth / maturation /eq of follicle / egg / sperm production (1) • FSH stimulates oestrogen release /eq (1) two from • LH stimulates release of progesterone / testosterone (1) • LH stimulates ovulation / egg release (1) • LH stimulates development of corpus luteum (1) • LH inhibits release of oestrogen (1)	4

Total 7 marks



Question Number	Answer	Mark
2	• sexual (1) • pollen (1) • anther (1) • stigma (1) • bees / moths / flies (1) • large / big / scented / (sweet) smelling (1) • style (1) • fertilisation (1)	8 grad

Total 8 marks



Question Number	Answer	Mark
1(a)(i)	The only correct answer is C V to P as V is anther and P is stigma A is not the answer as P is not anther and Q is not stigma B is not the answer as P is not anther and T is not stigma D is not the answer as it S not stigma	1

Question Number	Answer	Mark
1(a)(ii)	The only correct answer is A as Q is the style B is not correct as U is the filament C is not correct as V is the anther D is not correct as R is the petal	1

Question Number	Answer	Mark
1(a)(iii)	The only correct answer is C as T is the ovule A is not correct as P is the stigma B is not correct as S is the ovary D is not correct as V is the anther	1

Question Number	Answer	Additional guidance	Mark
1 (b)	An answer that makes reference to three of the following: • large <u>petals</u> /eq (1) • coloured <u>petals</u> / bright <u>petals</u> / scented <u>petals</u> (1) • stigma / style within flower / stigma sticky / eq (1) • stamen / anther within flower / eq(1) • nectary (1) • pollen large / sticky /eq (1)	allow converse ignore flower no / small petals green petals ignore coloured stigma / style outside flower / stigma feathery / hairy stamen outside flower / hinged / long filament no nectary ignore nectar small / dust / like	3

Question Number	Answer	Additional guidance	Mark
1 (c)	An explanation that refers to two of the following: • eaten by birds / animals / people / insects / eq (1) • disperse / taken / moved / carried to new area / elsewhere / eq (1) • egested / deposited / waste / defecate / thrown away / discarded / in faeces / eq (1)	allow consume /consumers ignore excreted allow excrement	2

Total 8 marks



Question Number	Answer	Mark
6 (a)(i)	B is the only correct answer A is incorrect as ovulation does not occur in the oviduct C is incorrect as ovulation does not occur in the uterus D is incorrect as ovulation does not occur in the vagina	1

Question Number	Answer	Mark
6 (a)(ii)	A is the only correct answer B is incorrect as fertilisation does not normally occur in the ovary C is incorrect as fertilisation does not usually occur in the uterus D is incorrect as fertilisation does not usually occur in the vagina	1

Question Number	Answer	Additional guidance	Mark
6 (b)(i)	X: oestrogen / estrogen (1) Y: progesterone (1)	Accept other correct names	2

Question Number	Answer	Additional guidance	Mark
6(b)(ii)	An description that makes reference to two of the following: - repairs / thickens the uterus lining / endometrium / eq (1) - for implantation / eq (1)	Accept reduces FSH levels / eq (1) Accept stimulates release of LH / eq (1)	2

Question Number	Answer	Mark
6 (c)	An explanation that makes reference to three of the following: • villi providing a large surface area (1) • for diffusion / active transport (1) • capillaries bring / blood supply brings nutrients / remove(s) waste products / eq (1) • blood supply / capillaries / blood vessel to maintain a diffusion gradient (1) • close distance between mother's and fetal blood for short diffusion pathway (1)	3

Total for Question 6 = 9 marks



Question Number	Answer	Mark
1(a)(i)	D (T and U) A is not the answer as P and Q are not both the male parts B is not the answer as P and R are not both the male parts C is not the answer as S and T are not both the male parts	1

Question Number	Answer	Mark
1(a)(ii)	A (P) B is not the answer as pollen grains do not germinate on R C is not the answer as pollen grains do not germinate on S D is not the answer as pollen grains do not germinate on T	1

Question Number	Answer	Mark
1(a)(iii)	C (R) A is not the answer as P does not become the seed B is not the answer as Q does not become the seed D is not the answer as T does not become the seed	1

Question Number	Answer	additional guidance	Mark
1(b)(i)	A description that makes reference to two of the following: • uses runners / stolons / eq (1) • stem / shoot (grows along ground) / eq (1) • breaks off / grows roots / produces new plant / clone / eq (1)	ignore cuttings	2

	Answer	additional guidance	Mark
1(b)(ii)	An answer that description that makes reference to four of the following: 1. (use sexual reproduction) cross with different variety / different plant / selective breeding / eq (1) 2. transfer pollen / cross pollinate / eq (1) 3. to produce different flavour / new flavour / desired flavour / variation / eq (1) 4. (use asexual) / runners / cuttings / micropropagation / eq (1) 5. produces genetically identical plants / clones / eq (1) 6. many offspring produced / large numbers / eq (1)	method linked to sexual method linked to asexual linked to asexual rapidly alone not enough	4

Total 9 marks

	Answer	additional guidance	Mark
--	--------	---------------------	------

Question Number	Answer	Mark
2(a)(i)	The only correct answer is A P is the anther B is not the answer as it is the filament C is not the answer as it is the stigma D is not the answer as it is the style	1

Question Number	Answer	Mark
2(a)(ii)	The only correct answer is B Q is the petal A is not the answer as it is the leaf C is not the answer as it is the stem D is not the answer as it is the style	1

Question Number	Answer	Mark
2(a)(iii)	The only correct answer is D structure S the stigma A is not the answer as they do not germinate on P anther B is not the answer as they do not germinate on Q petal C is not the answer as they do not germinate on R stem	1



Question Number	Answer	Mark
2(b)	An answer that makes reference to the following: • P / anthers exposed / hanging out / outside / eq (1) • S / stigma feathery / exposed / hanging out / longer / outside / eq (1) • Q / petals smaller/ absent / green / not coloured / not scented / eq (1)	3 allow hairy

Question Number	Answer	Additional guidance	Mark
2(c)(i)	runners / eq	allow corms / bulbs / rhizomes/ tubers	1

Question Number	Answer	Additional guidance	Mark
2(c)(ii)	cuttings/ eq	allow grafting / layering / micropropagation / tissue culture	1

Question Number	Answer	Additional guidance	Mark
2(c)(iii)	An answer that makes reference to two the following: • no / (less) <u>genetic</u> variation / a clone / eq (1) • maintain phenotype / colour / flavour / desired characteristic / same characteristics / eq (1) • faster / eq (1) • seeds not viable / produce rare plants / eq (1)	allow converse for sexual not just get a copy off ign more plants	2

--	--	--	--

total 10 marks



Question Number	Answer	Mark
7 (a) (i)	The only correct answer is A <i>B is incorrect as fertilisation does not occur in the ovary</i> <i>C is incorrect as fertilisation does not occur in the uterus</i> <i>D is incorrect as fertilisation does not occur in the vagina</i>	1

Question Number	Answer		Mark
7(a)(ii)	A description that makes reference to the following. • (oestrogen) repairs / thickens lining / thickens wall / eq (1) • (progesterone) retains / maintains lining / vascularises endometrium / prevents menstruation / eq (1)	Allow builds up lining Allow fall in progesterone causes lining to shed / causes menstruation Allow increase blood flow in lining	2

Question Number	Answer	Additional guidance	Mark
7(b)(i)	A description that makes reference to the following. • fusion of nuclei / fusion of egg and sperm / zygote (forms) / eq (1) • mitosis / <u>cell division</u> / (to form an embryo) / eq (1)	Reject meiosis	2

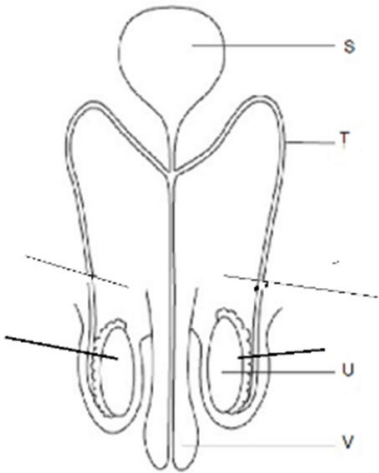
Question Number	Answer	Additional guidance	Mark
7 (b) (ii)	An answer that makes reference to five of the following. • number of (multiple births) has decreased / eq (1) • constant / steady / eq, decrease, (in multiple births) until 2007 / 2008 / 2009 / before recommendations / eq (1) • (steep) decrease / since 2007 / 2008 / 2009 / since recommendations / eq (1) • (so) less risk to health / multiple births increase health risks / eq (1) • (repeated IVF) is expensive / stressful / eq (1) • IVF success rate / fertility decreases with age / eq (1) • (older women have lower success rate) so better to use more than one embryo / eq (1) • no information on sample sizes / only one country / only UK data / eq (1) • reliable as data is for a long period of time / eq (1) • (could be affected by) other health issues / diet / genetics / sperm / eq (1)	Allow age references for any ages of ≥ 37 for older women MP3 also gets MP1 Allow recommendations have made it safer / multiple births are dangerous Allow older women have low(er) success rate / young(er) women have high success rate Allow restricting number of embryos for younger women has less effect on success / eq Allow cannot be generalised / needs to be researched in other countries / eq Allow no information about health issues / eq	5

(Total for Question 7 = 10 marks)

Question Number	Answer	Mark
8(a)(i)	The only correct answer is C (U) A is not the answer as R does not produce gametes B is not the answer as S does not produce gametes D is not the answer as X does not produce gametes	1

Question Number	Answer	Mark
8(a)(ii)	The only correct answer is A (R) B is not the answer as S is not the site of fertilisation C is not the answer as W is not the site of fertilisation D is not the answer as X is not the site of fertilisation	1

Question Number	Answer	Mark
8(a)(iii)	The only correct answer is D (X) A is not the answer as R is not where the placenta usually develops B is not the answer as S is not where the placenta usually develops C is not the answer as W is not where the placenta usually develops	1

Question Number	Answer	additional guidance	Mark
8(b) (i)		any cut of both sperm ducts / in or out of scrotum eq	1

Question Number	Answer	additional guidance	Mark
8(b)(ii)	An explanation that makes reference to two of the following • no sperm in semen / no sperm released / eq (1) • in / from urethra / penis no sperm ejaculated / (1) • transferred to female / eq (1) • egg not fertilised /no fertilisation /eq (1)	ignore sperm not produced ignore no semen released/ ejaculated	2

Question Number	Answer	additional guidance	Mark
8(c)	An answer that makes reference to four of the following 1. easier / simpler operation / testes scrotum outside/ less invasive / eq (1) 2. large study / reliable /significant / valid / eq (1) 3. no deaths in males / eq (1) 4. fewer complications in male / eq (1) 5. fewer failures in male / more successful / eq (1) 6. cheaper in male / eq (1) 7. no data on age / illness / medical conditions / mass / eq (1)	allow converse ignore risky / safe / dangerous ignore fewer deaths in males allow some deaths / more deaths in females	4

Total 10 marks



Question Number	Answer			Mark
5(a)				6 exp
	Hormone	Name of structure that secretes hormone	Functions of hormone	
	FSH	pituitary (1)	1. stimulate follicle growth / mature eggs / develop eggs / eq (1) 2. stimulates oestrogen secretion	
	LH / Lutenising hormone (1)	pituitary	1. cause ovulation / egg / ovum release / eq / stimulate progesterone release (1) 2. stimulates development of corpus luteum	
	oestrogen / estrogen (1)	ovaries	1. repairs lining of uterus 2. stimulates LH secretion	
	progesterone	ovaries / corpus luteum / placenta (1)	1. maintains the lining of uterus 2. inhibits LH	

Question Number	Answer	Additional guidance	Mark
5(b)	An answer that makes reference to one of the following points: • blood loss once a month / monthly period / eq (1) • breakdown of uterus lining / breakdown of endometrium / eq	Allow passing out / shedding / loss of uterus lining / endometrium	1 grad

Question Number	Answer	Additional guidance	Mark
5(c)	• $51 - 12 = 39$ • $39 \times 52 \times 7 = 14\,196$ days • $39 \times 365 = 14\,235$ • $39 \times 365.25 = 14\,247.5$ • $14\,196 \div 28 = 507$ • = 510 to 2 sig figs (3) OR • $51 - 12 = 39$ • $365 / 28 = 13(.04)$ • $13.04 \times 39 = 508$ • = 510 to 2 sig figs (3)	Award full marks for correct numerical answer without working Allow one mark for $\times 39$ OR for $\div 28$ Allow answer between 507 and 510 for 2 marks e.g. 507 / 508 / 509	3 exp

Question Number	Answer	Additional guidance	Mark
5(d)	An answer that makes reference to one of the following points: • not all eggs fertilised / eq (1) • no sexual intercourse / eq (1) • contraception / eq (1) • no implantation / eq (1) • miscarriages / eq (1) • some eggs not fertile / eq (1)	Allow eggs fertilised by abnormal sperm	1 exp

Total 11 marks

5(a)	A oviduct / Fallopian tube (1) B ovary (1) C cervix (1)	3
-------------	---	----------

Question Number	Answer	additional guidance	Mark
5(b)	A description that makes reference to two of the following points: • site of implantation of embryo / eq (1) • placenta grows (in uterus) / eq (1) • provides nutrition / removes waste from embryo/ / allow named substances/ eq (1)	allow zygote fertilised egg implants	2

Question Number	Answer	additional guidance	Mark
5(c)(i)	An explanation that makes reference to four of the following points: 1. M is oestrogen / N is progesterone (1) 2. M / oestrogen increases and peaks before ovulation / eq (1) 3. M / oestrogen repairs uterine lining (following menstruation) / inhibits FSH / stimulates release of LH / eq (1) 4. (ready) for implantation (of fertilised egg) / eq (1) 5. N / progesterone increases after ovulation / eq (1) 6. N maintains uterine lining / prevents menstruation / inhibits / prevents release of FSH and LH / eq (1) 7. drop in N / progesterone causes menstruation / uterine lining/ endometrium to break down/ eq (1)	allow from graph	4

--	--	--	--

Question Number	Answer	Mark
5(c)(ii)	A description that makes reference to the following points: • FSH / eq (1) • FSH causes growth of follicle (in ovary) / egg to mature / release of oestrogen / eq (1) OR • LH /eq (1) • causes ovulation/ release of egg / formation of Corpus Luteum /eq (1)	2

Total = 11 marks

Question Number	Answer	Additional guidance	Mark
5(a)(i)	pituitary (gland) (1)	Ignore anterior or posterior	1

Question Number	Answer	Mark
5(a)(ii)	The only correct answer is D <i>A is incorrect as it is oestrogen</i> <i>B is incorrect as it is LH</i> <i>C is incorrect as it is FSH</i>	1

Question Number	Answer	Additional guidance	Mark
5(a)(iii)	A description that makes reference to the following. • (FSH) matures eggs / follicles / eq (1) • (FSH) stimulates oestrogen (release) / eq (1) • (LH) induces ovulation / egg release / eq (1) • (LH) stimulates progesterone / oestrogen (release) / stimulates corpus luteum (development) / eq (1)	Allow grows / develops Allow oocytes Allow FSH makes (ovary / follicle) release oestrogen Allow estrogen / estradiol Allow oocyte Allow (LH) makes (ovary / corpus luteum) release progesterone / oestrogen Allow yellow body	4

Question Number	Answer	Additional guidance	Mark
5(b)	An answer that makes reference to five of the following. Overall comments - tablets are less effective / tablets have a wider range of effectiveness / implants or injections are more effective / eq (1) - no protection against HIV / (any method) may cause side effects / eq (1) Tablets <u>max one advantage from:</u> - tablets are easy to use / no need for medical treatment / no need for doctor / surgery / good if people scared of needles / not painful / eq (1) - easy to stop if, change mind / want to have children / quick to restart cycle (1) <u>max one disadvantage from:</u> - tablets easy to forget / need to take every day / eq (1) - tablets may not be effective if vomiting / may be affected by food / eq (1) Injection <u>max one advantage from:</u> - injections last long time / don't need to keep going to doctor / eq (1) - can't forget to take / don't need to take every day / no need to keep remembering (1) <u>max one disadvantage from:</u> - need to be given by doctor / health professional / eq (1) - can be painful / some people are scared of needles / eq (1) - longer for cycle to return / difficult to change mind / eq (1) Implant <u>max one advantage from:</u> - implant last long(est) time / don't need to keep going to doctor / eq (1) - can't be forgotten / no need to keep remembering / don't need to take every day (1) - good for people who have less access to doctors (as it lasts for 3 years) / eq (1) <u>max one disadvantage from:</u> - need to be given by doctor / health professional / eq (1) - could cause infection / damage tissues / leave scars / painful / eq (1) - implant could produce very high hormone levels / eq (1) - not easy to change mind / will take longer to return to normal with implant / eq (1)	Allow mp2 for any method Allow STI / other STIs/ named side effects Allow tablets easy to obtain / may be obtained from pharmacist Ignore injection lasts 12 weeks unqualified Ignore implant last 3 years unqualified Injection and implant are long lasting = two marks	5

(Total for Question 5 = 11 marks)



Question Number	Answer	Additional guidance	Mark
6(a)(i)	fertilisation / fertilise / fuse with egg / join with egg / combine with egg	Ignore meet with egg	1

Question Number	Answer	Additional guidance	Mark
6(a)(ii)	An answer that makes reference to two of the following points: - nucleus (1) - chromosomes (1) <u>haploid</u> number (1) - DNA (1) - acrosome (1)	Ignore genes / alleles	2

Question Number	Answer	Mark
6(a)(iii)	An explanation that makes reference to the following points: • (aerobic) respiration / energy / ATP (1) • movement / swimming (of sperm / of tail) (1)	2

Question Number	Answer	Additional guidance	Mark
6(b)(i)	- select 24.8% from table and convert to 0.248 - calculate 24.8% of 58 million 14 384 000 / 14 400 000 / 1.4×10^7 1.44×10^7 14.384×10^6 / 1.4384×10^7 / eq (2)	Award full marks for correct numerical answer without working One mark for $0.248 \times 58 \text{ million}$ / $24.8 \div 100 \times 58 \text{ million}$	2

Question Number	Answer	Mark
6(b)(ii)	An explanation that makes reference to five of the following points: <u>Arguments for:</u> • nicotine reduces normal/undamaged cells / nicotine increases damaged cells (1) • less (chance of) fertilisation / eq (1) • rats are similar to humans / rats are mammals / eq (1) <u>Arguments against:</u> • there are normal/undamaged sperm cells in nicotine samples / there are damaged cells with no nicotine (1) • investigation on rats (not humans) / eq (1) • rats were not smoking / small range(of concentrations) / no idea of nicotine concentration in cigarettes / eq (1) • not repeated / no idea of number of rats / not reliable (1)	5

Total 12 marks

Question Number	Answer	Mark
10(a)(i)	• A stigma (1) • B style (1) • C ovary (1)	3

Question Number	Answer	Additional guidance	Mark
10(a)(ii)	An answer that makes reference to the following points: • tube going down style (1) • tube entering the micropyle (1)	Reject arrows pointing upwards	2

Question Number	Answer	additional guidance	Mark
10(a)(iii)	A description that makes reference to two of the following points: • ovule becomes seed (1) • ovule wall becomes seed coat / testa (1) • ovary becomes fruit (1)	Ignore ovum	2

Question Number	Answer	Additional guidance	Mark
10(b)(i)	• 476 - 432 • $44 \div 432 \times 100 =$ • allow 10.2 / 10.19 / 10.185/ 10.1852/ 10.18519	award full marks for correct numerical answer without working Allow one mark for 44	2

Question Number	Answer	additional guidance	Mark
10(b)(ii)	An answer that makes reference to two of the following points: • in warm (and wet) conditions there are more fungi / bacteria/ microbes / eq (1) • so seeds are diseased or contents digested / consumed / seeds killed (by fungi /bacteria /microbes / eq) / eq (1) • enzymes are activated in storage (1) • seeds have (already) started to germinate in storage (1)	Allow converse for wet and cold	2

Question Number	Answer	additional guidance	Mark
10(b)(iii)	A description that makes reference to one the following: • (seed / testa) split / eq(1) • radicle / root (is seen) (1) • plumule / shoot (is seen)/ eq (1) • sprouts (1)		1

Total = 12 marks



Question Number	Answer	Mark
8(a)	the only correct answer is A anther B is not correct as ovary does not contain pollen grains C is not correct as petal does not contain pollen grains D is not correct as sepal does not contain pollen grains	1

Question Number	Answer	Mark
8(b)(i)	An answer that makes reference to two of the following points: • supplies glucose / sucrose / sugar / carbohydrate / nutrients (1) • respiration / energy / ATP (1) • supplies amino acids (1) • make protein (1) • supplies water (1) • cell elongation / eq (1)	2

Question Number	Answer	Additional guidance	Mark
8(b)(ii)	• $120 - 60 = 60$ minutes • $4.7 - 1.4 = 3.3$ in one hour • $3.3 \div 60 = 0.055$ (3)	Award full marks for correct numerical answer without working Award 1 mark for 1.4 <u>and</u> 4.7 or 3.3 Award one mark for $\div 60$	3

Question Number	Answer	Additional guidance	Mark
8(c)	An answer that makes reference to the following points: C plus and minus pesticide / range of concentrations of pesticides (1) O same / variety / age / mass / size, of apple tree type (1) R use many trees / orchard / repeats / eq (1) M1 number of apples / mass of apples (1) M2 same time / stated period of time (1) S1 same soil / fertiliser / compost / water / eq (1) S2 light/ temp/ CO₂/ bees / eq (1)	Allow same species Ignore yield	6

Total 12 marks

Question Number	Answer	Mark
7 (a)	The only correct explanation is B (6 and 12) A is incorrect because the root cell will not have 6 chromosomes C is incorrect because the pollen grain will not have 12 chromosomes D is incorrect because the pollen grain will not have 12 chromosomes	1

Question Number	Answer	Additional guidance	Mark
7 (b)	An explanation that makes reference to four of the following: (mark in pairs) • anthers hang outside / long / hinged filament / eq (1) • so blow pollen in the wind / eq (1) • stigma is feathery / hairy / hangs out of flower / eq (1) • to catch pollen / eq (1) • petal is small / not coloured / no nectary in flower (1) • as insects are not attracted to it / eq (1) • pollen is light / dust like / produced in large quantities (1) • so easily carried by wind (1)	Allow stamens Ignore scents	4

Question Number	Answer	Additional guidance	Mark
7 (c)(i)	percentage / % of tubes that grow / number of / how many grow /eq (1)		1

Question Number	Answer	Additional guidance	Mark
7 (c)(ii)	An explanation that makes reference to three of the following: - fewer (pollen tubes) grow when self-pollinated / more (pollen tubes) grow when cross pollinated / eq (1) (cross pollination) produces (more) genetic variation / eq (1) (so that) natural selection can occur / for natural selection to act on / eq (1) - some plants will have (different) adaptations / will have an advantage / are more adaptable / can survive different weather / eq (1)	Allow fewer grow when from same plant / more grow when from different plants / eq Allow some will have a selective advantage for 2 marks	3

Question Number	Answer	Additional guidance	Mark
7 (d)(i)	mitosis (1)		1

Question Number	Answer	Additional guidance	Mark
7 (d)(ii)	An answer that makes reference to two of the following: - plants will be genetically identical / have same gene / eq (1) - plants will have same characteristics / phenotype / eq (1) - many are produced / quick / eq (1) - can be produced at any time of year / eq (1)	Allow favourable characteristics retained Allow high yield	2

(Total for Question 7 = 12 marks)

Question Number	Answer	Additional guidance	Mark
5(a)(i)	B (X) <i>A is incorrect ovulation occurs in the ovary</i> <i>C is incorrect as ovulation occurs in the ovary</i> <i>D is incorrect as ovulation occurs in the ovary</i>		1

Question Number	Answer	Additional guidance	Mark
5(a)(ii)	An answer that makes reference to two of the following: • (progesterone is released) after ovulation / in second half of cycle / eq (1) • maintains uterus lining / maintain endometrium / prevents menstruation / eq (1) • so embryo can implant in the lining / to support an embryo / to support fetus / eq (1)	Accept from corpus luteum / during luteal phase Ignore thickens Accept menstruation occurs when progesterone drops / uterus lining breaks down when progesterone drops Accept embed into uterus lining Accept prepare for implantation Accept to prepare for zygote / <u>fertilised</u> egg Accept zygote implants Accept reduce FSH / LH Ignore egg if not fertilised Ignore baby Ignore prepare for pregnancy / maintain pregnancy unqualified	2

Question Number	Answer	Additional guidance	Mark
5(a)(iii)	An answer that makes reference to three of following: 1. villi / villus (1) 2. large surface (area) (1) 3. (blood / capillaries) maintains gradient / makes steep gradient / eq (1) 4. thin / short distance / maternal and fetal blood are close / eq (1) 5. diffusion / active transport (1)	Accept short diffusion path for 2 marks	3

Question Number	Answer	Additional guidance	Mark
5(b)(i)	C (haploid number of 23 chromosomes) <i>A is incorrect as sperm are not diploid</i> <i>B is incorrect as sperm are not diploid</i> <i>D is incorrect as sperm have 23 chromosomes</i>		1

Question Number	Answer	Additional guidance	Mark
5(b)(ii)	An answer that makes reference to five of the following: - sperm movement decreases with concentration / eq (1) - no further effect between 0.4 and 0.8 / levels off after 0.4 / eq (1) - no effect on sperm concentration / small reduction / slight effect / unclear effect / fluctuates / eq (1) <u>fertilisation</u> would not occur (if sperm cannot swim) / eq (1) (sperm) needs to swim to <u>oviducts</u> / <u>Fallopian tubes</u> / fertilisation occurs in <u>oviducts</u> / <u>Fallopian tubes</u> / eq (1) (may not work as) some sperm can (always) move / reach eggs / reach oviducts (with any concentration) / eq (1) - sample size is small / no repeats (so not reliable) / eq (1) - may not have same effect in humans / may have side effects / health impacts / humans would need bigger doses / eq (1) - no mention of age of mice / eq (1)	Accept no need to increase dose from 0.4 to 0.8 / 0.4 would be best dose / eq Accept would need dose of over 0.4 to be effective / eq Accept sperm cannot reach egg Accept sperm and egg do not fuse / eq Accept not totally effective / eq Accept 5% of sperm can (always) move Accept humans are different to mice / needs testing on humans / eq Accept no mention of size of mice / eq Accept no mention of health of mice / eq	5

(Total for Question 5 = 12 marks)

Question Number	Answer	Mark
5(a)(i)	An explanation that makes reference to three of the following points: - oxygen (1) - glucose (1) - respiration (1) - energy / ATP (1)	3 exp

Question Number	Answer	Additional guidance	Mark
5(a)(ii)	An explanation that makes reference to two of the following points: - antibodies (from mother) (1) (bind to) antigens (1) - to kill bacteria / pathogen / virus eq (1)	Allow destroy / bind to pathogens / clump pathogens / mark / label pathogen	2 grad

Question Number	Answer	Additional guidance	Mark
5(b)	An answer that makes reference to two of the following points: - fetus is female / a girl (1) - cells contain 46 chromosomes / 23 pairs / has a diploid number / has two sets of chromosomes / normal number of chromosomes / eq (1) - chromosomes have different lengths / sizes / shapes (1)	Allow does not have Down's syndrome /	2 exp

Question Number	Answer	Mark
5(c)(i)	An answer that makes reference to four of the following points: - calcium for bone / teeth growth / bone / teeth development / prevent rickets (1) - protein to grow / for enzymes / antibodies / eq (1) - iron for haemoglobin / red blood cells / prevent anaemia (1) - vitamin D for bone growth / bone development / calcium absorption / strong bones (1) - more energy as baby is heavy / mother becomes heavy / more energy for fetal development / to carry baby / eq (1)	4 exp

Question Number	Answer	Additional guidance	Mark
5(c)(ii)	9 = 50% more (1) 100% = $9 \times 2 = 18$ (1) 18 + 9 = 27 (1)	Allow one mark for 0.5 / 50% / $\frac{1}{2}$ / times 2 Allow 18 for two marks Award full marks for correct numerical answer without working	3 exp

Total 14

Question Number	Answer	Additional Guidance	Mark
8(a)	An explanation that makes reference to three of the following points: - no gametes formed / no meiosis / eq (1) - no <u>fertilisation</u> / <u>fusion</u> of gametes / zygote formed (1) - no <u>genetic</u> variation / offspring are clones / have same alleles as parents / have same alleles (as each other) / eq (1) - only one parent <u>cell</u> required (1)	Allow converse for sexual reproduction allow sperm and egg / reproductive cells allow same genes ignore only one parent	3

Question Number	Answer	Mark
8(b)(i)	The only correct answer is A (the oviduct) B is not the correct answer as it is not the site of fertilisation C is not the correct answer as it is not the site of fertilisation D is not the correct answer as it is not the site of fertilisation	1

Question Number	Answer	Mark
8(b)(ii)	The only correct answer is C (uterus / womb) A is not the correct answer as it is not where foetus develops B is not the correct answer as it is not where foetus develops D is not the correct answer as it is not where foetus develops	1

Question Number	Answer	Additional Guidance	Mark
8(b)(iii)	An answer that makes reference to four of the following points: • oestrogen (1) • thickens uterus lining (1) • development of secondary sexual characteristics / eq (1) • progesterone (1) • maintains uterus lining / eq (1)	stimulates LH / inhibits FSH allow example of secondary sexual characteristics eg breast development ignore thickens here inhibits LH / stimulates FSH allow maximum one mark for an effect not linked to a hormone	4

Question Number	Answer	additional guidance	Mark
8(c)(i)	= 3.22×62.1 = 200 (million) (1)	allow 199 /199.96/ 199.962	1

Question Number	Answer	additional guidance	Mark
8(c)(ii)	An explanation that makes reference to two of the following points: • number amount of sperm depends upon both factors / eq (1) • you could have a high conc but low volume (this would provide few sperm) / eq (1) • or a high volume but low conc (this would provide few sperm) / eq (1)	conc does not tell us how many sperm are there semen volume does not tell us how many sperm there are	2

Question Number	Answer	Additional Guidance	Mark
8(c)(iii)	$202 - 142 \div 202 \times 100$ $= 29.7 \% (2)$	Allow 1 mark for $202 - 142$ or 60 or 1 mark for 0.297 / eq allow 29.703 / 29.70297 etc	2

Total = 14 marks



Question Number	Answer	Mark
2(a)(i)	The only correct answer is C A is not correct as pollen grains are not made in A B is not correct as pollen grains are not made in B D is not correct as pollen grains are not made in D	1



Question Number	Answer	Mark
2(a)(ii)	The only correct answer is B A is not correct as it is not the stigma C is not correct as it is not the stigma D is not correct as it is not the stigma	1

Question Number	Answer	Additional guidance	Mark
2(b)	An explanation that makes reference to three of the following points: • tube grows down style (1) • tube enters the ovary / ovule (1) • tube enters via micropyle (1) • transports <u>nucleus</u> / male gamete to ovary / ovule / down style (1) • idea of fertilisation (1)	Allow pollen nucleus / male gamete, <u>fuses</u> with egg nucleus / female gamete / egg cell Allow gametes fuse	3

Question Number	Answer	Additional guidance	Mark
2(c)(i)	80 (2)	$600 \div 3 = 200$ $360 \div 3 = 120$ $200 - 120 = 80$ $600 - 360 = 240$ $240 \div 3 = 80$ one mark for 240 or (200 and 120) award full marks for correct numerical answer without working	2

Question Number	Answer	Additional guidance	Mark
2(c)(ii)	An answer that makes reference to two of the following points: • with <u>both</u> (chemicals) there is less growth (1) • (because) fewer proteins made / less protein synthesis (1) • with actinomycin, no mRNA is made / <u>DNA</u> not transcribed (1) • with cycloheximide, amino acids cannot be joined together / eq (1) • growth with actinomycin is higher than cycloheximide, as some mRNA is present / is then translated (1)	Allow stopping transcription stops mRNA production Allow correct reference to any process associated with translation e.g. prevents ribosome binding to RNA/ mRNA and tRNA cannot pair up / codons cannot join with anticodons / such as tRNA does not bring amino acids	4

Question Number	Answer	Additional guidance	Mark
2(d)	An answer that makes reference to three of the following points: • microscope / lens / magnifying glass (1) • slide / tile / eq (1) • cover slip (1) • stain / dye (1)	Allow petri dish / watch glass	3

Total 14 marks

Question Number	Answer	Mark
7(a)(i)	Radicle/ root / plumule / shoot has grown / seed split/ sprouts /eq (1)	1

Question	Answer	additional	Mark
----------	--------	------------	------

Number		guidance	
7(a)(ii)	An answer that includes two of the following • Temperature (1) • Volume of solution (1) • Humidity (1) • Oxygen (1) • Light (1) • pH (1) • Carbon dioxide (1)	ignore amount of water ignore wind allow soil / compost / growth medium	2

Question Number	Answer	additional guidance	Mark
7(b)(i)	An answer that includes two of the following S linear and half of each axis (1) L straight and passing through all points (1) A x axis correct way round (Na Cl or salt conc / eq) (1) U axes labelled with Na Cl / salt concentration in mmol and percentage / % germination (1) P points correctly plotted within one square (1)	if non linear scale can still get P bar chart loses L	5

Question	Answer	additional	Mark
----------	--------	------------	------

Number		guidance	
7(b)(ii)	An explanation that makes reference to four of the following points • (increasing (salt)concentration) decreases germination (1) • (as concentration of solution increases) (lower) water potential / concentration / osmotic <u>gradient</u> /eq (1) • less water absorbed / water exits /eq (1) • by osmosis (1) • to activate enzymes / digest starch / eq (1)	allow water potential / concentration gradient described /reversed eg more water molecules inside / eq	4

Question Number	Answer	Additional guidance	Mark
7(c)(i)	An answer that makes reference to the following points • roots grow towards gravity (1) • positively gravitropic / geotropic (1)	Allow converse for stems allow gravitrophic	2

Question Number	Answer	Additional guidance	Mark
7(c)(ii)	An answer that makes reference to the following points • roots grow away from light (1) • negatively phototropic (1)	Allow converse for stems	2

16 marks



Question Number	Answer	Mark
1(a)	An answer that makes reference to two of the following points: - so that sperm can swim / can reach egg / otherwise they cannot swim / otherwise they cannot reach egg / eq (1) - can fertilise egg / fertilisation can occur / (if abnormal) will not fertilise egg (1) - so (initial) fertility is not reduced / or (if abnormal) fertility of these men will (already) be reduced (1)	2

Question Number	Answer	Mark
1(b)(i)	An explanation that makes reference to two of the following points: - thickens / maintains, uterine wall / lining / endometrium / maintains pregnancy / eq (1) - inhibits FSH production / prevents more eggs maturing / eq (1) - inhibits LH production / prevents ovulation / eq (1)	2

Question Number	Answer	Mark
1(b)(ii)	- male sex hormone / increase male hormone level (1) - because progestin reduces testosterone / eq (1)	1

Question Number	Answer	Mark
1(b)(iii)	testes / testicles (1)	1

Question Number	Answer	Mark
1(c)(i)	reduce sperm production / eq (1)	1

Question Number	Answer	Mark
1(c)(ii)	to measure if sperm count fell / below 1 million per cm^3 / fertility dropped / eq (1)	1

Question Number	Answer	Mark
1(c)(iii)	prevent fertilisation / eq, as sperm production may be above 1 million per cm^3 / still high / eq (1)	1

Question Number	Answer	Mark
1(d)	- to ensure sperm production stays below 1 million per cm^3 / stays low / eq (1) - to see if, the treatment / progestin works / lowers sperm production (1)	1

Question Number	Answer	Additional guidance	Mark
1(e)	$98.4 \times 320/100 = 314.88$ $= 320 - 315$ 5 (2) $100 - 98.4 = 1.6 \%$ $1.6 \times 320 / 100 = 5.12 = 5 (2)$	Allow 1 mark for 315 or 1.6 in working Allow 5.1 or 5.12 award full marks for correct answer no working	2

Question Number	Answer	Mark
1(f)	An answer that includes any 4 of the following points <i>(For / positive about method)</i> • reduces pregnancy / 98.4 % work / (very) effective / eq (1) • 75% / most men / partners / couples, happy to continue (1) • do not need to be remember to take / eq (1) • does not require surgery / reversible (1) • no need for women to take hormones (1) <i>(Against / negative about method)</i> • side effects / acne / mood disorders / skin infections / skin irritation / eq (1) • does not protect against STI / named disease / eq (1) • suppression phase takes a long time / 26 weeks / eq (1) • may not be reversible / reduce long term male fertility / may take time to reverse / eq (1)	4

total =16 marks

Question Number	Answer	additional guidance	Mark
1 (a)	An explanation that makes reference to two of the following: • (two) different parent plants / cross with another plant / eq (1) • (produce different) gametes (1) • parent plants /gametes have different genotypes / alleles / genes / genetic material / DNA / eq(1) • (gametes) fuse / combine / fertilisation (1)	allow other flower	2

Question Number	Answer	additional guidance	Mark
1 (b)(i)	An explanation that makes reference to the following: • less competition for light / get enough / sufficient / more light / eq (1) • less competition for water / get enough / sufficient water / more water eq (1) • less competition for minerals / named mineral / get enough / sufficient minerals/ more minerals /eq (1)	allow one mark for less competition unqualified ignore space / CO₂	3

Question Number	Answer	Mark
1 (b)(ii)	• can grow in suitable / same conditions / habitat as parent (which successfully grew there) / has plant to <u>cross-pollinate</u> with / eq (1)	1

Question Number	Answer	additional guidance	Mark
1 (c)	An explanation that makes reference to three of the following: - warmth / optimum temperature for enzyme action / increased temperature for chemical reactions / eq (1) - water to mobilise enzymes / for chemical reactions / eq (1) - oxygen for respiration / eq (1) - light to stimulate growth / break dormancy / eq (1)	must have factor and reason not light for photosynthesis	3
Question Number	Answer	additional guidance	Mark
1 (d)	An explanation that makes reference to two the following: (bright colours to) attract animals / humans / easily seen / eq (1) - to eat the fruits / consume / eq (1) - as they contain glucose / sugars / eq (1)	ignore attract insects	2

Question Number	Answer	additional guidance	Mark
1 (e)	An answer that makes reference to : from fruit eaten and egested by/ passed through humans / from faeces / seeds not digested /eq (1)	no credit for more nitrates / minerals	1

Question Number	Answer	additional guidance	Mark
1 (f)	An answer that makes reference to : heat / warmth / high temperature (for evaporation) / dries out (tissue)/ eq (1)	not just evaporation of water	1

Question Number	Answer	Mark
1 (g)	A description that makes reference to three of the following: • use watch / clock / measure record to time fall (1) • from same height (1) • repeat / calculate mean time (1) • use same mass seeds / same seeds / same species / eq (1) • with and without fluff / different amounts of fluff/ eq (1)	3

total 16 marks

Question Number	Answer	Mark
1(a)	An explanation that makes reference to two of the following - self- pollination within same plant / flower /cultivar/ tree / uses one parent / eq (1) - cross-pollination from different plant / flower/ cultivar / tree/ uses two parents / eq (1)	2

Question Number	Answer	Mark
1(b)	A description that makes reference to four of the following - germinates /eq (1) - pollen tube grows down style / goes down style / eq (1) - enters ovule (via micropyle) / eq (1) - male nucleus / gamete travels down pollen tube / eq (1) - fuses with ovum / fuses with female gamete / fertilises ovum / fertilises female gamete / eq (1) - ovule becomes seed /eq (1) - ovary becomes fruit / eq (1)	4

Question Number	Answer	Additional guidance	Mark
1(c)(i)	carbon hydrogen oxygen / C H O (1)	Any order Extra elements scores 0	1

Question Number	Answer	Mark
1(c)(ii)	An answer that makes reference to two of the following • fruit eaten by animals / insects / birds / eq (1) • egested /lost in faeces / eq (1) • seeds dispersed / taken to new areas / eq (1)	2

Question Number	Answer	Mark
1(d)	An explanation that makes reference to two of the following • <u>pollen</u> from same plant / flower/ cultivar eq (1) • cannot germinate / no pollen tube_growth / eq (1) • no fusion / fertilisation / eq (1)	2

Question Number	Answer	Mark
1(e)	A description that makes reference to the following • flowers are large / petals are large (so seen by insects) /eq (1) • flowers / petals are coloured (so seen by insects)/eq (1) • flowers are scented / have scented petals /eq (1) • have nectary /produce nectar / eq (1) • anthers within flower / stigma within flower so insect brushes pollen / transfers pollen to stigma / eq (1)	3

Question Number	Answer	Mark
1(f)	An answer that includes wind pollinated / no insects to carry pollen long distance / eq (1)	1

Question Number	Answer	Additional guidance	Mark
1(g)	An explanation that makes reference to two of the following - triploid cells cannot divide by meiosis / cannot be divided by two / equally / eq (1) - cannot produce haploid (gametes) / produce one set / n chromosomes / eq (1) - fertilisation / fusion not possible / eq (1)	allow 'converse' for normal cultivars	2

Question Number	Answer	Mark
7 (a)	Hh / Hh and Hh / hH / hH and hH / hH and Hh / Hh and hH	1

Question Number	Answer	Mark
7 (b)	2.1 : 1 Allow 21 : 10, 2 : 1	1

Question Number	Answer	Mark
7 (c)	An answer that makes reference to two of the following points: - small sample size / too few crosses / eq (1) - random / chance (of fertilisation) (1) - of fertilisation / fusion of gametes / eq (1) - fewer yellow (than predicted) / more brown (than predicted) (1) - no HH offspring survive / ratio is 2 Hh : yellow to 1 hh brown / yellow mice more likely die / brown mice less likely to die (1) - mutations (may have occurred) (1)	4

Total 6 marks

Question Number	Answer	Mark
3(a)	spinal cord / chord	1 cler

Question Number	Answer	Mark
3(b)(i)	C 0.5 <i>A is incorrect because 0.5 is the answer</i> <i>B is incorrect because 0.5 is the answer</i> <i>D is incorrect because 0.5 is the answer</i>	1 comp

Question Number	Answer	Mark
3(b)(ii)	A diagram that makes reference to the following points: • one circle and one square shown (1) • two shapes unshaded (1)	2 grad

Question Number	Answer	Additional guidance	Mark
3(c)	An explanation that makes reference to three of the following points: • prevents translation / no translation (1) • prevents ribosomes attaching (to mRNA) (1) • prevents / no, codon binding to anticodon (1) • prevents amino acids joining / amino acid chain not made (1) • huntingtin / protein / polypeptide not made (1)	Allow tRNA does not bind to mRNA Allow less huntingtin / protein made	3 exp

Total 7 marks

Question Number	Answer	Mark
1(a)(i)	C cytoplasm <i>A is not correct as cellulose is not found in the bacterium</i> <i>B is not correct as chitin is not found in the bacterium</i> <i>D is not correct as a nucleus is not found in the bacterium</i>	1 comp

Question Number	Answer	Mark
1(a)(ii)	C 7 <i>A is not correct because 1 is not neutral pH</i> <i>B is not correct because 2 is not neutral pH</i> <i>D is not correct because 12 is not neutral pH</i>	1 comp

Question Number	Answer	additional guidance	Mark
1(a)(iii)	An explanation that makes reference the following points: • mutation (1) • variation (1) • <u>survive</u> (1) • reproduce / breed / offspring (1) • pass on allele / gene (1)		4 exp

Question Number	Answer	Mark
1(b)	An answer that makes reference the following points: • probiotic / cranberry / both / treatments (better than control) reduce (bacteria) /eq(1) • more reduction if taken together / eq (1) • cranberry (alone) reduces more than probiotic (alone) / eq(1)	2 grad

Total 8 marks



Question Number	Answer	Mark										
7(a)	• <table><thead><tr><th>Individual</th><th>Genotype</th></tr></thead><tbody><tr><td>P</td><td>Dd (1)</td></tr><tr><td>Q</td><td>Dd (1)</td></tr><tr><td>R</td><td>Dd</td></tr><tr><td>S</td><td>dd (1)</td></tr></tbody></table>	Individual	Genotype	P	Dd (1)	Q	Dd (1)	R	Dd	S	dd (1)	3
Individual	Genotype											
P	Dd (1)											
Q	Dd (1)											
R	Dd											
S	dd (1)											

Question Number	Answer	Mark
7(b)	1/8 / 0.125 / 12.5%	1

Question Number	Answer	Mark
7(c)	An answer that makes reference to four of the following points: - greater increase in testosterone in R / smaller increase in S / eq (1) - R male / S female / eq (1) - greater increase in oestrogen in S / less increase in R / eq (1) - more muscle / deeper voice / beard in R/ eq (1) - wider hips / breasts / in S (1) - body hair / growth spurt / eq (1) - gamete / sperm / egg production / start to menstruate (1) <u>secondary sexual characteristics</u> (1)	4

Total 8 marks

Question Number	Answer	Mark
4(a)	all of the genes / all of DNA in an organism / the <u>entire</u> DNA / entire genetic make up / eq (1)	1

Question Number	Answer	additional guidance	Mark
4(b)	A description that that makes reference to three of the following points: - DNA double (strand(ed)) (helix) / / eq (1) - DNA contains deoxyribose / (1) - DNA contains thymine / T / eq (1) - DNA longer (molecule) / eq (1)	RNA single stand RNA ribose RNA contains uracil / U RNA shorter	3

Question Number	Answer	Mark
4(c)	A description that makes reference to four of the following points: - transcription produces mRNA / eq (1) - mRNA copies code of DNA strand / DNA code copied / carried by mRNA / eq (1) - mRNA moves out of nucleus / into cytoplasm / eq (1) - binds with ribosome / eq (1) - tRNA brings amino acids to ribosome /eq (1) - anticodon binds with codons /eq (1) - translation produces polypeptide / protein / amino acid chain (1)	4

Total = 8 marks

Question Number	Answer	Mark
-----------------	--------	------

Question Number	Answer	Additional guidance	Mark
5(a)	An answer that makes reference to two of the following points: • DNA is double strand(ed) / double helix (1) • DNA contains deoxyribose (1) • DNA contains thymine / T not U / uracil(1) • DNA longer / larger (1)	allow converse for RNA single ribose uracil U not T thymine shorter /smaller	2

Question Number	Answer	Mark
5(b)(i)	GUA GUA GGA GUA GAU	1

Question Number	Answer	Mark
5(b)(ii)	4200 (1)	1

Question Number	Answer	additional guidance	Mark
5(c)	An explanation answer that makes reference to four of the following points: • (deletion / insertion) will change amino acid sequence / all amino acids / whole protein (1) • ref (to change / not change) (shape of) active site (1) • no enzyme binds / does not bind / fit / react with substrate /eq(1) • enzyme / protein does not function /eq (1) • (substitution) some codon(s) / triplet(s) / may code(s) for same amino acid(s) (1) • so not all changes (in a base / sequence) change any amino acids (1) • (substitution) (only) one amino acid changes in protein (1) • enzyme / protein still functions (1)	once once	4

Question Number	Answer	Mark
5(d)	An answer that makes reference to one of the following points: • radiation / gamma rays / x-rays / ultraviolet / UV light (rays) / alpha particles / eq (1) • mutagens / smoking / tobacco / alcohol (1)	1

Total = 10 marks

Question Number	Answer	Mark
5(a)(i)	An explanation that makes reference to the following • no nucleus (1) • (so) no chromosomes (1)	2

Question Number	Answer	Mark
5(a)(ii)	• mitosis / mitotic (1)	1

Question Number	Answer	Mark
5(a)(iii)	An answer that includes • contains a Y chromosome / has X and Y chromosomes / only one X chromosome / 23 rd pair are different / 23 one big one small / eq (1)	1

Question Number	Answer	additional guidance	Mark
5(b)(i)	An answer that makes reference to four of the following 1. karyotype 2 45 chromosomes / karyotype 1 46 chromosomes / only one in 23 rd pair / one less chromosome / eq (1) 2. karyotype 2 only 1 X / one sex chromosome / lacks an X or lacks a Y / eq (1) 3. so female karyotype as it lacks Y / eq (1) 4. does not undergo normal puberty/ delayed puberty eq (1) 5. does not develop secondary sexual characteristics / eq (1) 6. cannot release oestrogen / less oestrogen / eq (1) 7. cannot produce gametes / eggs / is infertile / cannot reproduce / eq (1) 8. slower repair of inner uterus lining/lining not being maintained (1) 9. may produce gametes that contain only 22 chromosomes / lack a sex chromosome / eq (1)	Fewer chromes Ignore 23 alone Lacks a sex chromosome scores mp 1 and mp 2 allow examples breast development / height / growth spurt / body hair less fertile	4

Question Number	Answer	Mark
5(b)(ii)	• mutation / failure of chromosomes to separate / failure in meiosis / one of the sex chromosomes did not replicate (just prior to cell division) / eq (1)	1

Total 9 marks



Question Number	Answer	Mark
4(a)	plasmid	1

Question Number	Answer	Additional Guidance	Mark
4(b)	An explanation that makes reference to three of the following points: • mutation (1) • survive/ not killed (1) • reproduce / multiply / eq (1) • pass on DNA / allele / gene (1)	Ignore pass on characteristics alone	3

Question Number	Answer	Additional guidance	Mark
4(c)(i)	$10 - 0.7 = 9.3$ $10\,000\,000 - 700\,000 = 9\,300\,000$ $9.3 \div 0.7 \times 100$ $9\,300\,000 \div 700\,000 \times 100$ 1329 % allow 1328.6 or 1328.57 (2)	award full marks for correct numerical answer without working one mark for 9.3 or 9 300 000	2

Question Number	Answer	Additional guidance	Mark
4(c)(ii)	An answer that makes reference to four of the following points: • stopping antibiotics allows non-resistant bacteria to increase / grow / no more increase in resistance or antibiotics allow resistant bacteria to increase / grow (1) • less selection pressure (for antibiotic resistance) / competition (for resources) (1) • most infections (would now be) caused by non-resistant bacteria (1) • antibiotics will be effective in most cases / against more bacteria (1) • use new / different antibiotics (instead of not using any) (1) • some patients may die / suffer / eq if not given antibiotics / from other things (1)	Allow converse	4

Total = 10 marks

Question Number	Answer	Mark
6(a)	A asexual reproduction <i>B is not correct as it increases genetic variation</i> <i>C is not correct as it increases genetic variation</i> <i>D is not correct as it increases genetic variation</i>	1 comp

Question Number	Answer	additional guidance	Mark
6(b)	An explanation that makes reference to five of the following points: • different (sequence of) <u>bases</u> in DNA / eq (1) • changes mRNA / codons (1) • transcription (1) • change tRNA / anticodons /(sequence of)amino acids (1) • translation (1) • changes <u>structure / shape</u> of protein /eq (1) • changes active site (1) • enzyme not functional / no binding / no enzyme substrate complex formed/ eq (1)	changes shape of active site = 2 marks	5 exp

Question Number	Answer	Mark
6(c)	An explanation that makes reference to four of the following points: • as some triplets / codons code for same amino acid / degenerative /eq (1) • no change in protein / polypeptide / enzyme produced (1) • active site not changed /affected (1) • mutation / allele may be recessive (1) • so not expressed in phenotype / if heterozygous / dominant allele present / eq (1) • mutation may occur in a non-coding sequence of DNA /eq (1)	4 exp

Total 10 marks

Question Number	Answer	Mark
5(a) (i)	The only correct answer is C 5 <i>A is not correct because it does code for 1 amino acid</i> <i>B is not correct because it does code for 3 amino acids</i> <i>D is not correct because it does code for 15 amino acids</i>	1

Question Number	Answer	Additional guidance	Mark
5(a) (ii)	GUA AGU UAA GUA AAG (2)	One error scores 1 Allow one mark for GTA AGT TAA GTA AAG	2

Question Number	Answer	Additional Guidance	Mark
5(a) (iii)	An explanation that makes reference to the following two points: - each triplet / codon codes for one amino acid / eq (1) - codons are discrete / independent of each other / nucleotides / bases are not shared between codons / eq (1) - example of triplet reading frames, e.g. CAT TCA / eq (1)	Allow one codon / triplet determines each / one amino acid Allow nucleotides / bases are not shared between amino acid (codes) Allow triplets read CAT TCA etc / or CAT/TCA	2

Question Number	Answer	Additional guidance	Mark
5(b)	A description that makes reference to four of the following points: (mRNA arrives at) ribosome (1) - mRNA has codons / is a template (1) - ribosome moves along mRNA strand (1) - tRNA brings amino acids (to ribosome) (1) - anticodon (on tRNA) binds with codon (on mRNA) / tRNA binds with mRNA (1) - amino acid chain produced / amino acid joined / polypeptide (1)	Allow ribosome moves along to next codon Allow codon is complementary to anticodon	4

Question Number	Answer	Mark
5(c)	the / its genes / DNA / genetic material (1)	1

Total 10 marks

Question Number	Answer	Additional guidance	Mark
7(a)(i)	An explanation that makes reference to two of the following: • less pressure / reduced heart volume / less blood pumped (each beat) (1) • less oxygen pumped to <u>muscles</u> (1) • less respiration (1)	Accept lower stroke volume Less oxygenated blood to muscles = 2 marks	2

Question Number	Answer	Mark
7(a)(ii)	only one copy of an allele is needed to affect the phenotype / an allele that is always expressed (1)	1

Question Number	Answer	Additional guidance	Mark
7(a)(iii)	A genetic diagram that shows: - parent genotypes of Hh and hh (1) - gametes as H or h and h (or h) (1) - offspring as Hh, hh (1) - offspring in correct ratios (of 1:1) and phenotypes correctly identified (1)	Accept other letters Ecf maybe for mp2 and 3	4

Question Number	Answer	Mark
7(a)(iv)	0.25 / $\frac{1}{4}$ / 25%	1

Question Number	Answer	Additional guidance	Mark
7 (b)	An answer that makes reference to two of the following: - recessive alleles are not always expressed (in the phenotype) / recessive alleles are not expressed in heterozygous individuals / only expressed when homozygous / eq (1) - dominant alleles are always expressed (in the phenotype) / are expressed when one is present / eq (1) - cats with a dominant allele can be prevented from breeding / cats with a recessive allele cannot always stopped from breeding / eq (1)	Accept recessive alleles are hidden when a dominant allele is present / recessive alleles are only expressed when homozygous Accept possession of one dominant allele means that the phenotype is identified / dominant alleles are always identified in phenotype	2

Total for Question 7 = 10 marks

Question Number	Answer	Additional guidance	Mark
3 (a)	a section / length of DNA that codes for a protein / polypeptide / chain of amino acids / eq (1)		1

Question Number	Answer	Additional guidance	Mark
3 (b)(i)	Cattle colour	Genotype	Allow RR, WW, WR Allow rr, ww, rw
	red	$C^R C^R$	
	white	$C^W C^W$	
	roan	$C^W C^R / C^R C^W$	

Question Number	Answer	Additional guidance	Mark
3 (b)(ii)	An answer that includes the following: - parental genotypes of $C^W C^R$ and $C^W C^R$ (1) - parental gametes of C^W or C^R (and C^W or C^R) (1) - offspring as 1 $C^R C^R$ 2 $C^W C^R$ 1 $C^W C^W$ (1) - probability calculated as 0.25 / $\frac{1}{4}$ / 25% (1)	Allow WR and WR Allow Cc and Cc Allow W or R Allow C or c Allow 1 RR, 2 WR, 1 WW Allow 1 CC (red) and 1 cc (white) 2 Cc (roan) Allow different letters ECF for wrong parental genotypes for MP2 and MP3 only	4

Question Number	Answer	Additional guidance	Mark
3 (c)(i)	An answer that makes reference to two of the following: - height is <u>polygenic</u> (1) - so multiple / many / more than one gene / different genes control height / eq (1) - animals may get a mixture of dominant and recessive <u>alleles</u> for <u>different</u> genes / eq (1) - environment / nutrition may affect height / eq (1)	Allow hair colour is <u>monogenic</u> Allow only one gene for hair colour Ignore multiple alleles Allow coat colour has no environmental effect / is entirely genetic	2

Question Number	Answer	Additional guidance	Mark
3 (c)(ii)	A description that makes reference to two of the following: - select cattle that are taller and mate them / eq (1) - select offspring (that are taller) and mate them / eq (1) - repeat (through generations) / eq (1)		2

Total 10 marks

Question Number	Answer	Additional guidance	Mark
7(a)(i)	many/multiple/lots of genes	Allow more than one gene / two or more genes Many genes and the environment / many characteristics by many genes = 0 Ignore many alleles	1

Question Number	Answer	Mark									
7(a)(ii)	<table border="1"> <thead> <tr> <th></th><th>Mode</th><th>Median</th></tr> </thead> <tbody> <tr> <td>females</td><td>163 to 164</td><td>163 to 164</td></tr> <tr> <td>males</td><td>176 to 178</td><td>176 to 178</td></tr> </tbody> </table> (1) (1)		Mode	Median	females	163 to 164	163 to 164	males	176 to 178	176 to 178	2
	Mode	Median									
females	163 to 164	163 to 164									
males	176 to 178	176 to 178									

Question Number	Answer	Mark
7(a)(iii)	An answer that makes reference to two of the following points: - genes / alleles / chromosome (1) (difference in) nutrition / diet / quality of food / quantity of food (1) (difference in) <u>metabolism</u> / <u>metabolic</u> rate / <u>respiration</u> (1) - hormones / named hormone (1) - osteoporosis / less bone mass (in women) (1)	2

Question Number	Answer	Additional guidance	Mark
7(b)(i)	An explanation that makes reference to four of the following points: • parents both Hh (1) • gametes are H and h (1) • offspring are HH, Hh, (Hh) and hh (1) • first child is hh / second child is HH or Hh (1)	Allow use of different letter Allow Mps 1, 2 and 3 from Punnett square Allow ecf for gametes only	4

Question Number	Answer	Additional guidance	Mark
7(b)(ii)	An answer that makes reference to two of the following points: • pedigree / family history / ancestors / family tree / check parents (1) • born with condition / always had it / condition developed later in life / not born with it (1) • <u>DNA test</u> / <u>genetic test</u> (1)	If (both) parents don't have white patch it is vitiligo / not piebaldism = 2	2

Total 11 marks

Question Number	Answer	Mark
5 (a)	XY / X and Y / YX / Y and X	1

Question Number	Answer	Mark
5(b)(i)	The only correct answer is D ZZ <i>A is incorrect because XY are the sex chromosomes of a human male</i> <i>B is incorrect because ZW are the sex chromosome of a female bird</i> <i>C is incorrect because ZY are not the sex chromosomes of a male bird</i>	1

Question Number	Answer	Additional guidance	Mark
5(b)(ii)	- determine probability of having one female - raise to the power of 4 = 0.0625 / 6.25% / 1/16 1 in 16 (2)	award full marks for correct numerical answer without working p of one female = 0.5 $(0.5)^4$ Allow one mark for 0.5 / $\frac{1}{2}$ / 50% / 1 in 2 in working	2

Question Number	Answer	Additional guidance	Mark	
5(c)(i)			4	

Question Number	Answer	Additional guidance	Mark
5(c)(ii)	An answer that makes reference to the following: - FSH = Q - LH = R - oestrogen = P - progesterone = S (3)	three or four correct = 3 two correct = 2 one correct = 1 more than one letter on a line = 0	3

Total 11 marks

Question Number	Answer	Mark
7(a)	Only A is correct as both are heterozygous <i>B is incorrect as both are not homozygous</i> <i>C is incorrect as both do not have long wings</i> <i>D is incorrect as one is not heterozygous and one homozygous</i>	1

Question Number	Answer	Mark																		
7(b)(i)	An answer that makes reference to the following points: - female gamete(s) as X (1) - offspring as XX and XY (1) <table border="1" data-bbox="679 831 1099 1171"> <tr> <td></td><td>X</td><td>Y</td></tr> <tr> <td>X</td><td>XX</td><td>XY</td></tr> <tr> <td>X</td><td>XX</td><td>XY</td></tr> </table> This also scores 2 <table border="1" data-bbox="791 1332 1107 1648"> <tr> <td></td><td>x</td><td>y</td></tr> <tr> <td>x</td><td>xx</td><td>xy</td></tr> <tr> <td></td><td></td><td></td></tr> </table>		X	Y	X	XX	XY	X	XX	XY		x	y	x	xx	xy				2
	X	Y																		
X	XX	XY																		
X	XX	XY																		
	x	y																		
x	xx	xy																		

Question Number	Answer	Mark
7(b)(ii)	An explanation that makes reference to the following points: • random / role of chance / eq (1) • fertilisation / eq (1) • fewer Y sperm / more X sperm / Y sperm die / X sperm swim better / eq (1)	2

Question Number	Answer	additional guidance	Mark
7(c)	An answer that makes reference to six of the following points: • C uses (rotting) apples and bananas (1) • O uses same flies / species / age /sex (1) • R uses several apples and bananas / repeat (1) • M1 counts / record number of flies / eq (1) • M2 measures after a <u>stated period</u> of time (1) • S1 controls age / number / mass / size of fruit / state of decomposition / no other fruit present / eq (1) • S2 controls temperature / light / oxygen / distance from fruit / size of room /container release same number of flies / eq (1)	not time to reach fruit	6

Total = 11 marks

Question Number	Answer	Additional guidance	Mark
9 (a)(i)	An answer that makes reference to the following points: • parents dd and Dd (1) • gametes d and D or d (1) • (child) genotype(s) dd (1) • child without syndactyly identified as dd (1) Also allow sex linkage cross as below: (i) Use a genetic diagram to show the genotypes of the parents, the possible gametes and the genotype and phenotype of their child. Use D to represent the dominant allele and d to represent the recessive allele. (4) Man (Father) Woman (Mother) Genotype $x^d y$ $x^D x^d$ Gametes $(x^d) (y)$ $(x^D) (x^d)$ Phenotype of their child $x^D x^D d$ $x^D x^d d$ $x^d x^D d$ $x^d x^d d$ $x^D y$ $x^d y$ $x^D x^d$ - Female girl child with syndactyly $x^D y$ - Male child with syndactyly $x^d x^d$ - Female child with no syndactyly $x^d y$ - Male child with no syndactyly	allow ECF for max of 2 allow mp 1 2 3 4 from Punnett square	4

Question Number	Answer	Additional guidance	Mark
9 (a)(ii)	- probability of having syndactyly = 0.5 - probability of being female = 0.5 = 0.25 (2) allow 25% or 1/4	award full marks for correct numerical answer without working one mark for 0.5 or 50% or 1/2	2

Question Number	Answer	Additional guidance	Mark
9(b)	An explanation that makes reference to three of the following points: - dominant allele is always expressed (in phenotype) / only requires one allele / recessive allele requires two copies to be expressed / recessive alleles are only expressed when homozygous / eq (1) - dominant condition more common / frequent / high probability of passing on / eq (1) - recessive condition has carriers (1) - recessive version can appear when both parents unaffected / skips generations / eq (1)	Allow converse Allow converse for dominant	3

Question Number	Answer	Additional guidance	Mark
9(c)	A description that makes reference to two of the following points: - polygenic (1) - many genes / more than one gene (controlling one phenotype) (1) - each has small effect (1)	Ignore alleles	2

Total 11 marks

Question Number	Answer	Additional guidance	Mark
4 (a)	An answer that makes reference to three of the following points: • (DNA is) double stranded / helix (1) • (DNA has) thymine / T / does not have uracil / U (1) • (DNA has) deoxyribose (1) • (DNA is) long(er) / large(r)	Allow converse (RNA) is single stranded (RNA) has uracil / U / does not have thymine / T (RNA) has ribose (RNA is) shorter	3

Question Number	Answer	Additional guidance	Mark
4 (b)	A description that makes reference to five the following points: • transcription occurs in the nucleus (1) • transcription uses <u>DNA</u> to make <u>RNA</u> / eq (1) • DNA unzips / one strand is copied / eq (1) • transcription makes / produces <u>messenger</u> RNA / <u>mRNA</u> (1) • translation takes place at the ribosomes / in cytoplasm (1) • translation involves <u>messenger</u> RNA / <u>mRNA</u> and <u>transfer</u> RNA / <u>tRNA</u> (1) • anticodons bind to codons / eq (1) • translation produces amino acid chain / protein / polypeptide / eq (1)	Transcription uses DNA to make messenger RNA = two marks Anticodons on tRNA bind to codons on mRNA = two marks	5

Question Number	Answer	Additional guidance	Mark
4 (c)	An answer that makes reference to the following points: • (if read in threes) = 4^3 or $4 \times 4 \times 4$ (1) • = 64 (1) • (64 is) greater / more than 20 (combinations) required / needed / eq (1) • (if read in twos) = 4^2 or $4 \times 4 = 16$ (1)	64 is greater than 20 is two marks	3

Total = 11 marks

Question Number	Answer	Mark
9(a)(i)	Sickle shaped red blood cells stick to each other / caught / trapped / eq walls of blood vessels / eq (1)	1

Question Number	Answer	Mark
9(a)(ii)	An explanation that makes reference to three of the following points • cold temperatures reduce blood flow / cause more sickling (1) • less oxygen (at high altitude) (1) • less respiration / (more) <u>anaerobic</u> respiration (1) • more lactic acid (1) • (less) energy / ATP (1)	3

Question Number	Answer	Mark
9(b)(i)	only expressed when homozygous / two copies / no dominant allele present / not expressed in heterozygote /eq (1)	1

Question Number	Answer	Additional guidance	Mark
9(b)(ii)	0.75 x 0.5 $\frac{3}{4} \times \frac{1}{2}$ 0.375 or $\frac{3}{8}$ or 37.5% (2)	Allow 1 mark for $\frac{3}{4}$ or 0.75 or 75% or one mark for $\frac{1}{2}$ or 0.5 or 50%	2

Question Number	Answer	Mark
9(c)	The only correct answer is D A is not correct as bacterium does not cause malaria B is not correct as fungus does not cause malaria C is not correct as plant does not cause malaria	1

Question Number	Answer	Mark
9(d)	The only correct answer is B A is not correct as chlorophyll not found in red blood cells C is not correct as iron is not a pigment D C is not correct as magnesium not found in red blood cells	1

Question Number	Answer	Additional guidance	Mark
9(e)	An answer that includes two of the following points • red cells smaller (1) • red cells have no nucleus (1) • red cells are biconcave /eq (1)	Allow converse for wbc allow (mature) RBC's lack mitochondria ign haemoglobin	2

Total 11 marks

Question Number	Answer	Mark
5(a)(i)	An explanation that makes reference to the following points: • male (1) • as has X and Y / different sized length of chromosomes / heterogametic / has a Y chromosome / female would be XX / eq (1)	2

Question Number	Answer	Mark
5(a)(ii)	An explanation that makes reference to two of the following points: • (Diagram 1 is) diploid (1) • because diploid has two of each chromosome / has 23 pairs / has 46 chromosomes / has 2 sets of chromosomes / eq (1) • haploid only has one of each pair / would have 23 chromosomes / has one set of chromosomes / would have half the number of chromosomes / eq (1)	2

Question Number	Answer	additional guidance	Mark
5(b)(i)	An answer that makes reference to two of the following points: • diagram 2 / Klinefelter has an extra chromosome / has 47 (1) • X chromosome / sex chromosomes are different / eq (1)	Allow converse for karyotype 1 has extra X chromosome scores 2 marks has three sex chromosomes scores two marks	2

Question Number	Answer	Additional guidance	Mark
5(b)(iii)	An answer that makes reference to the following points: • mutation (1) • failure of chromosomes to separate (1) • during meiosis / gamete formation (1)	Allow nondisjunction	2

Question Number	Answer	Additional guidance	Mark
5(b)(iii)	$49\% \text{ of } 66 \text{ million} = 32\,340\,000 \text{ men}$ $1/660 \times 32\,340\,000 = 49\,000 \text{ (2)}$	Award full marks for correct numerical answer without working one mark for 32 340 000	2

Question Number	Answer	Mark
5(b)(iv)	An answer that makes reference to one of the following points: • mutation more likely (1) • gametes are older / eq (1)	1

Total = 11 marks

Question Number	Answer	Mark
7(a)(i)	a gene is a section / length / part (of a molecule) of DNA that codes for a specific protein / polypeptide (1)	1

Question Number	Answer	Mark
7(a)(ii)	grey hair / grey (1)	1

Question Number	Answer	additional guidance	Mark
7(b)	An answer that includes the following four points: • Gg and Gg (1) • G or g G or g (1) • GG Gg Gg gg (1) • 3 grey : 1 white (1)	allow other symbols eg W and w or even G and w if cross works gametes separated or in circles allow full marks from a correct Punnet square ratio must be stated with phenotype or clearly 3 labelled grey and 1 labelled white in offspring allow 75% and 25% or $\frac{3}{4}$ and $\frac{1}{4}$ allow ECF/ TE for correct gametes and offspring from incorrect parents to 2 max	4

Question Number	Answer	additional guidance	Mark
7(c)	An explanation that makes reference to two of the following points: • cross with mouse with white hair / gg / homozygous recessive / do back cross / test cross / (1) • if all offspring grey – parent is homozygous / GG (1) • if some / any / half offspring white – parent is heterozygous / Gg (1)	allow ww/ dd / rr etc	2

Question Number	Answer	Mark
7(d)	An answer that makes reference to three of the following points: • most polygenic (1) • many genes / more than one gene / eq (1) • each of small effect / (1) • show continuous variation / example height / mass/ eq (1) • most single genes / monohybrid inheritance only affect one phenotype / characteristic (1)	3

Total = 11 marks

Question Number	Answer	Additional guidance	Mark
2(a)	An answer that makes reference to the following points: • S scale linear and half the grid (1) • L straight lines joining points (1) • A axes correct way around and labelled 'days' and 'number of cells $\times 10^3$' (1) • P points plotted correctly within one square (1) • K key shown (1)	Allow truncated y axis Bar graph loses S and L Extrapolation to 0 loses L Non-linear scale loses S and P	5

Question Number	Answer	Mark
2(b)	B number of cells <i>A is incorrect because germination rate is not measured in the investigation</i> <i>C is incorrect because pollution is the independent variable</i> <i>D is incorrect because time after germination is an independent variable</i>	1

Question Number	Answer	Mark
2(c)(i)	• mitosis	1

Question Number	Answer	Additional guidance	Mark
2(c)(ii)	An answer that makes reference to four of the following points: • temperature (1) • affects enzymes (1) or • water / moisture (1) • solvent / activates enzymes / dissolve chemicals / reactions (1) or • oxygen (1) • respiration (1) or • (sun)light (1) • phytochrome (1) or • pH (1) • affects enzymes (1)	Mp1 Ignore warmth / heat / cold Mp3 Ignore humidity	4

Question Number	Answer	Additional guidance	Mark
2(c)(iii)	An answer that makes reference to the following point: • age / species / type / variety / size / mass	Allow from same plant Ignore microbes / pests	1

Total 12 marks

Question Number	Answer	Additional guidance	Mark
5(a)	An explanation that makes reference to the following points: • (less) oxygen (transported) (1) • respiration / more <u>anaerobic</u> respiration (1)	Less aerobic respiration = 2	2

Question Number	Answer	Mark								
5(b)		2								
	<table><tr><th>Genotype of parents</th><th>Percentage of offspring likely to have PFK</th></tr><tr><td>both homozygous dominant</td><td>0</td></tr><tr><td>heterozygous x heterozygous</td><td>25 (1)</td></tr><tr><td>heterozygous x homozygous recessive</td><td>50 (1)</td></tr></table>	Genotype of parents	Percentage of offspring likely to have PFK	both homozygous dominant	0	heterozygous x heterozygous	25 (1)	heterozygous x homozygous recessive	50 (1)	
Genotype of parents	Percentage of offspring likely to have PFK									
both homozygous dominant	0									
heterozygous x heterozygous	25 (1)									
heterozygous x homozygous recessive	50 (1)									

Question Number	Answer		Mark
5(c)	An explanation that makes reference to the following points: • (all) offspring are homozygous dominant / none with recessive allele / none with affected allele / none heterozygous / none are carriers (1) • all offspring normal / no offspring have PFK (1)	Ignore less likely	2

Question Number	Answer	Mark
5(d)	An explanation that makes reference to two of the following points: • offspring all healthy/none have PFK means dog is homozygous (dominant) / no recessive allele (1) • offspring 50% healthy/some have PFK means dog is heterozygous / carrier / has recessive allele (1)	2

Question Number	Answer	Mark
5(e)(i)	The only correct answer is D GUCCAUACC <i>A is not correct as the sequence CAGGTATGG is wrong</i> <i>B is not correct as the sequence CAGGUAUGG is wrong</i> <i>C is not correct as the sequence GTCCATACC is wrong</i>	1

Question Number	Answer	Mark
5(e)(ii)	An explanation that makes reference to three of the following points: • T replaces G / G is replaced by T / GTA to TTA (1) • different mRNA / codon (1) • (different) tRNA / anticodon (1) • different amino acid(s) (1)	3

Total 12 marks

Question Number	Answer	additional guidance	Mark
5(a)(i)	C C G A T C A A C	all correct 2 marks one letter incorrect 1 mark	2

Question Number	Answer	Mark
5(a)(ii)	3 (1)	1

Question Number	Answer	additional guidance	Mark
5(a)(iii)	C C G A U C A A C	all correct 2 marks one letter incorrect 1 mark	2

Question Number	Answer	Additional Guidance	Mark
5(b)	30 % of 50 000 so 15 000 are A and 30 % are T 15 000 leaving 20 000 bases 40% (30 % are) T 15 000 (1) (20% will be) C 10 000 (1) (20% will be) G 10 000 (1)	allow 2 marks if put % in correctly instead of numbers so 30% T 20% C 20% G scores 2 marks	3

Question Number	Answer	additional guidance	Mark
5(c)	A description that includes: Transcription Location - transcription in nucleus / eq(1) Produces - transcription produces mRNA/ eq (1) Starts with - transcription starts with DNA /eq (1) Uses - no tRNA in transcription /eq (1)	or converse for Translation takes place in cytoplasm / ribosome mRNA exits nucleus / enters cytoplasm/eq produces amino acid chain / polypeptide / protein/eq starts with mRNA /eq (so transcription) from DNA to mRNA = start and produces = 2 marks uses tRNA/eq	4

Total 12 marks

Question Number	Answer	Additional guidance	Mark
5(a)(i)	all DNA of an organism / complete set of genes / all of genetic material of an organism / eq (1)	allow in a <u>diploid</u> cell	1

Question Number	Answer	Mark
5(a)(ii)	An explanation which makes reference to - a gene is a section of DNA that codes for a specific protein / polypeptide / eq (1) - allele is an alternative form / version of a gene / eq (1)	2

Question Number	Answer	Additional guidance	Mark
5(b)(i)	An answer that includes: (Parents) Bb Bb (1) (Gametes) B or b (B or b) (1) (Offspring) BB 2 Bb bb (1) (Phenotype ratio) 3 Black: 1 brown 75% Black: 25% brown or phenotypes in correct numbers evident (1)	allow any symbols allow different letters By x By BY x BY not 4 alleles eg not By bY ignore X and Y allow parent genotypes, gametes and offspring genotypes and ratio from Punnett square allow ECF allow correct offspring genotypes from incorrect parents 1 max	4

Question Number	Answer	Additional guidance	Mark
5(b)(ii)	calculation method not marking points 0.75×0.5 $= 0.375$ or 37.5 (%) or $3/8$ (2)	Full marks for correct answer If answer incorrect allow one mark for 0.5 or 50(%) or $1/2$ or 0.75 or $3/4$ or 75(%)	2

Question Number	Answer	Additional guidance	Mark
5(c)	An explanation that includes three of the following • cross with blue eyed female/ homozygous recessive female / eq (1) • if any offspring blue eyed then male is Bb / heterozygous / eq (1) • (if offspring brown eyed) repeat cross to obtain more foals/ eq (1) • if all offspring are brown / if never have blue eyed offspring / then male is BB/ homozygous / eq (1)	allow one mark for: Look at parents of male horse If one parent is blue eyed (bb) then Male horse is Bb / heterozygous (1)	3

Question Number	Answer	Additional guidance	Mark
9(a)	An answer that makes reference to one of the following: - only has an effect if two alleles are present (1) - no effect if dominant allele is present (1) - only has effect if dominant allele not present (1) - no effect in heterozygous (1) - only has an effect when homozygous / eq (1)	Accept expressed / eq for effect	1

Question Number	Answer	Mark
9(b)(i)	C (tt and Tt) <i>A is incorrect as both would be tasters</i> <i>B is incorrect as both would be tasters</i> <i>D is incorrect as neither would be tasters</i>	1

Question Number	Answer	Additional guidance	Mark
9(b)(ii)	An explanation that makes reference to the following: - correct parental genotypes (Tt and Tt) (1) - correct gametes (T or t and T or t) (1) - offspring: TT, Tt, Tt, tt (1) 0.375 / 3/8 / 37.5 (%) (1)	Accept other letters (e.g. Nn) for all mark points Accept use of mixed letters (e.g. N and T) for mp2, mp3, mp4 Accept mp1-3 from Punnett square ECF for mp2 and mp3 only if wrong parents	4

Question Number	Answer	Additional guidance	Mark
9(c)(i)	An explanation that makes reference to four of the following: • mutation occurs (1) • variation (in population) (1) • people do not eat poisonous plants / can detect poisonous plants / eq (1) • survive / eq (1) • reproduce / produced offspring / breed / eq (1) • pass on allele (to offspring) / eq (1)	Accept converse for mp3,4,5,6 if cannot taste PTC Accept gene passed on Accept mutation passed on Accept allele passed onto offspring for mp5 and mp4	4

Question Number	Answer	Additional guidance	Mark
9(c)(ii)	An answer that makes reference to two of the following: 1. people who taste PTC eat fewer vegetables / do not like taste of vegetables / eq (1) 2. (PTC tasters) get fewer vitamins / fewer minerals / less fibre / eq (1) 3. (PTC tasters) may develop scurvy / night blindness / constipation / eq (1) 4. heterozygotes carry a recessive allele / tasters may carry a non-tasting allele / heterozygotes can pass on a recessive allele / eq (1) 5. some humans lived in areas with few poisonous plants / had diets with fewer plants / had mainly meat-based diets / eq (1)	Accept converse for non-tasters Accept vegetables contain vitamins / minerals / fibre Accept converse for non-tasters Ignore nutrients Accept other correct named deficiency diseases Accept converse for non-tasters Accept people can be carriers of a recessive allele / eq Accept tasters may be carriers	2

(Total for Question 9 = 12 marks)

Question Number	Answer	Mark
8(a)(i)	D testis <i>A is incorrect as meiosis does not occur in kidney</i> <i>B is incorrect as meiosis does not occur in penis</i> <i>C is incorrect as meiosis does not occur in skin</i>	1 comp

Question Number	Answer	Mark
8(a)(ii)	C root tip <i>A is incorrect as mitosis is not observed in anther</i> <i>B is incorrect as mitosis is not observed in cotyledon</i> <i>D is incorrect as mitosis is not observed in xylem</i>	1 comp

Question Number	Answer	Mark																					
8(b)	<table border="1"> <thead> <tr> <th>Feature</th><th>Meiosis</th><th>Mitosis</th></tr> </thead> <tbody> <tr> <td>number of chromosomes in each original cell</td><td>46</td><td>46</td></tr> <tr> <td>number of daughter cells produced from each original cell</td><td>4</td><td>2</td></tr> <tr> <td>number of chromosomes in each daughter cell</td><td>23</td><td>46</td></tr> <tr> <td>ploidy level of daughter cells produced</td><td>haploid</td><td>diploid</td></tr> <tr> <td>genetic differences in daughter cells</td><td>present</td><td>absent /none/identical /eq</td></tr> <tr> <td>type of cell produced</td><td>gamete / sperm / egg / sex cell</td><td>body cell</td></tr> </tbody> </table>	Feature	Meiosis	Mitosis	number of chromosomes in each original cell	46	46	number of daughter cells produced from each original cell	4	2	number of chromosomes in each daughter cell	23	46	ploidy level of daughter cells produced	haploid	diploid	genetic differences in daughter cells	present	absent /none/identical /eq	type of cell produced	gamete / sperm / egg / sex cell	body cell	6 Grad 1 mark for each row
Feature	Meiosis	Mitosis																					
number of chromosomes in each original cell	46	46																					
number of daughter cells produced from each original cell	4	2																					
number of chromosomes in each daughter cell	23	46																					
ploidy level of daughter cells produced	haploid	diploid																					
genetic differences in daughter cells	present	absent /none/identical /eq																					
type of cell produced	gamete / sperm / egg / sex cell	body cell																					

Question Number	Answer	Mark
8(c) (i)	A description that makes reference to the following • random mating (1) • random fertilisation / gametes received/ eq (1) • environment (1) • mutation (1)	3 exp

Question Number	Answer	Mark
8(c) (ii)	An explanation to the following points • little / no <u>genetic</u> variation / have same genotype / alleles (1) • no genotype environment interaction / respond to drugs in same way /eq (1)	2 exp

Total 13 marks

Question Number	Answer	Mark
9(a)(i)	cleft chin or not / appearance of chin / eq (1)	1 grad

Question Number	Answer	Additional guidance	Mark
9(a)(ii)	An answer that makes reference to one of the following points: (the section of) DNA that determines whether the individual is cleft chin or not (1) - section of DNA that codes for a protein (1)	Allow (section of) DNA that codes for cleft chin characteristic	1 exp

Question Number	Answer	Mark
9(a)(iii)	(different) version(s) of the (cleft chin) gene / alternative forms of the gene (1)	1 exp

Question Number	Answer	Additional guidance	Mark
9(b)(i)	An answer that makes reference to the following points: - both parents Nn (1) - gametes produced N or n from each parent (1) - offspring genotypes shown NN Nn Nn nn (1) - offspring phenotypes shown 3 cleft 1 without cleft chin (1)	Allow full marks from a Punnett square Allow MP2 and MP3 for wrong parental genotypes	4 exp

Question Number	Answer	Additional guidance	Mark
9(b)(ii)	$0.25 \times 0.5 =$ $0.125 / \frac{1}{8} / 12.5 \%$	Allow 1 mark for $0.25 / 25 \% / \frac{1}{4}$ Allow full marks for correct numerical answer without working	2 grad

Question Number	Answer	Mark
9(b)(iii)	An answer that makes reference to one of the following points: - environment / diet means different shaped chin(1) - mutation (1)	1 exp

Question Number	Answer	Mark
9(c)	A description that makes reference to three of the following points: - use crosses between different rats / test cross pedigree analysis to predict outcomes / look at pedigree diagrams / family trees / family history (1) - if single gene offspring show simple pattern / shows 3:1 ratios / look like one parent / eq(1) - single gene shows discontinuous variation / two or three phenotypes (1) - polygenic leads to continuous variation / intermediate expression many different phenotypes / much more variation / three of more phenotypes (1)	3 exp

Total 13 marks

Question Number	Answer	Additional guidance	Mark
6 (a)	C is the correct answer (UAAGGCUCA) A is incorrect as T is not present in RNA B is incorrect as T is not present in RNA D is incorrect as the sequence is not complementary		1

Question Number	Answer	Additional guidance	Mark
6(b)	C is the correct answer (translation anticodon) A is incorrect because it is not transcription B is incorrect because it is not transcription D is incorrect because it is not a codon		1

Question Number	Answer	Additional guidance	Mark
6 (c)	An explanation that makes reference to three of the following: • mutation is a <u>rare / random</u> change to DNA / genetic material (1) • change in nucleotides / bases / triplets / eq (of DNA) (1) • change (in sequence of) amino acids (in proteins / polypeptide) (1) • changing enzyme / protein / producing different protein / enzyme / eq (1)	Accept codons Accept changing active site / changing shape of protein	3

Question Number	Answer	Additional guidance	Mark
6 (d)(i)	An description that makes reference to three of the following: • use of quadrat / gridding of area / eq (1) • random (selection of areas) (1) • count butterflies / eq (1) • repeat / means / eq (1)	Accept quadrats for two marks (mp1 and mp4)	3

Question Number	Answer	Additional guidance	Mark
6 (d)(ii)	A discussion that makes reference to five of the following: 1. increase in abnormal butterflies / more abnormal butterflies after 10 months (1) 2. (due to) longer exposure to radioactivity / eq (1) 3. larger increase in number of abnormal / mutated offspring (compared with adult after 10 months) (1) 4. mutations / genes / eq passed on to offspring (1) 5. recessive mutations may be carried by adults / eq (1) 6. if heterozygotes / carriers mate they may produce abnormal offspring / eq (1) 7. other factors could cause the abnormalities / abnormalities may not be due to mutations / not genes / DNA(1) 8. there is no control experiment / no data before the accident / no idea of normal number of abnormalities / eq (1) 9. radioactivity not measured / monitored / radioactivity may change / decay / eq (1) 10. do not know number of butterflies sampled / eq (1)	Accept adult / offspring / both Accept longer exposures increases number of mutations Accept more abnormal offspring than abnormal adults Accept adults increase by 15.7 and %, offspring increase by 41.9 % Accept no idea of health of butterflies / disease Accept no data from area with no radioactivity Accept no idea how long radioactivity lasted / changed Accept experiment has not been repeated / small sample size	5

Total: 13 marks



Question Number	Answer	Additional guidance	Mark
4(a)	calculation % dark-coloured moths in 1992 $27 \div 36 \times 100$ $= 75\%$ % dark-coloured moths in 1998 $9 \div 22 \times 100$ $= 41\%$ $75 - 41 = 34(\%)$ (3) allow 34.1 or 34.09 etc	allow 1 mark for 75 allow one mark for 41 or 40.9 full marks for correct answer no working	3

Question Number	Answer	Mark
4 (b)(i)	• Scale half grid and linear (1) • Lines straight and through all points (1) • Axis correct way round and labelled with number of moths (and year) (1) • Points correctly plotted within half a small square (1) • Key light-coloured and dark-coloured moths or lines labelled (1)	5 No L if extrapolation (to 0) No L if bar chart

Question Number	Answer	additional guidance	Mark
4(b)(ii)	An answer that makes reference to five of the following 1. numbers of light increases / (decrease then) increase (1) 2. numbers of dark decrease (then increase) / eq (1) 3. overall total numbers of moths decrease (then increase)/ eq (1) 4. due to disease predation lack of food / eq (1) 5. at start / up until 1994 more dark than light moths / eq (1) 6. at end (from 1994) more light than dark moths (apart from 1996) / eq (1) 7. as less coal (used) / burning / pollution in city decreased / eq (1) 8. dark less camouflaged / cannot hide / light more/ better camouflaged / better adapted in unpolluted areas OR dark better adapted in polluted areas / eq (1) 9. easily seen by birds / predators / eq (1) 10. (better adapted) pass on allele / gene to offspring / eq(1)		5

Total 13 marks

Question Number	Answer	Mark
5(a)	(alternative) form / version of a gene /eq (1)	1

Question Number	Answer	additional guidance	Mark
5(b)(i)	An answer that makes reference to the following - genotypes of parents Ss and Ss (1) - gametes formed S and s S and s (1) - genotypes of offspring SS Ss ss(1) - phenotypes of offspring stated or ratio 3 short to 1 long / eq (1)	Allow any symbols including different letters but not X or Y AB x AB A or B AA 2AB BB allow all marks from Punnet square allow te for incorrect parents 2 max gametes and offspring	4

Question Number	Answer	additional guidance	Mark
5(b)(ii)	An answer that makes reference to the following • prob of male 0.5 / prob of short hair 0.75 • combined prob = 0.375 (2)	allow 1 mark for 0.5 or $\frac{1}{2}$ or 0.75 $\frac{3}{4}$ allow 37.5% or $\frac{3}{8}$	2

Question Number	Answer	additional guidance	Mark
5(b)(iii)	An explanation that makes reference to two of the following • cross with long-haired / ss / homozygous recessive / eq (1) • if SS/ homozygous / all offspring short-haired / no long-haired / eq (1) • if Ss/ heterozygous some long-haired / eq (1)	allow other letters	2

Question Number	Answer	additional guidance	Mark
5(c)	A description that makes reference to four of the following • mutation / eq (1) • variation (in behaviour) / eq (1) • (guinea pigs) not eaten / survive not noticed by predators / eq (1) • reproduce / eq (1) • pass on <u>allele</u> / <u>gene</u> to offspring / eq (1)	allow converse	4

Total 13 marks

Question Number	Answer	Mark
4(a)	An answer that makes reference to: • (a rare random) change to DNA / change to gene / change to genetic material / eq (1)	1

Question Number	Answer	Mark
4(b)	An explanation that makes reference to five of the following points: • transcription makes mRNA / eq (1) • (mRNA will have) different codons / triplets / (base) sequence / order of bases / eq (1) • different tRNA binds / different amino acids / different anticodon (on tRNA) / eq (1) • different <u>sequence</u> of amino acids / <u>order</u> of amino acids / <u>chain</u> of amino acids (1) • different protein / different polypeptide / different structure of protein / different shape of protein / different enzyme / different enzyme properties / eq (1) • active site no longer fits substrate / ES complexes cannot form / eq (1) • may have no effect as same amino acid used / similar amino acid used (1)	5

Question Number	Answer	additional guidance	Mark
4(c)(i)	$132.6 + 43.2$ $= 175.8 \div 2$ $= \mathbf{87.9 (\times 10^8) (2)}$	allow full marks for correct answer no working Accept $132.6 + 43.2$ or 175.8 for 1 mark Accept 88 for 2 marks	2

Question Number	Answer	Mark
4(c)(ii)	An answer that makes reference to: two divisions in meiosis / one division in mitosis / mitosis and meiosis have different numbers of divisions / eq (1)	1

Question Number	Answer	Mark
4(c)(iii)	An answer that makes reference to four of the following points: - meiosis has higher mutation (in all strains) / mitosis has lower mutation / eq (1) - high(est) difference (between mitosis and meiosis) in 5207 (1) - small(est) difference between (between mitosis and meiosis) in 5209 (1) - low(est) mutation rates (for mitosis / meiosis) in 5209 (1) - high(est) rate for mitosis in 5160 (1) - high(est) rate for meiosis in 5207 (1) - differences between repeats of each strain / eq (1)	4

Total 13 marks

Question Number	Answer	additional guidance	Mark
9 (a)	only expressed / seen in phenotype of homozygous / requires two / both (copies) to be expressed in phenotype / only seen / expressed / shown if no dominant allele present / not expressed if dominant allele present / eq (1)	allow only expressed if aa / cc etc	1

Question Number	Answer	additional guidance	Mark
9 (b)(i)	- Parents Aa and Aa (1) - gametes A and a (1) - offspring genotypes AA Aa aa (1) - offspring phenotypes or ratio 3 no symptoms to 1 alkaptonuria / eq (1) eg parents AN and AN gametes A and N offspring AA AN AN NN	allow other symbols allow different letters eg A and N if cross works NOT X and Y gametes circled or in Punnet or separated allow ecf for max 2 marks for correct gametes and offspring ie mp 2 and 3 allow full marks for Punnet square	4

Question Number	Answer	Mark
9 (b)(ii)	0.375/ 37.5% / 3/8 / eq (1)	1

Question Number	Answer	additional guidance	Mark
9 (c)(i)	did not receive the drug / no treatment / eq (1)	current best treatment / placebo	1

Question Number	Answer	Additional guidance	Mark
9(c)(ii)	An answer that that makes reference to five of the following points: yes • control group so valid study /eq (1) • showed improvement /reduced symptoms / activity / life / eq (1) • quicker to stand up/eq (1) • improved distance walked/ eq (1) No because • small group size / should be tested on more people / repeat study / eq (1) • not all finished study/ eq (1) • adverse / side effects / eq (1) • one died in drug group /eq (1) • no information on age / mass / sex / other health conditions / activity / exercise / eq (1)	allow converse for control	5

Question Number	Answer	additional guidance	Mark
9(d)	An answer that that makes reference to two of the following points: - patients may not know what foods contain these / what proteins contain these/ eq (1) - present in many / most foods / most proteins /eq (1) - proteins required for growth / repair / eq (1)	allow contain these proteins allow provide essential amino acids	2

total 14 marks

Question Number	Answer	Additional guidance	Mark
6(a)	An answer that makes reference to the following • genotypes of parents AA and aa (1) • gametes formed A a (1) • genotype of offspring all Aa (1)	allow all marks from Punnet square (even if unlabelled) if incorrect parent genotypes allow TE for Gamete mark for 1 max to score any marks must have a capital and lower case allow any suitable letter including different letters	3

Question Number	Answer	Additional guidance	Mark
6(b) (i)	$858 - 608 = 250$ ratio = 608 to 250 2.43 or 2.4 or 2.432 (2)	allow 1 mark for unsimplified ratio 608:250 in working or as answer	2

Question Number	Answer	Additional guidance	Mark
6(b) (ii)	An explanation that makes reference to three of the following • expected ratio is 3:1 / 75% and 25%(1) • role of chance / probability / random /eq (1) • fertilisation / which gametes fuse /eq (1) • fewer axial survive / germinate / selection / fewer axial pollinated / eq	allow self fertilisation random fertilisation scores mp 2 and 3 allow converse	3

6 (c)	C axial flower plants and terminal flower plants / eq (1) O of same species / named species / age /colour / size / condition / with same number of flowers/ eq (1) R repeat / calculate mean (for many plants of axial and terminal) / eq (1) M1 count how many seeds/ number of seeds / amount of seeds / mass of seeds (per plant / per flower) / eq (1) M2 collect seed after same / stated time period/ ensure they self pollinate / pollinate using brush / cover and allow to self pollinate / eq (1) S1 grow at same temperature / same light / in green house / same carbon dioxide / eq S2 same water / same mineral ions / same soil / eq (1)	6
--------------	---	----------

Total 14 marks

Question Number	Answer	Additional guidance	Mark
6(a)	An explanation that makes reference to two of the following points : about reproduction /life cycle • short life span / short generation time / short life cycle / reproduce quickly / eq (1) about results data • can get many repeats / many generations / can get expected / predicted ratios / can get quick / reliable / valid results / eq (1) • have a range of visible characteristics / traits / phenotypes / eq (1) • that are inherited / controlled by genes / eq (1)	not just 10 days not just many offspring	2

Question Number	Answer	Additional guidance	Mark
6(b)(i)	An answer that makes reference to • (parent genotypes) LI and LI (1) • (offspring genotypes) LL, LI, II (1) • (offspring phenotypes) Long and short (1)	allow any symbols allow Ab x Ab allow LS x LS not 4 alleles LI Ss not X and Y allow parent genotypes from Punnett square allow ECF from incorrect parents allow genotypes and phenotypes	4

	(phenotype ratio) / 3 long: 1 short / eq (1)	of offspring 1 max	
--	--	--------------------	--

Question Number	Answer	additional guidance	Mark
6(b)(ii)	calculation method not marking points - prob of male 0.5 / prob of long wing 0.75 - combined prob = 0.375 (2)	full marks for correct answer no working allow 1 mark for 0.5 or 50% or $\frac{1}{2}$ or 0.75 or 75% or $\frac{3}{4}$ allow 37.5% or $\frac{3}{8}$	2

Question Number	Answer	additional guidance	Mark
6(b)(iii)	An answer that makes reference to four of the following points: male to female observed / actual 1. male 155 / female 165 / 48% male / 52% female (1) expect 2. expect 1:1 / 50% / same numbers / even / eq (1) compare 3. almost identical / little difference / (slightly) fewer males / (slightly) more females / eq (1) long to short observed / actual 4. long 241 / short 79 / 75% long / 25% short (1) expect 5. expect 3:1 / 75% long / 25% short (1) compare 6. (almost) 3:1 / little difference / eq (1) long /short /male / female 7. slight difference between long to short in male and female / slightly more long winged males than expected / eq (1) 8. 3.2 :1 for male / 76% long / 24% short (1) 9. 2.9 :1 for female / 75% long / 25% short (1)	No credit for quoting unprocessed data ie 118, 37, 123, 42 slightly fewer long winged females than expected	4

Question Number	Answer	Additional guidance	Mark
6(c)	An explanation makes reference to three of the following points: • short-winged flies cannot fly / feed / mate / can't move as well / cannot escape predators / eq (1) • do not survive / die out / extinct / eq (1) • less reproduction / no alleles passed on (to next generation)/ eq (1) • natural selection / selective disadvantage eq (1)	allow converse throughout for long / normal flies allow genes	3

total 15 marks

Question Number	Answer	Mark
1(a)	An explanation that makes reference to two of the following points: • less oxygen (1) • (less) respiration (1) • (less) energy / ATP (1)	2

Question Number	Answer	Mark
1(b)	An explanation that makes reference to three of the following points: • DNA unzips / separates / one strand copied / eq (1) • complementary / base pairing /eq (1) • template (1) • mRNA produced / eq (1) • transcription (1)	3

Question Number	Answer	additional guidance	Mark
1(c)	• no nucleus / DNA / no ribosomes/ mitochondria /eq	ign amino acids / genetic material	1

Question Number	Answer	Mark
1(d)	• can pass across placenta (1)	1

Question Number	Answer		Mark

1(e)(i)	An answer that makes reference to the following points: - parent genotype dd x Dd (1) - gamete d (and d) and D or d (1) - offspring genotype Dd and dd (1)	allow Punnett square any letter TE max 2	3
----------------	--	--	----------

Question Number	Answer	Mark
1(e)(ii)	50% / 0.5 / half / 50:50 not if contradicts ei	1

Question Number	Answer	Mark
1(f)	An explanation that makes reference to three of the following points: - memory cells (1) - remain in mother's blood (1) - recognise / identify antigen / binds with antigen (1) - more antibodies produced/ produced faster / sooner (1) - secondary immune response (1)	3

Question Number	Answer	Mark
1(g)	in the uterus / womb	1

Question Number	Answer	Mark
1(h)	(adult) (rhesus) positive / positive / eq	1

Total 16 marks