## Cell Division, Cell Diversity \& Cellular Organisation Model Answers 1

| Level | A Level |
| :--- | :--- |
| Subject | Biology |
| Exam Board | OCR |
| Module | Foundations in Biology |
| Topic | Cell Division, Cell Diversity \& Cellular Organisation |
| Booklet | Model Answers 1 |

Time allowed:

Score:

Percentage:

## 38 minutes

 /28/100

## Grade Boundaries:

| A* | A | B | C | D | E |
| :--- | :--- | :--- | :--- | :--- | :--- |
| $>69 \%$ | $56 \%$ | $50 \%$ | $42 \%$ | $34 \%$ | $26 \%$ |

## Question 1

In human cells, the tumour suppressor gene TP53 codes for a protein that interrupts the cell cycle if there is any damage to the DNA and prevents the copying of damaged DNA.

Which of the stages, $\mathbf{A}$ to $\mathbf{D}$, could TP53 interrupt the cell cycle?
A. mitosis
B. $G_{1}$
C. S
D. cytokinesis

DNA replication takes place during the $S$ phase which is when DNA is copied

## Question 2

The cell cycle includes a number of checkpoints.
Which of the following statements about the cell cycle is correct?
A. If damaged DNA is detected at a checkpoint apoptosis is triggered.
B. If damaged DNA is detected at the $\mathrm{G}_{2}$ checkpoint the cell cycle is halted and the cell tries to repair the damage.
C. If a mistake is detected at a checkpoint the cycle reverts to an earlier checkpoint and is repeated.

D The $\mathrm{G}_{1}$ checkpoint checks for mistakes in DNA replication.

The difference between G1 and G2 is essentially the checking of the newly replicated DNA

## Question 3

Sperm cells are an example of a specialised cell.


Which statement correctly describes one specialisation of a sperm cell?
A tail contains flagellum which generates ATP
B head contains chromosomes in homologous pairs
C acrosome contains enzymes to digest outer portion of egg

D midpiece contains mitochondria which enter egg

The tail dos not contain mitochondria these are in the mid-piece, the chromosomes are not in pairs as they are haploid and the only the head enters the egg

## Question 4

During cell division, the chromosome number in the cells changes.
The following sequences describe the chromosome number in cells before, during and after different types of cell division.

$24 n \rightarrow 2 n \rightarrow 4 n$


Which of the options, $\mathbf{A}$ to $\mathbf{D}$, correctly describes the stages of mitosis and meiosis in human cells?

A 1 is mitosis, 2 is meiosis
B 2 is mitosis, 3 is meiosis
C 3 is mitosis, 4 is meiosis
D 4 is mitosis, 1 is meiosis

Regardless of the type of cell division, the DNA content doubles as it replicates. Mitosis then pulls the sister chromatids apart, whilst meiosis pulls the pairs of chromosomes apart
followed by the chromatids being pulled apart

## Question 5

The haploid chromosome number in the koala, Phascolarctos cinereus, is 8.
Independent assortment of chromosomes in meiosis contributes to genetic variation in the gametes of the koala.

How many genetically different versions of koala gamete would it be possible for one individual to produce if independent assortment were the only source of genetic variation?

A 64
B 128
C 256
D 512

The number of different combinations is $2^{n}$ where n is the number of pairs of chromosomes.
In this case we are told the HAPLOID number is 8 so the DIPLOID number is 16 so there are 8 pairs of chromosomes. The number of combinations is therefore $2^{8}$ which is 256 .

## Question 6

(a) Mitosis and meiosis play an important role in the life cycles of organisms.

Fig. 2.1 and Fig. 2.2 represent an outline of the life cycles of two different organisms.


Fig. 2.1


Place a tick (3) in each row of the table to indicate the type of nuclear division that occurs at each of the letters $\mathbf{A}$ to $\mathbf{E}$.

|  | Mitosis | Meiosis |
| :---: | :---: | :---: |
| A |  | $\checkmark$ |
| B | $\checkmark$ |  |
| C | $\checkmark$ |  |


|  | Mitosis | Meiosis |
| :---: | :---: | :---: |
| D | $\checkmark$ |  |
| E |  | $\checkmark$ |

The rule book goes out of the window here. Don't rely on assumptions just look at
(b) Fig. 2.3 is a diagram that represents the different phases of the cell cycle.
$\mathbf{X}, \mathbf{Y}$ and $\mathbf{Z}$ represent checkpoints in the control of the cell cycle.


Fig. 2.3
(i) State all the letters in Fig. 2.3 that represent the phases of interphase.

G1, G2 and S
(ii) Suggest what is being checked at checkpoint $\mathbf{Y}$ on Fig. 2.3.

The DNA is being checked for any mutations

In the S or synthesis phase the DNA is replicated

G1 and G2 is when new organelles and macromolecules are made
(c) Table 2.1 indicates the relative time spent in different phases of the cell cycle for three different types of cell, $\mathbf{P}, \mathbf{Q}$ and $\mathbf{R}$.

| Cell type | Relative time spent in a phase |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | $\mathbf{G}_{\mathbf{1}} / \mathbf{G}_{\mathbf{0}}$ | $\mathbf{S}$ | $\mathbf{G}_{\mathbf{2}}$ | $\mathbf{M} / \mathbf{C}$ |
| $\mathbf{P}$ | 18 | 50 | 13 | 19 |
| $\mathbf{Q}$ | 18 | 25 | 11 | 16 |
| $\mathbf{R}$ | 100 | 0 | 0 | 0 |

Table 2.1
(i) Which of the cells $\mathbf{P}, \mathbf{Q}$ or $\mathbf{R}$ takes the shortest time to divide?

Q
The total time for $\mathbf{Q}$ is 70 which is the lowest of the three
(ii) Suggest why cell $\mathbf{P}$ spends twice as much time in phase $\mathbf{S}$ than cell $\mathbf{Q}$.

It has more DNA
(iii) What can be deduced about the behaviour of cell $\mathbf{R}$ ?

Give reasons for your answer.

- It does not progress beyond G0 or G1 / it spends all its time in G0 or G1
- It is not dividing by mitosis
- It might have already specialised
- It could be a red blood cell

Red blood cells don't have a nucleus
(d) An experiment was carried out where a student observed cells in different tissues under the microscope.

- The cells were undergoing mitosis.
- 200 cells were observed for each tissue.
- The number of cells in each stage of mitosis was recorded.

The results are shown in Table 2.2.

| Tissue <br> type$\quad$Number of cells in stage of mitosis | Total |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 55 | 7 | 73 | 200 |
| W | 85 | 59 | 6 | 50 | 200 |

Table 2.2
The student had expected that the results observed for tissue type $\mathbf{W}$ would not be significantly different from those for tissue type V.
(i) Identify the pieces of evidence in Table 2.2 that caused the student to suspect that the results for tissue type $\mathbf{W}$ might be significantly different from those for tissue type $\mathbf{V}$.
$W$ has more cells in prophase than $V$ but fewer cells in telophase

You could always include some figures for good measure, such as W has 20 more in prophase
(ii) The student decided to analyse the data using a statistical test.

A friend suggested using Student's $t$-test.
Why is Student's $t$-test not suitable for dealing with this data?
Student's $t$ test needs two or means and you can't calculate the means as there's
only two sets of data
(e) The chi-squared $\left(\chi^{2}\right)$ test can be used to analyse the data.
(i) Complete the rows for metaphase and telophase in the table below and calculate the $\chi^{2}$ value for the data.

The $\chi^{2}$ value is calculated using the following formula:

$$
\chi^{2}=\sum \frac{(O-E)^{2}}{E}
$$

| Cells | Observed <br> (O) | Expected <br> (E) | (O-E) | $(\mathbf{O - E})^{\mathbf{2}}$ | $\frac{(\mathbf{O}-\mathrm{E})^{\mathbf{2}}}{\mathrm{E}}$ |
| :--- | :---: | :---: | :---: | :---: | :---: |
| In prophase | 85 | 65 | 20 | 400 | 6.154 |
| In metaphase | 59 | 55 | 4 | 16 | 0.291 |
| In anaphase | 6 | 7 | -1 | 1 | 0.143 |
| In telophase | 50 | 73 | -23 | 529 | 7.247 |
| Total | 200 | 200 |  |  | 13.835 |

(ii) The value of chi-squared $\left(\chi^{2}\right)$ can be used to conclude whether the results for cells in tissue type $\mathbf{W}$ differ significantly from those for tissue type $\mathbf{V}$.

The number of degrees of freedom determines which row of the $\chi^{2}$ probability table is used.

The number of degrees of freedom is defined as:
the number of categories - 1
What will be the number of degrees of freedom used in this analysis?

There are 4 classes of results so that's 3 degrees of freedom
(iii) The student had expected that the results observed for tissue type $\mathbf{W}$ would not be significantly different from those for tissue type V.

Use your calculated value for $\chi^{2}$ and the information from the $\chi^{2}$ probability table below to conclude whether or not the results observed for tissue type $\mathbf{W}$ are significantly different from those for tissue type $\mathbf{V}$.

| Degrees of <br> freedom | Probability (p) |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathbf{0 . 9 9}$ | $\mathbf{0 . 9 5}$ | $\mathbf{0 . 0 5}$ | $\mathbf{0 . 0 1}$ | $\mathbf{0 . 0 0 1}$ |
| $\mathbf{1}$ | 0.00 | 0.00 | 3.84 | 6.64 | 10.83 |
| $\mathbf{2}$ | 0.02 | 0.10 | 5.99 | 9.21 | 13.82 |
| $\mathbf{3}$ | 0.11 | 0.35 | 7.82 | 11.35 | 16.27 |
| $\mathbf{4}$ | 0.30 | 0.71 | 9.49 | 13.28 | 18.47 |
| $\mathbf{5}$ | 0.55 | 1.15 | 11.07 | 15.09 | 20.52 |
| $\mathbf{6}$ | 0.84 | 1.64 | 12.59 | 16.81 | 22.46 |
| $\mathbf{7}$ | 1.24 | $\mathbf{2 . 1 7}$ | 14.07 | 18.48 | 24.32 |

- The calculated value of 13.8 is greater than the critical value of 7.82 at $p=0.05$
- The difference is significant and not due to chance
- It's 95\% certain that the results were not due to chance
- The difference is also significant at the $p=0.01$ value
- The null hypothesis is rejected

It really has to be worth learning this standard answer for $\mathrm{X}^{2}$ as it arises so often.

Look for the critical value, if it's greater than that, then the above answer applies, if it's less
than, then reverse the sequence of arguments
[Total: 17]

## Question 7

Fig. 23 shows a microscope image of a cross section taken from the stem of a sunflower, Helianthus annuus.


Fig. 23
(a) Calculate the magnification of this image.

## X 350

Measure the scale bar which should be 21 mm

Always convert to mm by multiplying by 1,000 to give 21,000
Divide this by the actual size which is $60 \mu \mathrm{~m}$
(b) (i) The cell labelled T on Fig. 23 is a parenchyma cell which carries out photosynthesis and stores starch. Suggest why cell $\mathbf{T}$ and the cells surrounding it, can be classified as parenchyma tissue.

This question is basically asking you to define the term tissue. If you're not sure then why is it in bold, if you have learned a definition of something then quote it, it can't be wrong and it it's not relevant the examiner will read through it anyway. It could pick up good marks though!
(ii) Name the two tissues labelled $\mathbf{Q}$ and $\mathbf{S}$ on Fig. 23.
Q..........................

S $\qquad$

Xylem has the large vessels, whereas phloem is always to the outside of the stem
(c) The tissues labelled $\mathbf{Q}$ and $\mathbf{S}$ in Fig. 23 are produced by mitosis from the tissue labelled $\mathbf{R}$ on Fig. 23. Identify the tissue labelled $\mathbf{R}$.
$\qquad$

Cambium consists of stem cells which are totipotent in plants. Such tissue is described as meristem.

