Structure and replication of DNA

Mark Scheme 1

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Nucleic acids and protein synthesis
Sub Topic	Structure and replication of DNA
Booklet	Theory
Paper Type	Mark Scheme 1

Time Allowed : **71 minutes**

Score : **/ 59**

Percentage : **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a** **P** – thymine **;** **R** thiamine / thiamin / thyamine
Q – cytosine **;**
R – guanine **;**
S – uracil **;** [4]

(b) **1** copy of the, DNA / gene, (coding) for a, polypeptide / globin **;** **A** protein

2 travels from, DNA / nucleus / chromosome, to ribosome **;**
A mRNA made in nucleus, attached to ribosome *so movement is implied*

3 for translation / for (haemo)globin production **;**

4 mRNA codes for, sequence / order, of amino acids **;** **A** for primary structure

5 *idea that* (nucleotide / base) sequence is a series of codons **;**

6 base pairing / AW, between codon on mRNA and anticodon on tRNA **;**
e.g. of
hydrogen bonds between bases
examples of base pairing: A–U / C–G
R binding between bases [max 3]

[Total: 7]

2 **(a) (i)** *hydrogen bonds drawn onto Fig. 6.1*

lines must go between O-H, N-H as follows

two lines between A and T H — O and N — H ;
three lines between C and G H — O and N — H and O — H ; [2]

(ii) hydrogen bonds hold (two), polynucleotides / strands / chains, together ;
A hold, (complementary) nucleotides / base pairs, together
A ora e.g. prevents, unwinding / strand separation
2 (many hydrogen bonds) give stability / DNA is stable molecule / DNA is long lasting / AW ; *ignore ref. to strength*
3 can be broken for, transcription / replication ;
4 ref. to (double) helix ; [2]

(b) (named) base / nucleotide, pairing ;
2 purine – pyrimidine ;
3 percentage of A = percentage of T ; **A** very similar
4 percentage of C = percentage of G ; **A** very similar
5 data quote in support ; [max 3]

(c) *idea that*

percentages of, A and T / C and G, are not the same / three percentages are similar; [1]

(ii) single-stranded <u>DNA</u> / not double-stranded / not a double helix ;
A may be other bases ; [1]

[Total: 9]

3 **(a)** *one mark per complete correct row*

DNA		
two, polynucleotides / chains / strands **A** double	single, polynucleotide / strand / chain	;
(double) helix	not a helix / straight chain ;	
deoxyribose	*differences between pentoses / sugar may be described in terms of OH on C_2*	;
thymine / no uracil	uracil / no thymine	;
hydrogen bonding (between all bases)	hydrogen bonds between some bases **A** no hydrogen bonds	;
ratio of A+G to C+T = 1 / AW	ratio of A+G to C+T varies	;
longer	s	;
one type	more than one type / three types / mRNA + tRNA + rRNA	;

[max 3]

(b) *(GCG)* CGC ;
(ACA) UGU ; [2]

(c) 714 ;; **A** 717 / 720
if, no / incorrect, answer given, award one mark for correct working [2]

(d) 1 (tRNA) carries amino acid to ribosome ;
2 ref. to specificity of amino acid carried ; **A** role in ensuring correct primary structure
3 ref. anticodon (on tRNA): codon (on mRNA) binding ;
4 ref. complementary / base pairing ; **A** A-U, C-G
5 ref to tRNA binding sites within ribosome ;
6 two tRNAs bound to, mRNA / ribosome, at same time ;
7 amino acids held close to each other / AW ;
8 (for) peptide bond formation ;
9 (tRNA) can be reused / binds another amino acid ; [max 4]

[Total: 11]

4 **(a)** interphase / S phase / synthesis phase ; **R** G1/G2 unqualified by interphase [1]

(b) **(i)** hydrogen ; [1]

(ii) **M** = adenine and **O** = cytosine ; [1]

(c) each strand, of DNA acts as a template (for the synthesis of a complementary strand) ;
A described in terms of base pairing
new DNA (molecule) has one, old / parental / original, strand and one, new / daughter strand ;
R 'half old and half new' unless clearly referring to two strands [2]

(d) *accept ora*
(errors are) mutations / named type of mutation ;
ora if corrected there are no mutations
(may lead to) production of altered proteins, so, impaired / loss, of function ;
A altered amino acid in, protein / primary structure
(may lead to) different antigens, so cells are rejected (by immune system) ;
idea that cells cannot function together / impaired coordination ;
ref. to cancerous cells / cancer(s) / tumours / sickle cell anaemia or other named monogenic condition ;
further detail ;
e.g. uncontrolled, division / mitosis / cell replication / cell grow
e.g. lack of contact inhibition / no apoptosis *or* described / (proto)oncogene(s) [2 max]

[Total: 7]

5 **(a)**

Statement	
an amino acid that is a major constituent of collagen	**J**
a component of RNA	**G ;**
a molecule polymerised to form glycogen	**D ;**
a molecule with a peptide bond	**H ;**
an important store of energy, insoluble in water	**K ;**
a molecule with hydrophilic and hydrophobic regions	**F ;**
an amino acid that forms disulfide (disulphide) bonds in proteins	**E ;**

[6]

(b) *Assume the answer is about DNA unless indicated otherwise. A comparison is not required. Information given below is for either DNA or collagen features.* ***A*** *ideas from either column. Do not penalise if points are not corresponding on one line / sentence as long as biologically correct. Only reject if biologically incorrect. If no attempt at 2 can* ***A*** *both marks from 1 if biologically correct.*

DNA	Colla
4 (different) monomers ;	more than four (different) monomers
(monomers =) nucleotides / polynucleotides ;	(monomers =) amino acids / polypeptides
double helix ; **A** two strands	triple helix **A** three stands
right handed helix ;	left handed helix
loose helix ;	tightly coiled
sugar ;	no sugar
phosphate / phosphorus ;	no phosphate / phosphorus **A** sulfur (sulphur) present
base(s) ;	no base(s)
phosphodiester bonds ;	peptide bonds
antiparallel strands ;	strands not antiparallel

A sugar phosphate backbone for 2 marks if nothing written by 2. [2]

[Total: 8]

6 **(a)** *one mark per row*

statement	**protein**	DNA	messenger RNA	cellulose
hydrogen bonds stabilise the molecule	✓	✓	x	✓ ;
glucose is the subunit molecule	x	**x**	**x**	✓ ;
subunits are joined by peptide bonds	✓	x	x	x ;
may be hydrolysed to amino acids	✓	x	x	x ;
contains uracil	x	x	✓	x ;

[5]

(b) CAG; **[1]**

(c) tRNA, combines with amino acid / carries amino acid to ribosome;
idea of specificity; e.g. each type of tRNA is specific to an amino acid
anticodon matches amino acid idea;
example from Fig. 3.1;
codon on messenger RNA pairs with anticodon on tRNA;
example from Fig. 3.1;
two sites on ribosome;
further detail; e.g. P and A site (and E)
leave ribosome after amino acid joins polypeptide;
continually reused; **[max 5]**

(d) variable region;
binding region to antigen;
<u>shape</u> is specific to, choleragen / antigen;
<u>complementary</u>;
ref to R groups on amino acids (in polypeptide / protein);
different, sequences of amino acids / primary structures;
ref to, folding of the molecule / secondary structure / tertiary structure; **[max 3]**

(e) poor sanitation / no treatment of faecal waste;
contamination of (drinking) water supply;
poverty / poor living conditions / poor hygiene / poor (health) education;

ref to natural disasters; e.g. assistance / aid / medical help / AW, cannot arrive in time

no rehydration therapy available (at time when needed);
no (effective) vaccine;
further detail; (bacteria live in gut, where immune system is not effective) **[max 3]**

[Total: 17]