

# Nucleic acids 1

Level: Edexcel AS 8BN0

Subject: Biology

Exam Board: Suitable for all boards

Topic: Nucleic acids 1

Type: Mark Scheme

To be used by all students preparing for Edexcel AS Biology 8BN0 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)
- Reference to DNA polymerase;
  - (Which is) specific;
  - Only complementary with / binds to 5' end (of strand);  
*Reject hydrogen bonds / base pairing*
  - Shapes of 5' end and 3' end are different / description of how different.

4

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- 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;  
 $1/500 \times 1/500/1/250\ 000$ ;  
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

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 |                               |                               |
|--------|--|-------------------------------|-------------------------------|
|        | $^{15}\text{N}/^{15}\text{N}$                | $^{15}\text{N}/^{14}\text{N}$ | $^{14}\text{N}/^{14}\text{N}$ |
| 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*
- (ii) (Cancer cells / DNA) divide / replicate fast(er) / uncontrollably;  
*Accept: converse argument for healthy cells*

2

1

[8]

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- (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  $\mu\text{m}$  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]

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- (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 /  $\text{H}^+$  / 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

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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 percentage decrease in number of cancer cells / greater proportion 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 identical 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*
- (ii) it has been produced by semi-conservative replication / one old strand and one new;  
One strand has  $^{15}\text{N}$  bases and the other  $^{14}\text{N}$ ;  
*Accept light / heavy N (therefore) it is less dense / lighter;*
- (iii) one band is in same position as generation 1;  
one band higher;  
*accept a line. N.B. need a visible gap*

1

2

2

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

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.*
- (ii) Cellulose / glycogen / nucleic acid / DNA / RNA;
- (b) (i) To keep pH constant;  
A change in pH will slow the rate of the reaction / denature the amylase / optimum for reaction;
- (ii) Purple / lilac / mauve / violet;  
*Do not allow blue or pink.*
- (iii) Protein present / the enzyme / amylase is a protein;  
Not used up in the reaction / still present at the end of the reaction;

1

1

2

1

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]