

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; 2
- (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 formed / produced by mitosis; 1
- [6]**
8. (a) (i) A / identified (e.g. 7):
has $\frac{1}{2}$ mass of DNA in B / $\frac{1}{4}$ mass of DNA in C / would have $\frac{1}{2}$
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) Interphase; 1
- (b) Drawing: Two chromatids joined by centromere; [If > 1 picture drawn,
allow if all correct]
Chromatids attached to spindle fibre by centromere;
Labels: 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
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
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

[8]

[6]

[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) $12/200 \times 24$ / 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]