Chapter 17

Inheritance

01. 0610_s20_qp_42 Q: 6

(a) Fig. 6.1 is a diagram showing some parts of a plant. The circle shows a magnified cross-section of part of the stem.

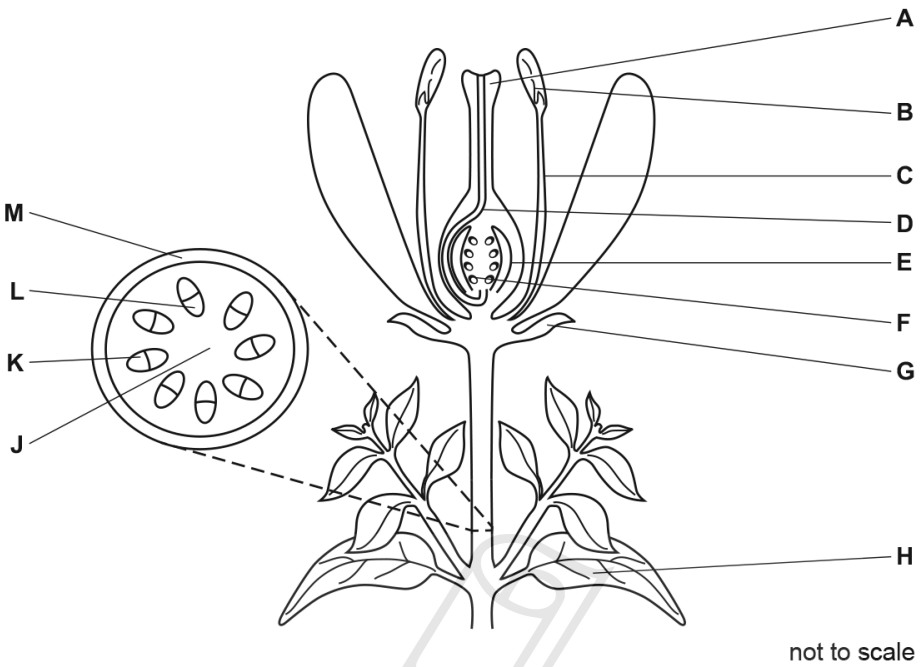

Fig. 6.1

(i) Table 6.1 contains statements about the functions of some of the structures in Fig. 6.1.

Complete the table by:

- stating the name of the structure
- identifying the letter that labels that structure.

Table 6.1

function	name of structure	letter from Fig. 6.1
provides support to the stem		
protects flower bud		
produces glucose		
produces pollen		
delivers male nuclei to the site of fertilisation		

[5]

(ii) State **one** letter from Fig. 6.1 that identifies a structure that contains a **haploid** nucleus.

..... [1]

(iii) State the name of the process that describes the transport of sucrose in a plant.

..... [1]

(iv) State **one** letter from Fig. 6.1 that is a structure that is an example of a source for sucrose transport.

..... [1]

(b) In addition to sucrose, amino acids are also transported in plants.

(i) State the name of a mineral ion that becomes part of an amino acid.

..... [1]

(ii) State the name of the structures inside cells that assemble amino acids into proteins.

..... [1]

(iii) State the name of the group of molecules that are made of proteins and act as catalysts.

..... [1]

[Total: 11]

02. 0610_w18_qp_43 Q: 2

The Indian muntjac deer, *Muntiacus muntjak*, is recorded as the mammal with the lowest number of chromosomes.

Fig. 2.1 is an image of the chromosomes in the nucleus of a diploid cell of a female muntjac deer.

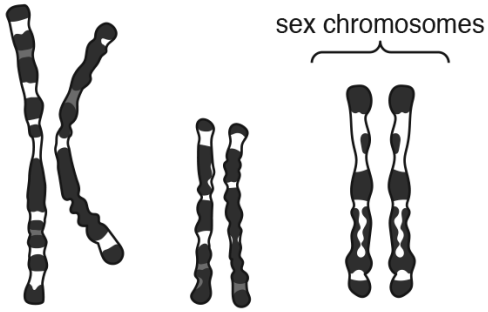

Fig. 2.1

(a) State the diploid number of chromosomes for the female muntjac deer.

..... [1]

(b) Fig. 2.2 is an image of the chromosomes in the nucleus of a diploid cell of a male muntjac deer.

Fig. 2.2

Describe how the sex chromosomes of the male muntjac deer shown in Fig. 2.2 differ from those of the female shown in Fig. 2.1.

.....

.....

.....[2]

(c) Explain how meiosis can result in variation in a species.

Use the words **chromosome** and **gametes** in your answer.

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.....[4]

(d) Another cause of variation is the formation of new alleles.

Describe how new alleles can be formed.

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.....

.....[3]

[Total: 10]

03. 0610_s17_qp_42 Q: 2

Many researchers are studying the structure and function of genes.

(a) Define the term *gene*.

.....

.....

.....[2]

(b) Every living cell is able to make proteins.

The process begins in the nucleus.

Describe how proteins are made in a cell.

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.....

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.....[4]

(c) Fig. 2.1 is a diagram of a protein used to move ions across membranes in root hair cells.

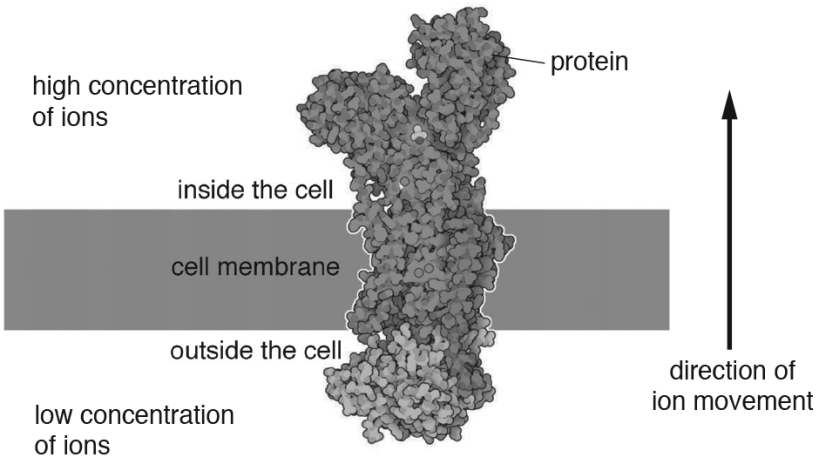

Fig. 2.1

(i) State the name of the process that moves mineral ions into root hair cells through cell membrane proteins.

.....[1]

(ii) Explain how protein molecules move ions across a membrane during this process.

.....

.....

.....

.....

.....

.....

.....[3]

(d) Proteins are also found in the blood.

State the names of **two** proteins found in the blood.

1 .....

2 .....

[2]

[Total: 12]

04. 0610_s17_qp_43 Q: 2

Quinoa, *Chenopodium quinoa*, is a dicotyledonous plant that produces seeds that resemble those of cereals, such as rice.

(a) State one feature shown by **all** dicotyledonous plants.

.....

.....[1]

(b) During seed development, amino acids are converted into storage proteins and proteases.

Protease molecules become active when the seed absorbs water at the start of germination.

Fig. 2.1 shows the formation of a storage protein and a protease in developing quinoa seeds and the action of protease on the storage protein during germination.

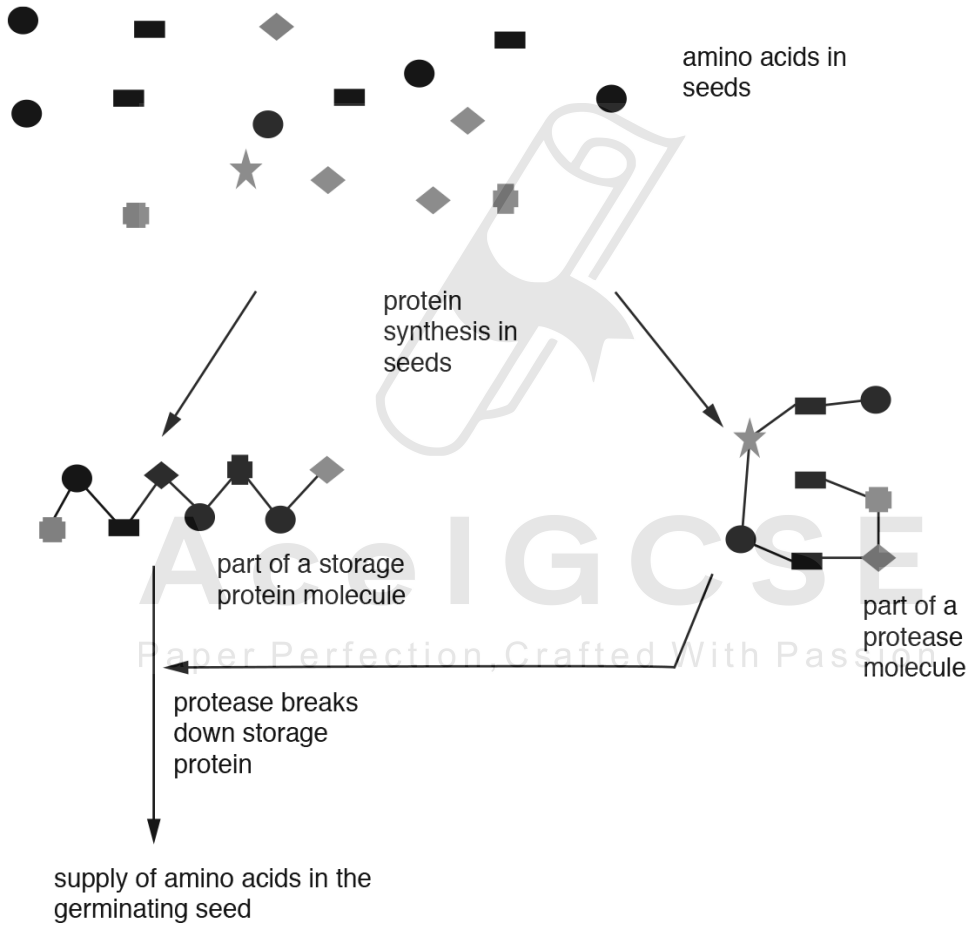

Fig. 2.1

(i) During seed development in quinoa some genes are 'switched on'.

Define the term *gene*.

.....

.....

.....[2]

(ii) Describe the differences in structure between the storage protein and the protease shown in Fig. 2.1.

.....

.....

.....

.....

.....[2]

(c) State the roles of mRNA and ribosomes in protein synthesis.

mRNA .....

.....

ribosome .....

.....

[2]

(d) Researchers investigated the effect of pH on the activity of the protease in quinoa seeds.

The results are shown in Fig. 2.2.

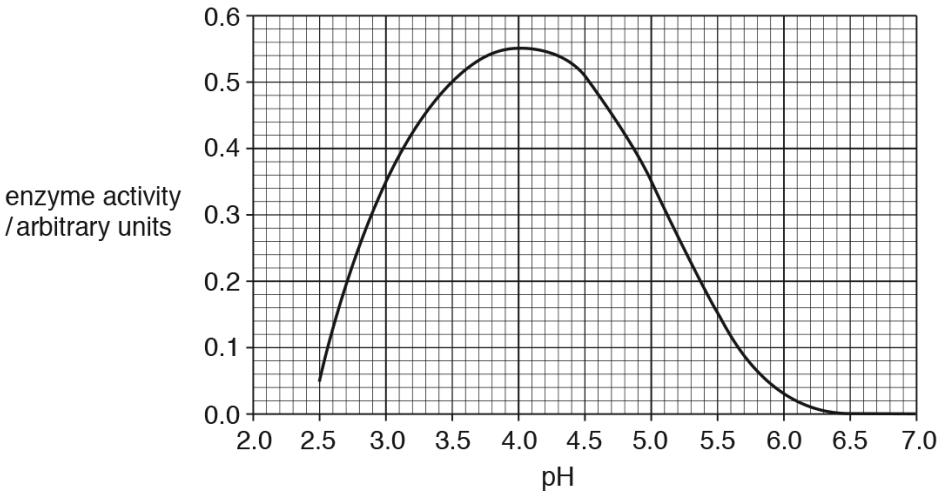

Fig. 2.2

(i) State **two** factors other than pH that would affect enzyme activity.

1 .....

2 .....

[2]

(ii) Describe the effect of increasing pH on the activity of the protease in quinoa seeds.

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.....[3]

(iii) Explain the activity of protease at pH 4.0 **and** at pH 7.0.

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.....[4]

[Total: 16]

05. 0610_m16_qp_42 Q: 6

A new species of frog was discovered in 2009 in the Amazon rainforest in Peru.

Fig. 6.1 shows this frog, *Osteocephalus castaneicola*.

Fig. 6.1

(a) State the genus of this animal.

.....[1]

In the past, anatomy was a way to classify species. DNA is now used to aid the classification of organisms.

(b) **(i)** Draw and annotate a diagram to show the structure of DNA.

[3]

(ii) Describe how DNA can be used to classify organisms.

.....

.....

.....

.....[2]

(c) DNA controls cell function by controlling the production of proteins.

(i) Proteins are coded for by a length of DNA.

What is the name given to the length of DNA which codes for a protein?

.....[1]

(ii) Describe the role of mRNA in protein synthesis.

.....

.....

.....

.....

.....

.....

.....[3]

[Total: 10]

06. 0610_w16_qp_43 Q: 5

(a) **(i)** Describe the structure of a DNA molecule.

.....

.....

.....

.....

.....

.....

.....[3]

(ii) State the function of a gene.

.....

.....[1]

(b) Molecular biologists identified a gene found in all species of bacteria and in mitochondria.

State the function of mitochondria.

.....

.....[2]

(c) Some scientists think that mitochondria evolved from bacteria because they are similar in size and structure. Bacteria belong to the Prokaryote kingdom.

Give **two** features of all prokaryotes.

1 .....

2 .....
[2]

DNA can be used to distinguish between different species of bacteria.

Molecular biologists compared the DNA sequences of the gene in mitochondria and six species of bacteria. They counted the number of differences.

Table 5.1 shows the number of differences between the DNA sequences.

Table 5.1

	mitochondria **A**	species **B**	species **C**	species **D**	species **E**	species **F**	species **G**
mitochondria **A**		29	26	34	25	3	23
species **B**			18	12	17	26	24
species **C**				19	10	19	14
species **D**					28	29	30
species **E**						19	6
species **F**							16
species **G**							

The most closely related species have:

- the least number of differences between their DNA sequences
- the shortest distance from a branching point on a classification tree.

(d) Use the information in Table 5.1 to complete the classification tree in Fig. 5.1. Place the letter for each species or the mitochondria in the box next to the correct branch of the classification tree. Two have been done for you.

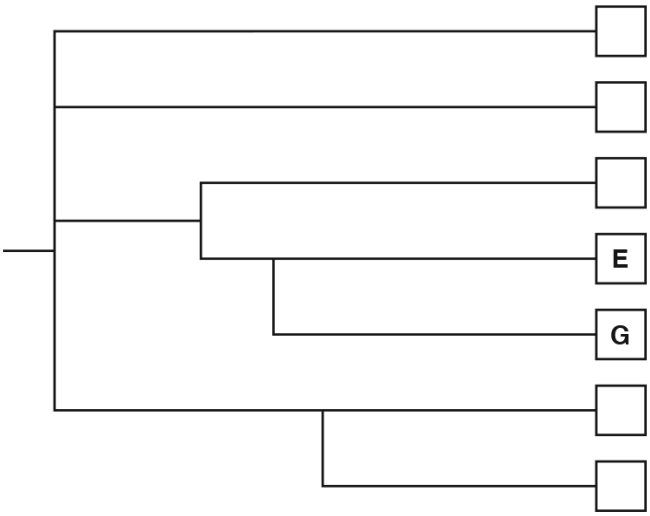

Fig. 5.1

[3]

(e) Suggest why using DNA sequences is a useful method for identifying species of bacteria.

.....

.....[1]

[Total: 12]

07. 0610_s19_qp_41 Q: 6

Fig. 6.1 shows some cells from the shoot tip of an onion, *Allium cepa*.

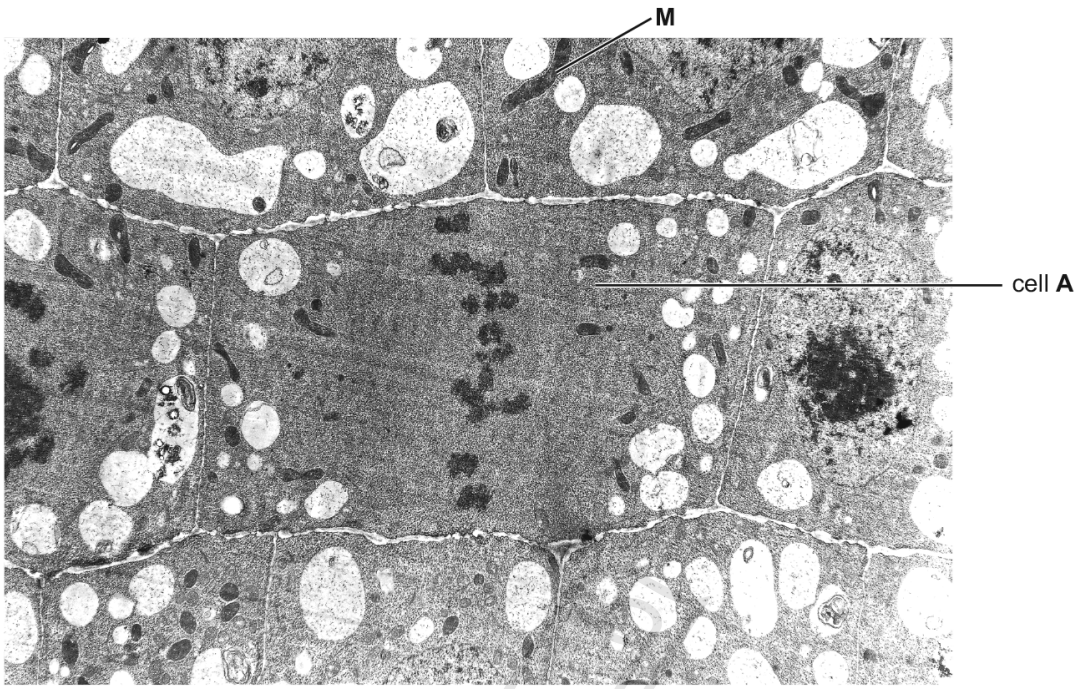

Fig. 6.1

(a) (i) State the evidence visible in Fig. 6.1 that identifies the cells of *A. cepa* as plant cells.

..... [1]

(ii) Cell **A** is dividing by mitosis.

State the role of mitosis in a shoot tip.

.....

.....

..... [1]

(b) The area labelled **M** is a mitochondrion.

Explain why mitochondria have an important role in dividing cells.

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..... [3]

(c) Cells just behind a shoot tip absorb water and grow in length. A plant hormone stimulates cell elongation and controls the response of stems to gravity.

(i) State the name of the plant hormone that stimulates cell elongation in stems.

..... [1]

(ii) Explain how the response of stems to gravity is controlled.

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..... [4]

(d) Some cells in shoot tips become leaf cells and others become cells in the stem or in flowers.

Explain why it is important that only some of the genes in cell **A** are expressed in these cells.

.....

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.....

.....

.....

..... [3]

[Total: 13]

08. 0610_w19_qp_42 Q: 3

Cells in the lining of the stomach secrete gastric juice, which contains hydrochloric acid and pepsin.

(a) **(i)** State **two** roles of hydrochloric acid in the stomach.

1 .....

2 .....
[2]

(ii) Describe the function of pepsin.

.....

.....

.....

..... [2]

(b) Define the term *assimilation*.

.....

.....

.....

..... [2]

(c) There are stem cells in the epithelial tissue that forms the lining of the stomach.

Explain why these stem cells are necessary.

.....

.....

.....

.....

..... [2]

(d) The epithelial cells of the small intestine have many microvilli.

State the role of the microvilli.

.....

.....

.....

..... [2]

(e) *Lactobacillus* is a type of bacterium. A study was carried out to investigate the ability of *Lactobacillus* to attach to the epithelial cells that form the lining of the small intestine.

Researchers added *Lactobacillus* bacteria to epithelial cells that had been grown in Petri dishes.

Every 15 minutes, the researchers estimated the average number of bacteria that were attached to the epithelial cells in the Petri dishes.

The results are shown in Fig. 3.1.

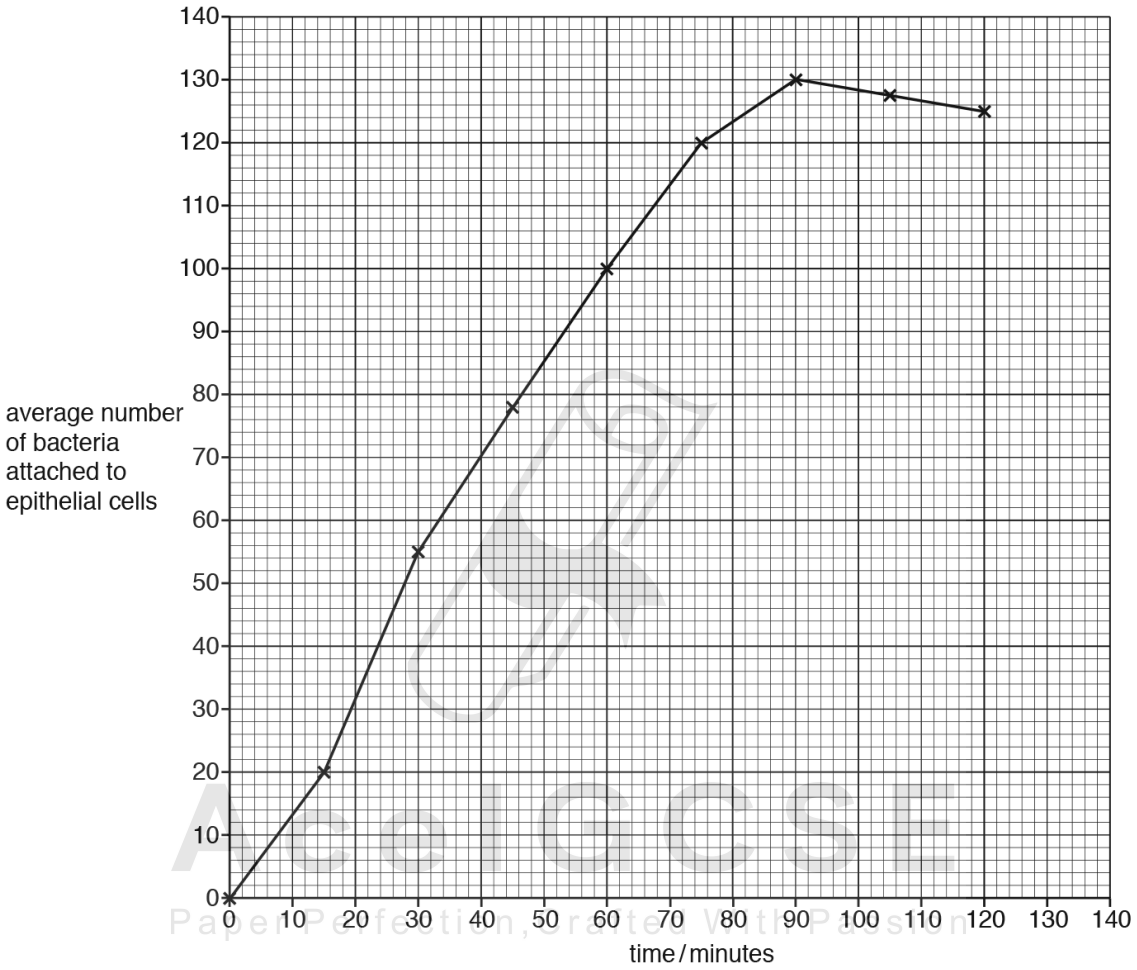

Fig. 3.1

Calculate the percentage increase in the average number of bacteria attached to epithelial cells from 45 minutes to 75 minutes.

average number of bacteria at 45 minutes ..... .

average number of bacteria at 75 minutes ..... .

Give your answer to the nearest whole number.

Space for working.

..... %
[3]

[Total: 13]

09. 0610_m20_qp_42 Q: 5

(a) Mitosis is a type of nuclear division.

Fig. 5.1 is a series of photomicrographs showing a cell dividing by mitosis.

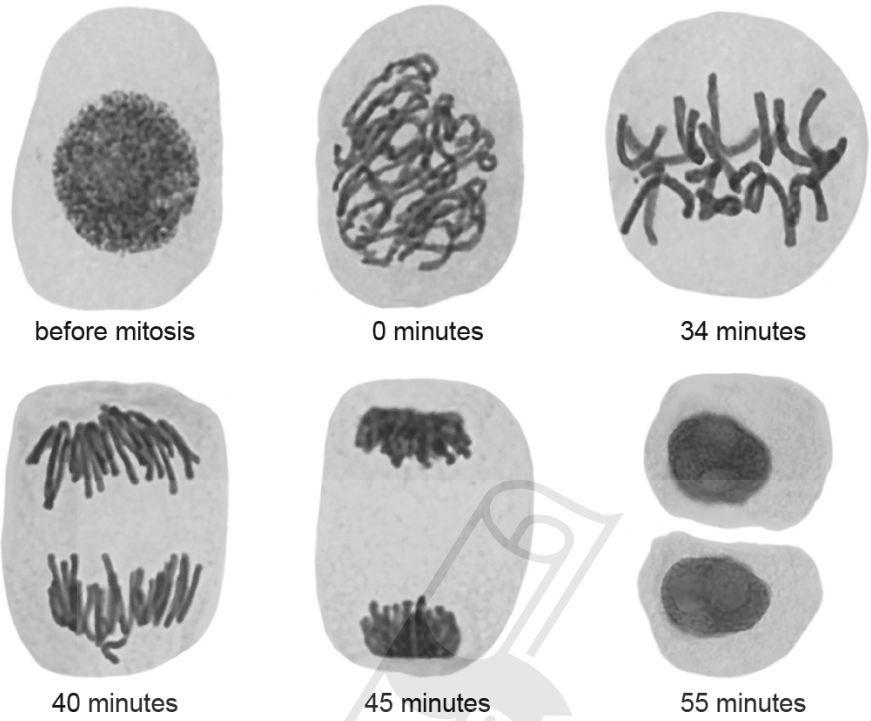

Fig. 5.1

(i) State the change that has occurred to the mass of DNA immediately before mitosis in Fig. 5.1.

..... [1]

(ii) Estimate the time when the chromosomes shown in Fig. 5.1 begin to separate.

..... [1]

(b) Meiosis is another type of nuclear division.

Describe how the nuclei in cells produced by meiosis differ from the nuclei in cells produced by mitosis.

.....

.....

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.....

.....

..... [3]

(c) Stem cells divide by mitosis during the growth of an embryo.

Describe the role of stem cells in the growth of an embryo.

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..... [2]

(d) An embryo develops into a fetus.

Outline the processes of labour and birth.

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..... [6]

[Total: 13]

10. 0610_s19_qp_41 Q: 4

(a) Table 4.1 shows four structures associated with the human male reproductive system.

Complete Table 4.1 by identifying the level of organisation of each structure.

Choose your answers from the list.

cell **cell structure** **organ**

organ system **organism** **tissue**

Table 4.1

structure	level of organisation
epithelium	
nucleus	
sperm	
testis	

[4]

(b) Fig. 4.1 shows the male reproductive system.

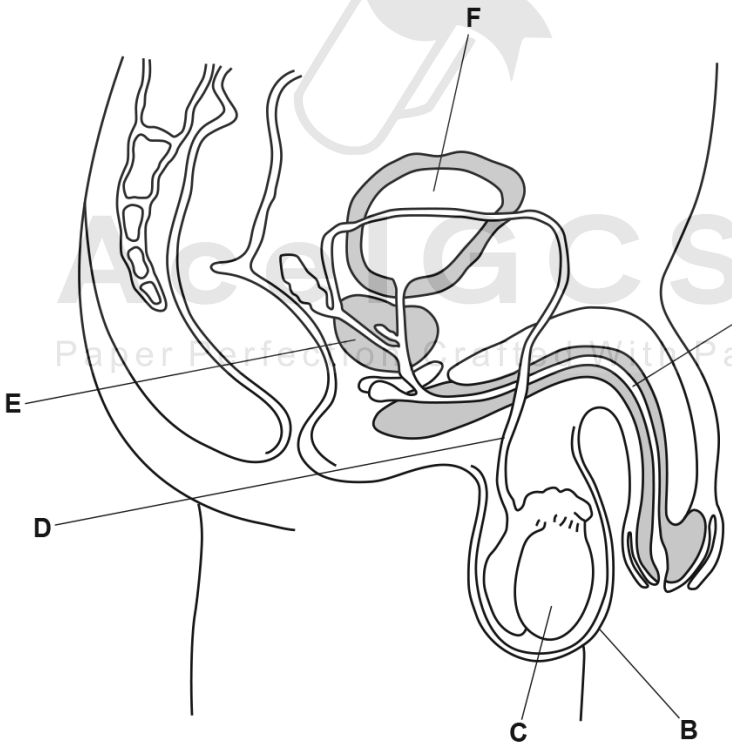

Fig. 4.1

Table 4.2 shows information about the male reproductive system shown in Fig. 4.1.

Complete Table 4.2.

Table 4.2

name of structure	function	letter in Fig. 4.1
testis		
	transports sperm but not urine	
	tube for urine and seminal fluid through the penis	
prostate gland		
	contains the testes	

[5]

(c) Draw an **X** on Fig. 4.1 on the structure where meiosis occurs. [1]

(d) Sperm and eggs each have a nucleus which is haploid.

(i) Define the term *haploid nucleus*.

.....

.....

..... [1]

(ii) State the number of chromosomes in a human haploid nucleus.

..... [1]

[Total: 12]

11. 0610_s19_qp_42 Q: 5

(a) The testes are part of the endocrine system because they produce hormones.

(i) State the name of the hormone released from the testes.

..... [1]

(ii) The testes are also part of the reproductive system. This means that the testes are part of two organ systems.

Complete Fig. 5.1 by stating **two** other organs that also belong to **two** organ systems.

One has been completed for you.

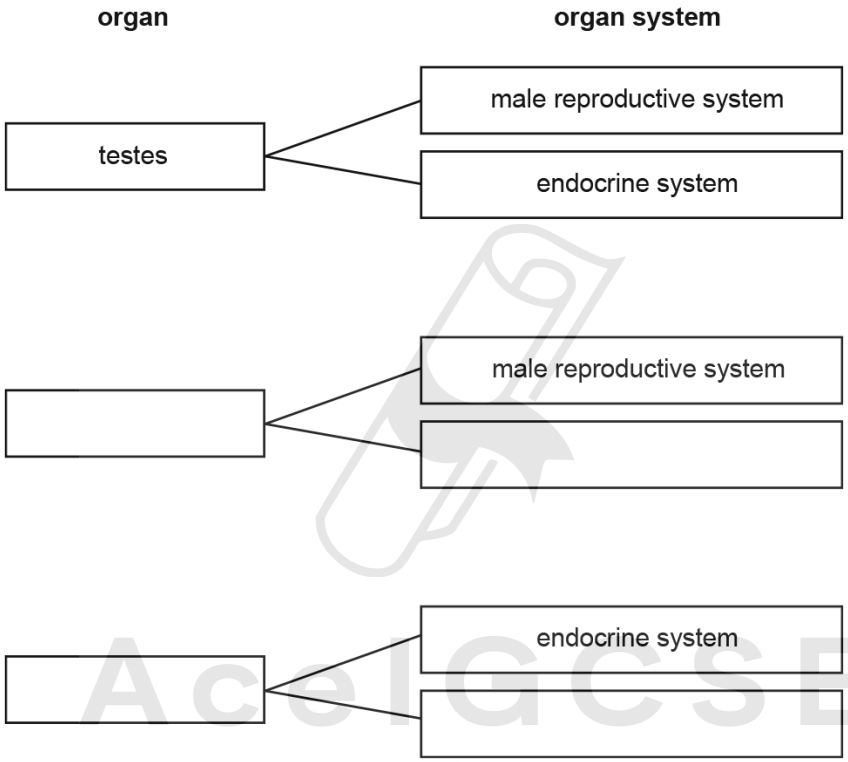

Fig. 5.1

[4]

Fig. 5.2 is a photomicrograph of part of a mammalian testis.

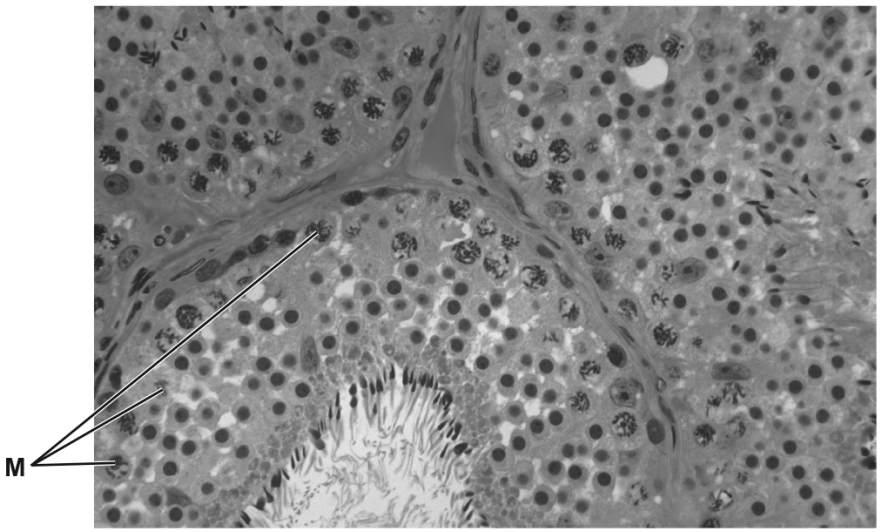

Fig. 5.2

(b) The cells labelled **M** in Fig. 5.2 are undergoing meiosis.

Explain why meiosis is necessary in the testes.

.....

.....

.....

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.....

.....

..... [3]

(c) Fig. 5.3 is a photomicrograph of a section through a sperm.

Fig. 5.3

Table 5.1 shows information about the sperm shown in Fig. 5.3.

Complete Table 5.1.

Table 5.1

letter on Fig. 5.3	name of the structure	function
P		
	haploid nucleus	
		releases energy
	flagellum	

[4]

(d) Draw and label **one** human egg cell.

Include at least one labelled feature that is not found in a sperm cell.

[3]

(e) Describe what happens to a fertilised egg cell before implantation in the uterus.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 18]

12. 0610_p20_qp_40 Q: 4

The four o'clock plant, *Mirabilis jalapa*, can have flowers of three different colours as shown in Fig. 4.1.

Fig. 4.1

(a) A student crossed some red-flowered plants with some yellow-flowered plants (**cross 1**).

She collected the seeds and grew them. All of the plants that grew from these seeds had orange flowers.

Complete the genetic diagram to explain the result of **cross 1**.

parental phenotypes	red flowers	×	yellow flowers
parental genotypes	**RR**	×	**YY**
gametes	.....	+	.....
offspring genotype	.....		
offspring phenotype	.....		

[3]

(b) The student then carried out three further crosses as shown in Table 4.1.

Table 4.1

		genotypes of offspring
cross 2	offspring of **cross 1** × offspring of **cross 1**	
cross 3	offspring of **cross 1** × red-flowered plant	
cross 4	offspring of **cross 1** × yellow-flowered plant	

Complete the table by writing in the genotypes of the offspring of **crosses 2**, **3** and **4**, using the same symbols as in the genetic diagram in **(a)**.

You may use the space below for any working.

[3]

(c) Flower colour in *M. jalapa* is **not** an example of the inheritance of dominant and recessive alleles.

Explain how the results of the crosses show that these alleles for flower colour are not dominant or recessive.

.....

.....

.....

.....

.....

..... [3]

(d) The flowers from *M. jalapa* were cross-pollinated.

Explain the difference between self-pollination and cross-pollination.

.....

.....

.....

..... [2]

(e) Some plant species are self-pollinated.

Discuss the long-term effects of self-pollination on the evolution of these plant species.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 15]

13. 0610_s20_qp_41 Q: 6

Colour blindness is a characteristic that is inherited. Colour blindness is more common in males than in females.

Fig. 6.1 is a pedigree diagram showing the inheritance of colour blindness in a family.

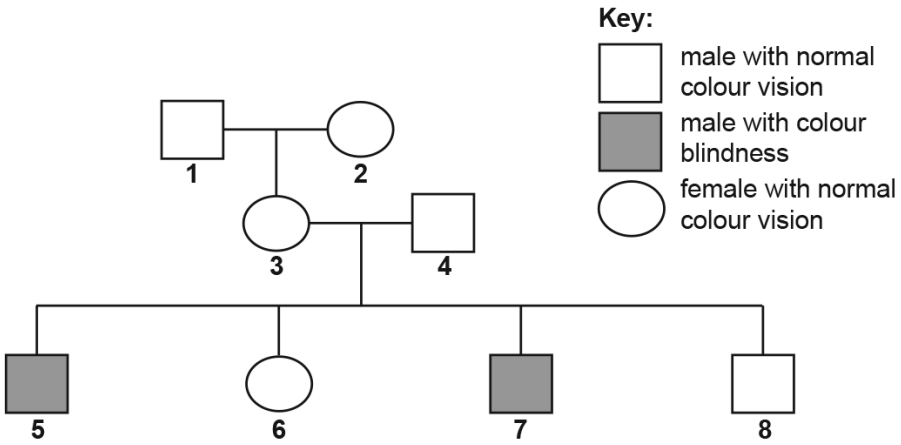


Fig. 6.1

(a) Define the term *inheritance*.

.....

.....

..... [1]

(b) **(i)** Using the symbols **B** and **b**, state the genotypes of individual **5** and individual **8** in the pedigree diagram.

5 .....

8 .....

[3]

(ii) Individual **3** is a carrier of colour blindness because she has one copy of the allele for colour blindness but has normal colour vision.

Describe the evidence from Fig. 6.1 that shows that individual **3** is a carrier.

.....

.....

.....

.....

.....

.....

..... [3]

(iii) There was no history of colour blindness in the parents and grandparents of individuals **1** and **2**.

Suggest how colour blindness first occurred in the family in Fig. 6.1.

.....

.....

.....

.....

..... [2]

[Total: 9]

14. 0610_m19_qp_42 Q: 2

(a) Fig. 2.1 shows some flowers of a snapdragon plant, *Antirrhinum majus*.

Snapdragons are insect-pollinated plants.

Fig. 2.1

(i) State **one** feature visible in Fig. 2.1 that suggests these flowers are insect-pollinated.

..... [1]

(ii) State how self-pollination differs from cross-pollination.

.....

.....

..... [1]

(iii) Suggest why self-pollination might be advantageous to a population of plants.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Petal colour in the flowers of snapdragon plants shows co-dominance.

The gene for petal colour has two co-dominant alleles:

- C^R for red petals
- C^W for white petals

Table 2.1 shows the genotypes and phenotypes of snapdragon plants with different petal colours.

Table 2.1

genotype	phenotype
C^RC^R	red
C^WC^W	white
C^RC^W	pink

(i) Explain the term *co-dominance*.

.....

.....

.....

.....

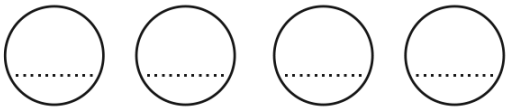
..... [2]

(ii) A botanist crossed two snapdragon plants with pink flowers.

Complete the genetic diagram to show the ratio of expected phenotypes in the offspring.

parental phenotypes pink flower × pink flower

parental genotypes C^RC^W × C^RC^W

gametes 

offspring genotypes ....

offspring phenotypes ....

phenotypic ratio .....

[4]

(iii) The botanist wanted to produce a generation of snapdragons that all had pink flowers.

State the phenotypes of the parent plants that the botanist would need to cross.

Explain your answer.

parent phenotypes .....

explanation .....

.....

.....

[2]

[Total: 13]

15. 0610_w19_qp_43 Q: 6

Fig. 6.1 is a photomicrograph of a blood clot.

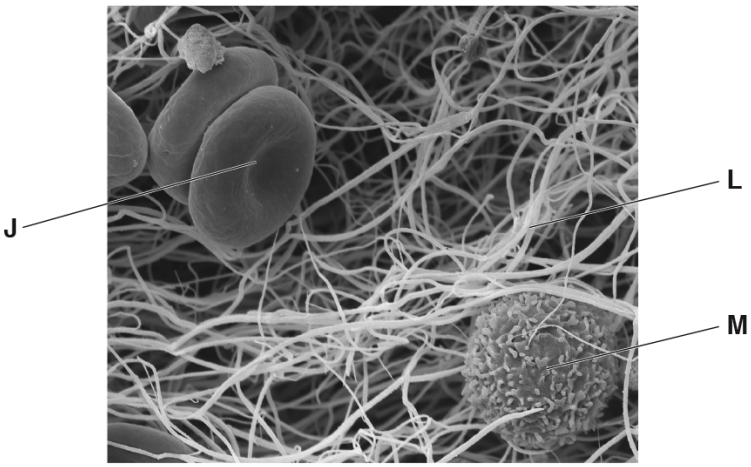


Fig. 6.1

(a) Describe how a blood clot forms.

Use the letters in Fig. 6.1 in your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(b) State the importance of blood clotting.

.....

.....

.....

.....

..... [2]

(c) There are four blood group phenotypes A, B, AB and O in humans.

(i) Define the term *phenotype*.

.....

.....

..... [1]

(ii) State the name of the type of inheritance that is shown by blood groups.

..... [1]

(iii) State the **two** possible genotypes for a person who has the phenotype blood group A.

1 .....

2 .....

[2]

[Total: 11]

16. 0610_w18_qp_41 Q: 4

The eye is a sense organ that responds to light.

Fig. 4.1 is a diagram of a section through the human eye.

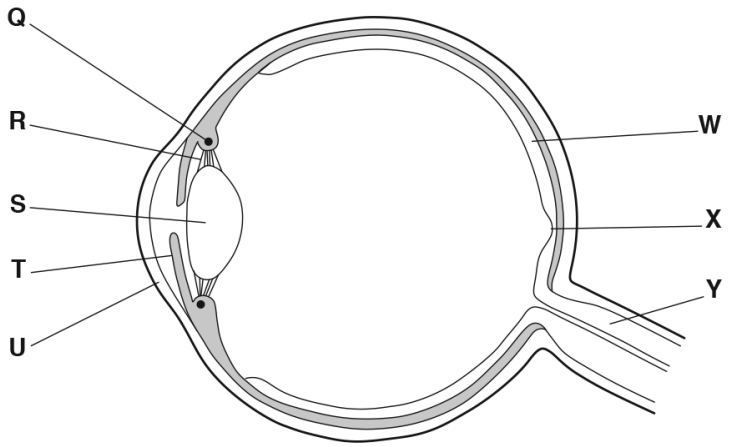


Fig. 4.1

(a) Table 4.1 describes some of the functions of the parts of the eye.

Complete the table by:

- naming the parts of the eye
- using the letters on Fig. 4.1 to identify the parts of the eye.

Table 4.1

function	name of part	letter on Fig. 4.1
carries impulses to the brain		
focuses light onto the back of the eye		
controls the tension of the suspensory ligaments		
tissue that detects light and colour		
location of most of the cone cells		

[5]

(b) **(i)** A pair of muscles in the eye work in opposition to each other to adjust the amount of light entering the pupil.

State the term that describes the action of a pair of muscles working in opposition to each other.

.....[1]

(ii) A different pair of muscles in the eye work in opposition to each other to view objects at different distances from the eye.

State the name of the process that allows the eye to view objects at different distances.

.....[1]

(c) Explain why the eye cannot easily identify different colours in **low** levels of light.

.....

.....

.....

.....

.....[2]

(d) Some people inherit colour blindness and cannot identify certain colours, even in bright light.

The gene responsible for colour vision is located on the X chromosome.

There are two alleles for this gene on the X chromosome:

- X^B – normal colour vision
- X^b – colour blindness.

(i) People that are heterozygous for colour blindness are called carriers.

State the genotype of a heterozygous female carrier.

.....[1]

(ii) There is no gene for colour vision on the male sex chromosome.

State the genotype of a colour-blind male.

.....[1]

Fig. 4.2 shows a pedigree diagram for colour blindness.

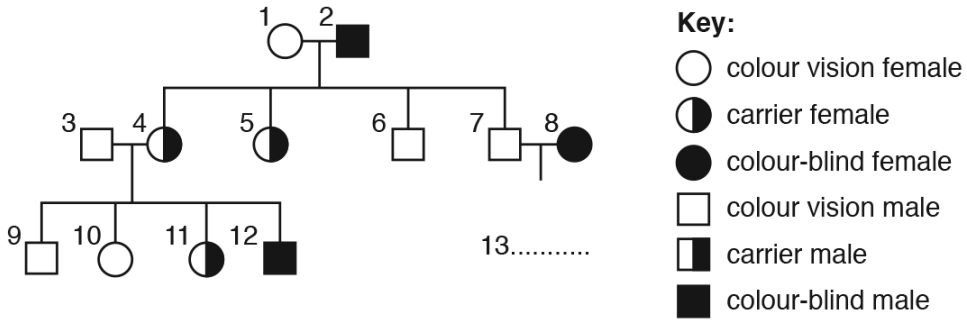


Fig. 4.2

(iii) Person **13** in Fig. 4.2 is male. His parents are person **7** and person **8**.

Use the key to complete Fig. 4.2 by drawing the correct symbol for person **13**. [1]

(iv) Colour blindness is a sex-linked characteristic.

Explain why females **4** and **5** are carriers even though their mother is not a carrier.

.....

.....

.....

.....

.....[2]

[Total: 14]

17. 0610_w18_qp_42 Q: 5

Fig. 5.1 shows a photomicrograph of human blood.

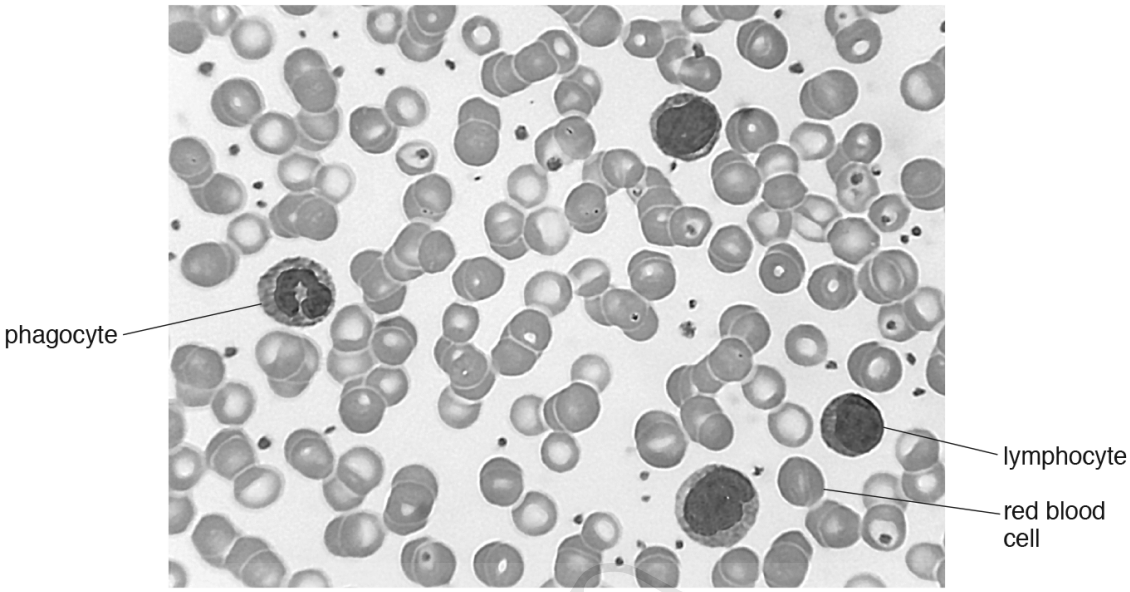


Fig. 5.1

(a) Describe the differences in appearance and the roles of the **three** cells labelled in Fig. 5.1.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

(b) Fig. 5.2 shows some of the stages of blood clotting.

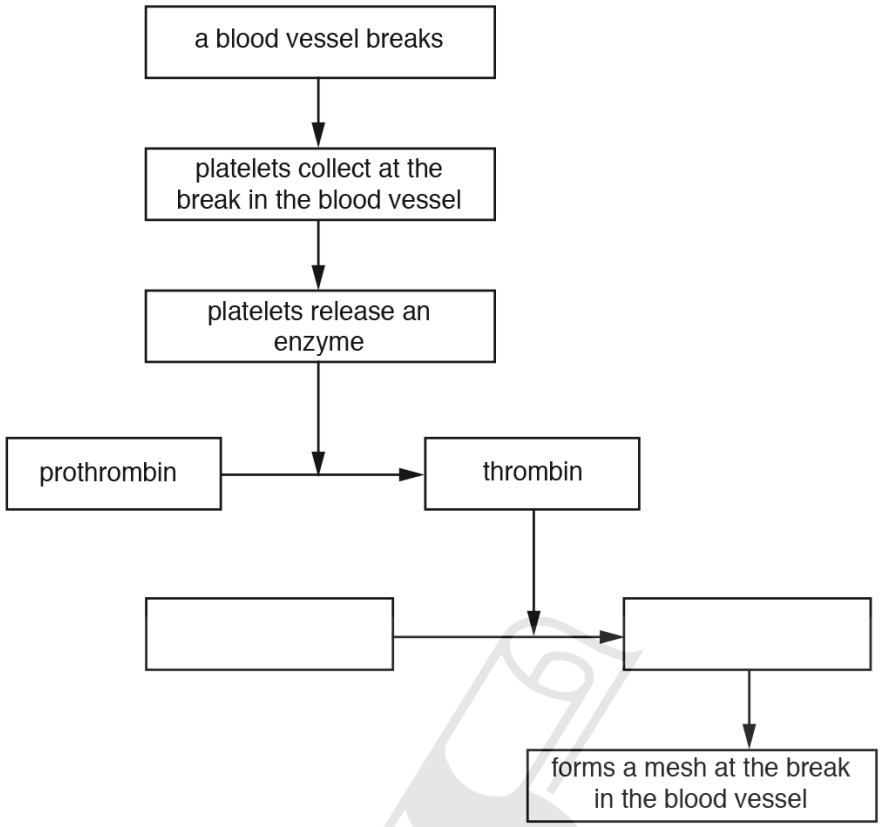


Fig. 5.2

(i) Complete Fig. 5.2 by filling in the **two** empty boxes. [1]

(ii) State **two** roles of blood clotting.

.....

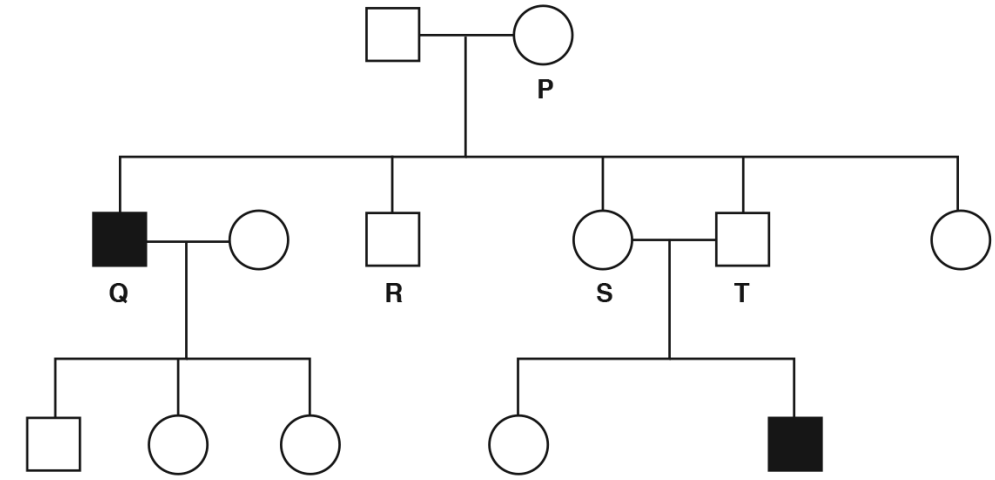
.....

.....

.....

..... [2]

(c) Haemophilia is a sex-linked blood disorder in which blood takes a long time to clot. Fig. 5.3 is a pedigree diagram showing the inheritance of haemophilia.



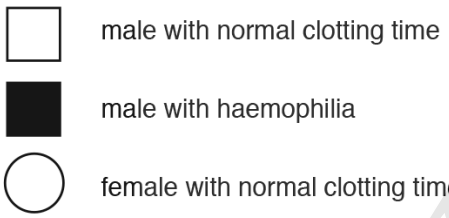


Fig. 5.3

The normal allele is represented by $\mathbf{X^H}$ and the mutant allele is represented by $\mathbf{X^h}$.

(i) State the genotypes of the people identified as **P**, **Q** and **R** in Fig. 5.3.

P .....

Q .....

R .....

[3]

(ii) The couple **S** and **T** are expecting another child.

What is the probability that the child will have haemophilia?

Space for working

..... [1]

(iii) Define the term *sex-linked characteristic*.

.....

.....

.....

.....

..... [2]

[Total: 15]

18. 0610_m17_qp_42 Q: 3

Colour blindness in humans is caused by a fault in some of the light receptor cells in the retina of the eye. Rod cells and cone cells are two types of light receptor.

(a) Complete Table 3.1 to state the function of three types of cell in the eye.

Table 3.1

type of cell in the eye	function
rod cells	....
cone cells	....
sensory neurones	....

[3]

(b) The number of rod cells and cone cells at places across the retina were recorded.

The diagram of an eye in Fig. 3.1 shows the angles from the fovea where the recordings were made.

The graph in Fig. 3.1 shows the number of rod cells and cone cells across the retina.

Use Fig. 3.1 to describe **and** explain the distribution of rod cells and cone cells across the retina.

.....

.....

.....

.....

.....

.....

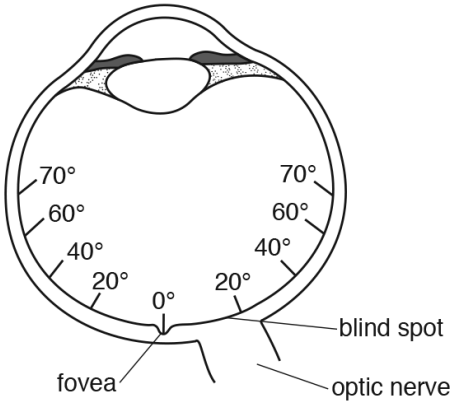
.....

.....

.....

.....

.....[5]



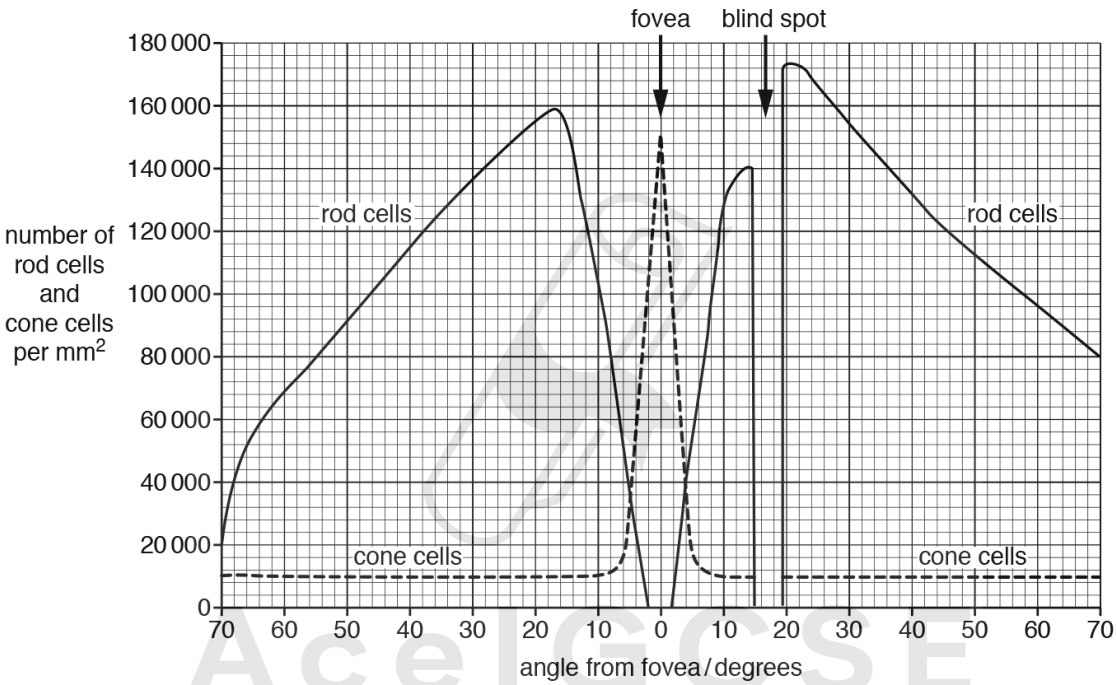


Fig. 3.1

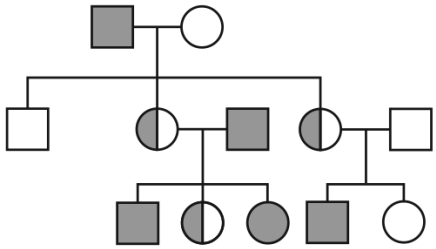
(c) Colour blindness is a sex-linked characteristic.

The gene for colour vision is on the X chromosome.

There are two alleles of this gene:

- **B** is the allele for normal colour vision
- **b** is the allele for colour blindness.

Fig. 3.2 is a pedigree chart showing the inheritance of colour blindness in a family. The key shows the sex chromosomes and the alleles of the gene for colour vision.



Key

male with normal colour vision	X^BY
colour-blind male	X^bY
female with normal colour vision	X^BX^B
carrier female with normal colour vision	X^BX^b
colour-blind female	X^bX^b

Fig. 3.2

Describe evidence from Fig. 3.2 that shows that colour blindness is a sex-linked characteristic.

.....

.....

.....

.....

.....[2]

(d) A man with normal colour vision (X^BY) and a woman who is colour-blind (X^bX^b) have a baby.

Complete the genetic diagram to predict the probability that the baby is colour-blind.

parental phenotypes	male with normal colour vision	x	colour-blind female	
parental genotypes	X^BY	x	X^bX^b	
parental gametes	.....	.....	.....	.....
offspring genotypes	.....	.....	.....	.....
offspring phenotypes	.....	.....	.....	.....

probability that the baby is colour-blind:

.....

[4]

[Total: 14]

19. 0610_w17_qp_41 Q: 3

The flowers of pea plants can be pollinated by bees.

(a) State **three** features of flowers that would attract insects such as bees.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(b) Successful pollination results in fertilisation.

Describe the events that occur after pollen grains leave the anther of a flower until fertilisation takes place.

.....

.....

.....

.....

.....

.....

.....

.....

.....[5]

(c) Following fertilisation, seeds will form.

In pea plants there are two alleles for height:

- tall (**T**)
- dwarf (**t**)

(i) Define the term *allele*.

.....

.....

.....[1]

(ii) A farmer wanted to identify the genotype of tall pea plants as either homozygous dominant or heterozygous.

He used a homozygous recessive dwarf pea plant to determine the genotype of the tall pea plants.

State the name of this type of genetic cross.

.....[1]

(iii) Complete the genetic diagram to determine the genotype of the parent plant if all the offspring from the cross are tall plants.

parental phenotypes	tall	×	dwarf
parental genotypes	.....	×	.....
gametes	....	+	....

offspring genotype .....

offspring phenotype .....
[4]

(iv) Another farmer wants to produce pure-breeding dwarf pea plants.

State the genotypes of both of the parent pea plants the farmer should use.

Give a reason for your choice.

genotypes .....

reason .....

.....

[2]

[Total: 16]

20. 0610_w17_qp_42 Q: 4

The garden pea, *Pisum sativum*, is a plant which has flowers that have both male and female parts. *P. sativum* is naturally self-pollinating.

(a) Discuss the advantages and disadvantages of self-pollination.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

(b) Gregor Mendel studied inheritance in the garden pea, *P. sativum*.

The flowers of *P. sativum* that he studied were either purple or white. The gene that controls flower colour has two alleles, **B** and **b**.

When Mendel crossed purple-flowered plants with white-flowered plants all the plants in the next generation had purple flowers.

(i) Table 4.1 shows five genetic terms that can be applied to Mendel's study of the inheritance of flower colour.

Complete Table 4.1 by stating an example of each genetic term. The first one has been completed for you.

Table 4.1

term	example in *P. sativum*
dominant trait	purple flowers
recessive allele	
phenotype	
homozygous genotype	
heterozygous genotype	

[4]

(ii) Test crosses can be used to determine the genotype of a plant with purple flowers.

The genetic diagrams show test crosses for purple-flowered plants with two different genotypes.

Complete the genetic diagrams for test cross 1 and test cross 2.

	test cross 1	**test cross 2**
parental phenotype	purple flowers × white flowers	purple flowers × white flowers
parental genotype	Bb ×	BB × .....
genotypes of gametes	○ ..... ○ ..... + ○ ..... ○	○ ..... ○ ..... + ○ ..... ○ .....
offspring genotypes	.....	.....
offspring phenotypes	.....	.....

[5]

(c) Pickerel weed, *Pontederia cordata*, is a plant that grows in shallow water on the edges of ponds and lakes in North America.

A few seedlings of these plants are white. The white seedlings cannot make chlorophyll.

Researchers carried out several crosses using pickerel weed plants.

Their results are shown in Table 4.2.

Table 4.2

cross	number of offspring	
	green	white
1	149	0
2	70	22

(i) Select suitable symbols for the alleles and state the possible genotypes of the parents for each cross.

cross 1 .....

cross 2 .....

[2]

(ii) It is **not** possible to carry out a test cross with pickerel weed plants.

Suggest why.

.....

.....

.....

.....

.....[2]

[Total: 17]

21. 0610_p16_qp_40 Q: 4

The four o'clock plant, *Mirabilis jalapa*, can have flowers of three different colours as shown in Fig. 4.1.

Fig. 4.1

(a) A student crossed some red-flowered plants with some yellow-flowered plants (**cross 1**).

She collected the seeds and grew them. All of the plants that grew from these seeds had orange flowers.

Complete the genetic diagram to explain the result of **cross 1**.

parental phenotypes	red flowers	×	yellow flowers
parental genotypes	**RR**	×	**YY**
gametes	.....	+	.....
offspring genotype	.....		
offspring phenotype	.....		

[3]

(b) The student then carried out three further crosses as shown in Table 4.1.

Table 4.1

		genotypes of offspring
cross 2	offspring of **cross 1** × offspring of **cross 1**	
cross 3	offspring of **cross 1** × red-flowered plant	
cross 4	offspring of **cross 1** × yellow-flowered plant	

Complete the table by writing in the genotypes of the offspring of **crosses 2**, **3** and **4**, using the same symbols as in the genetic diagram in **(a)**.

You may use the space below for any working.

[3]

(c) Flower colour in *M. jalapa* is **not** an example of the inheritance of dominant and recessive alleles.

Explain how the results of the crosses show that these alleles for flower colour are not dominant or recessive.

.....

.....

.....

.....

.....

..... [3]

(d) The flowers from *M. jalapa* were cross-pollinated.

Explain the difference between self-pollination and cross-pollination.

.....

.....

.....

..... [2]

(e) Some plant species are self-pollinated.

Discuss the long-term effects of self-pollination on the evolution of these plant species.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 15]

22. 0610_s16_qp_42 Q: 3

Anthocyanin is a red pigment found in carnation flowers. Some carnation plants have a gene for making anthocyanin.

(a) **(i)** A flower grower bred red carnations.

Describe how growers selectively breed plants.

.....

.....

.....

.....

.....

.....

..... [3]

(ii) Explain the disadvantages of using sexual reproduction to breed red carnations.

.....

.....

.....

.....

..... [2]

(b) Meiosis is necessary for sexual reproduction of carnation plants.

Define the term *meiosis*.

.....

.....

.....

.....

..... [2]

(c) Carnation plants show co-dominance for the anthocyanin gene. There are two alleles:

- F^A – allele for anthocyanin pigment (red flowers)
- F^N – allele for no anthocyanin pigment (white flowers)

(i) State the genotype of a carnation plant that is heterozygous for this gene.

..... [1]

(ii) Describe the phenotype of a heterozygous carnation plant for this gene.

.....

..... [1]

(iii) The breeder crossed a F^AF^N carnation plant with a F^AF^A carnation plant. Predict, using a genetic diagram, the proportion of pure breeding carnation plants in the offspring.

parental genotypes F^AF^N × F^AF^A

gametes .... + ...

Punnett square

offspring genotypes .....

offspring phenotypes .....

proportion of *pure breeding* carnation plants .....

[4]

[Total: 13]

01. 0610_s20_MS_42 Q: 6

<table>
<tr><td>(a)(i)</td><td>one mark per correct row
<table><tr><th>function</th><th>name of structure</th><th>letter from Fig. 6.1</th></tr><tr><td>provides support to the stem</td><td>xylem</td><td>L</td></tr><tr><td>protects flower bud</td><td>sepal</td><td>G</td></tr><tr><td>produces glucose</td><td>leaf</td><td>H</td></tr><tr><td>produces pollen</td><td>anther</td><td>B</td></tr><tr><td>delivers male nuclei to the site of fertilisation</td><td>pollen tube</td><td>D</td></tr></table>;;;;;</td><td>5</td></tr>
<tr><td>(a)(ii)</td><td>B / D / F ;</td><td>1</td></tr>
<tr><td>(a)(iii)</td><td>translocation ;</td><td>1</td></tr>
<tr><td>(a)(iv)</td><td>H ;</td><td>1</td></tr>
<tr><td>(b)(i)</td><td>nitrate (ions) ;</td><td>1</td></tr>
<tr><td>(b)(ii)</td><td>ribosomes / (rough) endoplasmic reticulum ;</td><td>1</td></tr>
<tr><td>(b)(iii)</td><td>enzymes ;</td><td>1</td></tr>
</table>

---

02. 0610_w18_MS_43 Q: 2

<table>
<tr><th></th><th>Answer</th><th>Mark</th><th>Partial Marks</th></tr>
<tr><td>(a)</td><td>6 ;</td><td>1</td><td>A 3 pairs</td></tr>
<tr><td>(b)</td><td>different lengths of (sex) chromosomes ;
different banding (patterns) of (sex) chromosome ;
different numbers of (sex) chromosomes ;
female has XX (chromosomes) and male has, XYY / AW (chromosomes) ;
female chromosomes are same as each other / male chromosomes differ from each other ;</td><td>2</td><td></td></tr>
<tr><td>(c)</td><td>(meiosis) produces gametes ;
(gametes) are haploid ;
gametes / AW, are genetically different (from each other) ;
fusion of gametes ;
at random ;
zygotes / offspring / AW, are genetically different (from parent) ;
sexual reproduction causes variation ;
AVP ;</td><td>4</td><td></td></tr>
<tr><td>(d)</td><td>an allele is a version of a gene ;
mutations (can cause new alleles to form) ;
change in the base / DNA, sequence ;
(ionising) radiation / (named) chemicals, cause mutations ;
AVP ;</td><td>3</td><td></td></tr>
</table>

	Answer	Mark	Partial Marks
(a)	a length of DNA ; that codes for a protein ;	2	**I** characteristics / traits **A** polypeptide for protein
(b)	**1** ribosomes make proteins ; **2** mRNA is copied, from gene / DNA ; **3** gene / DNA, remains in nucleus ; **4** mRNA moves, from nucleus to, cytoplasm / ribosome ; **5** mRNA passes through ribosome / AW ; **6** ribosome assembles amino acids (into a protein) / AW ; **7** (protein synthesis) uses energy ; **8** order of amino acids determined by base sequence of, mRNA / DNA / gene ;	4	**A** protein synthesis at, ribosomes / (rough) ER
(c)(i)(i)	active transport ;	1	
(c)(ii)	**1** protein uses, energy / ATP (from respiration) ; **2** *idea of* protein interaction with ions ; **3** (to) change shape of protein ; **4** ions move through the protein ; **5** against concentration gradient / lower concentration to high concentration (across a membrane) ; **6** AVP ;	3	e.g. ref to selective / specific shape
(d)	**1** plasma proteins ; **2** haemoglobin ; **3** (named) enzymes ; **4** antibodies ; **5** fibrinogen ; **6** (named) hormone ;	2	**A** fibrin **A** insulin / glucagon / ADH / oxytocin

04. 0610_s17_MS_43 Q:2

	Answer	Mark	Partial Marks
(a)	two cotyledons ; broad leaves ; leaves with branching veins ; petioles ; flower parts in multiples of four or five / flower parts not in threes ; pollen with three furrows or pores ; stem vascular bundles in a ring ; roots, develop from radicle ; AVP ;	1	**A** seed leaves **A** not adventitious e.g. secondary growth often present
(b)(i)	a length of DNA ; that codes for a protein ;	2	
(b)(ii)	different sequences of amino acids ; composed of different amino acids ; different shapes / folded differently / AW ;	2	
(c)	*mRNA to max 1* 1 mRNA carries copy of, gene / DNA / base pair sequence ; 2 goes from nucleus to, ribosome / cytoplasm ; 3 determines the specific, order / sequence, of amino acids ; *ribosome to max 1* 4 site of, protein synthesis ; ('protein synthesis' is in question) 5 ribosome assembles amino acids into proteins ; 6 passes through the ribosome / reads mRNA ;	2	
(d)(i)	1 temperature ; 2 surface area of substrate ; 3 concentration / volume / amount / number, of enzyme (solution) ; 4 concentration / volume / amount, of (named) substrate (solution) ; 5 type of enzyme ; 6 type of substrate ;	2	
(d)(ii)	1 increases and decreases ; 2 peaks at / optimum, at pH 4.0 / 0.55 (au) ; 3 no activity beyond pH 6.5 ; 4 curve is symmetrical / AW ; 5 any data quote, e.g. activity is 0.55 (au) at pH 4.0 ;	3	**A** works best / AW **I** denatured
(d)(iii)	1 pH 4 is the optimum (pH) ; 2 pH 7 enzyme is denatured ; 3 enzyme / protein / active site, has changed shape at pH 7; 4 shape of active site is complementary to substrate (4) / not (7) ; 5 enzyme-substrate complexes form (4) / not (7) ; 6 (most) effective collisions (between enzyme and substrate) (4) / none (7) ;	4	

05. 0610_m16_MS_42 Q:6

	Answer	Mark	Partial Marks
(a)	*Osteocephalus* ;	[1]	
(b) (i)	**1** two strands twisted to form helix ; **2** cross-links between the strands ; **3** A joins with T / C joins with G ; **4** all labels correct ;	[max 3]	**A** base / sugar / deoxyribose / phosphate / hydrogen bond / nucleotide / crosslinks / double helix
(ii)	the sequence of bases in DNA are used ; base sequences / DNA / genes, that are more similar mean that organisms are more closely related ; **ORA**	[2]	**I** genetic material
(c) (i)	gene ;	[1]	
(ii)	**1** mRNA carries a copy of the gene / DNA / base pair sequence ; **2** mRNA travel from the nucleus ; **3** to the ribosome / cytoplasm ; **4** order of amino acids depends on the sequence of bases in mRNA / AW ;	[max 3]	

06. 0610_w16_MS_43 Q: 5

	Answer	Mark	Partial Marks
(a)(i)	double helix; (strands) contain, bases / A and T and C and G; A joins with T / C joins with G; strands / bases, join / pair up, by crosslinks / hydrogen bonds; AVP;	3	**A** labelled drawing or description
(a)(ii)	codes for a protein;	1	
(b)	respiration; aerobic (respiration); release energy / make ATP;	2	**R** produce energy
(c)	cytoplasm; cell membrane; single celled / unicellular; no (true) nucleus / no nuclear membrane; loop of DNA / chromosome / naked DNA; no, (membrane-bound) organelles / mitochondria / chloroplasts; (peptidoglycan / murein) cell wall; AVP; e.g. plasmids	2	**A** nucleoid **R** cellulose cell wall **I** flagella, pili, mesosomes, capsules
(d)	**B** and **D** in box 1 and 2 (any order); **C** in box 3; **A** and **F** in box 6 and box 7 (any order);	3	
(e)	it is (more) accurate (than traditional classification systems); easi(er) / cheap(er) / quick(er) / (more) efficient / to use (than other (named) identification methods); **ora** allows large-scale identification (of many species simultaneously); only trace samples are required; (DNA sequences) within a species are very similar;	1	**A** samples do not need to purified **A** early identification of (pathogenic bacteria) for infections
		Total: 12	

07. 0610_s19_MS_41 Q: 6

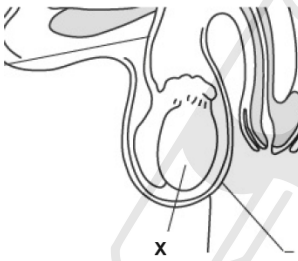
	Answer	Mark	Partial Marks
(a)(ii)	growth ; producing cells ; increase length of shoot / elongation of shoot ;	1	
(b)	dividing cell / cell division / mitosis, needs (lot of) energy ; carry out aerobic respiration ; provide / release, energy ; (for) a named function in dividing cells ; e.g. movement of chromosomes making cell wall making new (named) molecules (e.g. protein / DNA) making (named) organelle(s)	3	
(c)(i)	auxin ;	1	
(c)(ii)	*auxin / hormone:* made in the, shoot / stem, tip ; moves away from the tip ; moves to / collects on, lower side of stem ; stimulates cell elongation ; stem, bends / grows, upwards ; AVP ;	4	
(d)	plants have different, structures / parts / specialised cells ; *idea that* different parts / specialised cells, have different, functions / roles / features ; *idea that* specific proteins are required in, parts / specialised cells ; genes code for proteins ; therefore some genes, are required / are not required ; AVP ; e.g. *idea that* waste of (named) resource(s) if all genes expressed	3	

08. 0610_w19_MS_42 Q:3

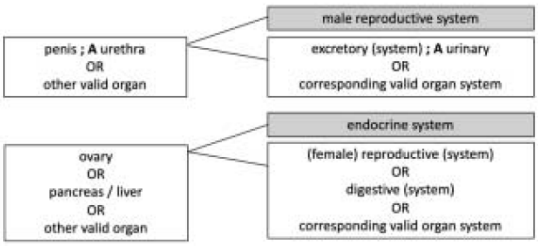
	Answer	Mark	Partial Marks
(a)(i)	provides, suitable / optimum, pH for (correct named) enzyme action ; activates, enzyme / pepsin ; kills / AW, bacteria / viruses / pathogens / microbes ; AVP ;	2	
(a)(ii)	(catalyses) breaks down / (chemically) digests, of protein ; to amino acids ;	2	
(b)	movement of digested food molecules into cells ; food molecules become part of cells ;	2	
(c)	(stem cells) divide by mitosis ; form (named) specialised cells (in stomach) ; to replace cells (in the lining of stomach) ; *idea that* cells are worn away from the surface of the stomach ; for repair of any damage to tissues ;	2	
(d)	increase / large, (surface) area ; for absorption (of named substances) / described; AVP ;	2	
(e)	54(%) ;;;	3	one mark for correct readings (78 minutes and 120 minutes) one mark for correct calculation one mark for whole number correctly rounded

09. 0610_m20_MS_42 Q:5

	Answer	Mark	Partial Marks
(a)(i)	doubles ;	1	**A** increases
(a)(ii)	34–39 minutes ;	1	**A** any value within this range
(b)	are genetically different (from each other and the parent cells) ; (produce) haploid (nuclei) ; ref. to reduction division / chromosome number being halved ;	3	
(c)	ref. to unspecialised cells ; that can become specialised ; ref. to expression of genes in specialised cells ; AVP ; e.g. continually divide	2	
(d)	breaking of the amniotic sac ; amniotic fluid is released ; contraction of (the muscles in the) uterus (wall) ; dilation of the cervix ; passage through the vagina ; (tying and) cutting the umbilical cord ; delivery of the afterbirth / placenta ; AVP ;	6	

<table>
<tr><th></th><th>Answer</th><th>Mark</th><th>Partial Marks</th></tr>
<tr><td>(a)</td><td>tissue ;
cell structure ;
cell ;
organ ;</td><td>4</td><td></td></tr>
<tr><td>(b)</td><td>
<table>
<tr><th>name of structure</th><th>function</th><th>letter on Fig. 4.1</th></tr>
<tr><td>testis</td><td>production of sperm / produces or releases testosterone</td><td>C ;</td></tr>
<tr><td>sperm duct</td><td>transports sperm but not urine</td><td>D ;</td></tr>
<tr><td><u>urethra</u></td><td>passage for urine and seminal fluid through the penis</td><td>A ;</td></tr>
<tr><td>prostate gland</td><td>secretes / produces, seminal fluid / nutrient-rich fluid / alkaline fluid / AW</td><td>E ;</td></tr>
<tr><td>scrotum / scrotal sac</td><td>contains testes</td><td>B ;</td></tr>
</table>
</td><td>5</td><td>one mark per row</td></tr>
<tr><td>(c)</td><td>X on testis / label line on testis with X ;
 
</td><td>1</td><td></td></tr>
<tr><td>(d)(i)</td><td>one set of chromosomes ;</td><td>1</td><td></td></tr>
<tr><td>(d)(ii)</td><td>23 ;</td><td>1</td><td></td></tr>
</table>

11. 0610_s19_MS_42 Q: 5

	Answer	Mark	Partial Marks
(a)(i)	testosterone ;	1	
(a)(ii)	one mark per box but organ system must match organ ;;;;  	4	
(b)	to produce, gametes / sperm ; for sexual reproduction ; to halve the number of chromosomes / produce haploid cells ; so that when fertilisation occurs the number of chromosomes return to the, same / diploid, number / AW ; creates (genetic) variation / AW ;	3	
(c)(i)	letter / name / function P / acrosome / contain enzymes / digests jelly coat ; Q / haploid nucleus / contains / AW, DNA / half number / unpaired, single set of / chromosomes / genes ; R / mitochondrion ; / releases energy S / flagellum / swimming / AW ;	4	one mark per row
(d)	drawing detail ; additional drawing detail / any drawn and labelled common cell structure e.g. nucleus, cytoplasm, cell membrane, mitochondria / DNA / ribosome / (r)ER ; drawn and labelled unique cell structure ; e.g. jelly (coat) / energy store / protein-rich layer / yolk / large volume of cytoplasm	3	
(e)	jelly coat (of fertilised egg) hardens ; *reference to* zygote ; mitosis / cell division ; embryo forms ; moves down oviduct ; AVP ; e.g. use of nutrients in cytoplasm	3	

(a) **R and Y**;
RY;
orange; [3]

(b)

	genotypes of offspring
cross 2	**RR**, **YY**, **RY**
cross 3	**RR**, **RY**
cross 4	**YY**, **RY**

allow: ecf from **4(a)** [3]

(c) Any three from:
phenotype of **RY** (offspring of **cross 1**) is different from either parent or the homozygous genotypes / owtte;
the phenotype was intermediate / mixture of two colours;
offspring of **cross 2** gives three phenotypes not two;
offspring of **crosses 3** and **4** both give two phenotypes;
if dominance **cross 3** or **4** would give one phenotype only;
allow: incomplete dominance
allow: both alleles are expressed [max 3]

(d) Any two from:
transfer of pollen from anthers or stamen to stigma;
self = within same flower (or flower on same plant);
cross = between flowers on different plants (of same species); [max 2]

(e) Any four from:
limited variation;
offspring become homozygous (over time) / owtte;
allow: reference to inbreeding / limited gene pool
variation is due to mutation;
low chance that mutations will be expressed / owtte;
offspring will be well adapted to conditions near parent;
if environment does not change;
limited opportunity for evolution if environment changes / will not be able to adapt to change in the environment;
allow: reference to disease in context (as a change)
avp; e.g. some variation due to reassortment of chromosomes and crossing over during meiosis / reduced variation leads to intraspecific competition locally; [max 4]

13. 0610_s20_MS_41 Q:6

(a)	transmission of genetic information from generation to generation ;	1
(b)(i)	1 correct use of X and Y in responses for individual 5 and individual 8 ; 2 correct X allele given for individual 5: X^bY / **b** ; 3 correct X allele given for individual 8: X^BY / **B** ;	3
(b)(ii)	*any three from:* colour blindness is a sex-linked characteristic ; she is, heterozygous for the gene / **Bb** ; she has, normal allele / **B**, so has normal colour vision ; but has passed on the, recessive allele / **b,** to her sons / 5 and 7 ; she has two **X** chromosomes which have the gene for colour vision ; father / 4, passes on his **Y** chromosome ;	3
(b)(iii)	*any two from:* mutation ; to give, recessive allele / **b** ; occurred in 3 *or* in one of her parents / 1 or 2 *or* her grandparents ; AVP ; e.g. other reason such as donated gamete	2

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14. 0610_m19_MS_42 Q:2

	Answer	Mark	Partial Marks
(a)(i)	(large) petals ;	1	
(a)(ii)	self-pollination is within the same, plant / flower ; OR cross-pollination is between different plants (of the same species) ;	1	
(a)(iii)	prevents extinction / enables survival of species ; more chances of fertilisation ; more chances of pollination ; no need for (named) pollinators ; useful if plants are (geographically) isolated / on their own / AW ; parent plants adapted to the environment, pass alleles to offspring / AW ; *idea of* sexual reproduction better than asexual reproduction for variation ;	3	
(b)(i)	both alleles are, expressed / neither allele is, dominant / recessive to the other ; the phenotype (of heterozygote is), intermediate / new / different / AW ; presence of multiple alleles, for one trait ;	2	
(b)(ii)	*gametes:* C^R , C^W + C^R , C^W ; *offspring genotypes:* C^RC^R, C^RC^W, C^RC^W, C^WC^W ; *offspring phenotypes:* red pink white ; *ratio:* 1 : 2 : 1 ;	4	
(b)(iii)	(parents phenotypes must be) red and white ; offspring must, inherit a C^R and a C^W allele / be heterozygous ;	2	

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15. 0610_w19_MS_43 Q: 6

	Answer	Mark	Partial Marks
(a)	*ref. to* platelets ; fibrinogen is converted to fibrin / **L** ; fibrinogen is soluble / fibrin is insoluble ; (**L** / fibrin) forms a, mesh / AW ; (**L** / fibrin) traps / AW, blood cells / **J** / **M** ; **J** is a red (blood) cell ; **L** is fibrin ; **M** is a, white (blood) cell / lymphocyte / phagocyte ;	5	
(b)	prevents blood loss / AW ; prevent (named) pathogens entering a wound ;	2	
(c)(i)	observable features (of an organism) ;	1	
(c)(ii)	co-dominance ;	1	
(c)(iii)	I^AI^A ; I^Ai ;	2	

16. 0610_w18_MS_41 Q: 4

	Answer	Mark	Partial Marks
(a)	function / name of part / letter on Fig. 4.1 carries impulses to the brain / optic nerve / **Y** ; focuses light onto the back of the eye / lens / **S** ; controls the tension of the suspensory ligaments / ciliary, muscles / body / **Q** ; tissue the detects light and colour / retina / **W** ; location of most cone cells / fovea / **X** ;	5	one mark for each correct row
(b)(i)	antagonistic ;	1	
(b)(ii)	accommodation ;	1	
(c)	cones are less sensitive in low light ; cones detect colour ; rods work in low light but can't detect colour / AW ;	2	
(d)(i)	X^BX^b ;	1	
(d)(ii)	X^bY ;	1	
(d)(iii)	solid shaded square on Fig. 4.2 ;	1	
(d)(iv)	one X chromosome from each parent / an X from father ; mother does not have any colour-blind alleles / father passes on one colour-blind allele ; (all female offspring are) heterozygous / X^BX^b ;	2	

17. 0610_w18_MS_42 Q:5

	Answer	Mark	Partial Marks
(a)	***red blood cell:*** *feature:* red blood cells smaller than (named) white blood cell(s) / ora ; biconcave (disc / shape) / no nucleus ; *role:* contains haemoglobin / transports oxygen / transports carbon dioxide ; ***lymphocyte:*** *feature:* little cytoplasm / large(r) nucleus / nucleus fills most of the cell ; *role:* *ref. to* active immunity / responds to, antigen(s) or vaccine(s) / produce, antibodies or antitoxins / *ref. to* memory cells ; ***phagocyte:*** *feature:* lobed / irregular-shaped / C-shaped / AW, nucleus ; *role:* engulf pathogens / phagocytosis / AW ;	6	
(b)(i)	fibrinogen ⟶ fibrin ;	1	
(b)(ii)	prevent blood loss ; prevent entry of (named), pathogens / microbes ; *ref. to* wound healing / tissue repair ;	2	
(c)(i)	(**P**) X^HX^h ; (**Q**) X^hY ; (**R**) X^HY ;	3	
(c)(ii)	0.25 / 25% / 1 in 4 / ¼ ;	1	
(c)(iii)	gene is located on, a sex chromosome / X or Y / X / Y ; characteristic is more common in, males / one sex (than the other) ;	2	

18. 0610_m17_MS_42 Q:3

	Answer	Mark	Partial Marks
(a)	part of the eye: function rod cells: night vision / detects low light ; cone cells: colour vision ; sensory neurone: transmits nerve impulses to brain ;	3	1 mark for each correct row
(b)	**1** more rod cells than cone cells in the retina ; **2** ref to uneven distribution of rod cells either side of fovea ; **3** no rod cells and no cone cells at blind spot ; **4** optic nerve enters / leaves retina at blind spot ; **5** only cone cells at the fovea / no rod cells at the fovea ; **6** maximum number of cone cells are at the, fovea / 0 degrees ; **7** maximum number of rod cells at 20–21 degrees ; **8** data quote include units ; **9** AVP ; **10** AVP ;	5	
(c)	more males affected than females / **ora** ; only females are carriers / males are affected or not ;	2	
(d)	correct gametes ; X^B,Y +X^b, X^b ; correct offspring genotypes ; X^BX^b, X^BX^b, X^bY, X^bY; correct offspring phenotypes ; carrier female, carrier female, colour-blind male, colour-blind male ; correct percentage ; 50 % ;	4	offspring phenotype must be linked to the correct offspring genotype

19. 0610_w17_MS_41 Q:3

	Answer	Mark	Partial Marks
(a)	scent ; nectar ; 'honey' guides ; colourful petals ; large petals ; pollen (as source of food) ;	3	**I** sticky pollen / stigma **I** stigma / anther, inside flower **A** mimicry
(b)	pollen lands on stigma ; pollen tube grows ; through style ; to ovary ; *(pollen nucleus / male gamete)* enters ovule ; through micropyle ; pollen and ovule / egg, nuclei fuse ;	5	
(c)(i)	a version / type, of a gene ;	1	***A*** alternative form *of a gene*
(c)(ii)	test cross ;	1	
(c)(iii)	*parental phenotypes* tall x dwarf *parental genotypes* **TT** ; x **tt** ; *gametes* **T T** x **t t** ; *offspring genotype* **Tt** ; *offspring phenotype* (100%) tall		**A** ecf from parental genotypes.
(c)(iv)	**tt** ; so that no dominant allele is present / all alleles are recessive / AW ; recessive alleles only expressed if no dominant allele present ;	2	**A** homozygous recessive

20. 0610_w17_MS_42 Q: 4

	Answer	Mark	Partial Marks
(a)	little / less / AW / no, variation / (genetic) diversity ; ref to becoming homozygous ; less chance of, surviving / adapting / evolving, to, changing conditions / new environments / (new) disease ; risk of extinction ; increase chance of genetic disease ; adapted variety spreads / AW ; only one plant needed / no mate required ; **R** if 'asexual reproduction' is given greater chance of pollination / ensures pollination occurs ; *idea that* reproduction / fertilisation, successful if no other plants (of same species) nearby ; less wastage of pollen ; not dependent on (named) agent of pollination ; AVP ; no hybrid vigour / smaller gene pool	4	**A** fewer alleles **I** ref to gene(s) **R** cloning / uniform(ity) **A** increased risk of abnormalities / genetic 'weakness' / AW **A** gametes **I** no wastage
(b)(i)	term: example in *P. sativum* dominant trait: purple flowers recessive allele: **b** ; phenotype: (flower) colour / purple (flowers) / white (flowers) ; homozygous genotype: **BB** and / or **bb** ; heterozygous genotype: **Bb** ;	4	
(b)(ii)	*parental phenotype* purple flowers x white flowers purple flowers x white flowers *parental genotype* Bb x bb BB x bb ; *genotypes of gametes* B b + b (b) B B + b (b) ; *offspring genotypes* Bb bb Bb (Bb); *offspring phenotypes* purple flowers, white flowers ; purple flowers ;	5	
(c)(i)	*test cross 1* **GG** x **GG** / **GG** x **Gg** **A GG** on its own **R GG** x **gg** ; *test cross 2* **Gg** x **Gg** ;	2	 **A Gg** on its own
(c)(ii)	white plants are, homozygous recessive / **gg** ; (white plants / no chlorophyll) cannot, photosynthesise / produce own food ; (therefore white plants) do not grow into mature plants / do not produce flowers / die before reproducing / AW ;	2	 **I** cannot survive unqualified

(a) **R and Y**;
RY;
orange; [3]

(b)

	genotypes of offspring
cross 2	**RR**, **YY**, **RY**
cross 3	**RR**, **RY**
cross 4	**YY**, **RY**

allow: ecf from **4(a)** [3]

(c) Any three from:
phenotype of **RY** (offspring of **cross 1**) is different from either parent or the homozygous genotypes / owtte;
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if dominance **cross 3** or **4** would give one phenotype only;
allow: incomplete dominance
allow: both alleles are expressed [max 3]

(d) Any two from:
transfer of pollen from anthers or stamen to stigma;
self = within same flower (or flower on same plant);
cross = between flowers on different plants (of same species); [max 2]

(e) Any four from:
limited variation;
offspring become homozygous (over time) / owtte;
allow: reference to inbreeding / limited gene pool
variation is due to mutation;
low chance that mutations will be expressed / owtte;
offspring will be well adapted to conditions near parent;
if environment does not change;
limited opportunity for evolution if environment changes / will not be able to adapt to change in the environment;
allow: reference to disease in context (as a change)
avp; e.g. some variation due to reassortment of chromosomes and crossing over during meiosis / reduced variation leads to intraspecific competition locally; [max 4]

22. 0610_s16_MS_42 Q: 3

	Answer	Mark	Partial Marks
(a) (i)	1 cross / breed, (parent) plants with desired feature ; 2 (grow seeds and) chose offspring for (desired) feature(s) ; 3 cross (offspring) plants showing features with, original variety / self / each other ; 4 keep / many generations of, crossing and selecting ; 5 any detail ; e.g. bagging flowers / transfer of pollen (with paintbrush) / detail of seed collection	[max 3]	
(ii)	1 two parents / gametes, are required ; 2 variation in offspring / offspring might not all be red ; 3 time consuming ; 4 AVP ; e.g. harvesting seeds / finding pollinators, can be difficult / limited number of seeds / wasteful in context of unused pollen	[max 2]	I cost / energy
(b)	1 reduction / nuclear, division ; 2 chromosome number is halved ; 3 (diploid to) haploid ; 4 results in genetically different, cells / gametes / AW ;	[max 2]	
(c) (i)	$F^A F^N$;	[1]	
(ii)	pink (flowers) ;	[1]	ecf from (c)(i)
(iii)	*gametes:* F^A , F^N , F^A , F^A ; *offspring genotype:* F^AF^A, F^AF^N ; *offspring phenotype:* red, pink ; *proportion of pure breeding carnation plants*: 50% / 1:1 / 0.5 / half ;	[4]	
		[Total:13]	