1. (a) D–B–A–C; 1

(b) (i) Spindle / spindle fibres / microtubules; 1

(ii) Contract / shorten;
to separate chromatids move chromatids / chromosomes towards poles; 2

(c) 50; 1

[5]

2. (a) (i) So that chromosomes can be seen; 1

(ii) To allow light through / make tissue layer thin; 1

(b) (i) Interphase;
DNA replicates during this stage; 2

(ii) Daughter cells / chromosomes have separated; 1

[5]

3. (a) (i) S / synthesis stage;

(ii) Anaphase / C; 2

(b) Division / cleavage of cytoplasm / cytokinesis; 1

(c) (i) Pull chromatids apart / attachment for centromeres; 1

(ii) Cells cannot complete cell division;
(therefore) number of cells does not increase; 2

[6]

4. (a) Increased in volume of cell / amount of cytoplasm / increase in mass / cell bigger;
Increase in number of organelles;
Protein synthesis / specific example;
DNA replication / chromosomes become chromatids / chromosomes copy;
I references to G1, G2 and S phases) max 2

(b) S, R, P, Q ;
I T if at start or end of sequence, if in middle of sequence mark incorrect) 1

(c) (i) Region where mitosis / cell division takes place / eq. ; 1

(ii) Spread the cells / make the specimen / eq. thinner / better light penetration; 1

(iii) Make chromosomes distinguishable / nucleus / genetic material / eq. ; 1

[6]

5. (a) (i) DACB 1

(ii) Attachment of centromeres;
Separation of (daughter) chromatids; 2

(b) Meiosis halves the number of chromosomes;
Restoration of diploid number at fertilisation;
Introduces variation;
Correct reference to natural selection / survival; 2 max

(c) (i) Sperm is haploid, liver is diploid / sperm formed by meiosis, liver cell formed by mitosis; 1

(ii) It has no nucleus; 1

[7]

6. (a) A and B = 23;
C = 46; 2

(b) Zygote / fertilised egg; 1

(b) Chromatids move apart / to (opposite) poles;
S / interphase;
Chromosome as chromatid pair / spindle forms / nuclear membrane degenerates / chromosomes condense;
Cytokinesis / telophase; 4

[7]

7. (a) (i) 20 1

(ii) 10 1

(iii) 10 1

(b) (i) (Daughter) chromatids will not separate / centromere won't divide;
Centromere attaches to spindle fibres;
NOT 'chromosomes can't be pulled apart'. Ignore references to stages of mitosis. 2

(ii) Red blood cells <u>formed</u> / <u>produced</u> by mitosis; 1

[6]

8. (a) (i) **A** / identified (e.g. 7):
has ½ mass of DNA in B / ¼ mass of DNA in C / would have ½ chromosome number of B / contains least DNA / has 23 chromosomes;
Reject haploid 1

(ii) 14 (arbitrary units);
Diploid number of chromosomes re-established;
Gametes are haploid (*or concept explained*) / each gamete will contain 7 units; 2 max

(b) Separation of chromatid pairs / chromatids within a pair / chromosomes;
Reject 'homologous chromosomes' 1

[4]

9. (a) (i) Correct sequence:
1. Interphase
2. Prophase
3. Metaphase
4. Anaphase
5. Telophase; 1

(ii) 1nterphase; 1

(b) <u>Drawing</u>: Two chromatids joined by centromere;[If > *I picture drawn, allow if all correct]*
Chromatids <u>attached</u> to spindle fibre by centromere;

<u>Labels</u>: Centromere + chromatid + spindle fibre correctly labelled; 3

(c) (i) 8 (*)

(ii) 4 (*) 1

(*) both correct

[6]

10. (a) (i) B; 1

(ii) C; 1

(b) Amount of DNA halved,
(At start of mitosis) DNA has replicated;
Chromatids/ chromosomes separate;
At anaphase;
Role of spindle; max 3

(c) (i) Stage B would take longer/ would not occur/
graph would be flat/ not so steep; 1

(ii) No DNA synthesis so cells don't divide/ reduced DNA synthesis so cells divide more slowly/ cytarabine inhibits cell division;
Stops/ slows formation of new cancer cells/ stops/
reduces spread of cancer: 2

[8]

11. (a) (i) D – B – A – C ; 1

(ii) Separation of chromatids /chromosomes; 1

(b) (i) Thymine is a component of DNA;
Chromosomes are/DNA is in the nucleus;
Chromosomes/DNA replicates/synthesised in this period; 3

(ii) One copy of each chromosome /of each gene to each daughter cell / genetically identical to parent / 2 identical daughter cells/to maintain chromosome number; 1

[6]

12. (a) (i) 20 units;

(ii) 40 units; 2

(b) (i) S-phase;
When DNA replicates/new DNA is produced; 2

(ii) Cytarabine different shape (from cytosine);
Will not fit with guanine/cannot form template/will not base pair; 2

[6]

13. (a) replication / duplication / doubling of chromosomes / 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]

14. (a) (i) Prophase; 1

(ii) Chromosomes/chromatids moved apart; 1

(iii) *A wide range of processes occurs during interphase. This list is by no means exhaustive, but we would expect to see answer such as:*

Increase in volume of cell/volume of cytoplasm / increase in mass / cell bigger; increase in number of organelles;
synthesis of protein/named protein;
DNA replication/increase / chromosomes copied;
ATP synthesis / respiration; max 2

(b) Divide real length of bar (in mm)/10 by 0.02; 1

(c) 12/200 x 24 / single error in otherwise correct method;
1.44 hours (1 hour 26 min); 2

[7]

15. (a) (i) where mitosis/division/growing/ occurs
(reject growing cells) 1

(ii) to distinguish chromosomes/chromosomes not visible without stain; 1

(iii) to let light through/thin layer; 1

(b) (i) 74 + 18/982;
= 9.4% / 9%; 2

(allow 1 mark for identifying prophase & metaphase i.e. 92 or correct method using wrong figures*)*

(ii) genetic differences/different types of garlic;
time of day;
chance;
age of root tip;
water availability;
temperature;
nutrient availability; 2 max

(environmental factors = 1 but cannot be awarded in addition to a name environmental factor)

[7]

16. (a) Interphase/S-phase; 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; max 2

Allow correct reference to variation

[6]

17. (a) Chromosomes: **C** = 8 *and* **D** = 4;
DNA: **C** = 300 *and* **D** = 150; 2

(b) (i) testis / ovary; 1
accept anther / carpel / stamen / testicle

(ii) to make chromosomes / chromatids / DNA / genetic material visible; 1

[4]

18. (a) Diagram showing two identical molecules;
Each with one original and one new strand; 2

(b) (i) 7.31 – 7.36;
Same as liver cell/blood cell/twice sperm cell; 2

(ii) 5.78;
Sperm cell + egg cell, both with 2.89/twice sperm cell; 2

[6]

19. (a) (i) (D) B E A C; 1

(ii) Metaphase; 1

(b) Interphase/S phase; 1

(c) (i) Healthy cells not dividing so number stays constant;
Cancer cells dividing (uncontrollably) so increasing in number; 2

(ii) Drug only kills some cancer cells;
These continue to divide; 2

[7]

20. (a)

Nucleus	**Number of chromosomes**	**Mass of DNA/arbitrary units**
At telophase of mitosis	26;	30;
From a sperm cell	13;	15;

4

(b) Cancer cells often have faulty/damaged DNA;

Protein/p53 faulty/not made;

Cell (with faulty /DNA) divides/completes cell cycle;

Uncontrolled division produces cancer; 3

p53 refers to the protein so do not accept reference to p53 mutating.

(c) (i) Interphase/S phase/synthesis phase; 1

(ii) Anaphase/**A**; 1

[9]