

Unit 2

The Variety of Living Organisms

DNA & Cell Division

Practice Exam Questions

1

(a) Deoxyribonucleic acid (DNA) is a polynucleotide.

(i) State how many different types of nucleotide are found in DNA.

.....[1]

(ii) Name the components of **one** of these nucleotides.

.....
.....[3]

(b) DNA replication is described as semi-conservative. Fig. 4.1 is a diagram showing the replication of a DNA molecule.

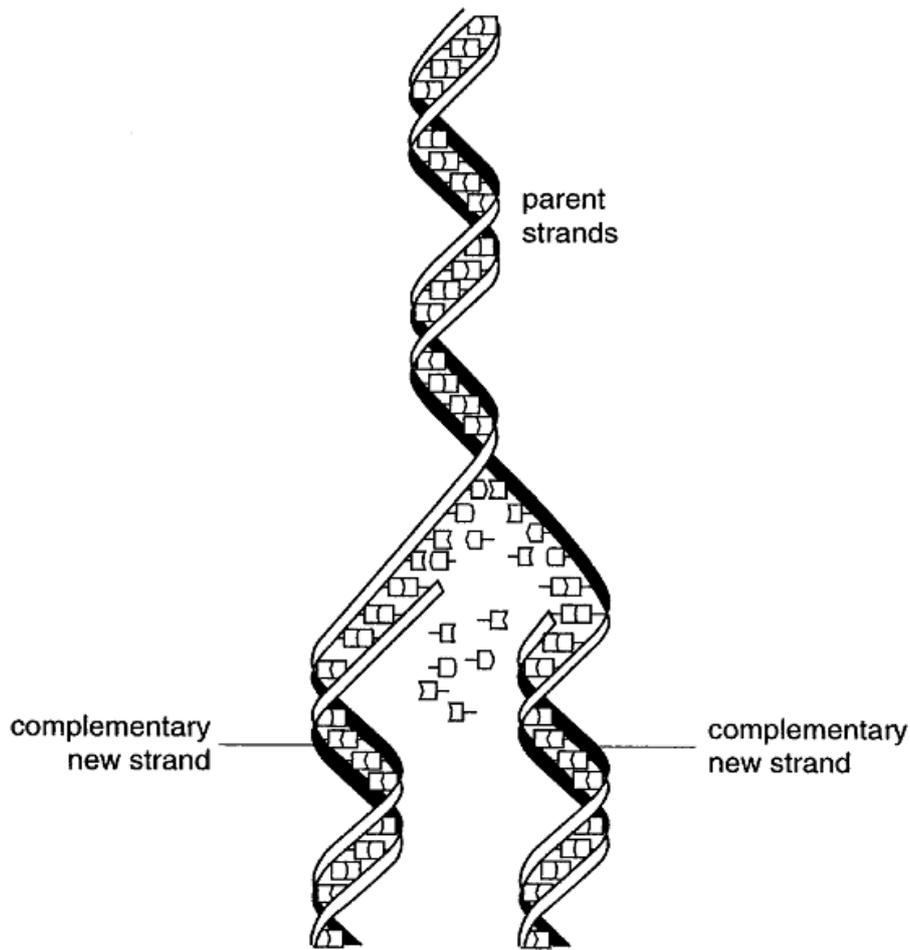


Fig. 4.1

Explain what is meant by the term *semi-conservative replication*.

.....
.....
.....
.....[3]

[Total: 7]

2

(a) Complete the following passage by using the most appropriate terms from the list to fill the gaps.

Each term should not be used more than once.

- | | | |
|----------------------|------------------------|------------------------|
| anti-parallel | β-pleated sheet | covalent |
| double helix | hydrogen | parallel |
| polypeptide | ribose | sugar-phosphate |

DNA is found in the nucleus. The molecule is twisted into a
 in which each of the strands are It has two
 backbones attached to one another by complementary
 bases. These bases pair in the centre of the molecule by means of bonds.

[4]

(b) Table 1.1 shows the relative proportions of different DNA bases in four different organisms.

Table 1.1

relative proportions of bases in DNA as a percentage				
organism	A	C	G	T
human	30.9	19.8	19.9	29.4
grasshopper	29.3	20.7	20.5	29.3
wheat	27.3	22.8	22.7	27.1
<i>E. coli</i>	24.7	25.7	26.0	23.6

(i) Describe the patterns shown by the data given in Table 1.1.

.....

[3]

4

(i) State what a gene codes for.

.....

 [1]

(ii) Suggest how changing the sequence of DNA nucleotides could affect the final product the DNA codes for.

.....

 [2]

5

(a) Name the type of nuclear division that produces two genetically identical nuclei.

..... [1]

(b) There are a number of stages during cell division.

The list, **J** to **N**, describes some processes that occur during the division of an animal cell.

J	the cell surface membrane is constricted
K	the nuclear envelope reforms
L	sister chromatids are pulled apart
M	the chromosomes condense
N	the chromosomes move to the equator

Match each letter, **J** to **N**, with a stage of cell division in the list below.

The first one has been completed for you.

- prophase **M**
- metaphase
- anaphase
- telophase
- cytokinesis

[4]

(c) During interphase the genetic material is copied.

State **two** other processes that occur during interphase.

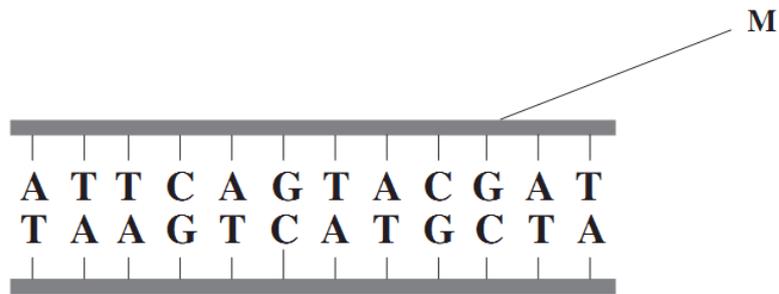
.....
.....
.....
..... [2]

(d) Suggest **two** ways that cell division in plants differs from cell division in animals.

.....
.....
.....
.....
.....
..... [2]

[Total: 9]

The diagram shows part of a DNA molecule.



(a) Name the **two** components of the part of the DNA molecule labelled **M**.

1

2

(2 marks)

(b) What is the maximum number of amino acids for which this piece of DNA could code?

(1 mark)

(c) Scientists calculated the percentage of different bases in the DNA from a species of bacterium. They found that 14% of the bases were guanine.

(c) (i) What percentage of the bases in this species of bacterium was cytosine?

Answer (1 mark)

(c) (ii) What percentage of the bases in this species of bacterium was adenine?

Answer (1 mark)

- (d) The scientists found that, in a second species of bacterium, 29% of the bases were guanine.

Explain the difference in the percentage of guanine bases in the two species of bacterium.

.....

.....

.....

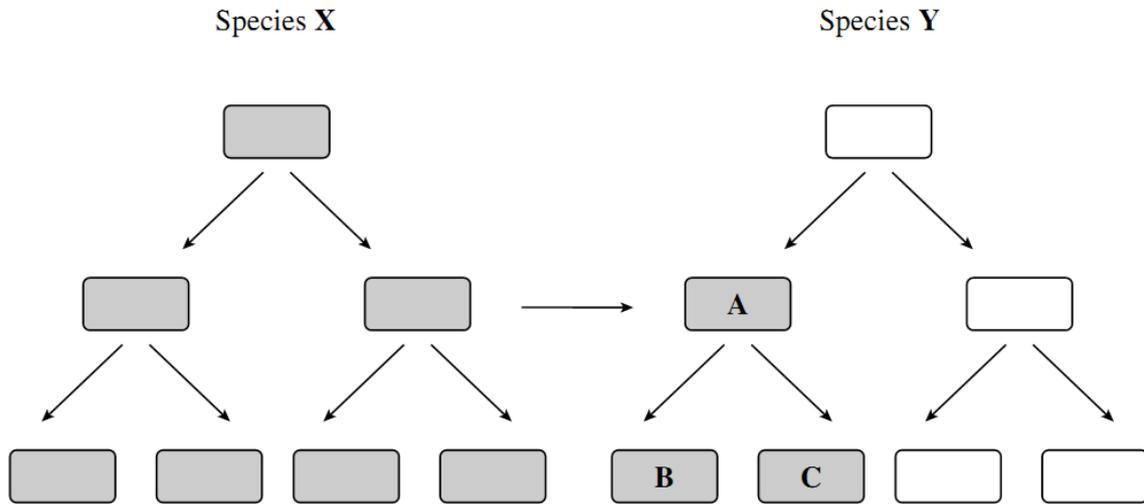
.....

(2 marks)

- (a) Give **one** way in which a DNA molecule in a prokaryote, such as a bacterium, is different from a DNA molecule in a eukaryote.

.....
.....

(1 mark)



- (b) (i) Use the diagram to explain why bacterium **A** is resistant to penicillin.

.....
.....
.....
.....
.....
.....

(3 marks)

- (b) (ii) Use the diagram to explain why bacteria **B** and **C** are resistant to penicillin.

.....
.....
.....
.....

(2 marks)

- (c) A person is infected with bacteria of species **Y**. Some of these bacteria are resistant to penicillin. A doctor gives the person a course of penicillin.

What would happen to the proportion of species **Y** bacteria that are resistant to penicillin? Explain your answer.

.....

.....

.....

.....

(2 marks)

8

(a) What name is used for the non-coding sections of a gene?

.....
 (1 mark)

Figure 1 shows a DNA base sequence. It also shows the effect of two mutations on this base sequence. **Figure 2** shows DNA triplets that code for different amino acids.

Figure 1

Original DNA base sequence	A	T	T	G	G	C	G	T	G	T	C	T
Amino acid sequence												
Mutation 1 DNA base sequence	A	T	T	G	G	A	G	T	G	T	C	T
Mutation 2 DNA base sequence	A	T	T	G	G	C	C	T	G	T	C	T

Figure 2

DNA triplets	Amino acid
GGT, GGC, GGA, GGG	Gly
GTT, GTA, GTG, GTC	Val
ATC, ATT, ATA	Ile
TCC, TCT, TCA, TCG	Ser
CTC, CTT, CTA, CTG	Leu

(b) Complete **Figure 1** to show the sequence of amino acids coded for by the original DNA base sequence. (1 mark)

(c) Some gene mutations affect the amino acid sequence. Some mutations do not. Use the information from **Figure 1** and **Figure 2** to explain

(c) (i) whether mutation 1 affects the amino acid sequence

.....

 (2 marks)

(c) (ii) how mutation **2** could lead to the formation of a non-functional enzyme.

.....

.....

.....

.....

.....

.....

(3 marks)

(d) Gene mutations occur spontaneously.

(d) (i) During which part of the cell cycle are gene mutations most likely to occur?

.....

(1 mark)

(d) (ii) Suggest an explanation for your answer.

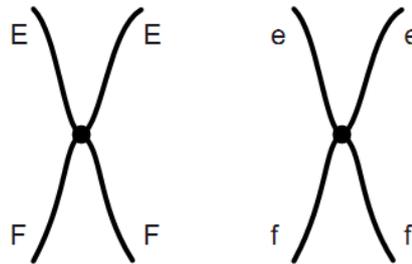
.....

.....

(1 mark)

Figure 3 shows a pair of chromosomes at the start of meiosis. The letters represent alleles.

Figure 3



(a) What is an allele?

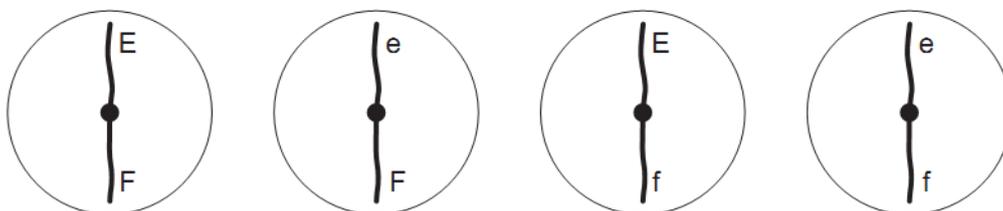
.....
.....
(1 mark)

(b) Explain the appearance of one of the chromosomes in **Figure 3**.

.....
.....
.....
.....
(2 marks)

(c) The cell containing this pair of chromosomes divided by meiosis. **Figure 4** shows the distribution of chromosomes from this pair in four of the gametes produced.

Figure 4



- (c) (i) Some of the gametes formed during meiosis have new combinations of alleles. Explain how the gametes with the combinations of alleles Ef and eF have been produced.

.....

.....

.....

.....

(2 marks)

- (c) (ii) Only a few gametes have the new combination of alleles Ef and eF. Most gametes have the combination of alleles EF and ef. Suggest why only a few gametes have the new combination of alleles, Ef and eF.

.....

.....

(1 mark)

- (d) **Figure 5** shows a cell with six chromosomes.

Figure 5

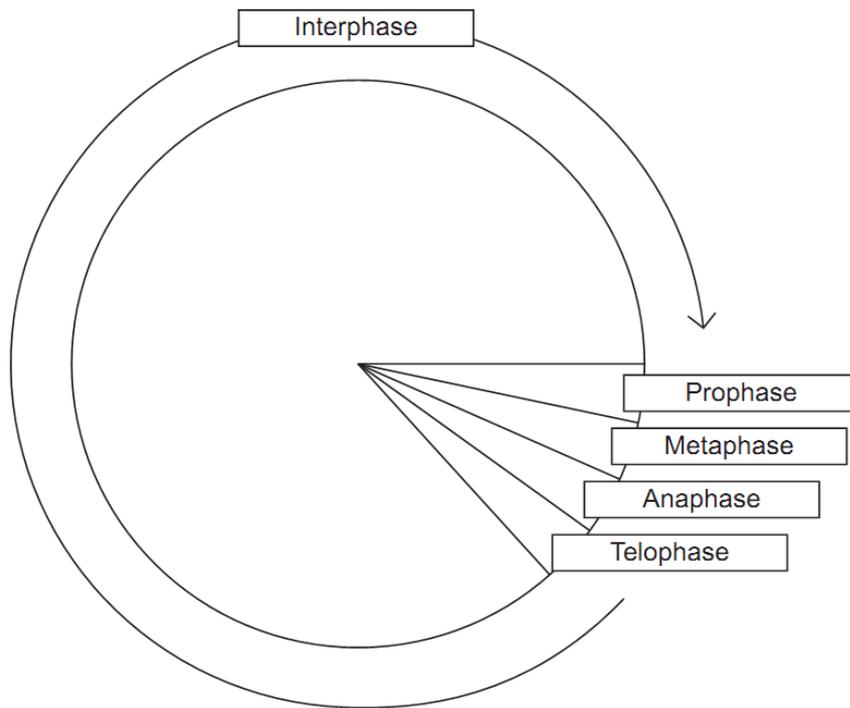


- (d) (i) This cell produces gametes by meiosis. Draw a diagram to show the chromosomes in one of the gametes.

(2 marks)

- (d) (ii) How many different types of gametes could be produced from this cell as a result of different combinations of maternal and paternal chromosomes? (1 mark)

The diagram shows a cell cycle.



(a) In prophase of mitosis, the chromosomes become visible. Describe what happens in

(a) (i) metaphase

.....
.....
.....
.....
.....

(2 marks)

(a) (ii) anaphase.

.....
.....
.....
.....
.....

(2 marks)

- (b) (i) Cells lining the human intestine complete the cell cycle in a short time. Explain the advantage of these cells completing the cell cycle in a short time.

.....
.....
.....

(1 mark)

- (b) (ii) The time required for a cell to complete the cell cycle was 4 hours 18 minutes. Calculate the time required in minutes for this cell to multiply to produce eight cells. Show your working.

Answer

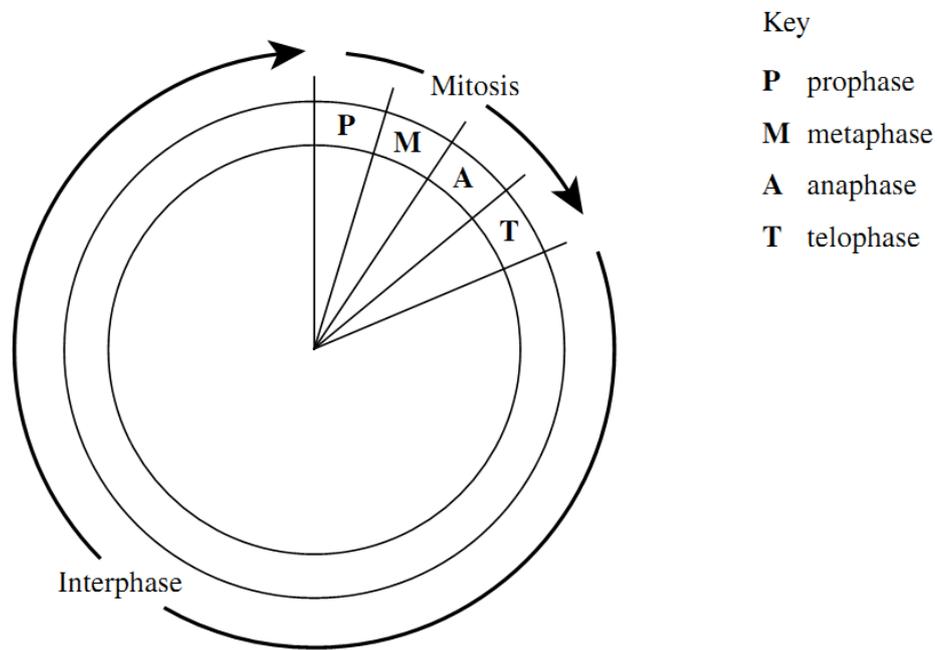
(2 marks)

- (c) Mikanolide is a drug that inhibits the enzyme DNA polymerase. Explain why this drug may be effective against some types of cancer.

.....
.....
.....
.....
.....

(2 marks)

The diagram shows a cell cycle.



- (a) The table shows the number of chromosomes and the mass of DNA in different nuclei. All the nuclei come from the same animal. Complete this table.

Nucleus	Number of chromosomes	Mass of DNA / arbitrary units
At prophase of mitosis	26	60
At telophase of mitosis		
From a sperm cell		

(4 marks)

- (b) If the DNA of the cell is damaged, a protein called p53 stops the cell cycle.

Mutation in the gene for p53 could cause cancer to develop. Explain how.

.....

.....

.....

.....

.....

.....

(3 marks)

(c) Drugs are used to treat cancer. At what phase in the cell cycle would each of the following drugs act?

(c) (i) A drug that prevents DNA replication

.....
(1 mark)

(c) (ii) A drug that prevents spindle fibres shortening

.....
(1 mark)

The diagram shows a short sequence of DNA bases.

T T T G T A T A C T A G T C T A C T T C G T T A A T A

- (a) (i) What is the maximum number of amino acids for which this sequence of DNA bases could code?

(1 mark)

- (a) (ii) The number of amino acids coded for could be fewer than your answer to part (a)(i). Give **one** reason why.

.....

.....

(1 mark)

- (b) Explain how a change in the DNA base sequence for a protein may result in a change in the structure of the protein.

.....

.....

.....

.....

.....

.....

(3 marks)

- (c) A piece of DNA consisted of 74 base pairs. The two strands of the DNA, strands **A** and **B**, were analysed to find the **number** of bases of each type that were present. Some of the results are shown in the table.

	Number of bases			
	C	G	A	T
Strand A	26			
Strand B	19		9	

Complete the table by writing in the missing values.

(2 marks)

DNA & Cell Division Answers and Markscheme

Question 1

- (a) (i) 4 ; 1
- (ii) deoxyribose ; **NOT** ribose
phosphate ;
nitrogen(ous) / organic / named , base ; **A** purine / pyrimidine
NOT uracil
NOT letter
NOT thiamine / thiamine
- take a correct base from a list unless that list includes uracil 3
- (b) 1 2 , molecules / helices , (of DNA) produced ;
 2 identical (molecules of DNA produced) ;
 3 (each made up of) 1 , original / parent / old , strand ;
 4 1 new strand ;
 5 original / parent / old , strands , act as template / described ;
 6 ref to (free DNA) nucleotides ; 3 max

[Total: 7]

Question 2

(a)	double helix ; anti-parallel ; sugar-phosphate ; hydrogen ;	4	
(b)	(i) percentages / amount , C & G similar (in all organisms) ; percentages / amount , A & T similar (in all organisms) ; different / named , organisms have different proportions of , bases / named base / AW ; greatest similarity between human and grasshopper ; least similarity between <i>E coli</i> and the other three ; <i>E. coli</i> has similar proportions of all bases / <i>E.coli</i> has slightly more CG than AT / (named) eukaryote has more AT than CG ; comparative figs with units to support any statement ;	3 max	mp 1 & 2 DO NOT CREDIT ref to a single organism mp 1 & 2 IGNORE ref to complementary DO NOT CREDIT statements in context of organism size e.g. statement that human has more A than <i>E. coli</i> / human has the most AT / <i>E. coli</i> has the most CG This mark is for a general statement e.g. human C = 19.8% <u>and</u> G = 19.9% human A = 30.9% <u>and</u> <i>E. coli</i> A = 24.7% 'human has more A (30.9%) than wheat (27.3%)' = 2 (mp 3 & 7)
(b)	(ii) (suggests) A , bonds / pairs / links / connects / joins , to T ; (suggests) C , bonds / pairs / links / connects / joins , to G ; (suggests) purine bonds to pyrimidine ; (evidence for) complementary base pairing / which bases pair with each other / base pairing rules ; suggests bases point 'inwards' rather than 'outwards' ;	2 max	IGNORE A – T or A = T unqualified IGNORE C – G or C = G unqualified ACCEPT 'bond' instead of 'pair'

Question 3

	1	untwist / unwind ;		1 DO NOT CREDIT unravel
S	2	unzip / described ;		2 DO NOT CREDIT strands separating without qualification
S	3	H bond breaks ;		
	4	both strands act as template ;		
N	5	(aligning of) free (DNA) <u>nucleotides</u> ;		5 DO NOT CREDIT bases
N	6	<u>complementary</u> , base / nucleotide, pairing ;		6 & 7 Do not consider for QWC if mark awarded in the context of breaking apart or DNA structure only, rather than forming new double helix
N	7	C to G <u>and</u> T to A / purine to pyrimidine ;		
R	8	hydrogen bonds reform ;		
R	9	sugar-phosphate back bone forms ;		
R	10	(using) covalent / phosphodiester, bond ;		
	11	<u>semi-conservative</u> replication ;		
	12	DNA polymerase ;		12 CREDIT at any stage in the process
	13	AVP ;		13 e.g. ligase / helicase / gyrase used in correct context C – G 3 H bonds / T – A 2 H bonds activation of free nucleotides (with 2 phosphates) synthesis in the 5' to 3' direction Okazaki fragments on lagging strand
			6 max	
		QWC - correct sequence – 1 S mark, then 1 N mark, then 1 R mark ;	1	It should be clear that candidate realises that the sequence is S, then N then R – even if not written in that order DO NOT CREDIT if any ref to transcription / translation

Question 4

(i)	polypeptide / protein / primary structure / a sequence of amino acids ;	1	DO NOT CREDIT 'codes for an amino acid' IGNORE enzyme / named protein
(ii)	different, sequence of amino acids / primary structure / AW ; different protein / protein folds up differently / different tertiary structure ; (product) no longer functions / different function ;	2 max	DO NOT CREDIT 'product' or incorrect biochemical (e.g. carbohydrate) ACCEPT suitable example, e.g. active site of enzyme no longer complimentary to substrate

Question 5

(a)	mitosis / mitotic division ;	1	DO NOT CREDIT meiosis, miosis ACCEPT mytosis
(b)	N ; L ; K ; J ;	4	Mark the first answer for each stage. If the first answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks .
(c)	1 checking, genetic material / DNA / chromatin / chromosome(s) / genes, (for errors) ; 2 protein synthesis ; 3 synthesis / replication / increase in number of, organelles / named organelle ; 4 ATP production / respiration ; 5 <u>cell</u> growth / increase in <u>cell</u> , volume / size ;	2 max	Mark the first two suggestions only. IGNORE DNA , replication / synthesis ACCEPT checking for mutations DO NOT CREDIT check for <i>cell</i> mutations ACCEPT named step e.g. transcription / translation / described CREDIT one named organelle only ACCEPT centriole as organelle IGNORE organelle growth IGNORE release energy DO NOT CREDIT produce / create, energy (in form of ATP) IGNORE cytoplasm replicates

5 continued:

(d)	<p><i>in plant</i></p> <p>(cell), plate / wall, forms (between new cells) ;</p> <p><i>idea of :</i> cytokinesis starts from middle of cell ;</p> <p>(only) occurs in meristem ;</p> <p>no centrioles ;</p> <p>AVP ;</p>	2 max	<p>Mark the first <u>two</u> suggestions only. Read as prose unless candidate has indicated two points by bullets or numbers – in this case mark the first comment in each bullet.</p> <p>Assume response refers to plants unless stated otherwise. Accept reverse argument for animals. CREDIT in animal no cell plate IGNORE plants have cell walls unqualified</p> <p>ACCEPT cytokinesis starts at outer edge in animals</p> <p>ACCEPT cambium / specialised tissues / cells IGNORE ref (root) cap, root tip / shoot tip CREDIT in animals most, cells / tissues, can divide</p> <p>ACCEPT centrioles not used to pull chromatids apart DO NOT CREDIT no spindle fibres in plants</p> <p>e.g. nuclear envelope does not reform in most plant cells in telophase I (it does form in most animal cells)</p>
Total		9	

Question 6

Part	Sub Part	Marking Guidance	Mark	Comments
(a)		Phosphate; Deoxyribose;	2	Q Candidates must specify deoxyribose. This term is a specification requirement. Ignore anything that is not incorrect.
(b)		4;	1	
(c)	(i)	14;	1	
(c)	(ii)	36;	1	If (c)(i) incorrect accept [50 – (c)(i)]
(d)		Different proteins; Different genes; Different (DNA) base sequences;	2 max	

Question 7

Part	Sub Part	Marking Guidance	Mark	Comments
(a)		(Prokaryotic DNA) is circular/in a loop/not associated with proteins/not in chromosomes/does not contain introns/does not contain junk DNA/shorter;	1	It refers to prokaryote
(b)	(i)	<u>Horizontal</u> transmission; Plasmid/DNA/gene for resistance; (Plasmid/gene/DNA) passed on by conjugation;	3	Q To gain first marking point, reference must be made to horizontal
(b)	(ii)	DNA/gene/plasmid is replicated/copied; Passed on to B and C when cell A divides/vertical gene transmission;	2	Q Reject second marking point if candidate refers to mitosis. Accept clones/multiplies
(c)		Penicillin kills non-resistant bacteria/resistant bacteria survive/are not destroyed; Resistant bacteria reproduce <u>and</u> increase in proportion;	2	Ignore ref to mitosis. Penalise ref to immunity once only.

Question 8

Part	Sub Part	Marking Guidance	Mark	Comments
(a)		Introns;	1	
(b)		Ile Gly Val Ser;	1	
(c)	(i)	Has no effect / same amino acid (sequence) / same primary structure;	1	Q Reject same amino acid formed or produced.
		Glycine named as same amino acid;	1	It still codes for glycine = two marks.
(c)	(ii)	Leu replaces Val / change in amino acid (sequence)/primary structure;	1	3 max
		Change in hydrogen/ionic bonds;	1	Q Different amino acid formed or produced negates first marking point.
		Alters tertiary structure/active site;	1	Active site changed must be clear for third marking point but does not need reference to shape.
		Substrate cannot bind / no longer complementary / no enzyme-substrate complexes form;	1	
(d)	(i)	Interphase/ S/synthesis (phase);	1	
(d)	(ii)	DNA/gene replication/synthesis occurs / longest stage;	1	Allow 'genetic information' = DNA. Allow 'copied' or 'formed' = replication/synthesis

Question 9

(a)		(Different) form/type/version of a gene / different base sequence of a gene;	1	
(b)		Two/sister <u>chromatids</u> ;	1	2 max
		Due to <u>DNA</u> replication;	1	
		Joined by a <u>centromere</u> ;	1	
(c)	(i)	Crossing over;	1	Negate first marking point for answers which refer to independent segregation. Chiasma/chiasmata = first marking point
		Exchange (of alleles) between chromatids/chromosomes;	1	
(c)	(ii)	Is infrequent/rare;	1	References to it being 'random', 'occurs by chance' or 'doesn't always occur' should not be credited without a clear idea that it is rare or infrequent.
(d)	(i)	Three chromosomes shown;	1	For first mark point allow drawings showing three chromosomes as single or double structures.
		One from each homologous pair;	1	
(d)	(ii)	8;	1	

Question 10

(a)(i)	Spindle formed / chromosome/centromere/chromatids attaches to spindle; Chromosomes/chromatids line up/move to middle/equator (of cell);	2	Do not award second mark for answers referring to chromosomes 'pairing up'. Ignore reference to homologous chromosomes unless context suggests pairing which negates second mark. Neutral: Details on nuclear membrane. Accept: Diagram for second marking point
(a)(ii)	Chromosome/centromere splits / chromatids/ 'chromosomes' separate/pulled apart; To (opposite) sides/poles centrioles (of cell);	2	Reject: Homologous chromosomes separate for first marking point. Accept: Diagram for second marking point. Chromatids/ 'chromosomes' move to poles/sides/centrioles = 2 marks.
(b)(i)	Form/replace cells quickly/rapidly / divide/multiply/replicate rapidly;	1	Neutral: Repair cells. Answers must convey idea of 'speed'.
(b)(ii)	Correct answer = 774 minutes/ 12 hours 54mins = 2 marks;; Incorrect answer but indicates 3 cell cycles involved = one mark;	2	
(c)	Prevents/slows DNA replication/doubling; Prevents/slows <u>mitosis</u> ; New strand not formed / nucleotides(of new strand) not joined together / sugar-phosphate bonds not formed;	2	First marking point must be in context of DNA replication not cell replication. Do not negate first marking point if role of DNA polymerase is described incorrectly e.g. Reject: 'joins bases/strands together'. Role of DNA polymerase must be correct for last marking point.

Question 11

Part	Sub Part	Marking Guidance	Mark	Comments									
(a)		<table border="1"> <thead> <tr> <th>Nucleus</th> <th>Number of chromosomes</th> <th>Mass of DNA/arbitrary units</th> </tr> </thead> <tbody> <tr> <td>At telophase of mitosis</td> <td>26;</td> <td>30;</td> </tr> <tr> <td>From a sperm cell</td> <td>13;</td> <td>15;</td> </tr> </tbody> </table>	Nucleus	Number of chromosomes	Mass of DNA/arbitrary units	At telophase of mitosis	26;	30;	From a sperm cell	13;	15;	4	
		Nucleus	Number of chromosomes	Mass of DNA/arbitrary units									
		At telophase of mitosis	26;	30;									
From a sperm cell	13;	15;											
Cancer cells often have faulty/damaged DNA;													
Protein/p53 faulty/not made;													
Cell (with faulty /DNA) divides/completes cell cycle;													
Uncontrolled division produces cancer;													
(b)			3	p53 refers to the protein so do not accept reference to p53 mutating.									
(c)	(i)	Interphase/S phase/synthesis phase;	1										
(c)	(ii)	Anaphase/A;	1										

Question 12

(a)(i)	9;	1	Accept: nine																			
(a)(ii)	Introns / non-coding DNA / junk DNA; Start/stop code/triplet;	1 max	Neutral: Repeats. Accept: 'Introns and exons present'. Reject: 'Due to exons'.																			
(b)	Change in amino acid/s /primary structure; Change in hydrogen/ionic/ disulfide bonds; Alters tertiary structure;	3	Reject: 'Different amino acid is formed' – negates first marking point. Neutral: Reference to active site.																			
(c)	<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="4">Number of bases</th> </tr> <tr> <th>C</th> <th>G</th> <th>A</th> <th>T</th> </tr> </thead> <tbody> <tr> <td>Strand A</td> <td>26</td> <td>19</td> <td>20</td> <td>9</td> </tr> <tr> <td>Strand B</td> <td>19</td> <td>26</td> <td>9</td> <td>20</td> </tr> </tbody> </table> <p>Second column correct; Columns three and four correct;</p>		Number of bases				C	G	A	T	Strand A	26	19	20	9	Strand B	19	26	9	20	2	
	Number of bases																					
	C	G	A	T																		
Strand A	26	19	20	9																		
Strand B	19	26	9	20																		