

1. (a) (i) 12 chromatids shown as 6 pairs either side of the equator of cell; spindle shown; 2
(ii) cell with one chromosome from each homologous pair; 1
- (b) (i) mutation; 1
(ii) environmental factors; 1
- (c) crossing over; 2
random assortment of chromosomes; 2

[7]

2. (a) diagram showing:
half of the sperm with X chromosome, half with a Y chromosome,
all eggs with an X chromosome (*labelling of gametes essential*);
offspring half male, half female with XX being female, XY being male
(*both genotypes and phenotypes required*); 2
- (b) produced by meiosis;
crossing over;
independent assortment of chromosomes; 2

- (c) (i)

Male honeybee body cell	Haploid
Honeybee ovum	Haploid
Honeybee sperm	Haploid

- 2 marks for all correct answers
1 mark for two correct answers 2
- (ii) produced by mitosis; 1

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3. (a) (i) Centromere; 1
- (ii) Attaches (chromatids / chromosomes) to spindle (in cell division) **OR** divides to separate chromatids; 1
- (b) Chromatids; 1

	(c)	<u>Haploid</u> , because no homologous / paired chromosomes present / allow “because all the chromosomes are different”;	1	
				[4]
4.	(i)	X between zygote and spores;	1	
	(ii)	independent assortment; crossing over;	2	
	(iii)	some (new phenotypes) may survive adverse conditions; resistant spores produced;	1 max	
				[4]
5.	(a)	(i) FfGg ;	1	
		(ii) DNA (in each chromosome) has replicated, (to give two chromatids); (so) two copies of the gene/allele, one on each chromatid;	2	
	(b)	F and G bearing chromosomes on same side of equator;	1	
	(c)	crossing over shown between non-sister chromatids; in correct place; diagram showing chromatids and alleles after cross over;	3	
				[7]
6.	(a)	6;	1	
	(i)	chromosomes are arranged in (homologous) pairs/bivalents; crossing over/chiasma present / exchange of genetic information; bivalents arranged independently;	2 max	
	(ii)	separation/splitting/pulling apart of <u>homologous</u> chromosomes/ <u>pairs</u> of chromosomes; <i>(must give indication that one chromosome moves to each side)</i> <i>(must be in the context of meiosis – not chromatid movements and not chromosomes separate)</i> pulled at centromere / by spindle / fibres;	2	

- (c) (i) the short arm of both chromosomes labelled on the middle homologous pair; 1
(B and b must be labelled on separate chromosomes)
- (ii) 8 = 2 marks;
 working showing genotypes with 1 allele from each pair
 (for example, **B C D**) = 1 mark 2

[8]

7. (a) 1
- | | | | | | |
|---|--|---|---|--|---|
| A | | A | a | | a |
| b | | b | B | | B |

- (b) bivalent; 1

- (c) (i) Ab, aB;
 (ii) AB, ab; 2

- (d) mutation;
 different/new allele formed / genes deleted or duplicated/ sequence of genes changed (*reject genetic information*);
random fusion of gametes / fertilisation;
 new combination of alleles;
 independent assortment (of chromosomes) (*accept random*);
 shuffling of maternal and paternal chromosomes/new combination of alleles;
(ignore references to stages of meiosis)
 any 2x2 4 max

[8]

8. (a) one / two / few genes versus many / polygenic;
 limited / none versus significant;
 limited / few versus wide / many; 3

- (b) named difference in environmental factor during pregnancy
 e.g. nutrient supply; 1

[4]

9. (a) greater environmental influence than genetic; 1

- (b) identical twins have same genotype / converse for non-identical;

compare identical and non-identical twins / identical twins who have been separated / non-identical twins in same environment; if genetic - similarity between identical twins / converse; large sample required / use a statistical test;

4

[5]

10. (a) (i) TB Tb tB tb;

1

(ii) homologous chromosomes appropriately labelled;

1

(iii) separation of chromatids;

1

(b) (i) crossing over occurs; between **D** and **G**;

sections of chromatids/chromosomes/DNA/genes exchanged;

3

(ii) crossing over is infrequent(between close genes);

1

[7]