Nucleic acids 1

Level: AQA A Level 7402
Subject: Biology
Exam Board: Suitable for all boards
Topic: Nucleic acids 1
Type: Mark Scheme

To be used by all students preparing for AQA A Level Biology 7402 foundation or higher tier but also suitable for students of other boards.

Mark schemes

1

(a) Box around single nucleotide. **1**

(b)

DNA strand	Percentage of each base			
	A	C	G	T
Strand **1**	(16)	**34**	**21**	**29**
Strand **2**	**29**	(21)	(34)	**16**

2 rows correct = 2 marks;
1 row correct = 1 mark.

2

(c)
1. Reference to DNA polymerase;
2. (Which is) specific;
3. Only complementary with / binds to 5' end (of strand);

Reject hydrogen bonds / base pairing

4. Shapes of 5' end and 3' end are different / description of how different.

4

[7]

2

(a) Presence of resistant and non-resistant varieties / mutation produces resistant variety;
Resistant ones survive / non-resistant ones killed by treatment;
These will reproduce and produce more resistant parasites / pass on resistance allele;

3

(b) Likelihood of being infected (by strain resistant to both drugs) is less;
1/500 × 1/500/1/250 000;
Drug has longer effective life;

max 2

(c) (i) As comparison / to show that nothing else in the treatment was responsible;

1

(ii) Given injections of saline / injection without SPf66;
(otherwise) treated the same as experimental group;

2

(d) (i) 100%;

1

(ii) 10%;

1

(e) (i) Different lengths of DNA have different base sequences / cut at specific sequence;
Results in different shape / different shape of active site;
Therefore (specific sequence) will only fit active site of enzyme;

3

(ii) Recognition sites contain only AT pairs;
Which would occur very frequently;

2

[15]

3 **Essay Using DNA in science and technology**

DNA and classification

2.2 Structure of DNA

2.3 Differences in DNA lead to genetic diversity

2.9 Comparison of DNA base sequences

Genetic engineering and making useful substances

2.5 Plasmids

5.8 The use of recombinant DNA to produce transformed organisms that benefit humans

Other uses of DNA

2.5 Cell cycle and treatment of cancer

5.8 Gene therapy;

Medical diagnosis and the treatment of human disease;

The use of DNA probes to screen patients for clinically important genes.

4 (a) 1. Separates / unwinds / unzips strands / helix / breaks H-bonds;

*1. **Q** Neutral: strands / helix split*

1. Accept: unzips bases

2. (So) nucleotides can attach / are attracted / strands can act as templates;

*2. **Q** Neutral: bases can attach*

2. Neutral: helix can act as a template

2

(b)

Sample	Type(s) of DNA molecule present in each tube		
	$^{15}N/^{15}N$	$^{15}N/^{14}N$	$^{14}N/^{14}N$
1	✓		
2		✓	
3		✓	✓

One mark for each correct row

3

(c) (i) 1. Similar shape / structure (to cytosine) / added instead of cytosine / binds to guanine;

1. Accept: idea that only one group is different

1. Reject: same shape

2. Prevents (complementary) base pairing / prevents H-bonds forming / prevents formation of new strand / prevents strand elongation / inhibits / binds to (DNA) polymerase;

2. Accept: prevents cytosine binding

Neutral: 'prevents DNA replication' as given in the question stem

Neutral: 'competitive inhibitor' unqualified

Neutral: inhibits DNA helicase

2

(ii) (Cancer cells / DNA) divide / replicate fast(er) / uncontrollably;

Accept: converse argument for healthy cells

1

[8]

5

(a) 1. Strands separate / H-bonds break;

*1. **Q** Neutral: strands split*

1. Accept: strands unzip

2. DNA helicase (involved);

3. Both strands / each strand act(s) as (a) template(s);

4. (Free) nucleotides attach;

4. Neutral: bases attach

4. Accept: nucleotides attracted

5. Complementary / specific base pairing / AT and GC;

6. DNA polymerase joins nucleotides (on new strand);

6. Reject: if wrong function of DNA polymerase

7. H-bonds reform;

8. Semi-conservative replication / new DNA molecules contain one old strand and one new strand;

8. Reject: if wrong context e.g. new DNA molecules contain half of each original strand

6 max

(b) (i) 18;

Do not accept 17.5

1

(ii) 10;

1

(iii) 1. Horizontal until 18 minutes;
Allow + / - one small box

2. (Then) decreases as straight line to 0 μm at 28 minutes;
2. Allow lines that start from the wrong place, ending at 0 at 28 minutes

2

(c) (i) Two marks for correct answer of 19.68 or 19.7;;
Accept 19hrs 41mins

One mark for incorrect answers in which candidate clearly multiplies by 0.82;
Allow one mark for incorrect answers that clearly show 82% of 24 (hours)

2

(ii) 1. No visible chromosomes / chromatids / visible nucleus;

1

(iii) **D** (no mark)

1. Lower % (of cells) in interphase / higher % (of cells) in mitosis / named stage of mitosis;
1. Accept: 'less' or 'more' instead of '%'
1. Do not accept: higher % (of cells) in each / all stage(s)

2. (So) more cells dividing / cells are dividing quicker;
2. Accept: uncontrolled cell division
*2. Do not award if Tissue **C** is chosen*

2

[15]

6 (a) nucleotide;

1

(b) (i) 21.4, 21.4; 28.6;

2

(ii) amounts of A and T / C and G / complementary bases different;
therefore no base-pairing;

2 max

[5]

7 (a) (i) substances / molecules have more (kinetic) energy / moving faster;
(reject vibrate)

increased collisions / enzyme substrate complexes formed;

2

(ii) causes denaturation / tertiary structure / shape change / H^+ / ionic bonds break;
(shape) of active site changed;
substrate no longer binds / not complementary to (active site);

3

(b) all substrate changed into product / reaction is complete;
same amount of product formed as same initial substrate concentration;

2

[7]

8

(a) 1. Sugar-phosphate (backbone) / double stranded / helix **so** provides strength / stability / protects bases / protects hydrogen bonds;

Must be a direct link / obvious to get the mark

Neutral: reference to histones

2. Long / large molecule **so** can store lots of information;

3. Helix / coiled **so** compact;

Accept: can store in a small amount of space for 'compact'

4. Base sequence allows information to be stored / base sequence codes for amino acids / protein;

Accept: base sequence allows transcription

5. Double stranded **so** replication can occur semi-conservatively / strands can act as templates / complementary base pairing / A-T and G-C so accurate replication / identical copies can be made;

6. (Weak) hydrogen bonds **for** replication / unzipping / strand separation / many hydrogen bonds **so** stable / strong;

Accept: 'H-bonds' for 'hydrogen bonds'

6

(b) 1. (Mutation) in **E** produces highest risk / 1.78;

2. (Mutation) in **D** produces next highest risk / 1.45;

3. (Mutation) in **C** produces least risk / 1.30;

Must be stated directly and not implied

E *>* ***D*** *>* ***C*** *= 3 marks*

Accept: values of 0.78, 0.45 and 0.30 for MP1, MP2 and MP3 respectively

If no mark is awarded, a principle mark can be given for the idea that all mutant alleles increase the risk

3

(c) **180**;

1

(d) **(Similarities):**

1. Same / similar pattern / both decrease, stay the same then increase;

2. Number of cells stays the same for same length of time;

Ignore: wrong days stated

(Differences):

(Per unit volume of blood)

3. Greater / faster decrease in number of healthy cells / more healthy cells killed / healthy cells killed faster;

Accept: converse for cancer cells

Accept: greater <u>percentage</u> decrease in number of cancer cells / greater <u>proportion</u> of cancer cells killed

4. Greater / faster increase in number of healthy cells / more healthy cells replaced / divide / healthy cells replaced / divide faster;

Accept: converse for cancer cells

*For **differences**, statements made must be comparative*

3 max

(e) 1. More / too many healthy cells killed;

2. (So) will take time to replace / increase in number;

Neutral: will take time to 'repair'

3. Person may die / have side effects;

2 max

[15]

9

(a)
1 two strands therefore semi-conservative replication (possible);
2 base pairing / hydrogen bonds holds strands together
3 hydrogen bonds weak / easily broken, allow strands to separate;
4 bases (sequence) (exposed so) act as template / can be copied;
5 A with T, C with G / complementary copy;
6 DNA one parent and one new strand;

4 max

(b)
1 chromosomes shorten / thicken / supercoiling;
2 chromosomes (each) two <u>identical</u> chromatids / strands / copies (due to replication);
3 chromosomes / chromatids move to equator / middle of the spindle / cell;
4 attach to individual spindle fibres;
5 spindle fibres contract / centromeres divide / repel;
6 (sister) chromatids / chromosomes (separate) move to opposite poles / ends of the spindle;
7 each pole / end receives all genetic information / identical copies of each chromosome;
8 nuclear envelope forms around each group of chromosomes / chromatids / at each pole;

7 max

(c) cancer cells killed, normal body cells survive;
cancer cells low oxygen (as blood supply cannot satisfy demand);

2

[13]

10 (a) (i) base / named bases;

reject nucleotide or uracil

1

(ii) it has been produced by semi-conservative replication / one old strand and one new;
One strand has ^{15}N bases and the other ^{14}N;

Accept light / heavy N (therefore) it is less dense / lighter;

2

(iii) one band is in same position as generation 1;
one band higher;
accept a line. N.B. need a visible gap

2

(b) (i) A = 31 and JT = 31;
C = 19;

2

(ii) viral DNA single-stranded / not double-stranded;
evidence from table e.g. not equal amount of A and T / C and G / all different;

2

*ignore no base-pairing In this **Question** assume It' means viral DNA*

[9]

11 (a) (i) (Molecule) made up of many identical / similar molecules / monomers / subunits;

Not necessary to refer to similarity with monomers.

1

(ii) Cellulose / glycogen / nucleic acid / DNA / RNA;

1

(b) (i) To keep pH constant;
A change in pH will slow the rate of the reaction / denature the amylase / optimum for reaction;

2

(ii) Purple / lilac / mauve / violet;
Do not allow blue or pink.

1

(iii) Protein present / the enzyme / amylase is a protein;
Not used up in the reaction / still present at the end of the reaction;

2

[7]

12 (a) 1. Degenerate: more than one (base) triplet for each amino acid;

2. Non-overlapping: each base is part of only one triplet.

Accept codon (as would be applicable to mRNA code)

2

(b) A = adenine

C = cytosine

G = guanine

U = uracil

All four correct = 2
One error = 1
Two or more errors = 0

2 max

(c) AGT;

1

[5]

13 (a) × 20 000

Accept range from 18 000 to 22 000

1

(b)

✓	
✓	
	✓

1 mark for each correct column

2

(c) 1. DNA contains thymine **and** RNA contains uracil;

2. DNA contains deoxyribose **and** RNA contains ribose.

2

[5]

14 (a) Deoxyribose.

1

(b) 1. Thymine 18 (%);
2. Guanine 32 (%).

2

(c) DNA polymerase.

1

(d) 1. (**Figure 1** shows) DNA has antiparallel strands / described;
2. (**Figure 1** shows) shape of the nucleotides is different / nucleotides aligned differently;
3. Enzymes have active sites with specific shape;
4. Only substrates with complementary shape / only the 3' end can bind with active site of enzyme / active site of DNA polymerase.

4

[8]

15 (a) 1. Outside of virus has antigens / proteins;
2. With complementary shape to receptor / protein in membrane of cells;
3. (Receptor / protein) found only on membrane of nerve cells.

Accept converse argument

3

(b) 1. No more (nerve) cells infected / no more cold sores form;
2. (Because) virus is not replicating.

2

(c) Prevents replication of virus.

1

(d) MicroRNA binds to cell's mRNA (no mark)
1. (Binds) by specific base pairing;
2. (So) prevents mRNA being read by ribosomes;
3. (So) prevents translation / production of proteins;
4. (Proteins) that cause cell death.

4

[10]