

- b** Breed the shorthaired guinea pig with a homozygous longhaired guinea pig (ss). If it is heterozygous (Ss), both longhaired and shorthaired offspring will be produced (in a 1:1 ratio):

	S	s
s	Ss	ss
s	Ss	ss

If it is homozygous (SS), all offspring will have short hair:

	S	S
s	Ss	Ss
s	Ss	Ss

- 10 ▶ a** A gene is a length of DNA, coding for the production of a protein. Alleles are different forms of a gene. The phenotype is the appearance of an organism, or the features that are produced by a gene. (The way that a gene is 'expressed'.)
- b** Let allele for red coat = R and allele for white coat = W (note that different letters are used, since this is a case of codominance).

i

	R	R
W	RW	RW
W	RW	RW

ii

	R	R
R	RR	RR
W	RW	RW

iii

	R	W
R	RR	RW
W	RW	WW

- c** Ratios in (b) are:

- i** all roan;
ii 1 red: 1 roan;
iii 1 red : 2 roan : 1 white.

- b** It would decrease as it would not give an advantage; rats that don't have the gene will breed equally well. (In fact rats with the warfarin gene have a selective disadvantage when warfarin is not being used, although students will not know this.)

- 8 ▶ a** They have a heavy beak, which is adapted to crush seeds.
b They have a long, narrow beak, which can be used to probe under the bark of trees for insects.
c Ancestors showed slight variations in their beaks. Where the variation enabled a bird to catch insects, or eat leaves and other food better than birds with other types of beak, the birds survived better and reproduced (survival of the fittest), passing on their genes for the adaptation. Eventually groups of birds became so different from members of other groups that they couldn't interbreed, and formed new species.
- 9 ▶ a** As a result of (random) mutations.

- b** Selection pressure: a factor in the environment that affects the fitness of an organism. In this case the presence of toxic metals means that the non-tolerant plants will be killed and not reproduce to pass on their genes.

Selective advantage: varieties that survive in the presence of a selection pressure are said to have a selective advantage. In this example the plants that are tolerant to toxic metals have a selective advantage when compared with the non-tolerant plants.

Natural selection: the overall process that, when metals are present, results in fewer non-tolerant plants and an increase in the number of tolerant plants. If it continues, natural selection results in evolution.

- c** When there are no toxic metals, the metal-tolerant plants must have some sort of selective disadvantage over the non-tolerant ones. For example, they may need to use metabolic energy (ATP) to protect their cells against metals or get rid of metal ions. If there are no metal ions in the soil, this is a waste of resources.

CHAPTER 19

- 1 ▶ D** **2 ▶ B** **3 ▶ A** **4 ▶ D**
- 5 ▶ a** It means that the organisms that are best adapted to their environment are more likely to survive and reproduce.
b Darwin and Wallace.
- 6 ▶ a** An organism that causes disease.
b Fungi and bacteria.
c Random mutations produce some bacteria that are resistant to an antibiotic. If the antibiotic continues to be used, the resistant bacteria will survive and the non-resistant ones will be killed. The resistant bacteria have a selective advantage over the non-resistant bacteria; they quickly reproduce and cause disease.
- 7 ▶ a** Rats with the resistant gene survived and reproduced, so now many more rats carry the gene. Rats without the gene did not survive to reproduce.

CHAPTER 20

- 1 ▶ D** **2 ▶ C** **3 ▶ B** **4 ▶ A**
- 5 ▶ a** Both involve selection of which animals or plants survive to breed.
b In selective breeding the farmer / breeder does the selection. In natural selection it is the survival of the fittest in a habitat that leads to selection.
- 6 ▶ a** 1) Plants have resistance to disease, so they are not killed by fungi, bacteria, etc.
 2) Plants are better suited to climate, so can grow well in a particular location.
 3) Plants have a better balance of nutrients; produce more nutritious food, or have a high vitamin content etc.
 (Or any other correct reason.)
- b** Two from: quicker to produce large numbers of plants because only a few cells needed; plants can be produced at any time of year since grown inside; large numbers of plants can be stored easily until needed.

- c** All have same genes since produced by mitosis from cells of the same parent plant.
- 7 ▶ a** Milk yield, and feed to milk conversion rate.
- b** Choose a cow with the best characteristics and give hormone / FSH injections to cause multiple ovulations. Collect ova and use IVF to fertilise with sperm collected from a bull with the best characteristics. Separate cells of embryos that develop and produce large numbers of embryos. Screen for sex (males) and implant into surrogate mother cows.
- 8 ▶ a** Hybrid G was produced by selective breeding. Individual plants from pure lines of A and B were selected (for size of cobs) and crossed to produce hybrid E. Similarly, individual plants from pure lines of C and D were selected and crossed to produce hybrid F. Plants from hybrids E and F were then selected for their cob size, and crossed to produce hybrid G. (Crossing would be done by transfer of pollen from anthers to stigmas of plants.)
- b** Cob G is larger, it has more seeds and the cobs are more uniform size/shape.
- c** Any sensible suggestion, e.g. breed from each under identical environmental conditions, or sequence the genes to show differences.
- 9 ▶** The essay should include:
- examples of traditional selective breeding of crop plants or domestic animals
 - advantages of this type of artificial selection, e.g. to crop yield, characteristics of animals
 - cloning of plants and its advantages
 - cloning animals and its uses
 - causes for concern with cloned organisms (e.g. cloned plants all genetically identical, so susceptible to same pathogens; cloned animals like 'Dolly' may have genetic defects; ethical issues).

END OF UNIT 5 QUESTIONS

- 1 ▶ a** Toxic copper ions (1), only copper-tolerant plants will grow and reproduce / non-tolerant plants will die (1).
- b** Predation by lions (1), only those wildebeest that are fast runners (or equivalent) will survive and reproduce / slow animals will be killed and not reproduce (1).
- c** Presence of pesticide (1), only those pests resistant to the pesticide will grow and reproduce / non-resistant pests will die (1).
- 2 ▶ a** Tips of stems and side shoots removed (explants) (1); explants trimmed to 0.5–1 mm (1); put explants onto agar containing nutrients and hormones (1); when explants have grown transfer to compost in greenhouse (1).
- b** All have same genes since produced by mitosis from cells of the same parent plant.
- c i** Kinetin causes growth of shoots (1); auxin causes growth of callus and roots (1).
- ii** Use 2 mg per dm³ of auxin to cause growth of callus (1), then reduce to 0.02 mg per dm³ and add 1 mg per dm³ of kinetin until shoots have grown (1). Then use 2 mg per dm³ of auxin and 0.02 mg per dm³ of kinetin to grow roots (1).
- d** One advantage from: quicker to produce large numbers of plants because only a few cells needed; plants can be produced at any time of year since grown inside; large numbers of plants can be stored easily until needed. Disadvantage: all plants have same genes, so susceptible to same diseases / could all be affected at same time (2).
- 3 ▶ a** Both 1 and 2 are tasters (1). If the gene was recessive, all their children would also be tasters, but 4 is a non-taster (1 mark for explanation or correct genetic diagram).
- b** Individual 3 is Tt (1), because if TT, she couldn't supply a 't' allele to have daughters who are non-tasters (1). Individual 7 is tt (1), because this is the only genotype that produces a taster (1).
- c** Individual 5 could be either TT or Tt (1), since her husband 6 is a non-taster (tt), and so she could donate a 'T' allele from either genotype to produce a son who is Tt (1 mark for explanation or correct genetic diagram).
- d** Individual 3 must have the genotype Tt (1). Individual 4 must be tt (1). So the cross produces a 1:1 ratio of tasters to non-tasters / probability is 0.5 that a child is a taster (1). (1 mark for correct genetic diagram):
- | | | |
|---|----|----|
| | T | t |
| t | Tt | tt |
| t | Tt | tt |
- 4 ▶ a** D, C, B, E, F, A (all correct = 2 marks, 1 mark if one or more wrong).
- b** Mitosis (1), because there are only two cells produced / only one division / no reduction division / no pairing of homologous chromosomes (1).
- c** 46
- d** Any two of:
- mitosis produces two daughter cells, meiosis produces four daughter cells
 - daughter cells from mitosis are genetically identical to each other and the parent cell; daughter cells from meiosis are genetically different from each other and the parent cell
 - mitosis produces daughter cells with the same number of chromosomes as the parent cell / diploid to diploid; meiosis halves the chromosome number / diploid to haploid.
- 5 ▶ a** From the nucleus of a mammary gland cell of sheep A (1).
- b** Nucleus of an egg is haploid / has half set of chromosomes; nucleus of an embryo is diploid / has full set of chromosomes (1).
- c** Sheep A.
- d** It does not involve fertilisation of an egg by a sperm (1); the embryo grows from a body cell nucleus (mammary gland cell nucleus) rather than from a zygote (1).
- e** Cloning (genetically modified) animals to produce human proteins (to treat diseases) (1). Cloning (genetically modified) animals to supply organs for transplants (1).