Mark schemes

1 (a) (i) Faster / greater / more effective response in children;

Do not accept children have more haemoglobin

1

(ii) Use line of best fit;

1

Extrapolate / extend line (and read from graph);

Allow calculation using rate of increase per day = one mark.
However for both marks this must be linked to line of best fit.

1

(iii) More than one polypeptide chain;

Allow many polypeptide chains.

'Haemoglobin has four polypeptide chains' must be in correct context to gain mark.

1

(b) (i) Has same water potential;

Allow converse for effect of using distilled water or a concentrated solution.

1

No (net) water movement / osmosis;

1

Cells will not swell / burst / change size;

No osmotic lysis = two marks

1

(ii) Pernicious anaemia (cells) greater range / spread / variation of diameters /widths;

Some pernicious anaemia (cells) wider than 9 (µm) / some less than 5.5 (µm) / without pernicious anaemia none more than 9 (µm) / none less than 5.5 (µm);

Pernicious anaemia (cells) peak / most frequent at 8.5 (µm) / peak / most frequent at higher diameter / / without pernicious anaemia peak / most frequent at 7 (µm) / peaks at lower diameter;

There are several alternatives for marking points 2 and 3

2 max

[9]

2 (a) Cannot make (active) enzyme A (which converts precursor to linamarin) / cannot make linamarin;

1

(b) (i) **AL** + **Al** + **aL** + **al** ;

1

(ii) Meiosis separates alleles / homologous chromosomes / pairs of chromosomes;
Independent assortment / means either of **A** / **a** can go with either of **L** / **l**;
Accept "random segregation" but cancel if reference to crossing-over

2

(c) From parental genotypes: **AaLl** × **AaLl** (no mark)
Note: If wrong parental genotypes / wrong gametes: ALLOW correct derivation of offspring genotypes = 1 max

Correct derivation of offspring genotypes; max 2 marks if error in Punnett square

	AL	**Al**	**aL**	**al**
AL	AALL	AALl	AaLL	AaLl
Al	AALl	AAll	AaLl	Aall
aL	AaLL	AaLl	aaLL	aaLl
al	AaLl	Aall	aaLl	aall

Correct identification of offspring genotypes with at least one **A** and two **l** alleles (= grey cells in above table);
Correct proportion: 3 / 16 / 3:13 / 18.75% ;

3

(d) (i) There was no (significant) difference in damage between cyanogenic andacyanogenic / being cyanogenic has no effect;

1

(ii) The difference (from expected / from chance variation) is significant / difference / results not just due to chance;
Reject null hypothesis;
Being cyanogenic does help protect from slug damage;

3

(e) High slug population:
1. Find <u>only</u> cyanogenic plants / only cyanogenic plants survive;
2. (Cyanide release) limits / stops feeding by slugs / slugs killed;*Accept: converse argument re. acyanogenic plants*

Low slug population:
3. Find both types of plant;
4. Less selection pressure on plants from slugs / no selective advantage / noselection / described;

4

[15]

3

(a) 1. Homologous chromosomes pair up / bivalents form;

2. Crossing over / chiasmata form;
3. Produces <u>new combination</u> of **alleles;**
4. Chromosomes separate;
5. At random;
6. Produces varying combinations of chromosomes / genes / alleles (*not twice*) ;
7. Chromatids separated at meiosis II / later;

Independent assortment / random segregation = marking points 4 and 5

6 max

(b) (i)

Parental phenotypes	Agouti			White	
Parental genotypes	BbAa			bbaa	;
Gamete genotypes	BA	Ba	bA ba	ba	;
Offspring genotypes	BbAa	Bbaa		bbAa bbaa	;
Offspring phenotype	Agouti	Black		White White	;

Phenotypes must match genotypes

Allow marking points 2 and 3 if correctly derived from wrong parental genotypes

4

(ii)

Colour of offspring	***Observed (O)***	***Expected (E)***	***(O-E)***	***$(O-E)^2$***	***$\frac{(O-E)^2}{E}$***
Agouti	34	30	4	16	0.53
Black	35	30	5	25	0.83
White	51	60	9	81	1.35
			$\Sigma \frac{(O-E)^2}{E}$ = **2.71 or 2.72**		

;; 2

(χ^2 correct = 2 marks)

($(O-E)^2$ all correct = 1 mark)

p = 0.05;
2 degrees of freedom;
Differences due to chance / no significant difference as χ^2 less than / to left of critical value OR Not due to chance / difference is significant as χ^2 greater than to right of critical value;

(as appropriate for candidates χ^2)

3

[15] (a) Chromosomes: **C** = 8 *and* **D** = 4;

4

DNA: **C** = 300 *and* **D** = 150;

2

(b) (i) testis / ovary; *accept anther / carpel / stamen / testicle*

1

(ii) to make chromosomes / chromatids / DNA / genetic material visible;

1

[4] (a) group of organisms with similar features;

5 can (interbreed to) produce fertile offspring;

2

(b) directional selection;
any TWO from

selection against one extreme / for one extreme;
against broadest beaks in B and narrowest beaks in **A** / for narrowest in **B** and broadest in **A**; whole distribution / range / mean / mode / median is shifted towards favoured extreme;

3 max

[5]

6

(a) (variation in) temperature will affect the solubility of oxygen / rate of respiration / use of oxygen by cells / diffusion / gas exchange; *to gain credit point made must concern oxygen*

1

(b) (i) there is no difference between the partial pressure of oxygen in the two groups / the partial pressure of oxygen is the same in each group;

1

(ii) results may have been due to chance and statistical test allows us to determine the probability of this / of the difference between results being significant;
enables acceptance or rejection of null hypothesis;
The key points here are chance and probability used in the correct context.

2

(c) **A**;
because partial pressure of oxygen only reduced when zinc in water / in **Y** / because when injected zinc / in **X** has no effect on partial pressure of oxygen in blood;

2

(d) less oxygen transport to cells / in fish / in blood;anaerobic respiration;
lactic acid produced / less carbon dioxide removed (from gills);
more H^+;

3 max

(e) (i) copper;calculation based on comparing concentration in woodlice with that in leaves;
accept any suitable method here, giving marks for the method and explanation. For example, calculating ratio of concentration in woodlice to concentration in leaves.

2

(ii) not absorbed from gut / passes out in faeces / egested / urine / excreted;

1

(iii) woodlice eat large amount of leaves;copper stored / accumulates in body;

2

(f) (i) mutation;

1

(ii) (as a component of) nucleic acids / DNA / RNA / nucleotides;phospholipids;
ATP / ADP;

2 max

(iii) arsenic-tolerant plants would not be able to take up phosphates / take up a littlephosphate; since likely to involve same mechanism / same carrier / protein; (process of) growth would be poorer than non-tolerant plants;

3

[20]

7

(a) Excitation of chlorophyll molecule / electrons / energy of (pairs of) electrons raised to higher energy level;

Electron(s) emitted from chlorophyll molecule;

Electron(s) to electron transport chain;

Loss of energy by electron(s) along electron transport chain;

Energy lost by electron(s) is used to synthesise ATP;

From ADP + Pi;

"By electrons" need not be stated in each marking point if it can be reasonably inferred that the candidate is referring to electrons

max 5

(b) Little green light reaches bottom as absorbed by surface dwellers / water;
Red and blue not absorbed and so penetrate;
Variation in pigments of sediment dwellers;
Bacteria with chlorophyll at an advantage as chlorophyll absorbs red and blue; (Survive to) reproduce in greater numbers and pass on advantageous alleles / genes in greater numbers / increase in frequency of advantageous alleles in subsequent generations;
Increase in frequency / numbers of bacteria with chlorophyll;

6

[11] (a) Interphase / S-phase;

8

1

(b) **A D C E B;**

1

(c) Attachment of centromeres / chromosomes / chromatids; Separation of centromeres /chromatids / chromosomes;

2

(d) Halves chromosome number / haploid;

Diploid / full number restored at fertilisation;

Allow correct reference to variation

max 2

[6] (a) (i) Continuous variation – range of values / not discrete categories / many

9 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;
Or
S.D. allows statistical use;
Tests whether or not differences are significant;

max 2

[4]

(a) (meiosis) anaphase I;

10

chromosomes are moving apart;
chromosomes still double structures;

3

(b) chromosomes in each (homologous) pair twist around each other;
chromatids break and rejoin to chromatid on sister chromosome;
(accept points from a suitable diagram)

2

[5]

(a) Chromosomes attach to equator / middle of cell / spindle;

11

Prophase;
Anaphase;
DNA replication / synthesis / chromosome copying / duplication;
Telophase;

5

(b) (i) Meiosis;

1

(ii) 32;

1

[7]

(a) Later fertilisation / cell fusion; (NOT just 'sexual reproduction')

12

Restoring diploid / original number / not doubling chromosome number;
ALLOW ref '½ + ½'

2

(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;
Genetically different (product)	Genetically identical (product);

IGNORE refs. To location

max 3

[5] (a) replication / duplication / doubling of chromosomes /

13 replication of DNA / transcription of DNA;

1

(b) (i) cell to show correct number of chromosomes;correct shape and position of centromere;

2

(ii) as (i) except everything halved – *Ignore crossing over*;
(if mitosis and meiosis reversed, allow 1 if otherwise correct)

2

(c) to replace cells;

1

[6] (a) 1. Chromosomes shorten / thicken / condense;

14

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;

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

max 6

(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 / exampledescribed;

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 every chromosome / receive all the genetic information;

ACCEPT converse argument for hybrid plants

3 [15]

15

(a) *Two linked points:*

Crossing over / exchange of material (between chromatids);
Different combinations of alleles / linkage groups changed / broken;

OR

Independent assortment / alignment of (homologous) chromosomes;
Different combinations of (maternal and paternal) chromosomes / alleles;

2 max

(b)

Gamete genotype D | M | d | m;

Offspring genotype D | M | d | m;

Offspring Abnormal males / (all) (no females); phenotypes

3

[5]

16

(a) (i) join / attach nucleotides, to form a strand / along backbone / phosphodiester bonds;

(reject reference to H bonds, complementary base pairing)

1

(ii) ribosome / RER;

1

(b) (i) CGTTACCAA;

1

(ii) CGU UAC CAA;

1

(c) substitution;

1

(d) (i) alanine;

1

(ii) (mutation 1) no change(to sequence of amino acids);
codon for alanine / degenerate codon / same amino acid coded for;

2

(mutation 2)
(change in sequence) valine replaced by alanine / codon for alanine;
folding / shape / tertiary structure / position of bonds may change;
(reject peptide bonds)

2

[10]

(a) haplopid cells produced / halves chromosome number;

17

fertilisation / fusion of gametes, diploid number restored;
chromosome number constant at each generation;

2 max

(b) principle of 2 chromosomes per cell;
4 correct combinations, long with short;

2

(c) (i) 8;

(ii) 8;

2

(d) (in males) more gametes produced / rapid gamete production / more lost;

1

[7]

(a) (i) TB Tb tB tb;

18

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] (a) high energy radiation / ionising particles;

19

named particles / α, β, γ;
colchicine; x rays /
cosmic rays; uv (light);
carcinogen / named carcinogen;
mustard gas / phenols / tar (qualified);

1 max

(b) (i) removal of one or more bases / nucleotide;
frameshift / (from point of mutation) base sequence change;

2

(ii) sequence of bases in mRNA would change;
(sequence of) amino acids different / different primary structure;
(active site / enzyme 1) changed tertiary shape / changed active sites; white pigment does not bind; lilac pigment not produced / white pigment remains unchanged / enzyme 1 does not function;

4 max

(iii) blue and lilac; white;

colour of petal
(white)
blue
lilac;
white;

2

[9] (a) different form of a gene;

20 1

(b) hydrogen bonds broken;semi-conservative replication / both strands used (as templates);
nucleotides line up complementary / specific base pairing / A and T / C and G;
DNA polymerase;

4

(c) deletion causes frame shift / alters base sequence (from point of mutation);changes many amino acids / sequence of amino acids (from this point); substitution alters one codon / triplet / one amino acid altered / code degenerate / same amino acid coded for;

3

[8] (a) (i) 8 'chromatids' each side;

21 spindle drawn;

2

(ii) 4 chromosomes;
1 from each homologous pair;

2

(b) produces haploid cells / chromosome number halved; fertilisation maintains the diploid / chromosome number (in next generation);

2

[6] (a) to get haploid / n / half number of chromosomes (in cells);

22

so that each cell gets one copy of each chromosome / gene / full set of genes / so that fertilisation produces diploid / constant chromosome number; results in independent assortment;

2

(b) (i) 4;

1

(ii) meiosis (has halved the chromosome number);

1

(ii) (mitosis because) zygote gets two chromosomes from each gamete / has four chromosomes;

accept haploid for two and diploid for four

gamete-producing plant has two chromosomes,
so mitosis to produce gametes with two;

2

[6] (a)

23

1

(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 2 × 2

4 max

[8] (a) sections of chromatids exchanged;

24

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 / loss of alleles for short seedsfrom population;
3. (possible appearance of) new alleles through mutation;
4. process repeated over many generations;

(G - allow 1 mark idea for that 'largeness' selected, survives and inherited)

4

[9]

QWC 1

(a) meiosis halves the chromosome number / from diploid to haploid / produces haploid / n

25 cells; when gametes fuse / at fertilisation, the diploid number is restored / this keeps the chromosome number constant / correct from one generation to the next / after sexual reproduction;
introduces genetic variation / independent assortment / crossing over;

3

(b) **M** between moss plant and spore;

1

[4]

26 (a) limited genetic diversity in modern varieties / greater genetic diversity in old varieties / older varieties contain other (useful) alleles / genes;
old varieties useful for future breeding programmes;

2

(b) (i) seeds lose viability / will not germinate / develop after long storage;

1

(ii) preserve variety of alleles / different genotypes / maintain genetic variation;
prevent inbreeding / reduces the chance of homozygosity;

2

[5] (a) mutation changes the amino acid sequence / primary structure of Factor VIII protein;

27 changes the tertiary structure / 3D shape;

2

(b) (mutant) Factor VIII protein is non-functional / does not work with Factor IX;so no conversion of Factor X to active form and pathway blocked;

2

(c) boy's blood contains (active) Factor VIII;
Factor VIII haemophiliac's blood contains (active) Factor IX;
the mixture has both Factors and so the pathway can complete / blood clots;

2 max

[6] (a) 6;

28 **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 homologous chromosomes / pairs 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;

*(**B** and **b** must be labelled on separate chromosomes)*

1

(ii) 8 = 2 marks; working showing genotypes with 1 allele from each pair
(for example, **B C D**) = 1 mark

2

[8]