

## 2.2 THE CELL CYCLE, INCLUDING MITOSIS 2 – MARK SCHEMES

### Q1.

- (a)
1. Binary fission;
  2. Replication of (circular) DNA;
  3. Division of cytoplasm to produce 2 daughter cells;
  4. Each with single copy of (circular) DNA;
    1. *Ignore reference to 'chromosome'*
    2. *Ignore 'copy'.*
    4. *Ignore references to number of plasmids.*

2 max

- (b)
1. Both denatured (by high temperature);
  2. Denaturation faster at 60 °C due to more (kinetic) energy;
  3. Breaks hydrogen / ionic bonds (between amino acids / R groups);
  4. Change in shape of the active site / active site no longer complementary **so** fewer enzyme-substrate complexes formed / substrate does not fit;
    3. *Ignore references to disulphide bonds*
    3. *Accept (at 60 °C) Change in shape of the active site / active site no longer complementary **so** no enzyme-substrate complexes formed / substrate does not fit;*

4

- (c)
1. To digest protein;
  2. (So) they can absorb amino acids for growth / reproduction / protein synthesis / synthesis of named cell component;  
**OR**  
(So) they can destroy a toxic substance / protein;
    1. *For 'digest' accept 'break down' here.*
    2. *Accept '(so) they can destroy antibodies / antibiotics / viral antigens / bacterial antigens'*

2

- (d)
1. Hydrolyse (peptide bonds) to release amino acids;
  2. Amino acids can cross (cell) membrane;  
**OR**  
Dipeptides cannot cross (cell) membrane;  
**OR**  
Maintain concentration gradient of amino acids for absorption;  
**OR**  
Ensure (nearly) maximum yield from protein breakdown;
    2. *Ignore references to crossing gut membranes.*
    2. *Accept 'there are carrier proteins for amino acids'*
    2. *Accept 'no carrier proteins for dipeptides'*

2

[10]

### Q2.

- (a)
1. Gives rise to new plants / plantlets;
  2. So must be able to develop into different tissues / other specialised cell types / differentiate;
    1. *Ignore references to leaves / callus*

(b) Two marks for 5 : 1/50 : 10/1 : 0.2;;  
*One mark for ratio correctly identified but expressed incorrectly as 1 : 5 / 10 : 50 / 0.2 : 1;*

2

2

(c) (i) 1. Meiosis / independent assortment / crossing over;  
2. (Fusion of) genetically different gametes / random fertilisation;

2

(ii) Will be clones / produced by mitosis / will be genetically identical / less variation / all plants will have desired characteristics;

*If the reference is to identical must be genetically identical, but allow less variation without the reference to genetical.*

1

[7]

### Q3.

(a) Given only saline;

Otherwise treated exactly the same way;

2

(b) Ethical consideration, e.g., leads to death / suffering of mice;

Large number to improve reliability / reduce sampling error;

Number of mice related to cost / space available / animal husbandry;

2 max

(c) Vary in shape / do not grow uniformly;

*Q Allow descriptions of variation in shape.*

1

(d) 7.44 and 1.74;;

7.42 and 1.72;;

(Ratio) 4.28 : 1;;

(Ratio) 4.31 : 1;;

(Percentage decrease) 76.6%;;

(Percentage decrease) 76.8%;;

*Any of the answers shown gain two marks.*

*An answer of 23.4% or 23.2%*

*Percentage decrease gains one mark.*

*Correct method of calculating rate / ratio / percentage increase with an incorrect answer gains one mark.*

2 max

(e) Reference to Mitosis;

As chromosomes cannot attach (to spindle) / chromatids cannot separate (on

spindle);

**Q** Do not penalise confusion between chromosomes and chromatids in second marking point

Cell division / cell cycle slows down;

**Q** Mitosis slows down = 2 marks

**Q** Mitosis stopped = 1 mark

**Q** Mitosis must be spelt correctly

3

(f) (i) (Degree of) spread / variation from the mean;

1

(ii) Both chemicals (on their own) slow down growth / are effective;

Taxol is more effective than OGF;

Combined treatment (seems) most effective;

SD overlap for OGF with taxol and taxol (on its own) so not conclusive / could be chance / both treatments could be equally effective;

**Q** Ignore all references to significance

4

[15]

#### Q4.

(a) Binary fission;

*Reject mitosis*

1

(b) 1. Keep lid on Petri dish

**OR**

Open lid of Petri dish as little as possible.

2. To prevent unwanted bacteria contaminating the dish.

**OR**

*L. monocytogenes* may be dangerous / may get out.

**OR**

3. Wear gloves

**OR**

Wear mask

**OR**

Wash hands;

4. To prevent contamination from bacteria on hands / mouth

**OR**

Prevent spread of bacteria outside the lab;

**OR**

5. Use sterile pipette

**OR**

Flame the loop

**OR**

Flame the neck of the container of the culture;

6. To maintain a pure culture of bacteria 4 max
- (c) Cinnamon; 1
- (d) 1. Thyme is the most effective / best (at 4 °C);  
2. Clove and cinnamon same effectiveness at 4 °C as 35 °C (so suitable);  
3. Bay and nutmeg are less effective at 4 °C than 35 °C (so unsuitable). 3
- (e) Less kinetic energy  
**OR**  
Less movement of oil molecules / of phospholipid molecules 1 max
- [10]**

**Q5.**

- (a) To ensure the colour is the same at the start; 1
- (b) Yes – curve on graph with bromelain present remains approximately constant / rises very slightly;  
Would decrease if killing of cells occurred / would increase if cells still dividing; 2
- (c) Use of mouse cells (rather than human);  
(Carried out) *in vitro* / not in living organisms;  
Only tested on one type of cancer;  
Not possible to predict effect on humans (as no data collected); 3 max
- (d) The faster the rate of division the faster the cancer would grow;  
By measuring rate of cell division you could see how effective the treatment was; 2
- (c) Not ethical to replace conventional treatment;  
As life of patient is at risk (if bromelain not effective); 2
- [10]**

**Q6.**

- (a) (i) 22; 1
- (ii) 1. Odd number of chromosomes / 33 chromosomes (in leaf cell);  
2. Chromosomes cannot pair / cannot undergo meiosis / would result in half chromosomes / cannot form haploid cells; 2
- (b) (i) Fast growth / produces crop fast / produces large crop;

*Do not insist on relative statement.  
Accept similar terms for fast. E.g. "better" growth  
Do not accept unqualified references to profit.*

1

(ii) Leaves less likely to break / higher breaking strength;

1

(c) Low genetic diversity because they are produced by mitosis;

Will all have the same DNA / genes / alleles / will be genetically identical / will be clones;

**OR**

Low genetic diversity because they are not produced by meiosis;

No crossing over / independent segregation / will not be genetically different;

*Independent segregation is the specification term. Accept other such as random assortment.*

2

[7]

**Q7.**

(a) 1. Strands separate / H-bonds break;

*1. Q Neutral: strands split*

*1. Accept: strands unzip*

2. DNA helicase (involved);

3. Both strands / each strand act(s) as (a) template(s);

4. (Free) nucleotides attach;

*4. Neutral: bases attach*

*4. Accept: nucleotides attracted*

5. Complementary / specific base pairing / AT and GC;

6. DNA polymerase joins nucleotides (on new strand);

*6. Reject: if wrong function of DNA polymerase*

7. H-bonds reform;

8. Semi-conservative replication / new DNA molecules contain one old strand and one new strand;

*8. Reject: if wrong context e.g. new DNA molecules contain half of each original strand*

6 max

(b) (i) 18;

*Do not accept 17.5*

1

(ii) 10;

1

- (iii) 1. Horizontal until 18 minutes;  
*Allow + / - one small box*
2. (Then) decreases as straight line to 0  $\mu\text{m}$  at 28 minutes;  
*2. Allow lines that start from the wrong place, ending at 0 at 28 minutes*
- 2
- (c) (i) Two marks for correct answer of 19.68 or 19.7;;  
*Accept 19hrs 41mins*
- One mark for incorrect answers in which candidate clearly multiplies by 0.82;  
*Allow one mark for incorrect answers that clearly show 82% of 24 (hours)*
- 2
- (ii) 1. No visible chromosomes / chromatids / visible nucleus;
- 1
- (iii) **D** (no mark)
1. Lower % (of cells) in interphase / higher % (of cells) in mitosis / named stage of mitosis;  
*1. Accept: 'less' or 'more' instead of '%'*  
*1. Do not accept: higher % (of cells) in each / all stage(s)*
2. (So) more cells dividing / cells are dividing quicker;  
*2. Accept: uncontrolled cell division*  
*2. Do not award if Tissue C is chosen*
- 2
- [15]**
- Q8.**
- (a) Variable that is changed;  
*Reject 'the variable that changes'.*
- 1
- (b) 1. Idea of a confounding variable;
2. (So) genetically similar;  
*2. Do not accept 'genetically identical / same DNA'.*
3. (So) have similar salt tolerance / response to salt water / response to watering treatment;
4. (So) have similar yield / mass of seeds;  
*Do not accept 'amount / number of seeds' or 'growth rate'.*
- 2 max
- (c) Mitosis;  
*Ignore cell division*
- 1
- (d) 1. Irrigation with sea water / **C** / **D** increased yield compared with no

irrigation / **A**;

*For 'yield' accept 'mass of seed' throughout.*

2. Yield was lower when irrigated with sea water / **C** / **D** compared with fresh water / **B**;

*Only penalise once for use of 'amount / number of seeds'.*

3. Yield was lower when watered with sea water throughout growth and seed formation / **C** than when watered with sea water just at seed formation / **D**;

*Accept use of figures from table.*

*'It' refers to watering with seawater / mixture.*

2 max

- (e) 1. Irrigation with sea water / **C** / **D** increases concentration of salt in soil;

*Ignore reference to standard deviation / quality of the data.*

2. Lower water potential in the soil linked to reduced uptake of water;

3. Salt concentration in the soil might / might not increase in the future;

*Mark point 3 includes the principle for mark point 1 so mp3 gains 2 marks (for mp1 and mp3)*

4. Might decrease plant growth / yield in the future;

5. Less food / fewer seeds for future planting;

*Mp 3 and 4. Allow 'further' for the idea of 'in the future'.*

3 max

[9]

### Q9.

- (a) (i) anaphase;

1

- (ii) sister / identical chromatids (separate);  
move to opposite poles / ends / sides;

2

- (b) (i) interphase;

1

- (ii) ATP production / protein synthesis / replication of centrioles;

1

- (iii) 1.2;

1

- (c) short duration of interphase;

1

[7]

### Q10.

- (a) (cut out gene using an) endonuclease / restriction enzyme;

reference to specificity / recognition site;  
 sticky ends;  
 use the same enzyme to cut;  
 plasmid / virus / potato DNA;  
 fixed by ligase;  
 method of introducing vector e.g. micropipette / virus injects DNA /  
 remove plant cell wall;

6 max

- (b) different genes are expressed;  
 producing different enzymes / proteins;

2

[8]

**Q11.**

- (a) genetically identical cells / individuals;

1

- (b) mitosis;

1

- (c) no differentiation at this stage / same genes being expressed;

1

- (d) brown - genes / DNA / genetic 'information' from the nucleus (expressed);

1

- (e) embryo cell diploid, egg cell haploid;  
 contain different alleles / forms of the colour gene;

2

- (f) damage to nucleus / cells during transfer;

1

[7]

**Q12.**

- (a) mass of undifferentiated / unspecialised / totipotent cells;  
uncontrolled cell division;  
 (not 'repeated')

metastasis / (cells break off and) form new tumours /  
 spread to other parts of body;

3

- (b) cancer takes time to develop / exposure when young but cancer  
 triggered later; other organs destroyed before death occurs /  
 metastasis affects other organs;  
 immune system less effective in old people;  
 longer time of exposure to UV / accumulation of mutagenic effect;

1 max

- (c) dark skin / melanin / pigment stops UV light / prevents burning;  
 so less cancer risk in dark skinned people / less likely to develop tumours;  
 (allow converse)

2

[6]



**Q13.**

(a) (During prophase)

1. Chromosomes coil / condense / shorten / thicken / become visible;
2. (Chromosomes) appear as (two sister) chromatids joined at the centromere;

(During metaphase)

3. Chromosomes line up on the equator / centre of the cell;
4. (Chromosomes) attached to spindle fibres;
5. By their centromere;

(During anaphase)

6. The centromere splits / divides;
7. (Sister) chromatids / chromosomes are pulled to opposite poles / ends of the cell / separate;

(During telophase)

8. Chromatids / chromosomes uncoil / unwind / become longer / thinner.

*No marks for naming the stages*

*Reject references to homologous chromosomes / pairing of chromosomes*

*Ignore references to spindle formation during prophase*

5 max

- (b)
1. Homologous chromosomes pair up;
  2. Independent segregation;
  3. Maternal and paternal chromosomes are re-shuffled in any combination;
  4. Crossing over leads to exchange of parts of (non-sister) chromatids / alleles between homologous chromosomes;
  5. (Both) create new combinations of alleles;

5

[10]

**Q14.**

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

## Q15.

(a) C

*Auto mark*

1

- (b) 1. No separation of chromatids/chromosomes/centromeres;  
*Accept anaphase prevented*  
*Accept nondisjunction*  
*Reject homologous pairs*
2. Chromatids/chromosomes all go to one pole/end/sides of cell/not pulled to opposite poles;
3. Doubles chromosome number in cell/one daughter cell gets no chromosomes or chromatids;  
*Accept DNA for chromosomes*  
*Accept ploidy*  
*Ignore references to 'genetic information'*  
*Ignore simple descriptions of what normally happens in mitosis*

2 max

- (c) 1. (No, because) at 100 there are still **some** (7%) cancer cells dividing/undergoing mitosis;  
*Accept idea that all division stops only at 1000*
2. So, cancer not destroyed/may continue to grow/spread/form tumours;  
*Must refer to cancer spreading not cells dividing*
3. Best concentration may be between 100 and 1000/need trials between 100 and 1000;
4. This research in culture, don't know effect of KI on people;  
*Reject 'not tested on humans'*  
*Reject 'done in animals'*
5. (Yes, because) above 100 produces little increase in % of cells not dividing/undergoing mitosis/at 100, **most** (93%) cancer cells unable to divide/dead;  
*Must clearly link lack of monopolar mitotic spindles with cell division*
6. Above 100 may be harmful (to body);  
*Accept 'above 100/high concentrations produce harmful side effects/named effects'*
7. Higher concentrations more expensive;
8. (Above 100) will have more effect on (rapidly dividing) cancer cells;  
*Must relate to 100*

4 max

- (d) 1. 10 cm<sup>3</sup> of 10 000 nmol dm<sup>-3</sup>/ (original) solution;  
2. 90 cm<sup>3</sup> of water;  
*If ratio correct but make wrong volume e.g. 1 litre, award 1 mark*

2

**Q16.**

- (a) 1 two strands therefore semi-conservative replication (possible);  
 2 base pairing / hydrogen bonds holds strands together  
 3 hydrogen bonds weak / easily broken, allow strands to separate;  
 4 bases (sequence) (exposed so) act as template / can be copied;  
 5 A with T, C with G / complementary copy;  
 6 DNA one parent and one new strand;

4 max

- (b) 1 chromosomes shorten / thicken / supercoiling;  
 2 chromosomes (each) two identical chromatids / strands / copies  
 (due to replication);  
 3 chromosomes / chromatids move to equator / middle of the spindle / cell;  
 4 attach to individual spindle fibres;  
 5 spindle fibres contract / centromeres divide / repel;  
 6 (sister) chromatids / chromosomes (separate)  
 move to opposite poles / ends of the spindle;  
 7 each pole / end receives all genetic information /  
 identical copies of each chromosome;  
 8 nuclear envelope forms around each group of chromosomes /  
 chromatids / at each pole;

7 max

- (c) cancer cells killed, normal body cells survive;  
 cancer cells low oxygen (as blood supply cannot satisfy demand);

2

[13]

**Q17.**

- (a) 1 Cut gene out of cell / make gene using mRNA / obtain gene with restriction  
 enzymes;  
 2 Cut DNA using restriction enzyme / plasmid cut with restriction enzyme;  
 3 Correct reference to sticky ends;  
 4 Join DNA using ligase / insert gene into vector;  
 5 Plasmid / named vector transferred to cell;  
 6 Method of transfer e.g. heat shock;  
 7 Reference to marker gene;  
 8 Select bacteria containing new gene;

max 6

- (b) Cells can metastasise / break off / spread to other parts of the body;  
 Remaining cells continue to divide forming a new tumour / secondary;

2

- (c) Antibodies specific;

Normal cells have different antigen / cancer cell has particular antigen;

Enzyme **only** present in cancer cells so drug **only** activated at / near cancer cells;

3

- (d) All cells contain DNA;  
Would stop / inhibit DNA replication in normal cells;  
Stops / inhibits cell division;  
Named example on growth / repair e.g. no new blood cells made / no wound healing;

4

[15]

### Q18.

- (a) 1. Rank all STs in ascending order;  
2. Find value with same number (of people) above and below.  
*Accept find middle value*

2

- (b) Not ethical to fail to treat cancer.

1

- (c) Yes since with ipilimumab:

1. Median ST increased by 2.1 months;
2. Percentage of patients showing reduction in tumours increased from 10.3% to 15.2%;

No because:

3. No standard errors shown / no (Student) t- test / no statistical test carried out;
4. (So) not able to tell if differences are (statistically) significant / due to chance (alone);
5. Improvement might only be evident in some patients / no improvement in some patients;
6. Quality of (extra) time alive not reported;

*If answers relate only to 'Yes' or 'No', award 2 marks max*

4 max

- (d) 1. Faulty protein recognised as an antigen / as a 'foreign' protein;  
2. T cells will bind to faulty protein / to (this) 'foreign' protein;  
3. (Sensitised) T cells will stimulate clonal selection of B cells;  
4. (Resulting in) release of antibodies against faulty protein.

3 max

[10]