2018 Cell and Nuclear Division STQ

2018 / H2 / ACJC PRELIM / P2 Q6 (Mutations)

- 1 Many diseases arise due to gene mutations and/or chromosomal aberrations.
 - (a) Distinguish between gene mutations and chromosomal aberrations.

[2]

Fig. 6.1 shows an error occurring during meiosis II.



Fig. 6.1

(b) (i) Complete Fig. 6.1 with the correct chromosome structures and chromosome number (in terms of n) in the gametes. [2]

(ii) Explain the error shown in Fig. 6.1.

[2]
(iii) Predict the chromosomal number (in terms of n) in each of the four gametes if a similar error had occurred in meiosis I instead of meiosis II.
[1]
(c) Such errors can occur during mitosis too. Comment on whether this would lead to changes in the gene pool of a population.
[1]

[Total: 8]

2018 / H2 / EJC PRELIM / P2 Q3 (Stem Cells)

2 Bone marrow contains stem cells that divide by mitosis to form blood cells. The fate of a stem cell was tracked and it was recorded that during the observed duration the stem cell divided asymmetrically each time.

Fig. 3.1 shows changes in the mass of DNA in a human stem cell from bone marrow during three cell cycles.





- (a) With reference to the information provided above,
 - (i) Describe what happens to bring about the changes in the mass of DNA per cell at time period **K** and at time period **L**.

Κ

A bone marrow cell was extracted and observed under the electron micrograph shown in Fig.

3.2. The student focused on an organelle which he described as having "an envelope surrounding genetic material containing both darker and lighter stained patches, distinct from the site where ribosomal subunits were assembled".





(b) Explain the significance of the "darker and lighter stained patches" that the student referred to, in a cell undergoing differentiation.

[3]	

The use of embryonic stem cells (ESCs) for stem cell therapy and research is controversial and considered by many people as unethical. Scientists have circumvented this issue through the use of induced pluripotent stem cells (iPSCs) as an alternative to ESCs.

Fig. 3.3 summarises the procedure for obtaining iPSCs and its use.





(C)

[Total: 10]

2018 / H2 / JJC PRELIM / P2 Q7

3 Fig. 7.1 shows an electron micrograph of a chromosome in prophase II.





- (a) Name the structures A and B. [2]
 - A ______B _____
- (b) Explain why the chromosome occurs as a double structure. [2]

The risk of mis-segregation of chromosomes increases with age among women. This can lead to aneuploid embryos. Fig. 7.2 shows an oocyte undergoing nuclear division with mis-segregated and lagging chromosomes.



Fig. 7.2

(a) Identify the stage in meiosis as shown in Fig. 7.2. [1]

(b) With reference to Fig. 7.2, suggest how aneuploid embryos are formed. [3]

[Total: 8]

2018 / H2 / NYJC PRELIM / P2 Q2

Fig. 2.1 shows some Allium sp. plant cells in various stages of the mitotic cell cycle.



Fig. 2.1

(a) (i) Identify the three stages shown by the labelled cells.

Α		
В		
С		
(ii)	Identify the stage of mitosis that follows that shown in cell C .	[3]
		[4]
		[1]

(iii) In the cell outline below, draw and label the structures visible in a cell that is in the stage you have named in (ii). 2n for this plant is 6.



(b) Uncontrolled cell division can result in cancer. Some types of cancer can be treated by chemotherapy, which involves the injection of chemicals into the bloodstream.

One chemical used for chemotherapy is called Methotrexate. This is a reversible competitive inhibitors of one of the enzymes in the metabolic pathway that results in the formation of purines.

Explain how the use of Methotrexate will slow down the mitotic cell cycle.

(c) Prokaryotic organisms such as *Escherichia coli* divide by simple cell splitting (binary fission), not mitosis.

Apart from ribosomes, prokaryotes have no organelles comparable to those found in eukaryotes and have a circular 'chromosome' with no centromere.

[2]

With reference to the information above and your knowledge of mitosis, suggest why mitosis does **not** occur in prokaryotes.

[2] [Total: 11]

2018 / H2 / PJC PRELIM / P2 Q4

5 There have been many breakthroughs in stem cell research in the recent years. It has been discovered that stem cells are involved in the replacement of worn-out cells and repair of damaged tissues. Further research is being conducted to better understand the mechanism involved in controlling the behaviour of stem cells in order to better manipulate them to treat various diseases and disorders.

Stem cells undergo cell division to produce genetically identical daughter cells. Fig. 4.1 shows two cells, each at a different stage of cell division.





(a) With reference to Fig. 4.1, state the stages of cell division in Cell A and Cell B.

Cell A	
Cell B	[1]

[Turn over Fig. 4.2 shows information about the movement of chromatids in a cell that has just started metaphase of mitosis.

Fig. 4.2

(b)	(i) With reference to Fig. 4.2, state the duration of metaphase in the cell.				
			[1]		
	(ii)	Complete line Y on the graph.	[1]		

(iii) Account for your answer in (b)(ii)

[3]

The movement of chromatids is dependent on spindle fibres, which are made up of many tubulin subunits. Spindle fibres are lengthened at one end during mitosis by the polymerisation of tubulin subunits through GTP hydrolysis.

(c) Contrast between the structure of tubulin with that of DNA.

[Total: 8]

2018 / H2 / RI PRELIM / P2 Q3 (Inheritance)

- **6** During meiosis, the cell divides to produce gametes.
- (a) Discuss the role of centromere in the production of gametes.

(b) The graph in Fig. 3.1 shows the length of the spindle fibres during meiosis.





- (i) In which regions of the graph did the centromeres detach from the spindle fibres?
 -[1]
- (ii) Fig. 3.2 shows a particular stage in meiosis



Fig 3.2

Which region on the graph corresponds to the stage shown in the Fig. 3.2.

......[1]

(ii) Name and identify 2 corresponding stages on the graph in Fig 3.1 that contributes to genetic variation in gametes, and explain how they bring about genetic variation.

Stage
Explanation
Stage
Explanation
[6]

(c) Most human traits as well as medical conditions are under genetic influence.

A gene is found to control a rare disease, Wiskott–Aldrich syndrome (WAS) which is characterised by eczema, low platelet count and immune deficiency.

Another gene that controls hair type has 2 alleles. 1 allele results in straight hair, another codes for curly hair. Presence of both results in wavy hair.

In **couple 1**, a normal female with straight hair married a wavy-haired male suffering from WAS. Predicted phenotypic ratio of their offspring is as follows:

WAS		Hair
Female	All normal	1 wavy : 1 straight
Male	All normal	1 wavy : 1 straight

For **couple 2**, a wavy-haired female suffering from WAS married a wavy-haired normal man. Predicted phenotypic ratio of their offspring is as follows:

	WAS	Hair
Female	All normal	1 curly : 2 wavy : 1 straight
male	All affected	1 curly : 2 wavy : 1 straight

(i) What is the mode of inheritance of the WAS disease?

......[1]

(ii) Use suitable symbols to represent the alleles of the gene controlling the WAS disease.

.....[1]

(iii) Use a genetic diagram to explain the results of **couple 2**.

[4] [Total : 17]

2018 / H2 / RVHS PRELIM / P2 Q6

7 A germline cell is undergoing meiosis to produce gametes. Fig. 6.1 shows a stage in this process.





(a) (i) Identify the stage of meiosis shown in Fig. 6.1 [1] (ii) Explain you answer in (a)(i). [2]

(b Describe the role of centrioles in the next stage of meiosis.

Fig. 6.2 shows an error in anaphase II.

)





(c) Explain why this error may increase the risk of cancer in a newborn. [3]

(d) Kinase inhibitors are often used to target such cancers associated with Ras proto-oncogenes by interrupting their downstream signalling.
 Suggest how kinase inhibitors can interrupt Ras signalling pathway. [1]

2018 / H2 / TJC PRELIM / P2 Q5

8 Fig. 5.1 shows a stage in the mitotic cell cycle in an animal cell.



Fig. 5.1

_____[1]

[2]

- (a) With reference of Fig. 5.1,
 - (i) identify the stage of mitosis;
 - (ii) state two features which are characteristic of this stage.

(b) Distinguish between the terms haploid and diploid.

(c) Explain the importance of mitosis in organisms.

		[3]

(d) In many multicellular organisms, such as mammals, the time taken for the mitotic cell cycle varies considerably between different tissues, but is very carefully controlled in each cell.

Suggest the importance of this control in mammals.

[2]

[Total: 10]