1. (a) Meiosis I

23 23

meiosis II

23 23 23 23; 1

(b) Random assortment of chromosomes/correct description;
crossing over/chiasma formation/correct description;
by reducing chromosome number it makes possible random fertilisation; max. 2

(c) Causes variation in phenotype/characteristics of organisms/some better adapted/have more favourable characteristics;
correct reference to (natural) selection of better adapted organisms;
selection of different phenotypes in different environments;
eventually leads to species change/change in gene pool/change in gene frequencies; max. 2

[5]

2. (a)
1. Chromosomes shorten/thicken/condense;
2. Chromosomes associate in homologous/(described) pairs / formation of bivalents / tetrads;
3. Crossing-over / chiasma formation;
4. Join to spindle (fibres) / moved by spindle;(*)
5. (At) equator/middle of cell;(*)
6. (join via) centromere / kinetochore;(*)
7. (Homologous) chromosomes move to opposite poles / chromosomes separate/move apart; (*ALLOW* ‚are pulled apart')
8. (Pairs of) chromatids separated in 2nd division; max 6

(*) OR " independent assortment"
unqualified = 1 mark

(b)
1. Crossing-over; [*IGNORE* any wrong ref. to timing]
2. Independent/random assortment/orientation/segregation of (homologous) chromosomes in meiosis I;
3. Independent/random assortment/orientation/segregation of chromatids in meiosis II;

\+ Any **three** from:
4. Different adaptations / some better adapted;
5. Some survive / example described;
6. To reproduce;
7. Pass on gene/allele;
8. Allows for changing environment/different environment/example described; max 5

(c) (i) 21; 1

(ii) 1. *T. aestivum* has 2 copies of each type of chromosome/is diploid;
2. *T. aestivum's* chromosomes can form bivalents/can assort in meiosis/ can produce haploid gametes;
3. *T. aestivum's* gametes receive a copy of <u>every</u> chromosome/ receive <u>all</u> the genetic information; 3
[*ACCEPT* converse argument for hybrid plants]

[15]

3. (a) Later fertilisation/cell fusion; (NOT just „sexual reproduction") Restoring diploid/original number/not doubling chromosome number; 2
[ALLOW ref „½ + ½"]

(b) Any three pairs from:
need comparison of meiosis and mitosis each time

Meiosis	Mitosis
(Homologous) chromosomes associate in pairs	(Homologues) independent/do not pair (IGNORE ref. separation
Crossing-over/chiasmata formation	No crossing-over;
Two/(nuclear stages) divisions/ → 4 offspring cells	One/(nuclear stage) division/ → 2 offspring cells;
<u>Genetically</u> different (product)	Genetically identical (product);

[IGNORE refs. To location] max 3

[5]

4. (a) (i) Continuous variation – range of values/not discrete categories/ many categories/no gaps; 1

(ii) Crossing over / chiasmata;
Random segregation / independent assortment;
In meiosis I and meiosis II; max 2

(b) Range influenced by single „outlier" (*accept anomaly*) / converse for S.D.;
S.D. shows dispersion/spread about mean;
Range only shows highest and lowest values/extremes;
S.D. allows statistical use;
Tests whether or not differences are significant; max 2

[5]

5. (a) First meiotic division (**A**) will show cells with chromosomes appearing as double structures/two chromatids still joined/ chromosomes in **A** and chromatids in **B** /homologous pairs are separating;

Must be in context of anaphase

Diploid number of chromosomes /appropriate number for **A** and **B**; 2

Allow reverse argument for second meiotic division If answer is unqualified, assume that it refers to cells at **A***, since this is the logic of the question.*

(b) Crossing over / chromatids exchange sequences of DNA / chiasmata;
Random/independent segregation/assortment (of chromosomes) / chromosomes from homologous pairs move independently at meiosis I;
And meiosis II; max 2

[4]

6. (a) (i) *Selecting the nettle plant*:
Random number table avoids bias in placing of quadrat;
„Nearest centre" avoids bias in choosing plant to measure; 2

1 mark for "method avoids bias"

(ii) *Measuring the sixth leaf:*
To allow valid comparison/so as not to introduce another variable;
Reduces/avoids influence of growth/age;
Reduces/avoids influence of light/shading; max. 2

(b) (i) Definition of range + SD / effect of outliers on range + SD;
Ranges are similar in both areas;
Suggests that variation within populations is similar;
SD smaller in area of high light intensity;
Shows that area of high light intensity is a more uniform population; 4

(ii) Standard error (of the mean); 1

(c) 1.164 / 1.16 / 1.2 , however derived = 2 marks
0.83 – 0.86 / 1.1, however derived = 1 mark 2

Evidence of correct use of both sets of figures, but inappropriate answer = 1 mark

[11]

7. (a) polygenic inheritance / several genes;
many categories / continuous range / single or multiple allele inheritance would produce discrete categories / eq.; 2

(b) (SE gives idea of) variability of mean;
time / population mean would lie within these limits in 68% / 70% / 2/3 of samples; 2

[4]

8. (a) greater prospect for selecting egg mass using values from table;
genetic influence is much higher / lower influence of environment; 2

(b) (i) position of a gene / allele on a chromosome; 1

(ii) 87.5%; 1

(iii) pairing together of (deleterious) recessive alleles; 1

[5]

9. (a) (i) continuous 1

(ii) caused by more than one gene 1

(b) Sicco is shorter than Spelt;
greater range of height in Spelt 2

[4]

10. (a) continuous variation;
suggests many genes involved / polygenic inheritance; 2

(b) identical twins have same genotype;
compare data from identical and non-identical twins /
identical twins who have been separated;
if genetic, - greater similarity between identical twins;
large sample required / use a statistical test; max 3

[5]

11. (a) (i) 1.00;
because they have the same genes; 2

(ii) dizygotic twins share an average of 50% of their genes;
only an average, therefore may be higher or lower than this; 2

(b) (i) Yes because MZ have high concordance;
DZ lower concordance; 1

(ii) intra-uterine environment may be different for the two twins;
further qualification, e.g. one may receive more nutrients 2

[7]

12. (a) continuous; 1

(b) (i) difference in mean of parents/significant difference in length of parents;
mean cob length of F_1 generation halfway between parental lengths;
more variation in F_2 than F_1; 2

(ii) variation present in parental/F_1 generation;
plants in parental/F_1 generation genetically identical; 2

(c) mean halfway between means for Tom Thumb and F_1/
between 9 and 11 cm cob length; 1

[6]

13. (a) Variation results from environmental factors;
Slight differences in uterus which affect development of twins;
Such as nutrient supply; max 2

(b) (i) Need to rule out differences due to "accidents"/more likely to determine effect on longevity 1

(ii) Smaller differences between monozygotic twins;
Suggests genes involved;
Not identical, therefore environment involved;
Differences may not be significant/may be due to chance; max 3

[6]

14. (a) (i) range between extremes/no discrete types;
strong environmental influence;
polygenic/many genes involved;
quantitative. 2

(ii) discrete types;
little/no environmental influence/only genetic;
(often alleles of) 1/2 gene;
qualitative.
(*reject references to few genes*) 2

(b) blood groups no environmental influence, (so only two types);
height has environmental factors (producing a range for each type) 2

[6]

15. (a) sections of chromatids exchanged;
sections have different alleles;
new combinations of (linked) alleles;
(*allow 1 mark for idea that ‚genes"are exchanged, if no other marks gained*) 3

(b) (i) length controlled by many genes /polygenes;
each gene may have different alleles / idea of additive effects;
OR
environmental factors / or named factor;
how named factor may affect growth of seeds; 2 max

(ii) 1. selection of large seeds for sowing;
2. higher proportion of alleles for long length;
3. loss of alleles for short seeds from population;
4. reference to distribution curves, e.g lower end 'cut off';
5. (possible appearance of) new alleles through mutation;
6. process repeated over many generations;
(*G - allow 1 mark idea for that „largeness"selected, survives and inherited*) 4

[9]
QWC 1

16. (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]

17. (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]

18. (a) Independent assortment/random alignment of (homologous) chromosomes;
Different combinations of maternal and paternal chromosomes;

OR

*C*rossing over;
Different combination of alleles/exchange of genetic material; 2

(b) (i) Variety **A** plants are taller;
Variety **A** with a greater range of heights;
Variety **A** plants are normal distribution/less skewed; 2 max

Q *Do not credit imprecise references to plant* ***A*** *being taller. Accept unambiguous description for third point. Unqualified pronouns in the context of this question refer to artery*

(ii) Will give higher yield as shorter stems;
More energy goes to producing grain/less likely to be blown down; 2

Q *Do not accept unqualified references to such features as expense*

(c) Show greater variation;
Likely some individuals will have alleles/characteristics for survival; 2

[8]