



IG.B7 Chromosomes, DNA and Mitosis

EDEXCEL 4BI1 · Calculator allowed · about 45 minutes

Total Marks

Name: _____ Date: ____ / ____ / ____

Answer ALL questions. Show all your working.

- 1** Define the term 'chromosome' as used in the context of cells and inheritance. Name the subcellular location where chromosomes are found in most human cells.

(Total for Question 1 is 1 mark)

- 2** Define the term 'gene' in the context of DNA and inheritance and give one example of a characteristic a gene might influence.

(Total for Question 2 is 1 mark)

- 3** Define the term 'allele' when describing variation between individuals of the same species. Give a short example.

(Total for Question 3 is 1 mark)

- 4** Define DNA in the context of chromosomes and state its overall shape as proposed by Watson and Crick.

(Total for Question 4 is 2 marks)

- 5** Describe the components of a nucleotide, the repeating unit of DNA, as used in 4BI1 specification diagrams. Name the four bases used in DNA.

(Total for Question 5 is 2 marks)

- 6** Describe, in one sentence, Watson and Crick's model idea that explains how the two DNA strands are held together and name the complementary base pairs.

(Total for Question 6 is 2 marks)

- 7** Label the stages of mitosis in order for the diagram of a dividing animal cell: a student has drawn five boxes for the sequence after interphase. Give the five stage names in their correct order and name the final cell division process that follows in animal cells.

(Total for Question 7 is 2 marks)

- 8** State whether mitosis produces genetically identical cells or genetically different cells, and state the chromosome number term used for normal human body cells produced by mitosis.

(Total for Question 8 is 1 mark)

- 9** Describe two roles of mitosis in multicellular organisms, giving one short example for each role.

(Total for Question 9 is 2 marks)

- 10** State what is meant by the term 'diploid' and give the diploid chromosome number for a normal human somatic cell.

(Total for Question 10 is 2 marks)

- 11** Give one simple observable difference between mitosis in animal cells and mitosis in plant cells, referring to the final stage of division.

(Total for Question 11 is 1 mark)

- 12** Describe briefly how chromosomes behave during metaphase and anaphase of mitosis in an animal cell, using the terms 'chromatid', 'centromere' and 'spindle'.

(Total for Question 12 is 2 marks)

- 13** Explain how asexual reproduction by mitosis can produce genetically identical offspring, and give one advantage and one disadvantage of asexual reproduction for a species.

(Total for Question 13 is 3 marks)

- 14** Explain the importance of mitosis in multicellular organisms. Give three distinct points that together explain why mitosis is essential for these organisms.

(Total for Question 14 is 4 marks)

- 15** A human skin cell before mitosis contains 46 chromosomes. After mitosis and cytokinesis are complete, how many chromosomes will each daughter cell have, and will they be genetically identical to the original cell? Explain briefly.

(Total for Question 15 is 3 marks)

- 16** A scientist observes a tissue sample where cells are rapidly dividing by mitosis. Suggest two reasons why the rate of mitosis might be high in this tissue and give one method the scientist could use to identify cells in mitosis under a microscope.

(Total for Question 16 is 3 marks)

Mark scheme · IG.B7 Chromosomes, DNA and Mitosis

Question 1

- **B1** a structure made of DNA and protein that carries genes, found in the nucleus of cells
- **Answer: A structure of DNA and protein that carries genes; found in the nucleus**

Question 2

- **B1** a section of DNA that codes for a particular characteristic or a particular protein
- **Answer: A section of DNA that codes for a particular characteristic or protein, e.g. eye colour**

Question 3

- **B1** one of two or more alternative forms of a gene that cause variation in a characteristic
- **Answer: One of two or more alternative forms of a gene, e.g. an allele for brown eyes or an allele for blue eyes**

Question 4

- **B1** deoxyribonucleic acid, a molecule that stores genetic information in the sequence of nucleotides
- **B1** exists as a double helix made of two strands twisted around each other, as described by Watson and Crick
- **Answer: Deoxyribonucleic acid, a molecule storing genetic information; a double helix of two twisted strands**

Question 5

- **B1** a nucleotide contains a sugar (deoxyribose) and a phosphate group
- **B1** and a nitrogenous base attached to the sugar (adenine, thymine, cytosine or guanine)
- **Answer: Each nucleotide has a sugar (deoxyribose), a phosphate group and a nitrogenous base: adenine, thymine, cytosine or guanine**

Question 6

- **B1** the two strands are held together by base pairing between specific complementary bases
- **B1** adenine pairs with thymine and cytosine pairs with guanine
- **Answer: The two strands are held by specific base pairing: adenine with thymine and cytosine with guanine**

Question 7

- **B1** correct sequence of the five mitosis stages: prophase, metaphase, anaphase, telophase, cytokinesis is named as the final division process
- **B1** names cytokinesis or states cell membrane pinches in or cleavage furrow forms as the final cell division process in animal cells
- **Answer: Prophase, metaphase, anaphase, telophase, cytokinesis; the final division process is cytokinesis**

Question 8

- **B1** produces genetically identical cells and the term is diploid
- **Answer: Genetically identical cells; diploid**

Question 9

- **B1** growth, with example such as increase in number of cells during organism development or child growth
- **B1** repair, with example such as replacing skin cells after a cut or healing tissue
- **Answer: Growth, e.g. increasing cell number as an organism grows; repair, e.g. replacing skin cells after a cut**

Question 10

- **B1** diploid means having two sets of chromosomes, one from each parent
- **B1** 46 chromosomes in a normal human somatic (body) cell
- **Answer: Diploid means two sets of chromosomes; humans have 46 chromosomes in somatic cells**

Question 11

- **B1** animal cells: cleavage furrow forms and cell pinches in; plant cells: cell plate forms between daughter nuclei
- **Answer: Animal cells form a cleavage furrow and pinch in; plant cells form a cell plate to divide the cytoplasm**

Question 12

- **B1** in metaphase chromosomes (each made of two sister chromatids joined at the centromere) line up at the cell equator attached to spindle fibres
- **B1** in anaphase the spindle fibres shorten and pull sister chromatids apart at the centromere toward opposite poles
- **Answer: Metaphase: chromosomes, each with two sister chromatids joined at a centromere, line up at the equator attached to the spindle. Anaphase: spindle fibres pull chromatids apart at the centromere toward opposite poles.**

Question 13

- **B1** states that asexual reproduction involves mitosis where the nucleus divides to make genetically identical daughter cells
- **B1** advantage: rapid population increase or no need for a mate, giving quick colonisation
- **B1** disadvantage: low genetic variation, making the population vulnerable to disease or environmental change
- **Answer: Asexual reproduction uses mitosis so daughter cells inherit identical DNA, producing genetically identical offspring. Advantage: fast reproduction without a mate, allowing rapid colonisation. Disadvantage: low genetic variation so vulnerability to disease or changing conditions.**

Question 14

- **B1** growth: mitosis increases cell number so organisms can grow
- **B1** repair and replacement: mitosis replaces damaged or dead cells, restoring tissues such as skin or blood
- **B1** maintenance of chromosome number: mitosis preserves the diploid chromosome number so daughter cells have the correct genetic complement
- **B1** one additional correct significance, e.g. enables asexual reproduction in some species or produces genetically identical cells needed for specialised tissue function
- **Answer: Mitosis is important because it increases cell number for growth, replaces damaged or dead cells for repair, keeps the diploid chromosome number so daughter cells have correct genetic information, and allows asexual reproduction or production of identical specialised cells when needed.**

Question 15

- **B1** each daughter cell will have 46 chromosomes
- **B1** states they will be genetically identical to the original cell
- **B1** brief reason: mitosis replicates the chromosomes and then separates sister chromatids so each daughter gets a full set
- **Answer: Each daughter cell will have 46 chromosomes and will be genetically identical to the original cell, because mitosis copies the chromosomes and separates sister chromatids so each daughter receives the same full set.**

Question 16

- **B1** possible reason 1: tissue is growing, e.g. in a developing embryo or a growing child
- **B1** possible reason 2: tissue is repairing damage or renewing cells, e.g. healing a wound or high turnover tissue like bone marrow
- **B1** method: stain chromosomes (e.g. with a DNA stain) and look for condensed chromosomes or mitotic figures under a light microscope
- **Answer: Rate may be high because the tissue is growing (development) or repairing and renewing cells; identify mitotic cells by staining DNA and observing condensed chromosomes or mitotic figures under the microscope.**