**Replication and Division of Nuclei and Cells (5.1): Cambridge (CIE) A Level Biology 9700 Exam Questions by Topic**

22 questions · 55 marks · about 66 minutes. Answer in the spaces, then check the mark schemes at the end.

**Question 1 · Paper 2 · February/March 2025 (22) · Q5(a) · 4 marks**

**5 (a)** Eukaryotic cells and prokaryotic cells contain DNA.

Complete the passage about DNA in eukaryotic cells and prokaryotic cells, using the most appropriate terms.

In eukaryotic cells, the DNA is located mainly in the chromosomes of the nucleus. Chromosomal DNA is associated with proteins called ..... . Two other eukaryotic cell structures that contain DNA are mitochondria and ..... .

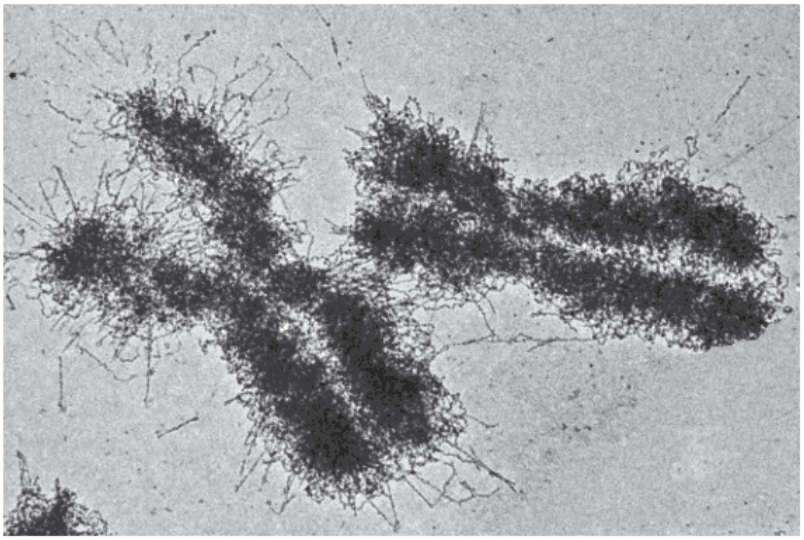
In prokaryotic cells, for example ....., the DNA is found in the ..... and is usually circular.

[4]


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**Question 2 · Paper 2 · May/June 2024 (22) · Q5(b) · 4 marks**

**(b)** Fig. 5.1 is a transmission electron micrograph of two human chromosomes at metaphase of mitosis.



magnification = ×14 000

**Fig. 5.1**

Describe the structure of chromosomes at metaphase, such as the two chromosomes shown in Fig. 5.1.

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**Question 3 · Paper 2 · October/November 2023 (22) · Q1(a) · 1 mark**

**1** During interphase and mitosis of the cell cycle, the chromosomes within a cell go through a number of changes. Each chromosome is composed of DNA complexed with proteins.

**(a)** In interphase, individual chromosomes are too diffuse (long and thin) to be visible using a microscope. In this stage, the chromosomal material is known as chromatin.

State the term used to describe the proteins that are complexed with DNA and form part of chromatin.


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**7** **(a)** Fig. 7.1 shows two chromosomes in one stage of meiosis.

The letters G to M represent the dominant alleles of seven genes and the letters g to m represent the recessive alleles of the same seven genes.

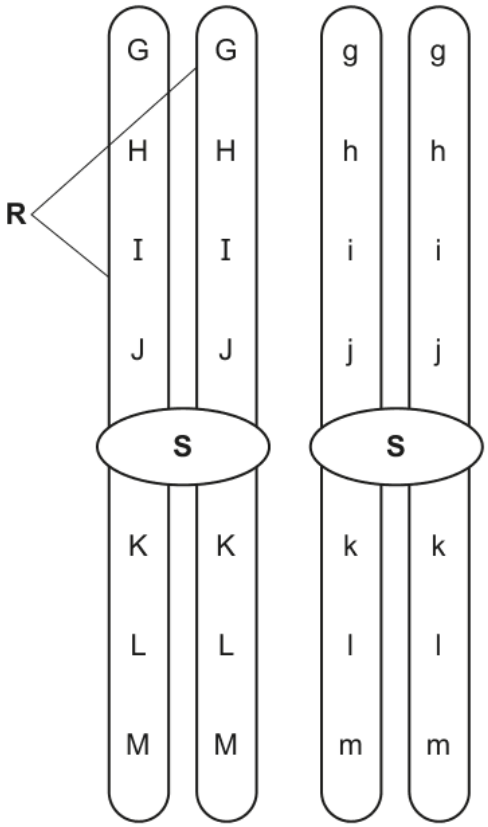



**Fig. 7.1**

**(i)** Name the structures labelled **R** and **S** on Fig. 7.1.

**R** .....

**S** .....

[2]


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**Question 5 · Paper 2 · May/June 2019 (22) · Q2(e) · 3 marks**

**(e)** The gas exchange system includes some cells that are able to divide by mitosis.

Explain why it is important to have these cells in the gas exchange system.

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**Question 6 · Paper 2 · February/March 2019 (22) · Q6(a) · 2 marks**

**6** Plant and animal cells carry out mitosis to form two genetically identical cells from one original cell.

**(a)** State **other** reasons why mitosis is important in **both** plants and animals.

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**Question 7 · Paper 2 · October/November 2018 (22) · Q3(a) · 2 marks**

**3** The response of the human body to tissue damage depends on the types of tissues involved. Epithelial tissue, liver tissue and cardiac muscle tissue each respond differently to damage.

- Epithelial tissue of the gas exchange system contains stem cells.
- Liver tissue contains cells in a non-dividing state that can enter a cell cycle when stimulated.
- Cardiac muscle tissue contains cells that cannot divide at all. Damage is permanent and is associated with scar tissue formation.

**(a)** Explain the importance of mitosis in the repair of damaged tissue.

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**Question 8 · Paper 2 · May/June 2023 (22) · Q3(c) · 3 marks**

**(c)** The cell cycle can be divided into different parts.

Complete sentences **A**, **B** and **C** to provide more information about the mitotic cell cycle.

**A** The part of the cell cycle that occurs immediately after mitosis is

.....

**B** The part of the cell cycle in which the S phase occurs is

.....

**C** The main event that occurs during the S phase is

.....

[3]


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**Question 9 · Paper 2 · October/November 2023 (22) · Q1(c) · 3 marks**

**(c)** Outline the changes that occur to the structure and behaviour of a chromosome:

- from the start of the S phase to the end of interphase
- during prophase of mitosis.

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**Question 10 · Paper 2 · October/November 2022 (22) · Q2(f) · 3 marks**

**(f)** HCMV is known to infect some types of human cell that carry out the mitotic cell cycle.

Studies have shown that in the presence of one tegument protein, UL69, the cell cycle stops in the G1 stage.

Outline the effects the presence of UL69 will have on the normal activity of the mitotic cell cycle.

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**5** Each meristem cell in a leaf bud is able to grow and divide by mitosis to produce two daughter cells that are genetically identical to each other and to the original dividing cell.

**(a)** Fig. 5.1 lists the stages in the mitotic cell cycle of a meristem cell.

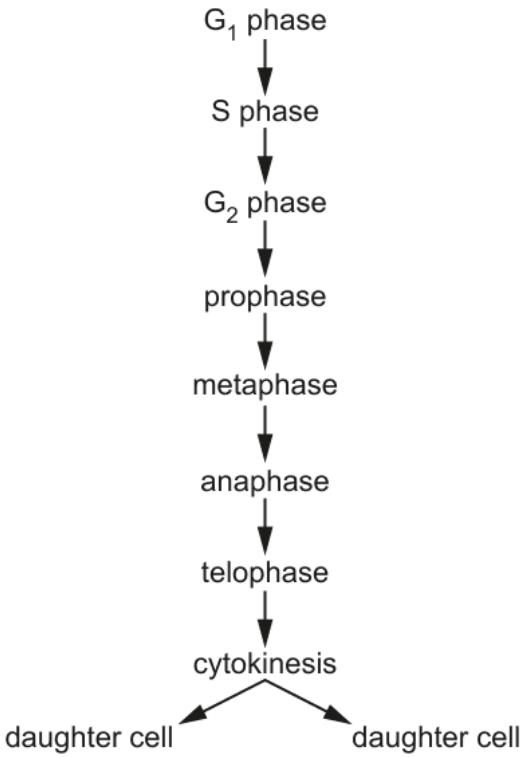



**Fig. 5.1**

**(i)** Outline **and** explain the events occurring during S phase, metaphase and anaphase of the mitotic cell cycle that are important in the production of genetically identical daughter cells.

S phase .....

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metaphase .....

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anaphase .....

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.....

[4]


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**Question 12 · Paper 2 · February/March 2021 (22) · Q5(a)(ii) · 1 mark**

**(ii)** Immediately after cytokinesis, daughter cells are **not** identical even though they are genetically identical.

Suggest a reason why daughter cells are **not** identical immediately after cytokinesis.

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.....

**Question 13 · Paper 4 (A level) · May/June 2023 (42) · Q2(c) · 1 mark**

**(c)** The production of haploid gametes by meiosis also involves division of the cytoplasm.

State the term used to describe this division of the cytoplasm.

**Question 14 · Paper 2 · February/March 2022 (22) · Q2(b) · 1 mark**

**(b)** State the role of telomeres during DNA replication.

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.....

**Question 15 · information from earlier in the question**

**(b)** Telomerase is an enzyme that is active during interphase in some cells.

Telomerase helps to maintain telomeres present on chromosomes.

**Question 15 · Paper 2 · May/June 2023 (23) · Q1(b)(ii) · 2 marks**

**(ii)** Some people with a long lifespan have cells showing a higher than normal activity of telomerase.

Suggest why a long lifespan could result from a higher telomerase activity.

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**Question 16 · Paper 2 · October/November 2019 (22) · Q6(a) · 2 marks**

**6** Telomerase is an enzyme that is important in maintaining the telomeres that are located at the ends of chromosomes.

**(a)** Explain the importance of telomeres.

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.....

**Question 17 · Paper 2 · May/June 2022 (22) · Q1(d) · 4 marks**

**(d)** Stem cells are also located in the wall of the small intestine. These cells divide by mitosis continuously.

Suggest **and** explain the importance of mitosis by stem cells in the small intestine.

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**Question 18 · Paper 2 · February/March 2022 (22) · Q2(c) · 3 marks**

**(c)** Multiple myeloma is a type of cancer in the bone marrow where some of the stem cells start to produce abnormal blood cells.

- One treatment is to collect stem cells from the bone marrow of the person with multiple myeloma. Healthy stem cells are isolated and grown in the laboratory.
- Radiation is then used to destroy all stem cells and cancerous cells in the bone marrow.
- Finally, large numbers of the healthy stem cells grown in the laboratory are returned to the bone marrow.

Suggest the role of stem cells in this treatment of multiple myeloma.

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**Question 19 · Paper 2 · October/November 2018 (22) · Q3(b) · 2 marks**

**(b)** Explain why stem cells are important in tissue repair.

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**Question 20 · Paper 2 · October/November 2024 (22) · Q4(b) · 2 marks**

**(b)** Uncontrolled cell division is a characteristic feature of tumour formation from a differentiated cell.

Describe **other** features of tumour formation from a fully differentiated cell.

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**Question 21 · Paper 4 (A level) · May/June 2020 (42) · Q1(b) · 2 marks**

**(b)** Tumours can form in the liver.

Explain how a liver tumour develops.

.....

.....

**Question 22 · Paper 2 · October/November 2016 (22) · Q5(a)(ii) · 4 marks**

**(ii)** In a person with lung cancer one or more healthy cells undergo changes to produce cancerous cells that can form a tumour.

Suggest **and** explain the cellular changes that occur in the development of lung cancer.

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## Mark schemes

**Question 1 · Paper 2 · February/March 2025 (22) · Q5(a) · 4 marks**

| | | |
|---|---|---|
| 5(a) | histones ;<br>chloroplasts ;<br>bacteria / cyanobacteria / Archaea ;<br>**accept** named prokaryote<br>cytoplasm ; | **4** |

**Question 2 · Paper 2 · May/June 2024 (22) · Q5(b) · 4 marks**

| | | |
|---|---|---|
| 5(b) | **I** *ref. to* homologous chromosomes to describe the chromosomes in Fig. 5.1<br><br>*any* ***four*** *from:*<br>each has two, sister / (genetically) identical, chromatids ;<br>**R** homologous<br>(chromatids) joined by a centromere ;<br>each chromatid has a (single) DNA molecule ;<br>**A** 2 chromatids and 2 DNA molecules<br>DNA associated with, histone proteins / histones / basic proteins ;<br>telomeres / repeating non-coding sequences, at ends of, chromatids / chromosomes ;<br>AVP ; e.g. chromosomes, highly / most, condensed | **4** |

**Question 3 · Paper 2 · October/November 2023 (22) · Q1(a) · 1 mark**

| | | |
|---|---|---|
| 1(a) | histones ; **A** basic / histone, proteins | **1** |

**Question 4 · Paper 4 (A level) · February/March 2021 (42) · Q7(a)(i) · 2 marks**

| | | |
|---|---|---|
| 7(a)(i) | **R** – (sister) chromatids ;<br>**S** – centromere ; | **2** |


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**Question 5 · Paper 2 · May/June 2019 (22) · Q2(e) · 3 marks**

| | | |
|---|---|---|
| 2(e) | *any three from:*<br><br>*to produce, new / daughter, cells…*<br>**1** that are genetically identical **;**<br>**2** to replace, old / damaged / dead, cells **; A** named cells<br>**3** to repair (damaged / injured / diseased) tissue **;**<br>**A** named tissue<br>*if mp 2 and 3 not gained, allow 1 mark for replacing damaged tissue*<br><br>**4** *ref.to* function **;** *in context*<br>**5** AVP **;** *idea of* increase in number of cells / growth, to accommodate increase in size of gas exchange system in growing infants / AW | **3** |

**Question 6 · Paper 2 · February/March 2019 (22) · Q6(a) · 2 marks**

| | | |
|---|---|---|
| 6(a) | *any **two** from:*<br><br>asexual reproduction **;**<br>growth by increase in number of cells **;**<br>(tissue) repair **;**<br>regeneration of body parts **;**<br>replacement of, dead / worn out, cells **;** | **2** |

**Question 7 · Paper 2 · October/November 2018 (22) · Q3(a) · 2 marks**

| | | |
|---|---|---|
| 3(a) | *any two from*<br>**1** (division that) produces, new / daughter, cells **A** produces more cells<br>**or**<br>(so) replaces, damaged / lost / dead, cells **;**<br><br>**2** new / daughter, cells, genetically identical **;**<br>**A** *ref. to* clone if correct context<br>**A** genetic information not lost<br>**I** same number of chromosomes<br><br>**3** (all) new cells can retain function **;** AW | **2** |

**Question 8 · Paper 2 · May/June 2023 (22) · Q3(c) · 3 marks**

| | | |
|---|---|---|
| 3(c) | **A** = cytokinesis **; A** division of the cytoplasm / cytoplasmic division<br><br>**B** = interphase **;**<br><br>**C** = DNA replication **;**<br>**A** semi-conservative replication / production of sister chromatid<br>**A** DNA, synthesis / AW<br>**I** chromatid duplication / chromatid replication | **3** |


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**Question 9 · Paper 2 · October/November 2023 (22) · Q1(c) · 3 marks**

| | | |
|---|---|---|
| 1(c) | *assume sequential interphase to prophase if not named*<br><br>*any **three** from:*<br><br>*interphase max 2*<br>(chromosomal) DNA replicates **;** **A** DNA synthesis<br>**I** chromatin<br>**R** if stated as in, G1 / G2<br><br>(each new molecule of) DNA, complexes / associates / AW, with, histones / proteins **;**<br><br>sister / identical, chromatids form, qualified **;** e.g. after (DNA) replication /during / end of, S phase<br>*must be clear they are formed before prophase*<br><br>*prophase max 2*<br>chromatids / chromosome, condense **;** **R** if also in prophase<br>**A** become(s) shorter and fatter<br>**A** coiling / supercoiling, *in context of,* DNA / chromosomes / chromatids<br>**R** chromosomes condense to form chromatin<br><br>becomes visible / appears, as two (sister / identical) chromatids **;** **I** composed of two chromatids<br><br>becomes attached to the spindle fibres **;**<br><br>(spindle) microtubules attach to centromere / kinetochore formation **;** | **3** |

**Question 10 · Paper 2 · October/November 2022 (22) · Q2(f) · 3 marks**

| | | |
|---|---|---|
| 2(f) | **I** transcription and translation stops<br><br>*any **three** from:*<br><br>**1** no, S phase / $G_2$ phase / mitosis / cytokinesis **;**<br>**A** remains in ($G_1$) interphase<br>**A** synthesis phase *for* S phase<br>**I** named mitotic stages<br>*look for* **CON** e.g. 'no S-phase, so mitosis only has one chromatid'<br><br>**2** (semi-conservative) DNA, replication / synthesis, does not occur **;**<br>**A** sister / identical, chromatids, do not form<br>**R** if a phase is stated and it is not given as the S-phase<br><br>**3** failure to pass checkpoints / does not reach checkpoints **;**<br>**A** ref. to no error checking occurs (*in context of checkpoints)*<br>**I** proofreading / error checking, (by DNA polymerase) during DNA replication<br><br>**4** cell does not, grow / increase in size / increase cytoplasm **;**<br>*(context of preparing for mitosis / cytokinesis)* **A** grows to normal (non-dividing) size<br><br>**5** *idea that* the cell does not, duplicate / synthesise, organelles / extra materials *(context is for, cytokinesis / new cells)* **;**<br>**A** centrioles do not replicate<br>**A** microtubules not synthesised<br>**R** if stated as occurring in S phase (even if e.g. $G_2$ given as well) | **3** |


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**Question 11 · Paper 2 · February/March 2021 (22) · Q5(a)(i) · 4 marks**

| | | |
|---|---|---|
| 5(a)(i) | *if one phase not attempted, max 3*<br>*any **four** from:*<br>*S phase:*<br>**1** DNA replication ;<br>explanation:<br>**2** produces two genetically identical, DNA molecules (one for each daughter cell ;<br>**A** (sister) chromatids for DNA molecules<br>**A** description of semi-conservative replication<br>*metaphase:*<br>**3** chromosomes / pairs of sister chromatids align / orientate at (spindle) equator ;<br>**A** metaphase plate for equator ;<br>*explanation:*<br>**4** chromosomes orientated so that sister chromatids will be shared out to daughter cells / AW ;<br>*anaphase:*<br>**5** centromere splits / spindle fibres shorten / AW ;<br>*explanation:*<br>**6** so that daughter chromosomes / sister chromatids / identical chromatids, move to opposite poles ;<br>**7** AVP ; e.g. ref. to checkpoints **and** ref. to error, detection / repair<br>ref. to kinetochore / centromere, and attachment to spindle fibres at, metaphase / anaphase | **4** |

**Question 12 · Paper 2 · February/March 2021 (22) · Q5(a)(ii) · 1 mark**

| | | |
|---|---|---|
| 5(a)(ii) | unequal sharing out of, cytoplasm / organelles / named organelles, (at cytokinesis) ;<br>**A** uneven sizes | **1** |

**Question 13 · Paper 4 (A level) · May/June 2023 (42) · Q2(c) · 1 mark**

| | | |
|---|---|---|
| 2(c) | cytokinesis ; | 1 |

**Question 14 · Paper 2 · February/March 2022 (22) · Q2(b) · 1 mark**

| | | |
|---|---|---|
| 2(b) | *any **one** from:*<br>prevent the loss of, genes / genetic information ; **A** prevent loss of coding DNA<br>AVP ; e.g. prevents the ends of two chromosome from fusing / joining | **1** |


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**Question 15 · Paper 2 · May/June 2023 (23) · Q1(b)(ii) · 2 marks**

| | | |
|---|---|---|
| 1(b)(ii) | *any **three** from:*<br><br>telomeres, maintained / AW, for, longer / greater length of time ;<br><br>allows increased, number of cell cycles / DNA replication cycles / AW ;<br>**A** allows, mitosis / cell division, to occur more times AW<br>**R** speeds up, mitosis / cell division / cell cycle<br><br>*idea of* prevents loss of genes (at ends of chromosomes, for a longer time) ;<br>**A** loss of, genetic information / coding DNA<br>**A** less, genes / AW, lost<br>**I** loss of genetic material<br><br>*ref.* greater ability to replace, damaged / worn out / old, cells ;<br>*in context of active for a longer time*<br><br>*idea of* cell metabolism remains optimal / cell does not go through apoptosis / AW ; | **2** |

**Question 16 · Paper 2 · October/November 2019 (22) · Q6(a) · 2 marks**

| | | |
|---|---|---|
| 6(a) | **I** maintains length of chromosomes / prevents chromosome shortening<br><br>*any two from:*<br><br>permit continued replication ;<br><br>prevent loss of genes ;<br>**I** prevents gene damage genetic material is neutral<br>**A** genetic / coded, information *for genes*<br>**A** information on DNA<br>**A** protein coding regions of DNA<br>**A** exons<br><br>protect ends of chromosomes from being, degraded / AW ;<br><br>AVP ;<br>e.g. prevents ends of chromosomes from being attached to each other<br>not mistaken for a break in DNA that needs repairing | **2** |


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1(d) *any **four** from:*

| **suggestion max 3** |
|---|
| **1** to replace, old / dead / damaged / injured, cells<br>**or**<br>to, repair / replace, damaged tissue ;<br><br>**I** repair cells<br>**I** replace old tissues |
| **2** cells are produced that can, differentiate / become specialised (into intestinal cells);<br>**I** multipotent / AW<br><br>**R** if, stated / strongly implied that, <u>all</u> cells produced by mitosis become specialised |
| **3** produce cells that are genetically identical ;<br>**A** clones<br><br>**A** identical / same, DNA / genetic material / genetic information |
| **4** growth ; **R** growth of cells |
| **5** renew / replenish / restore number of / AW, stem cells ;<br><br>**I** increase in stem cells |

**4**

| **explanation** |
|---|
| **6** *idea of* <u>function</u> in context of mp1 or 2 or 3 ;<br>e.g. repair allows tissues to function<br><br>specialisation / differentiation, allows, cells / tissue, to function<br><br>genetically identical so cells can function as a tissue |

*look for other approaches e.g.*
*'replace damaged cells that no longer function'* is mp1 and


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**Question 18 · Paper 2 · February/March 2022 (22) · Q2(c) · 3 marks**

| | | |
|---|---|---|
| 2(c) | *any **three** from:*<br>1 stem cells (grown in the lab) can undergo mitosis, ; **A** divide<br>2 stem cells are, undifferentiated **/** unspecialised ;<br>3 (when back in the person being treated) stem cells can, differentiate **/** specialise, into (all) blood cell types ;<br>**A** are multipotent<br>4 to, re-populate / replace / bring back to normal levels, the person's own blood cell supply ; **A** tissue repair | **3** |

**Question 19 · Paper 2 · October/November 2018 (22) · Q3(b) · 2 marks**

| | | |
|---|---|---|
| 3(b) | *any two from*<br>**1** cell cycle continuous / continually divide / AW ;<br>**2** (produce cells that) can, differentiate / specialise / described ;<br>**A** multipotent / pluripotent **I** totipotent<br>*divide to produce a cell that can divide and a cell that differentiates = 2 marks*<br>**3** can produce, cells / tissue, that can still function (as before) ; | **2** |

**Question 20 · Paper 2 · October/November 2024 (22) · Q4(b) · 2 marks**

| | | |
|---|---|---|
| 4(b) | *any **two** from:*<br>result of mutation **; A** example proto-oncogene to oncogene<br>tumour suppressor gene inactive<br>**I** mutation / mutated, *as a single term*<br>short(er) / fast(er) / many / continuous, cell cycle(s) / cell divisions **;**<br>**A** shorter interphase<br>**A** cells do not stop dividing **I** ref. to mitosis<br>no contact inhibition / mitosis continues beyond space available /<br>cell formation may spread to other nearby areas / AW **;**<br>ref. to normal (cell cycle) checkpoints not occurring **;**<br>**A** *idea that* substances needed for error checking not, available / functioning<br>**A** errors not checked<br>loss of (original / normal) function **; A** example **A** non-functional<br>(cell cycle continues because) fault in / errors in / no response to, cell signalling **;**<br>cells do not carry out apoptosis / no programmed cell death **;**<br>AVP **;** e.g. different cell metabolism<br>increase in telomerase (activity)<br>telomeres do not shorten as quickly<br>formation / presence, of blood vessels (feature of tumour) **A** angiogenesis<br>lack of adhesion between cells<br>ref. metastasis / described e.g. cells travel in, blood / lymph, to form tumours elsewhere in body<br>**I** ref. to tumour spread in blood | **2** |

**Question 21 · Paper 4 (A level) · May/June 2020 (42) · Q1(b) · 2 marks**

| | | |
|---|---|---|
| 1(b) | *any **two** from:*<br>1 uncontrolled mitosis / continuous cell cycle / cell cycle checkpoints not controlled ;<br>2 abnormal mass of cells formed ;<br>3 no programmed cell death / no apoptosis / cells immortal ;<br>4 AVP ; e.g. mutation of, tumour suppressor gene / (proto)oncogene | **2** |


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**(ii)** *four from*

**1** *ref. to* mutation ;

**2** further detail ; e.g.
change in sequence of, nucleotides / bases, of, DNA / gene
tumour suppressor gene, switched off / stops functioning / alters / AW
formation of oncogene
proto-oncogene altered

**3** uncontrolled, mitosis / cell division / cell replication ; AW

**4** *ref. to* changes to checkpoints / coordination of cell cycle lost ;
**A** cell does not, receive / respond to, signals (to stop dividing)

**5** loss of function / lack of differentiation / lack of specialisation / AW ;
*allow loss of function idea if referring to the mass of cells*

**6** other detail of, tumour cell / cellular changes ;
e.g. immortal / no apoptosis / no programmed cell death
no contact inhibition / grows to invade healthy tissue / AW
more protein synthesised (for growth)
(release cell signalling molecules for) vascularisation / blood vessel formation
changed size compared to normal cell size
telomeres do not shorten / AW [4]


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