

Answers for extension worksheet – Chapter 4

- 1 a** All female kittens would be tortoiseshell, with the genotype $X^B X^O$, while all males would have black fur and have the genotype $X^B Y$. (4)
- b** The kittens had the genotypes $X^O Y$ (orange male), $X^B Y$ (black male), $X^B X^O$ (tortoiseshell female), $X^O X^O$ (orange female).

This information can be put into a Punnett grid as follows:

		tortoiseshell female	
		X^B	X^O
unknown male	$X^?$	$X^B X^O$	$X^O X^O$
	Y	$X^B Y$	$X^O Y$

The unknown male must have been an orange male, $X^O Y$. (4)

- 2 a** Mitosis is nuclear division that results in the production of two genetically identical cells. Meiosis is nuclear division that results in the production of four gametes that are not genetically identical. (2)

Meiosis occurs only in testes and ovaries, while mitosis occurs in somatic cells and in ovaries and testes during the early stages of gamete formation. (1)

- b** Brothers develop from different ova and sperm cells, which will contain different combinations of parental alleles. Identical twins develop from one ovum that has been fertilised by one sperm cell and subsequently separated into two at an early stage of development. The two parts contain the same alleles and are genetically identical. (2)
- c** For each fertilisation there is a 50/50 chance of the baby being a boy or a girl, unrelated to the sex of previous children. Therefore, the couple cannot predict that their next (or any subsequent children) will be girls. (2)
- d** Non-disjunction occurs when chromatids fail to separate correctly during meiosis. It results in gametes with one additional chromosome (in humans, 24 instead of 23). Most trisomies (having three copies of a chromosome rather than two) are fatal so that zygotes do not develop, but a trisomy in chromosome 21 leads to Down's syndrome. (2)
- e** Chromosomes only condense and become visible at certain stages of the cell cycle. Cells sampled during amniocentesis must be allowed to divide so that their chromosomes can be seen and analysed. (2)

- 3 a** Gel electrophoresis draws DNA fragments through agarose gel depending on their size and charge. Small fragments are able to move more quickly than large ones, and so they travel further down the gel in the time allowed. (1)
- b** The second sample may have been larger than the others and in the time allowed for the gel to 'run' it has not yet separated into bands. (1)
- c** No sample has been applied to the third position. This may be to check that there are no anomalies due to impurities in the gel or apparatus. (1)
- d** Father A shares no DNA bands in common with the child whereas father B has one band in common so is more likely to be the father. (1)
- e** The reference bands show the commonly used markers that are checked in forensic or paternity tests. They indicate that the samples have moved correctly and minimise the risk of errors being made. (1)
- 4 a i** A transgenic organism contains DNA from more than one species. The term is usually applied to organisms whose DNA has been modified by genetic engineering. (1)
- ii** A plasmid is a small circular piece of DNA found in bacteria. Genes can be introduced into plasmids from other organisms and the bacteria will then transcribe them to produce the protein specified by the genes. (1)
- b i** Restriction enzymes cut DNA at specific (known) locations so that genes can be introduced at that point (for example, into a plasmid). (1)
- ii** Ligase enzymes rejoin fragments of DNA so that the introduced genes are fixed into the chromosome of another organism. (1)
- 5 a B** – the sheep whose nucleus was used. The nucleus contains two sets of chromosomes from which the ovum then developed. (2)
- b** The removed nucleus was haploid, while the inserted donor nucleus was diploid. (1)
- c** advantages:
cloned animals are all genetically identical;
the technique is used in producing animals that can (for example) manufacture proteins useful to humans in their milk, such as blood clotting factors or treatments for CF (2)
- d** disadvantages:
many cloned animals have been found to be born with abnormalities, because 'old' genes from mature donor animals are used to produce them and these have already differentiated to produce different cells which may cause long-term problems;
the technique is expensive and requires advanced technology (2)