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;
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

[7]

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/spliting/pulling apart of <u>homologous</u> chromosomes/
<u>pairs</u> of chromosomes;
(*must give indication that one chromosome moves to each side*)
(*must be in the context of meiosis – not chromatid movements
and not chromosomes separate*)
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 chomatids;   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]