

OCR GCSE GATEWAY BIOLOGY A • J247

BIOLOGY



EXAM QUESTION PACK

B5.1 INHERITANCE

SCORE

/154

PERCENTAGE

%

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Gateway Biology A (9-1)

Inheritance

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate
forename

Candidate
surname

Centre number

Candidate number

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **154**.
- The total number of marks may take into account some 'either/or' question choices.

- 1 A sperm cell of a mouse has 20 chromosomes.

Which row in the table shows the correct number of chromosomes in each cell?

	Number of chromosomes in	
	a mouse egg cell	a mouse eye cell
A	40	40
B	20	20
C	20	40
D	40	20

Your answer

[1]

- 2 The DNA of the unborn baby can be found in the blood sample of the mother.

This DNA is tested to see which chromosomes are present.

Which conclusion is correct?

- A If a Y chromosome is present then it must be a boy.
- B If a Y chromosome is present then it must be a girl.
- C If an X chromosome is present then it must be a boy.
- D If an X chromosome is present then it must be a girl.

Your answer

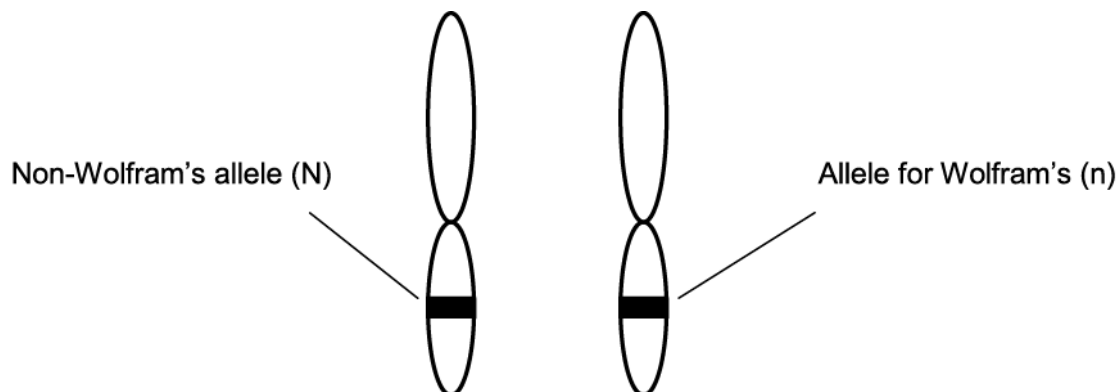
[1]

3(a) Wolfram's Syndrome is a genetic disorder.

It is caused by a recessive allele (n).

In people with Wolfram's syndrome, a protein does not function correctly.

The diagram shows a pair of chromosomes from a person called Tim.



Complete these sentences.

Tim does not have Wolfram's syndrome.

This is because his genotype is _____

This means the probability of any one of his sperm having the Wolfram's allele is _____

[2]

(b)

(i) Meena is expecting a baby.

Tim is the father.

Complete this genetic diagram.

		Tim	
Meena	N		
	n		

[2]

(ii) Wolfram's syndrome can affect the production of hormones from the pancreas.

Meena and Tim's doctor tells them that there is a chance that their baby will have problems controlling its blood glucose level.

Explain why the doctor thinks this.

Use information from part (i) and your biological knowledge.

[4]

4 In many countries people rely on bananas for food.

Black sigatoka is a disease of banana plants.

It is caused by a fungus.

Banana plants grown by farmers are usually produced asexually.

This process uses mitosis.

This means that if one banana plant can die of black sigatoka then they all can.

Write down why.

[1]

5 A mouse has a diploid chromosome number of 40.

Which row in the table shows the correct number of chromosomes in each cell?

	Number of chromosomes in	
	a mouse egg cell	a mouse eye cell
A	40	40
B	20	20
C	20	40
D	40	20

Your answer

[1]

6 FOP is a disorder that causes soft tissue in the body to turn to bone.

It is caused by a dominant allele.

People who have this condition are often infertile.

Natural selection predicts that the number of children born with the condition will go down.

Which explanation can explain why the number of people with FOP is staying constant?

- A The allele is being produced regularly by mutation.
- B Dominant alleles can remain hidden for generations.
- C The allele may increase the rate of meiosis.
- D The allele has no effect on a person's phenotype.

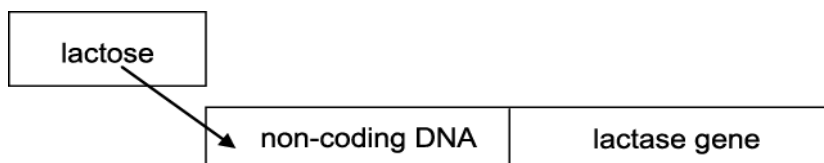
Your answer

[1]

7 Bacteria can produce an enzyme called lactase which digests lactose.

The enzyme is only made when lactose is present.

This is because there is a non-coding area of DNA which switches the lactase gene on.



Bacteria can have a mutation in the non-coding DNA.

What is a possible effect of such a mutation?

- A Lactase cannot be made even if lactose is present.
- B Lactase is made but will have a different order of amino acids.
- C Lactase is made but it will be the wrong shape to digest lactose.
- D Lactose is made rather than lactase.

Your answer

[1]

8 Some plants have been genetically engineered so that they grow larger.

Each cell of the plant has a new gene inserted so that it produces a different protein.

What does genetic engineering do to the plant?

- A It changes the phenotype and the genotype.
- B It changes the genotype but not the phenotype.
- C It changes the phenotype but not the genotype.
- D It changes neither the genotype nor the phenotype.

Your answer

[1]

9(a) Wolfram's Syndrome is a genetic disorder.

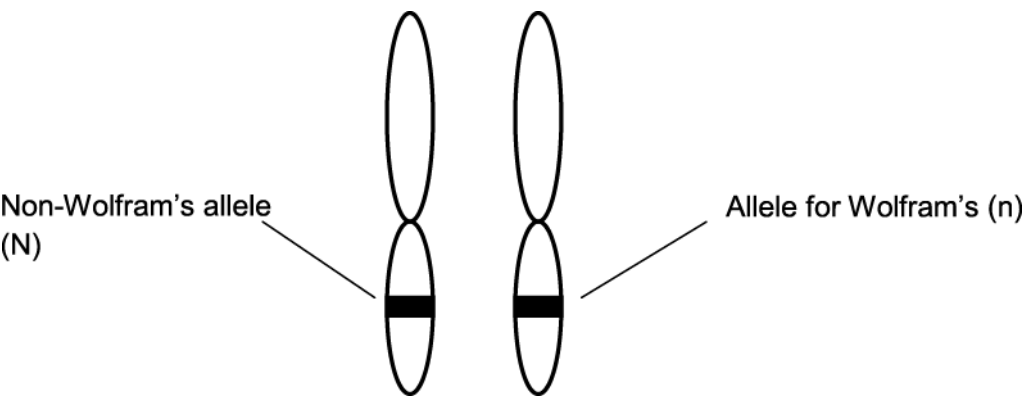
It is caused by a recessive allele (n).

In people with Wolfram's syndrome, a protein does not function correctly.

Explain how a change in an allele can stop a protein functioning correctly.

[4]

(b) The diagram shows a pair of chromosomes from a person called Tim.



Fill in the table to show Tim's genotype and phenotype.

Choose your answers from this list.

- does not have Wolfram's syndrome
- has Wolfram's syndrome
- heterozygous
- homozygous dominant
- homozygous recessive

genotype	
phenotype	

[2]

(c)

(i)

Meena is expecting a baby.

Tim is the father.

Complete this genetic diagram.

		Tim	
Meena	N		
	n		

[2]

(ii) Wolfram's syndrome can affect the pancreas.

Meena and Tim's doctor tells them that there is a chance that their baby will have problems controlling their blood glucose level.

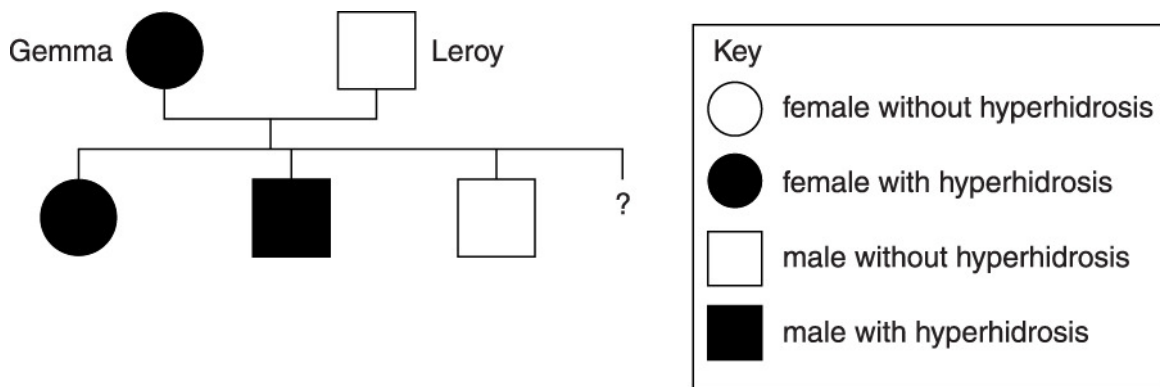
Explain why the doctor thinks this.

Use information from part (c) (i) and your biological knowledge.

[4]

10(a) Scientists have discovered that this is caused by a **dominant** allele.

Look at this family tree.



Gemma and Leroy are expecting a fourth child.

What is the probability that it will have hyperhidrosis?

Explain how you worked out your answer.

probability = ...

explanation

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

(b) Some people sweat too much.

This is called hyperhidrosis.

Gemma's doctor injects her with a drug that makes her sweat less.

(i) Put a tick (✓) in the box that describes what this drug changes.

Gemma's genotype but not her phenotype

☐

Gemma's phenotype and her genotype

☐

neither Gemma's phenotype nor her genotype

☐

Gemma's phenotype but not her genotype

☐

[1]

(ii) The drug contains an antigen made by bacteria.

The drug stops the sweat glands working for about 4 months.

It only works for this long because the antigens are gradually destroyed by Gemma's body.

Explain how Gemma's body destroys antigens.

[2]

11 Some people sweat too much.

This is called hyperhidrosis.

Scientists have discovered that this is a genetic disorder.

(i) Gemma's cells contain the gene that causes hyperhidrosis.

Write about where in cells genes are found.

----- [2]

(ii) Gemma can **not** pass on hyperhidrosis to her friends.

Explain why.

----- [2]

12 Some humans and animals have an inherited condition called cornea plana.

It causes the cornea to be less curved than normal.

Scientists performed an experiment on mice to try and work out how cornea plana is inherited.

They mated together two mice who had normal vision.

There were nine offspring and three had cornea plana.

Complete these sentences about the inheritance of cornea plana.

Cornea plana is caused by a change to a gene.

A change in a gene is called a _____.

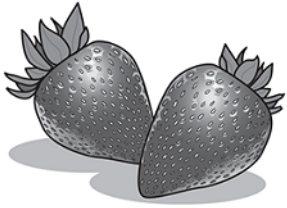
The allele that causes cornea plana is _____ to the normal allele.

[2]

13 A farmer is choosing which strawberry plants to grow.

He reads an advert in his farming magazine.

Buy strawberry plants from us!



We have been selectively breeding strawberry plants for many years.
This has produced a plant with very sweet tasting strawberries.
All the plants we sell are clones of this plant.
We guarantee that none of the plants we sell are genetically modified.

The company are sure that **every** plant they sell will produce sweet strawberries.

Explain why they are so sure.

[2]

14(a) A student answered some questions in a biology test.

His answers contain mistakes.

Explain what they are.

Question: Write down three examples of proteins.

Student's answer: DNA, collagen, insulin

Student's mistake _____
_____ [1]

(b) Question: Why are sperm cells and egg cells different in size?

Student's answer: Egg cells are bigger because they supply all the chromosomes and genes for the zygote.

Student's mistake _____

_____ [2]

(c) Question: How do enzymes work?

Student's answer: An enzyme is like a key that fits into a substrate's active site.

Student's mistake _____

_____ [2]

15 Some humans and animals have an inherited condition called cornea plana.

It causes the cornea to be less curved than normal.

Scientists performed an experiment on mice to try and work out how cornea plana is inherited.

They mated together two mice who had normal vision.

There were nine offspring and three had cornea plana.

Complete these sentences about the inheritance of cornea plana.

Cornea plana is caused by a change to a gene.

A change in a gene is called a _____.

The allele that is produced is _____ to the normal allele.

The two parent mice must be _____ for the allele for cornea plana.

[3]

16 There are two main types of reproduction, sexual and asexual.

Which is an **advantage** of sexual reproduction?

- A Creates more variation
- B Produces larger numbers of offspring
- C Produces offspring that are all identical so well adapted
- D Only needs one parent

Your answer

[1]

17 What did Gregor Mendel discover?

- A A theory for how life on Earth started
- B How characteristics are inherited in pea plants
- C The shape of the DNA molecule
- D The theory of natural selection

Your answer

[1]

18 An organism has the genotype TT.

Which term describes this organism?

- A Heterozygous dominant
- B Heterozygous recessive
- C Homozygous dominant
- D Homozygous recessive

Your answer

[1]

19 Which process produces gametes?

- A Diffusion
- B Fertilisation
- C Meiosis
- D Mitosis

Your answer

[1]

20(a)

Characteristics can be examples of continuous or discontinuous variation.

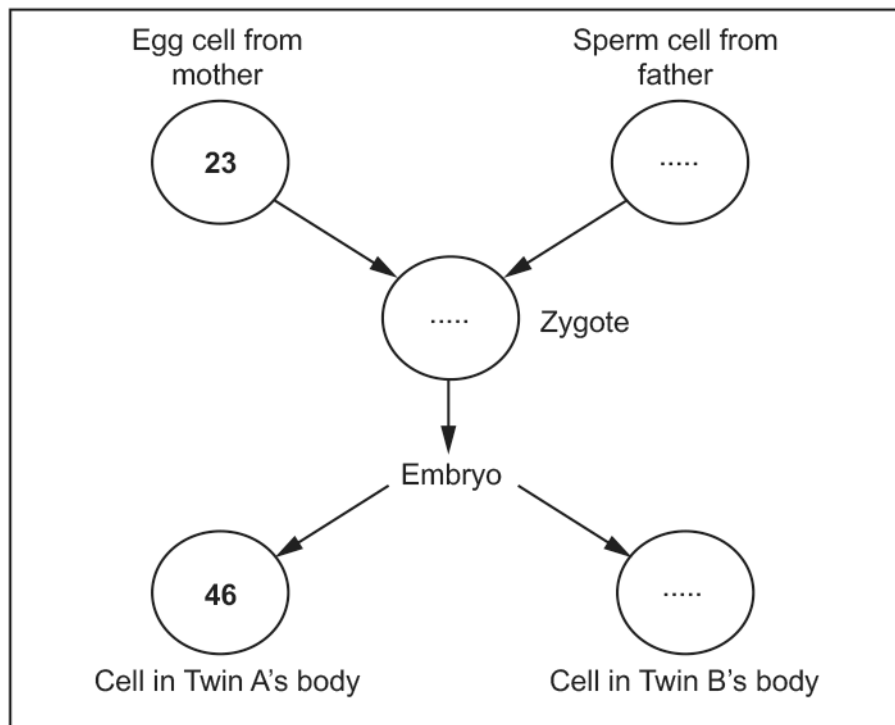
Write the **four** characteristics below in the correct columns of the table.

Sex	Blood group	Height	Eye colour
Continuous variation		Discontinuous variation	

[2]

(b) Identical twins occur when an embryo splits into two.

In the diagram below, some of the chromosome numbers in the different cells have been given to you.



Complete the diagram to show the number of chromosomes in:

- The sperm cell
- The zygote
- The cell in Twin B's body.

[3]

21(a)

The sex chromosomes determine the sex of a baby.

What are the sex chromosomes of a male and of a female?

Male -----

Female -----

[2]

(b) The data in the table shows the ratio of males to females in England and Wales.

	Ratio of males to females in England and Wales
At birth	105 males : 100 females
Average over the whole population	98 males : 100 females

(i) What percentage of babies are male at birth?

Answer = ... % [1]

(ii) In a hospital 410 babies are born in a week.

Calculate how many of them are likely to be male.

Answer = ... [1]

(iii) On average, men do not live as long as women.

How does the data in the table show this?

.....

.....

.....

..... [2]

22(a) Retinitis pigmentosa is a genetic condition.

It is caused by a mutation to a gene. This mutation produces a recessive allele.

If people have retinitis pigmentosa then the cells in their retina are damaged.

Explain the meaning of these terms.

Mutation -----

Gene -----

[2]

(b) If a person has two alleles for retinitis pigmentosa, they will not be able to see properly.

(i) Why does a person need two affected alleles to have the condition?

----- [1]

(ii) Why does the condition affect the ability to see properly?

----- [1]

- (c) Two people are heterozygous for retinitis pigmentosa and are expecting a baby.

Complete the genetic diagram to work out the probability that the baby will have the condition.

R is the normal allele and r is the allele for retinitis pigmentosa.

	R	r
R		
r		

Answer = ... [3]

- 23 Which of these processes can produce a **new** allele?

- A A change in the environment
- B Asexual reproduction
- C Mutation
- D Selective breeding

Your answer

[1]

- 24 Why is the process of meiosis important in making gametes?

- A The cells produced are diploid.
- B The cells produced are genetically identical.
- C The cells produced are much smaller in size.
- D The cells produced have half the number of chromosomes.

Your answer

[1]

25 What is a genome?

- A A description of the number of chromosomes in an organism.
- B All the proteins that one organism can produce.
- C A store of seeds to preserve genetic variation.
- D The entire genetic material of an organism.

Your answer

[1]

26 A harmful protein can cause pain in the joints. A new treatment is being developed to stop the protein causing pain.

What effect would this treatment have on the person's phenotype and genotype?

- A Changes both the phenotype and genotype
- B Changes the genotype only
- C Changes the phenotype only
- D No change to their phenotype or genotype

Your answer

[1]

27(a) Retinitis pigmentosa is a genetic condition that affects the eyes.

It is caused by a mutation to a gene. This mutation produces a recessive allele.

The condition causes rod cells in the retina to break down.

Explain the meaning of these terms.

Gene -----

Allele -----

[2]

(b)

- (i) Two people who are heterozygous for retinitis pigmentosa are expecting a baby.

Draw a genetic diagram to calculate the probability that the baby will have the condition.

Use R for the normal allele and r for the allele for retinitis pigmentosa.

Answer = ... [3]

- (ii) If the baby has retinitis pigmentosa, it will have normal colour vision but will not be able to see well in dim light.

Explain why.

.....

.....

.....

..... [3]

28(a) The data in the table shows the ratio of males to females in England and Wales.

	Ratio of males to females in England and Wales
At birth	105 males : 100 females
Average over the whole population	98 males : 100 females

Describe how sex is determined in humans.

You may use a genetic diagram in your answer.

----- [2]

(b) In 2015 there were approximately 698 000 babies born in England and Wales.

Calculate how many of these were male.

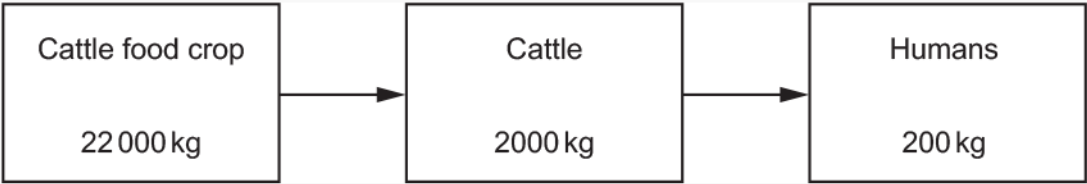
Answer = ----- [2]

(c) There are more females than males living in England and Wales as an average over the whole population.

Suggest **one** reason why there are more females.

----- [1]

29 The diagram shows the flow of biomass through an agricultural food chain.



High levels of light intensity can damage plants. To prevent damage, plants have a protection mechanism.

When light intensity levels get **too high**, the protection mechanism switches on. This stops the plant absorbing too much light.

When the light intensity drops to safe levels, the protection mechanism switches off **slowly**.

Explain why this mechanism would **reduce** the biomass available to humans.

30 Which combination of gametes will produce a male baby?

- A A sperm with XY chromosomes and an egg with XX chromosomes.
- B A sperm with one X chromosome and an egg with one Y chromosome.
- C A sperm with one Y chromosome and an egg with one X chromosome.
- D A sperm with XX chromosomes and an egg with XY chromosomes.

Your answer

☐

[1]

31 Cystic fibrosis is a genetic condition caused by a recessive allele (f).

Which is the genotype of a person **with** cystic fibrosis?

- A Heterozygous and ff
- B Heterozygous and Ff
- C Homozygous and ff
- D Homozygous and FF

Your answer

☐

[1]

32 Which of these is an example of **discontinuous** variation?

- A Body weight
- B Hand span
- C Height
- D Sex

Your answer

☐

[1]

33 Each cell in the eye of a kangaroo has **16** chromosomes.

How many chromosomes are there in one kangaroo **sperm cell**?

- A 4
- B 8
- C 16
- D 32

Your answer

[1]

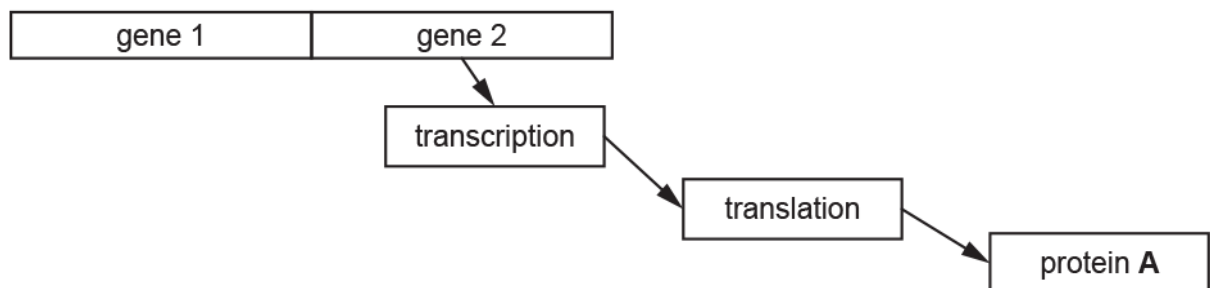
34 What was Mendel's contribution to modern genetics?

- A He developed the theory of natural selection.
- B He discovered that most characteristics are controlled by multiple genes.
- C He worked out how sex determination occurs in mice.
- D He found a pattern that shows how characteristics are passed on.

Your answer

[1]

35 Gene 1 and gene 2 are both needed for the production of protein A.



What is the function of **gene 1** in this process?

- A It codes for the amino acids in protein A.
- B It codes for the mRNA needed to make protein A.
- C It acts as the site for protein synthesis.
- D It controls the expression of **gene 2**.

Your answer

[1]

36 Some people get very painful headaches called migraines.

Scientists think that this is caused by a protein in the brain called CGRP.

Levels of the CGRP protein are higher in the brains of people who get migraines.

Doctors are trying to find a treatment to prevent migraines.

They have produced an antibody against the CGRP protein.

The doctors test the antibody treatment on migraine patients.

The patients are divided into two groups:

- One group is given an injection of the antibody
- The second group receives an injection of a placebo.

They record the mean number of days each patient had migraines before and after treatment.

The table shows their results.

Treatment	Mean number of migraine days per patient before treatment	Mean number of migraine days per patient after treatment	Percentage decrease in migraine days per patient
antibody injection	9.1	4.4	
placebo	9.1	6.4	29.7

(i) Explain why a placebo group is used in drug testing.

[3]

(ii) Calculate the percentage decrease in migraine days in the patients that had the antibody injection.

Give your answer to 1 decimal place.

Percentage decrease = ... %

[3]

- 37 Huntington's disease is a genetic condition. It is caused by a **dominant allele**.

Explain what is meant by the term dominant allele.

[2]

38(a) Rats are a major pest in many areas of the world. They can reduce food security and spread diseases.



Warfarin is a chemical that is used as a rat poison. It stops platelets working in the blood.

Describe the function of platelets in the blood.

----- [2]

(b) Some rats are resistant to warfarin. When fed with large amounts of warfarin the rats do not die.

Scientists found that the resistance is due to the dominant allele R.

Two resistant rats (Rr) mate.

Complete this genetic diagram to find the ratio of resistant rats to non-resistant rats that would be expected to be produced.

		Rr	
Rr	R		
	r		

Ratio = ... [3]

(c) After several years, the percentage of resistant rats in the population had increased.

Use Darwin's theory of natural selection to explain this observation.

[3]

(d) Scientists are now trying to find another poison to use on rats.

They have introduced a chemical called phosphine. This blocks the action of mitochondria in rat cells.

Explain why this might kill rats.

[3]

39(a) Rats are a major pest in many areas of the world. They can reduce food security and spread diseases.



Warfarin is a chemical that is used as a rat poison. It stops the correct functioning of platelets in the blood.

Explain why warfarin can be used as a rat poison.

[2]

(b) In 1958, some rats were found that were resistant to warfarin. They did not die, even when fed with large amounts of the poison. Scientists found that the resistance was due to dominant allele **R**.

Two resistant rats can mate and produce non-resistant rats.

Draw a genetic diagram below to show how these non-resistant rats can be produced.

[3]

(c) When scientists studied the resistant rats they found that there were two different types.

Homozygous rats are resistant to warfarin but need to eat 20 times more vitamin K.

Heterozygous rats are resistant to warfarin but only need slightly increased amounts of vitamin K.

The scientists found that the non-resistant rats never died out completely.

Explain why.

----- [2]

40 The table shows features of **meiosis**.

	Type of cells made	Genetic variation introduced
A	body cells	✓
B	body cells	x
C	gametes	✓
D	gametes	x

Which row in the table is correct?

Your answer

[1]

- 41 Scientists found DNA from a Stone Age woman trapped in gum from a tree. The woman had chewed the tree gum. Using this DNA scientists were able to predict some of her features.

Which feature would scientists have been able to predict from her DNA alone?

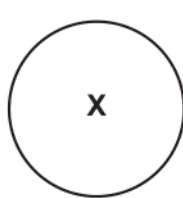
- A Body weight
- B Diet
- C Eye colour
- D Height

Your answer

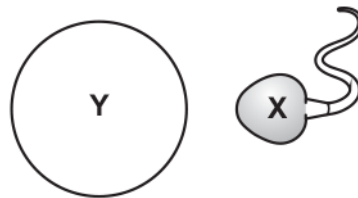
[1]

- 42 The diagrams show gametes and sex chromosomes.

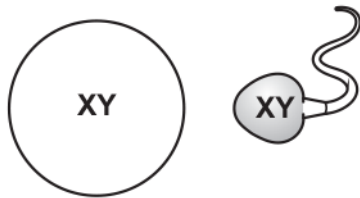
Which diagram shows the correct combination of sperm and egg to produce a **male** baby?



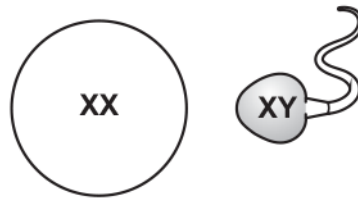
A



B



C



D

Your answer

[1]

43 Gregor Mendel studied the inheritance of characteristics in pea plants.

Which of these is a possible reason why he chose pea plants for his experiments?

- A Pea plants can produce many offspring, quite quickly.
- B Pea plants can reproduce asexually.
- C Pea plants do not develop mutations.
- D Pea plants do not produce gametes.

Your answer

[1]

44 Tigers have a diploid number of 38 chromosomes.

How many chromosomes are present in a tiger sperm cell?

- A 2
- B 19
- C 38
- D 72

Your answer

[1]

45(a) Hypercholesterolemia (HC) is caused by a dominant allele on chromosome 19. This allele has mutations which cause a change in the order of DNA nucleotides.

Write the words **allele**, **chromosome** and **nucleotide** in the boxes to show their size from smallest feature to largest feature.

Smallest feature

Largest feature

[1]

(b) One in 500 people are heterozygous for HC.

There are 66 000 000 people in the UK.

Calculate how many people in the UK are heterozygous for HC.

Number of people = ... [1]

(c) A woman who does **not** have HC and a man who is heterozygous are expecting a baby.

What is the probability of the baby having HC?

Complete the genetic diagram to explain your answer.

D is the dominant HC allele and d is the recessive allele.

		Man	
		D	d
Woman	d		
	d		

Probability = ... [2]

46 Why are the effects of most mutations **not** observed?

- A Most mutations do not affect the genotype or phenotype.
- B Most mutations do not affect the phenotype.
- C Mutations mainly affect internal body processes.
- D Mutations often kill the organism.

Your answer

[1]

47 The table describes meiosis.

	Genetic description of cells made	Genetic variation introduced	Type of cells made
A	haploid	✓	body cells
B	diploid	X	body cells
C	haploid	✓	gametes
D	diploid	✓	gametes

Which row in the table is correct?

Your answer

[1]

48 How can a mutation in non-coding DNA change the activity of a cell?

- A It can change the amino acid sequence in a protein.
- B The base sequence of mRNA may be altered.
- C The shape of a protein may be changed.
- D Transcription of mRNA may be stopped.

Your answer

[1]

49(a) Fanconi anaemia is a genetic disorder. It results in the bone marrow being destroyed.

This causes a decrease in the numbers of red blood cells, white blood cells and platelets.

Explain **two** possible symptoms of Fanconi anaemia.

1

.....

2

.....

[2]

(b) Table 19.1 shows normal ranges for blood components in people **without** Fanconi anaemia.

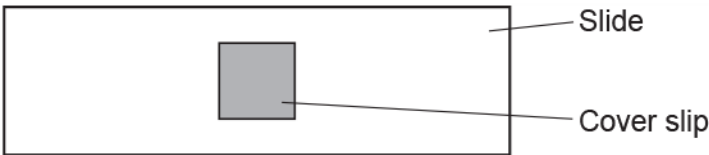
Blood component	Number per mm ³
red blood cell	$4.5 - 6.5 \times 10^6$
white blood cell	$6.0 - 16.0 \times 10^3$
platelet	$1.5 - 4.0 \times 10^5$

Table 19.1

(i) Suggest why there is such a wide range of white blood cell numbers.

----- [2]

(ii) The diagram shows a microscope slide containing blood from a patient.



The square cover slip is 10 mm wide and the thickness of the blood underneath is 0.001 mm.

Calculate the volume of blood under the cover slip.

Volume of blood = ... mm³ [1]

(iii) Under the cover slip are 1000 white blood cells.

Does the blood sample provide evidence that the patient has Fanconi anaemia?

Use Table 19.1 and your answer to part (ii) to justify your answer.

[3]

(c) There are many different genetic disorders that can affect blood cells. Details of three of these are found in Table 19.2.

Name of disorder	Cause of disorder	Symptom
D-B anaemia	dominant allele	low red blood cell numbers
S-D syndrome	recessive allele	low white blood cell numbers
Fanconi anaemia	recessive allele	small numbers of all blood cells

Table 19.2

A blood smear from another patient shows that he has 3×10^6 red blood cells per mm^3 of blood. Neither of his parents have a blood disorder.

Use Table 19.1 and Table 19.2 to explain which blood disorder the patient could have.

Name of disorder -----

Explanation -----

[3]

50(a) Hypercholesterolemia (HC) is the result of a mutation in the genome. It is caused by a dominant allele on chromosome 19. The mutation involved causes a change in the DNA nucleotides.

Write the words **allele**, **chromosome**, **genome** and **nucleotide** in the boxes to show their size from smallest feature to largest feature.

Smallest feature	
Largest feature	

[1]

(b) One in 500 people are heterozygous for HC.

There are 66 000 000 people in the UK.

Calculate how many people in the UK are heterozygous for HC.

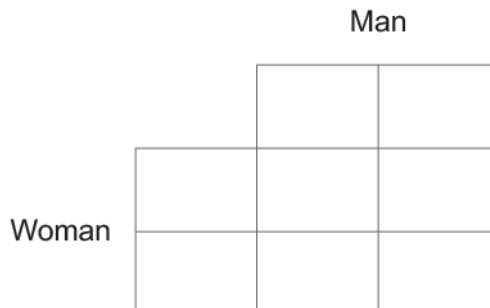
Number of people = ... [1]

(c) A woman who does not have HC and a man who is heterozygous are expecting a baby.

What is the probability of the baby having HC?

Complete the genetic diagram to explain your answer.

Use **D** for the dominant HC allele and **d** for the recessive allele.



Probability = ... [2]

(d) The allele that is affected by HC codes for a protein called LDL receptor protein.
The faulty allele often has four extra nucleotides, making a total of 2521 nucleotides.

Calculate the number of **amino acids** found in the healthy, **unaffected** protein.

Number of amino acids = ... [2]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			C	1	
			Total	1	
2			A	1	
			Total	1	
3	a		Nn / heterozygous (1) 0.5 (1)	1 1	allow 50% / ½ / 1 in 2 / 50:50
	b	i	Tim's and Meena's genotypes Nn (1)	1	
		i	correct genotypes of offspring (NN, Nn, Nn, nn)	1	
		ii	baby may be nn (1)	1	
		ii	one in four chance of baby being affected (1)	1	
		ii	pancreas produces insulin (1)	1	
		ii	insulin controls blood glucose level (1)	1	
			Total	8	
4			all genetically identical / all have the same genes (1)	1	all clones (1)
			Total	1	
5			C	1	
			Total	1	
6			A	1	
			Total	1	
7			A	1	
			Total	1	
8			A	1	
			Total	1	
9	a		change in base sequence of DNA (1) change in order of amino acids (1) protein shape changes (1)	1 1 1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			reference to shape not being suited to function e.g. change in enzymes active site shape (1)	1	
	b		heterozygous (1)	1	
			does not have Wolfram's syndrome (1)	1	
	c	i	Tim's and Lucy's genotypes Nn (1)	1	allow correctly completed punnet square
		i	correct genotypes of offspring (NN, Nn, Nn, nn) (1)	1	
		ii	baby may be nn (1)	1	
		ii	one in four chance of baby being affected (1)	1	
		ii	pancreas produces insulin (1)	1	
		ii	insulin controls blood glucose level (1)	1	
			Total	12	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
10	a		50% / 1/2 / 1 in 2 (1) Gemma must be / heterozygous / (only) got one dominant allele and Leroy is / homozygous recessive / has no dominant allele (1)	2	allow 50/50 allow letters such as Hh and hh in a punnet square but must indicate which genotype belongs to who Look for correct labelling on diagram Examiner's Comments There were a lot of Punnett squares drawn in response to this question, the majority correct. Although many did work out the correct ratio, a number of candidates tried to work out the probability based on the ratio of brothers and sisters affected, rather than the genotypes of Gemma and Leroy.
	b	i	Gemma's phenotype but not her genotype (1) last box	1	Examiner's Comments A good discriminator question.
		ii	any two from: (antigens trigger) white blood cells release antibodies / antitoxins (1) antibodies / antitoxins lock on to antigens (and destroy them) (1) white blood cells engulf antigens (1)	2	allow attach on to antigens allow phagocytosis / digest antigen ignore eaten ignore antibodies engulf antigens ignore pathogens Examiner's Comments The best responses clearly described the roles of white blood cells in antibody production and phagocytosis. With a few candidates there was some confusion between antigens, antibodies and even antibiotics, for example 'antibodies engulfing antigens' or 'antigens producing antibodies'. Other candidates incorrectly referred to pathogens.
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
11		i	any two from: in the nucleus (1) on/in the chromosomes (1) in the DNA (1)	2	allow mitochondria (1)
		ii	it is a non-infectious (disease) (1) not caused by a pathogen / is caused by a gene (1)	2	allow non-contagious / can not be caught allow it is inherited ignore it's genetic (in question) Examiner's Comments In part (i) three quarters of candidates gained at least 1 mark, with a third of these gaining 2, for correctly referring to the nucleus, chromosomes or DNA. In part (ii) a quarter of the candidates gained both marks for explaining that hyperhidrosis is a non-infectious disease because it is caused by a gene not a pathogen. Although a mark was given for saying that the condition is caused by a gene, there was no credit for simply saying that it is a 'genetic disorder', as this term had already been given in the question. Candidates should be made aware of this principle of marking. Credit was given for saying that the condition is inherited, but candidates should be aware that it 'can be passed to relatives' is not the same as 'can be inherited'.
			Total	4	
12			mutation (1) recessive (1)	2	
			Total	2	
13			all clones (1) so are genetically identical / have the same genes (1)	2	
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
14	a		DNA is not a protein (1)	1	ignore just DNA
	b		any two from: egg cells do not supply all the chromosomes / genes (1) BUT (sperm and) eggs (each) supply half of the genetic material / genes / chromosomes (2)	2	egg cells are larger because they do not need to swim / contain food reserves (1)
	c		the substrate is like a key (not the enzyme) (1) the substrate fits into the enzyme's active site (not the other way round) (1)	2	allow: the enzyme is like a lock (not a key) (1) allow: the enzyme has an active site not the substrate (1) allow: 'enzyme and the substrate are the wrong way round' (2)
			Total	5	
15			mutation (1) recessive (1) heterozygous / carriers (1)	3	ignore different
			Total	3	
16			A ✓	1 (AO1.1)	
			Total	1	
17			B ✓	1 (AO1.1)	
			Total	1	
18			C ✓	1 (AO1.1)	
			Total	1	
19			C ✓	1 (AO1.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance								
20	a		<table><tr><th>Continuous</th><th>Discontinuous</th></tr><tr><td>height</td><td>sex</td></tr><tr><td></td><td>blood group</td></tr><tr><td></td><td>eye colour</td></tr></table> ✓✓	Continuous	Discontinuous	height	sex		blood group		eye colour	2 (AO1.1)	All four correct = 2 marks Three correct = 1 mark Two or less correct = 0 marks <u>Examiner's Comments</u> There was some confusion in the answers, mixing up continuous and discontinuous variation. Lower ability candidates did not gain marks here.
Continuous	Discontinuous												
height	sex												
	blood group												
	eye colour												
	b		sperm cell 23 ✓ zygote 46 ✓ body cell 46 ✓	3 (AO1.1)	 <u>Examiner's Comments</u> The majority of candidates achieved full marks here for correctly identifying the number chromosomes in each of the cell types.								
			Total	5									

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
21	a		male sex chromosomes are XY ✓ female sex chromosomes are XX ✓	2 (AO 2 × 1.1)	Examiner's Comments The majority of candidates did not recall that males have XY and females have XX sex chromosomes. This question was a good differentiator. Most common errors were linking gametes or chromosome number of gametes to male and female respectively. This is shown in Exemplar 3, which achieved 0 marks. Exemplar 3 Male <u>23</u> Female <u>23</u> [2]
	b	i	51.2 (%) ✓	1 (AO 2.2)	ALLOW 51 / 51.22 or correct rounding Examiner's Comments This question differentiated well, with the higher ability candidates more likely to correctly calculate the percentage.
		ii	210 (%) ✓	1 (AO 2.2)	ALLOW 209 Examiner's Comments This answer was correctly calculated by half of the candidates.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	in the whole population, there are more females / less males ✓ however more males are born (than females) ORA ✓	2 (AO 2 × 3.1a)	IGNORE less males alive IGNORE there are less males over the whole population than at birth If no other mark scored, credit ratio of males has decreased from birth <u>Examiner's Comments</u> The most common mark scored was that in the whole population there are more females (than males). Of those candidates that didn't score, the vast majority did not compare males against females and stated the number for males at birth compared to the whole population. Exemplar 4 scored full marks. Exemplar 4 because ✓ at birth there are more males than females but throughout the whole population there are more females than males. ✓ [2]
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
22	a		mutation: change in a gene / DNA / deletion of a base / addition of a base / change in order of bases ✓ gene: a section/length of DNA ✓ OR codes for a protein ✓	2 (AO 2 × 1.1)	AW nucleotide for base ALLOW codes for the order/sequence of amino acids IGNORE codes for a characteristic <u>Examiner's Comments</u> There were some good answers here demonstrating their knowledge and understanding of the meaning of the terms mutation and gene. Mutation was the most common credited answer.
	b	i	(the allele) is recessive ✓	1 (AO 2.1)	ALLOW neither dominant <u>Examiner's Comments</u> Candidates need to apply their knowledge and understanding of genetics to achieve this mark. It differentiated well with the higher ability candidates' understanding that the allele is recessive. The majority of candidates referred to the number of eyes, and that they need two to become stronger / dominant, which did not gain credit.
		ii	The retina is damaged/doesn't function ✓	1 (AO 1.1)	ALLOW retina detects light / focuses the image / contains light receptors <u>Examiner's Comments</u> This was a well differentiated question. The majority of lower ability candidates did not gain the mark as common answers were too generalised such as 'it affects the eyes'.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance									
	c		<table border="1"><tr><td></td><td><i>R</i></td><td><i>r</i></td></tr><tr><td><i>R</i></td><td><i>RR</i></td><td><i>Rr</i></td></tr><tr><td><i>r</i></td><td><i>Rr</i></td><td><i>rr</i></td></tr></table> ✓✓ probability = 0.25 / ¼ / 25% / 1 in 4 / 1:3 ✓		<i>R</i>	<i>r</i>	<i>R</i>	<i>RR</i>	<i>Rr</i>	<i>r</i>	<i>Rr</i>	<i>rr</i>	3 (AO 2 × 1.2) (AO 3.2b)	All genotypes correct = 2 marks Three genotypes correct =1 mark One / two genotypes correct =0 marks <u>Examiner's Comments</u> The majority of candidates achieved 2 or 3 marks correctly identifying the genotypes in the offspring. Some candidates couldn't work out the probability...
	<i>R</i>	<i>r</i>												
<i>R</i>	<i>RR</i>	<i>Rr</i>												
<i>r</i>	<i>Rr</i>	<i>rr</i>												
			Total	7										
23			C ✓	1 (AO2.1)										
			Total	1										
24			D ✓	1 (AO1.1)										
			Total	1										
25			D ✓	1 (AO1.1)										
			Total	1										

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
26			C ✓	1 (AO1.2)	Examiner's Comments This question assessed candidates' understanding of how the phenotype and genotype are affected under different conditions. Many candidates' responses were that it was only the genotype that would be affected by the treatment rather than the correct response being only the phenotype.  This may indicate a misconception in candidates thinking that anything that happens within the body has to do with the genotype. Key:  Misconception
			Total	1	

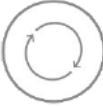
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance									
27	a		Gene: a length of DNA that codes for a protein ✓ Allele: an alternative form/version of a gene ✓	2 (AO 2 × 1.1)	IGNORE section of DNA that codes for a specific characteristic ALLOW a particular copy of a gene <u>Examiner's Comments</u> This question tested recall knowledge AO1.1 of the definitions of two genetic terms. The most common error was to only describe the gene as a section of DNA coding for a characteristic rather than coding for a protein. Candidates had a better knowledge of what an allele was.									
	b	i	<table border="1"><tr><td></td><td>R</td><td>r</td></tr><tr><td>R</td><td>RR</td><td>Rr</td></tr><tr><td>r</td><td>Rr</td><td>rr</td></tr></table> correct gametes ✓ correct genotypes of offspring ✓ probability = 0.25 / ¼ / 25% / 1 in 4 / 1:3		R	r	R	RR	Rr	r	Rr	rr	4 (AO 2.2) (AO 2.2) (AO 3.2b)	ALLOW other forms of diagrams other than Punnett square <u>Examiner's Comments</u> This question assessed AO2.2 with the application of practical techniques in completing a genetic cross. This was particularly well done by most candidates, except some candidates did not choose the symbols recommended in the question and this caused them confusion in interpretation. The question also included an AO3 mark for interpreting and drawing a conclusion from the Punnett square. The most common error was to give 75% as the response. Some candidates also made an error by describing the ratio as 1 in 3 when they should have written 1 in 4 or 1:3. These errors could be minimised by improving examination technique, where candidates are made aware of common errors in interpreting genetic diagrams.
	R	r												
R	RR	Rr												
r	Rr	rr												

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	rod cells are do not work / damaged ✓ rod cells can work in dim light ✓ but cannot detect colour ✓	3 (AO 2.1) (AO 2.1) (AO 1.1)	ALLOW rods cells broken down / cones are not broken down IGNORE rod cells broken down (as in stem of question) ALLOW converse for cones ALLOW converse for cones ALLOW rods only see in black and white <u>Examiner's Comments</u> This question covered AO1.1 and AO2.1. Candidates often did not identify that rod cells were damaged. They frequently just put rod cells break down, missing out it was 'only' the rod cells, and hence were just repeating what was in the stem of the question. Good responses also discussed cones cells so got the reverse argument.
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
28	a		sperm/male gametes contain either an X or Y chromosome and eggs/female gametes contain an X chromosome ✓ indication that XX is female and XY is male ✓	2 (AO 2 × 1.1)	ALLOW correct Punnett square but unlabelled for gamete mark ALLOW correct Punnett square that indicates XY is male and XX is female for 2 marks <u>Examiner's Comments</u> Most candidates scored well on this AO1 question. Candidates who didn't gain marks either mixed up the genders, saying females were XY, or occasionally they used incorrect nomenclature m and f, and some had YY as a possible genotype.
	b		First check answer on answer line If answer = 357512 award 2 marks $\frac{105}{205} \times 698000$ ✓ = 357512 ✓	2 (AO 2 × 2.2)	ALLOW answer given to several dps <u>Examiner's Comments</u> This question assessed candidates' mathematical skills in AO2.2. In the main, many candidates got maximum marks. Common incorrect responses were due to rounding errors, including rounding before multiplying. Lower ability candidates simply halved 689000. Some candidates made rounding errors but only wrote the final answer and had not shown any working. They were not able to gain the mark for correct working out even though they had most likely done this. Improved examination technique and practice would overcome this.  Examination technique needs candidates to focus on candidates showing their working out on calculations.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		males do not live as long/OR A ✓	1 (AO3.1b)	ALLOW they (females) live longer <u>Examiner's Comments</u> In this AO3 question many candidates tried to explain why it was likely that males die, but few referred to them dying earlier than females, or that females live longer. Higher ability candidates correctly referred to the longer life expectancy of females.
			Total	5	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
29	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed explanation including conclusions about how the mechanism affects photosynthesis and links this to less biomass available to humans in the food chain. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Explanation of how the mechanism affects photosynthesis or affects the biomass available to humans. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Demonstrates some knowledge of how the mechanism affects photosynthesis or affects the biomass available to humans. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6 (AO 3. × 1.1) (AO 2. × 2.1) (AO 1. × 3.2b)	AO1.1 Demonstrate knowledge of photosynthesis and biomass. • Photosynthesis requires light energy • Mechanism reduces photosynthesis • Trapped by the leaves and used to produce food molecules • Photosynthesis required for plant growth • Plant biomass is a food source for animals including humans AO2.1 Apply knowledge and understanding of photosynthesis to the production of biomass • More light energy converted to heat, then less energy for photosynthesis • Less photosynthesis then plants can make less food / plants can grow less • Less plant biomass leads to less available food AO3.2b Draw conclusions linking photosynthesis to biomass in food chains • In low light intensities, light availability is the limiting factor • Less plant growth/crops therefore less food for cattle/less food for humans / in the food chain <u>Examiner's Comments</u> This Level of Response question assessed all three main assessment objectives. It was common to be limited to a low level mark due to repeating the stem of question regarding less biomass all through their response instead of linking the protection mechanism's impact to less light, less photosynthesis so less glucose/food made and consequently less food for cattle and humans. Candidates that did not appreciate that a reduction in light resulted in a reduction in photosynthesis, which also limited their answer to a low level.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					There was little evidence of candidates planning their response. Taking time to consider how to answer a LoR, might encourage them to make notes and think through key areas. A common low level answer was to refer to the loss of energy due to the energy needed to switch on the mechanism. It was noted how many candidates did not link biomass to growth or production of food. However, those candidates that realised that the key to the answer was essentially linked to factors influencing photosynthesis, produced excellent responses. Exemplar 5 High light intensity levels cause the plant to absorb less light, reducing the amount of photosynthesis that takes place. This means the plant will not grow as much/as quickly so there is less crop ^{that grow}. As a result yield decreases so the mass of crop decreases. This means there is less food available for humans to consume. When the protection mechanism switches off slowly, there is a gradual increase in the amount of glucose the plant makes which slowly increases biomass available. However if it slowly increases the level of photosynthesis there is still less energy available for human consumption. This answer has less light/less photosynthesis and less crop and links this to the impact on the food chain so all Level 3, 6 marks This candidate has been credited Level 3 maximum 6 marks. They have structured their answer in a concise manner but included all the relevant marking points. The candidate describes the protection mechanism's impact in reducing light and photosynthesis. The candidate states that the decrease in mass of crops and food made means there is consequently less food for the humans to consume. They continue to give a reason why there will still be less energy available even when the plants resume photosynthesis due to the mechanism switching off slowly.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
30			C	1 (AO 1.1)	<u>Examiner's Comments</u> This question proved to be the most challenging question in section A. Many candidates did not recognise the correct combination of gametes which will produce a male baby which is C - A sperm with one Y chromosome and an egg with one X chromosome. All incorrect responses demonstrated equal weighting.
			Total	1	
31			C	1 (AO 2.2)	<u>Examiner's Comments</u> This question assessed the candidate's application of their knowledge and understanding of genotypes. All incorrect responses demonstrated equal weighting, confusing homozygous and heterozygous along with dominant and recessive genotypes.
			Total	1	
32			D	1 (AO 1.1)	<u>Examiner's Comments</u> This question assessed knowledge and understanding of discontinuous variation. Roughly half of candidates achieved this mark. Those who didn't opted for a named example of continuous variation instead.
			Total	1	
33			B	1 (AO 2.1)	<u>Examiner's Comments</u> This question assessed the candidate's application of their knowledge and understanding of gamete chromosome numbers. The main incorrect response was D, and candidates doubled the body cell diploid number provided instead of halving it to provide the haploid chromosome number.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
34			D	1 (AO 1.1)	
			Total	1	
35			D	1 (AO 1.1)	<u>Examiner's Comments</u> Recalling their knowledge in this AO1.1 question was answered well by higher ability candidates, less so by others. Lower ability candidates were frequently distracted by A.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
36		i	control ✓ can act as a comparison / to check the drug works ✓ idea of identifying / eliminates any psychological effect ✓	3 (AO 1.1)	ALLOW placebo contains no active drug / dummy injection ALLOW see the effects of the drug ALLOW to test if receiving something from a doctor or the drug itself is having the effect / some people believe they are feeling better when they are not ALLOW to eliminate placebo effect ALLOW tricks body into thinking it is taking a medicine <u>Examiner's Comments</u> This AO1.1 question tested knowledge of using a placebo group in drug development. Although it was described in a range of ways, most candidates realised the reason for a placebo group was to make sure that any improvement was not merely psychological. Fewer candidates stated that a placebo was a control, i.e. contains no active drug. Some candidates' responses focused on double blind tests and side effects. Very few candidates referred to the data in the table.
		ii	FIRST CHECK ANSWER ON THE ANSWER LINE If answer = 51.6 (%) award 3 marks 9.1-4.4 = 4.7 ✓ (4.7÷9.1) x 100 ✓ = 51.6 (%) ✓	3 (AO 2 x 2.2) (AO 1 x 1.2)	51.648 / 51.65 / 51.7 = two marks ALLOW ECF on the rounding IGNORE sign <u>Examiner's Comments</u> The AO2.2 part of this question resulted in candidates making a common error in not deriving 4.7, but the function and answer to their function were usually correct. Very few candidates scored zero, but a few worked out the correct answer then didn't round it correctly, so did not get the AO1.2 marking point.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
37			an allele is a form/version of a gene ✓ dominant means that it always expresses itself when present ✓	2 (AO 1.1)	ALLOW only needs one allele present to be expressed/shown in the phenotype ALLOW allele which is expressed instead of another <u>Examiner's Comments</u> This AO1.1 question proved to be very challenging, even for some higher ability candidates. Many candidates did not define the term allele at all, limiting their maximum mark to 1.  AfL Candidates should be encouraged to learn definitions. Many candidates didn't seem to really understand the term dominant, in a biological context, using words like stronger, override or overpower.
			Total	2	

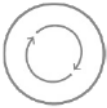
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
38	a		clots the blood ✓ prevents bleeding / allows wounds to heal / forms a scab ✓	2 (AO 1.1)	IGNORE clump blood ALLOW prevents pathogens getting into the body <u>Examiner's Comments</u> There was some confusion in the responses describing the role of platelets whereby candidates thought platelets had a role in the specific immune response. Only higher ability candidates gained a mark here.
	b		R r R RR Rr r Rr rr ratio 3 : 1 ✓ ✓ ✓	3 (AO 2.1) <	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		Any three from: variation with some rats resistant and some who are not ✓ (resistant rats) more likely to survive/less likely to be killed ORA ✓ (resistant rats more likely) reproduce ORA ✓ pass on the allele / gene for resistance ORA ✓	3 (AO 2.1)	IGNORE selective breeding ALLOW mutation for resistance ALLOW offspring produced / breed together ALLOW pass on advantageous gene IGNORE trait is passed on / genes are passed on <u>Examiner's Comments</u> Candidates had to apply their knowledge of natural selection to explain why the percentage of resistant rats was increasing. There were a range of marks given for this question. Most none scoring responses were too vague and not using key terms. Most candidates did not appreciate that there was variation for resistance within the population.
	d		Any two from: (stops/less) respiration ✓ (no/less) energy/ATP ✓ key process interrupted e.g. cell metabolism/protein synthesis/chemical reactions/active transport ✓	3 (AO 2.1)	<u>Examiner's Comments</u> This question was one of the most challenging application of knowledge and understanding questions. The most common awarded mark was appreciation that energy release would be affected. A lot of responses were very general and would say the rat can't breathe or can't get any oxygen.
			Total	11	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
39	a		platelets are needed for blood clotting ✓ the rat would keep bleeding/bleed to death ✓	2 (AO 2.1)	<u>Examiner's Comments</u> Many candidates were able to score both marks on this AO2.1 question although some did not mention platelets. A significant number of candidates, however, linked the poison to clotting incorrectly, saying blood would clot too much or in the wrong place. In that type of response, there were references to heart attacks and strokes. Some candidates referred to wounds clotting.
	b		parents are Rr and Rr ✓ offspring are RR, Rr, Rr, rr ✓ rr identified as being non-resistant ✓	3 (AO 2.2)	ALLOW all marks from a Punnett square ALLOW ECF on offspring <u>Examiner's Comments</u> Many candidates scored on this AO2.2 question. The most frequent way candidates did not get maximum marks was by omitting to identify the correct offspring genotype. Candidates needed to annotate rr. A significant number of candidates only identified the non-resistant rate, not noticing that homozygous dominant rats were also present in that ratio; and therefore only stating 25% were homozygous. Candidates should be encouraged to routinely include the phenotypic ratio.  AfL Some candidates made errors on the Punnett square diagram. The main error was to cross R with r and derive RR. Candidates should be encouraged to check their answers for this type of error.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		Rr/heterozygous rats more likely to survive than RR/homozygous rats as they need less vit K / ORA ✓ therefore, when two Rr rats mate rr rats will be born ✓	2 (AO 2.2)	ALLOW rats that need less vit K are more likely to survive <u>Examiner's Comments</u> Where candidates successfully answered this AO2.2 question, it was from developing ideas from the previous question and linking the vitamin K survival rate in the heterozygous rat to when two Rr rats mate rr rats will be born. Many responses to this question showed confusion. Candidates referred to a variety of incorrect explanations such as non-resistant alleles becoming dominant and rats finding enough vitamin K to become non-resistant but immune to warfarin. Other incorrect responses included non-resistant rats surviving because they don't need much vitamin K and rats in some areas not getting access to warfarin.
			Total	7	
40			C ✓	1 (AO1.1)	
			Total	1	
41			C ✓	1 (AO2.1)	
			Total	1	
42			A ✓	1 (AO1.1)	
			Total	1	
43			A ✓	1 (AO2.1)	
			Total	1	
44			B ✓	1 (AO2.1)	ALLOW 19
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
45	a		smallest largest ✓ nucleotide allele chromosome	1 (AO1.1)	
	b		66000000 ÷ 500 = 132 000 ✓	1 (AO2.2)	ALLOW 0.132 million or 132 thousand or 1.32×10^5
	c		man D d d Dd dd woman d Dd dd 50% / 0.5 / ½ ✓ ✓	2 (AO1 x 2.2) (AO1 x 3.1a)	ALLOW 1 in 2 or 1:1 ALLOW ecf for probability
			Total	4	
46			B ✓	1 (AO1.1)	
			Total	1	
47			C ✓	1 (AO2.1)	
			Total	1	
48			D ✓	1 (AO1.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
49	a		Any two from: anaemia / tiredness / lack of energy due to lack of red blood cells ✓ inability to fight off infections / prone to infections due to lack of white blood cells/WBC ✓ slow blood clotting due to lack of platelets ✓	2 (AO2 x 1.1)	DO NOT ALLOW incorrectly matched symptom to blood cell type ALLOW less immunity / reduced immune response / weakened immune system due to lack of white blood cells/WBC ALLOW (recurring) nosebleeds / bruise easily due to lack of platelets
	b	i	people may be ill with infection / have a pathogen / just recovering from infection ✓ therefore have produced more white blood cells to destroy the pathogen/produce antibodies ✓ OR weakened immune system/cancer/cancer treatment reducing white blood cell number so less white blood cells to defend against pathogens/produce antibodies	2 (AO2 x 2.1)	IGNORE fighting(off) pathogens
		ii	Area = $10 \times 10 = 100(\text{mm}^2)$ Volume = $100 \times 0.001 = 0.1 (\text{mm}^3)$ ✓	1 (AO2.2)	
		iii	No (no mark) $1000 \div 0.1$ OR 1000×10 ✓ number of white blood cells/mm^3 is 10×10^3 / 1.0×10^4 / 10000 ✓ within the range of $6.0 - 16.0 \times 10^3$ ✓	3 (AO2 x 2.2) (AO3.2b)	ALLOW ECF from (ii) ALLOW number of white blood cells /mm^3 = 10 000 ALLOW within the normal white blood cell range/ 6000 – 16000

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		(Fanconi anaemia) (no mark) (3 x 10 ⁶ is a) low red blood cell count ✓ must be Fanconi anaemia because: caused by recessive allele ✓ obtained from heterozygous/carrier parents who don't have a blood disorder ✓ OR cannot be D-B anaemia because: neither parents have a blood disorder ✓ it is caused by a dominant allele ✓	3 (AO3x3.2 b)	if incorrect disorder then no marks IGNORE low numbers of all cells
			Total	11	
50	a		smallest nucleotide allele chromosome genome largest	1 (AO1.1)	
	b		66000000 ÷ 500 = 132 000 ✓	1 (AO2.2)	ALLOW 0.132 million or 132 thousand
	c		man Dd d woman d d Dd dd ✓ 0.5 / 50(%)✓	2 (AO2.2) (AO3.1a)	ALLOW appropriate use of other lower/upper case letters ALLOW ECF ALLOW 1 in 2 / ½ / 1:1 ✓ DO NOT ALLOW 1:2
	d		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 839 award 2 marks 2517/3 ✓ = 839 ✓	2 (AO2 x 1.2)	ALLOW 840 or 2521/3 ✓
			Total	6	