Model Answers: Hard

1

The correct answer is **B** because cancerous tissues are formed as a result of uncontrolled mitotic cell division; usually as a result of loss of control of the cell cycle due to **mutations** in key genes that control when a cell divides and stops dividing.

A is incorrect as root hairs are extensions of the epidermal cells located in roots; they are **not** cells.

C is incorrect as gametes are **haploid** cells, formed by **meiosis**.

D is incorrect as antibodies are **proteins** formed by plasma cells (which themselves are produced by mitotic divisions of activated B-lymphocytes).

2

The correct answer is **B** because:

- The diagram is showing a cell in **interphase** where the chromosomes have uncoiled
- There are **20** chromosomes in this cell
- The diploid number is the full set of chromosomes an organism has in each cell, therefore the **diploid** number is 20

A is incorrect as this is the haploid number

C is incorrect as this is the number of chromatids that would occur **after replication**

D is incorrect as this is the diploid number of a human cell. The question has not said that the organism is a human therefore the assumption should not be made.

3

The correct answer is **D** because adult stem cells have already partially differentiated and therefore **limited** specialised cells can be formed from them. For example, stem cells in bone marrow can produce cells that differentiate into all the different types of blood cell.

A is incorrect as **pluripotent** stem cells (embryonic stem cells) are cells that are mostly undifferentiated and could form most specialised cells (some cells have differentiated into cells to form the embryo and foetus e.g. placental cells)

B is incorrect as totipotent cells can differentiate into **any** type of cell, they are the cells that form from fertilisation (zygote) to the 16-cell stage embryo (morula) as well as forming extra-embryonic cells that form the placenta

C is incorrect as omnipotent stem cells can only produce one cell type, they arise from multipotent stem cells

4

The correct answer is **D** as the telomeres are short repeated sequences of DNA bases (in humans this is TTAGGG). They are found at the end of chromosomes and form loops to protect DNA from deterioration or fusing with other chromosomes. Telomeres are like coding regions because they are made of the same nucleotides however they do not code for a protein and do not have DNA polymerase initiation sites.

A is incorrect as telomeres are composed of **DNA**.

B is incorrect as telomeres are at the end of the chromosomes and therefore composed of DNA nucleotides.

C is incorrect as telomeres are **not only** C/G nucleotides, although these are found in higher concentrations and therefore there would be more hydrogen bonds.

5

The correct answer is **D:**

- As the condensing (supercoiling) of the chromosomes allows alignment during metaphase to occur more easily
- Separation of the chromosomes (sister chromatids) during anaphase is easier
- Chromosomes are most condensed during metaphase

A is incorrect as condensing prevents proteins (e.g. transcription factors or enzymes) from attaching to the genes

B is incorrect as chromatin is the term used to refer to DNA and histones (proteins) that make up eukaryotic chromosomes

C is incorrect as the volume of the cell does not change whether the cell is in interphase (when the chromosome is uncoiled) or when it is undergoing mitosis

6

The correct answer is **C** because

- The presence of the methyl groups alter the pH of the histone protein (usually basic)
- DNA is acidic, as a result of histone methylation the histone is not as tightly bound, therefore the DNA is less coiled which exposes the gene sequence which can be read, transcribed and therefore expressed (it will be switched on)

A & **D** are incorrect as the change in pH of the protein will make the DNA less tightly bound resulting in the gene being switched **on**

B is incorrect as genes are only activated (on) when histones are less tightly bound

7

The correct answer is **D** because before a cell can divide by mitosis it needs to replicate its DNA (this occurs during the S phase, with S standing for 'synthesis'). Once the cell starts progressing through S phase, it is committed to dividing by mitosis. The growth factor needs to signal to initiate this process.

A is incorrect as G_1 is the phase of the cycle between the last cell division and the S phase (where DNA is replicated). During this phase the cell may carry out its normal function, or it may start making the substances it needs to divide. Growth factors that bind straight after cytokinesis won't have time to grow or synthesise proteins.

B is incorrect as this stage is at the start of mitosis where nuclear division starts to take place, therefore the growth factor signal will have already will have already been received.

C is incorrect as this is leading into the **G_2 phase** where the replicated DNA is checked and repaired and preparation for division occurs, therefore the growth factor signal will have already been received.

8

The correct answer is **B** because membrane receptor proteins have no role in controlling the division of cells.

A is incorrect as mutated **DNA repair proteins** would **reduce** the chance of corrections being made to genes that control cell division and therefore increase the chances of uncontrolled division occurring

C is incorrect as mutated **cell death proteins** would result in cells **continuing** to multiply

D is incorrect as mutated **cell adhesion proteins** could lead to alterations in the signalling between cells and could lead to metastasis (when cancerous cells travel to different parts of the body)

9

The correct answer is **C** because

- 72 base pairs x 0.52nm (the length of **each** base pair) = 37.44nm (the length of the DNA or 'long piece of string')

- Area that this ‘string’ must be packed into is 10nm, therefore 37.44 divided by 10 = **3.7**

A is incorrect as it is only **one** base pair being included in the ratio calculation.

B is incorrect as this is the length of the **DNA linker.**

D is incorrect as each base pair is 0.52nm long and if there are 72 of them then it is a multiplication **not** division.

10

The correct answer is **C** because

- **Embryonic cells** are **stem cells** and therefore are **continually** dividing and differentiating into new cells to form the organism
- **B-lymphocytes** are being **cloned** to form plasma and memory cells that can produce antibodies
- Both cells are frequently dividing and therefore will contain the enzyme **telomerase** (at low levels) to combat telomere shortening each time the cell divides

A is incorrect as B-lymphocytes are needing to be continually replicated during an immune response.

B & **D** are incorrect as heart cells do not have to be continually replicated and therefore do not contain telomerase.