

# 1.4 Cells: Division

## Question Paper

Course	DP IB Biology
Section	1. Cell Biology
Topic	1.4 Cells: Division
Difficulty	Hard

**Time allowed:** 60  
**Score:** /49  
**Percentage:** /100

### Question 1a

a)  
Bowel cancer can result from adenoma polyps. Adenoma polyps form as a result of mutations occurring in dividing cells of the colon lining.

Suggest the differences in the cell cycle of a cancer cell compared with that of a normal intestinal cell.

[2 marks]

[2 marks]

### Question 1b

b)  
Compare and contrast the process of cytokinesis in plants and animals.

[3 marks]

[3 marks]

### Question 1c

c)  
Before the cell progresses from  $G_1$  into S phase, it needs to pass through a checkpoint, which prevents the cell cycle from proceeding if certain conditions are not met.

Suggest one reason why a cell might not progress through the checkpoint.

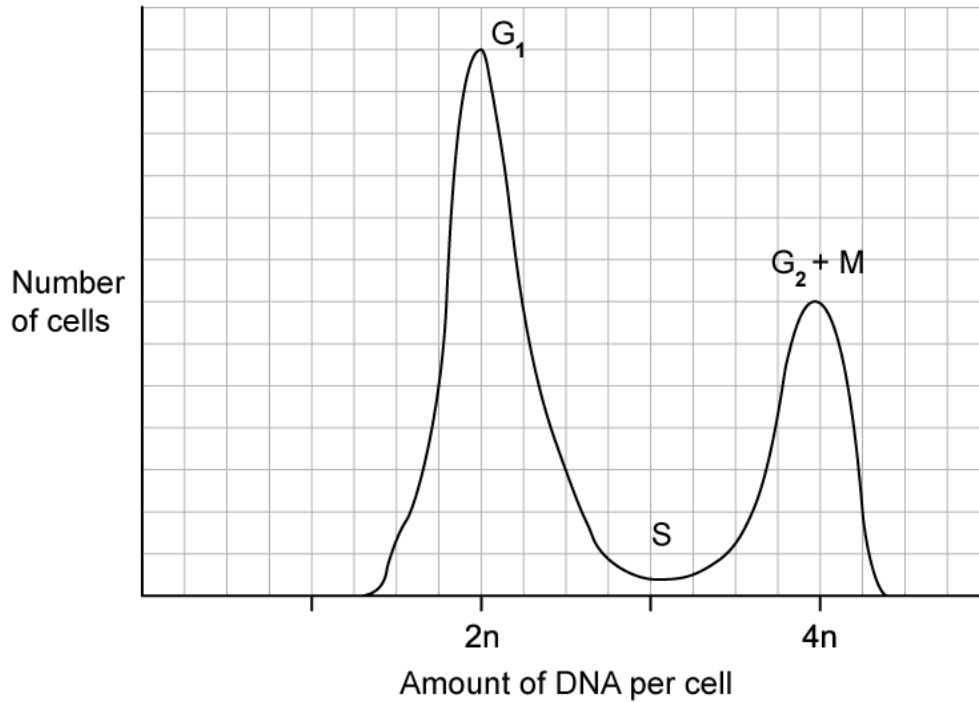
[2 marks]

[2 marks]

**Question 1d**

d)

The graph below shows data produced from a flow cytometer. This measures the number of cells that are labelled with DNA bound to a fluorescent dye, as this is proportional to DNA content. The stages of the cell cycle are indicated.



Suggest why, during the S phase, that the amount of DNA per cell is between 2n and 4n.

[ 2 marks]

[ 2 marks]

### Question 2a

a)

During the cell cycle, there are various checkpoints the cell meets to determine if there are any errors. If an error cannot be repaired then the cell goes through cell death (apoptosis).

Scientists have developed cancer drugs that can inhibit the cell cycle and cause the cell to carry out apoptosis. **Paclitaxel** and **5-fluorouracil** are two of these cancer drugs.

- **Paclitaxel** binds to spindle microtubules preventing the spindle from performing its function
- **5-fluorouracil** prevents the synthesis of thymine nucleotides

Determine at which stages of the cell cycle these drugs would take effect and inhibit the cell cycle.

[2 marks]

[2 marks]

### Question 2b

b)

Discuss the role serendipity plays in scientific discoveries, using a named example.

[3 marks]

[3 marks]

### Question 2c

c)

Sketch a graph to illustrate which cyclin is controlling the different phases of the cell cycle.

[3 marks]

[3 marks]

## Question 2d

d)

In order to identify which phase of the cycle a cell is in, other than mitosis, biochemical analysis is used. Radioactive thymidine is one example of a biochemical used.

Suggest, giving a reason, which phase is readily identified when radioactive thymidine is used.

[2 marks]

[2 marks]

### Question 3a

a)  
A team of biologists estimated the number of cells in different phases of the cell cycle in *Saccharomyces cerevisiae* (brewer's yeast). They took two samples, **A** and **B**, from different environmental conditions. One sample came from a nutrient-rich environment, the other from a nutrient-poor environment.

Their results are shown in the table below.

Phase of the cell cycle	Sample A / number of cells counted	Sample B / number of cells counted
G <sub>1</sub>	312	451
S	203	294
G <sub>2</sub>	136	196
Mitosis	27	39
<b>Total</b>	<b>678</b>	<b>980</b>

In sample **A**, a full cell cycle took 1 hour and 35 minutes, whereas, in sample **B**, a full cell cycle took 60 minutes. Calculate the time, in minutes, that the cells in sample **A** were in S phase during one cycle. Show your working.

[2 marks]

[2 marks]

### Question 3b

b)  
The biologists studying the *Saccharomyces cerevisiae* (brewer's yeast) from part (a) hypothesised that when the yeast was exposed to stressful conditions, the growth rates were low.

Suggest, with a reason, which sample came from the nutrient-rich conditions.

[2 marks]

[2 marks]

### Question 3c

c)

The availability of nutrients is also a key factor in regulating the cell cycle of *Schizosaccharomyces pombe* (fission yeast). Below is a table containing data scientists collected for two sites which were deficient in nitrogen and phosphate.

Phase of the cell cycle	Deficient in nitrogen / number of cells counted	Deficient in phosphate / number of cells counted
G <sub>1</sub>	207	181
S	135	118
G <sub>2</sub>	90	79
Mitosis	0	0
<b>Total</b>	<b>432</b>	<b>378</b>

Deduce, giving a reason, the point at which a nutrient-poor environment would arrest the cell cycle of the *Schizosaccharomyces pombe*.

[2 marks]

[2 marks]

### Question 3d

d)

The *Saccharomyces cerevisiae* (brewer's yeast) nuclei are, on average, 2 μm in diameter, but the DNA molecules packed into them have been measured up to 355 μm in length.

Describe the process that enables the DNA molecules, that comprise the 16 chromosomes of yeast, to be packed into the nuclei.

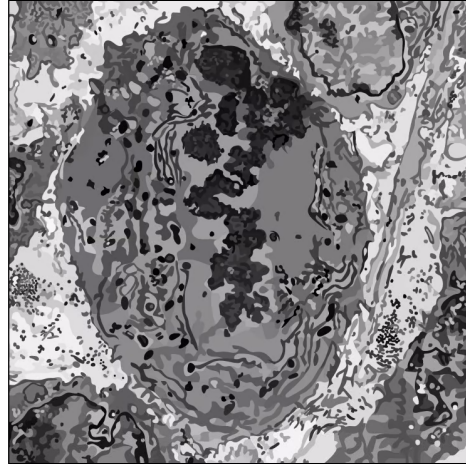
[2 marks]

[2 marks]

### Question 4a

a)

The diagram below shows a drawing of an electron micrograph of a cell undergoing mitosis.



Deduce which phase of mitosis this cell is in.

[1 mark]

[1 mark]



**Question 4b**

b)

The diagram below shows a sample of root tissue collected by a researcher.



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Calculate the mitotic index.

[2 marks]

[2 marks]

### Question 4c

c)

A student's research determined that the cell cycle of the growing tissue in a similar root as part (b) was 1,560 minutes in length, and that on average, cells spent 5 hours in the visible stages of mitosis.

Calculate the percentage difference between the data gathered by the student and the mean length of the mitotic stages found by the researcher in part (b).

[2 marks]

[2 marks]

### Question 4d

d)

Suggest **two** possible reasons why there may have been differences in the mitotic index the researcher determined and the student's value.

[2 marks]

[2 marks]

### Question 5a

*One mark is available for clarity of communication throughout this question.*

a)

MPXV is a virus that belongs in the same group as smallpox and cowpox.

Explain why viruses, such as MPXV, do not have a cell cycle.

[4 marks]

[4 marks]

### Question 5b

b)  
Some cell biologists believe that the use of the term 'cell division' should be discontinued and replaced with 'cell multiplication'.

Evaluate this claim using your knowledge of the cell cycle.

[5 marks]

[5 marks]

### Question 5c

c)  
*Human papillomaviruses* are the main cause of cervical cancer.

Explain how mutagens can interrupt the cell cycle to cause cancer.

[6 marks]

[6 marks]

