## Protein synthesis

## Mark Scheme 4

| Level | International A Level |
| :--- | :--- |
| Subject | Biology |
| Exam Board | CIE |
| Topic | Nucleic acids and protein synthesis |
| Sub Topic | Protein synthesis |
| Booklet | Theory |
| Paper Type | Mark Scheme 4 |


| Time Allowed: | 56 minutes |
| :--- | :--- |
| Score : | $/ 46$ |
| Percentage : | $/ 100$ |
|  |  |

Grade Boundaries:

| A $^{*}$ | A | B | C | D | E | U |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| $>85 \%$ | $77.5 \%$ | $70 \%$ | $62.5 \%$ | $57.5 \%$ | $45 \%$ | $<45 \%$ |

1 (a) 1 code is three, bases / nucleotides; A triplet code

12a AVP ; e.g. protein produced, is non-functional / not produced / incomplete
(b) 13 individuals in population have great reproductive potential / AW ;

14 numbers in population remain roughly constant ;
15 variation in members of population;
16 environmental factors / named factor (biotic or abiotic) ; linked to 17 and 18
17 (cause) many, fail to survive / die / do not reproduce ;
18 those best adapted survive / survival of the fittest ;
19 (reproduce to) pass on alleles; $\mathbf{R}$ genes
20 genetic variation leads to change in phenotype ;
21 ref: changes in, gene pool / allele frequency;
22 over time produces evolutionary change;
23 new species arise from existing ones / speciation ;
24 directional / stabilising, selection;
(a) primary
sequence / arrangement / order / AW, of amino acids ;
secondary
$\alpha$, helix / helices ; A description ignore any ref to $\beta$ / pleated, sheet
tertiary
folding of, one / each, polypeptide / globin ; A coiling
(shape) held in place by interactions between, R-groups / side chains ;
A three or more named interactions
quaternary
(arrangement / interaction, of) four polypeptides / four globins / two $\alpha$ and two $\beta$ globins ; A chains $\mathbf{A}$ ref. to more than one polypeptide if specific ref. to $\alpha$ and $\beta$ chains
haem / prosthetic group ; A porphyrin
(b) six / first five and seventh, amino acids are the same ; ora amino acid at position 6 is different
both are 1. val-2.his-3.leu-4.thr-5.pro....7.glu ; take from diagram variant 1 is, glutamic acid / glu (whereas), variant 2 is, valine / val ;
(c) (i) withstands pressure; prevents, overstretching / AW ; prevents, bursting / rupture / AW ;
(ii) assume answer is about collagen unless told otherwise

1 polypeptides are not identical (v. 2 identical, $\alpha / \beta$, polypeptides) ;
2 triple helix or three, polypeptides / helices (v. 4 polypeptides);
3 only composed of amino acids or no, prosthetic group / haem / iron ;
4 (fibrous so) not globular ;
5 no complex folding / AW (v. complex folding); A no tertiary structure
6 glycine is repeated every 3rd position / more glycine ;
7 repeating triplets of amino acids / large number repeating amino acid sequences (v. greater variety) ;
8 AVP ; e.g. different primary structure / AW variation in amino acid sequences (v specific sequences) all polypeptides, helical / AW (v. a different to $\beta$, polypeptides) hydrogen bonds between polypeptides (v. Van der Waals) covalent bonds between molecules (to form fibrils) (v. none) 300nm long polypeptides (v 5-10nm) each polypeptide over 1000 amino acids (each 141 / 146 amino acids) [max 1]
[Total: 9]

3 (a) allow points on annotated diagram
if only diagram drawn, max 1 mark if not annotated
if written response given, only use diagram (if correct) to confirm mark points
$\begin{array}{lll}\mathbf{1} & 6 \text { carbons ; (v. } 5 \text { carbons) } & \text { A } 1 \text { more } \\ \mathbf{2} & 6 \text { oxygens ; (v 4) } & \text { A } 2 \text { more } \\ \mathbf{3} & 12 \text { hydrogens ; (v10) } & \text { A } 2 \text { more } \\ \mathbf{4} & 5 \text { OH groups } v 3 \text { OH groups ; } \\ \mathbf{5} & 6 \text {-membered ring / pyranose ; (v. } 5 \text {-membered ring / furanose }) \\ \mathbf{6} & \text { carbon 2, OH (pointing down) / has O ; (v. H pointing down / no O) AW } \\ \mathbf{7} & \mathrm{H} \text { and OH other way round on carbon } 1 \text {; AW } \\ \mathbf{8} & \mathrm{H} \text { and OH other way round on carbon } 3 \text {; AW }\end{array}$
(b)

| type of bond(s) | biological macromolecule |
| :--- | :--- |
| $\beta, 1-4$ glycosidic | cellulose ; |
| $\alpha, 1-4$ and $\alpha, 1-6$ glycosidic | amylopectin ; |
| phosphodiester | mRNA ; |
| peptide | protein ; |

$\mathbf{R}$ if more than one molecule in box
(c) condensation / polymerisation / esterification;
(d)

|  | replication | transcription |
| :---: | :---: | :---: |
| 1 | DNA polymerase | RNA polymerase ; |
| 2 | (free activated) DNA nucleotides | RNA nucleotides ; |
| 3 | (complementary) base pairing A-T | base pairing A-U ; |
| 4 | both strands, involved / act as template / AW | one strand involved; |
| 5 | all / AW, the DNA molecule, is copied / unzips / AW | part / gene(s), copied ; |
| 6 | (two) DNA molecules produced A DNA produced | messenger RNA / mRNA / pre-mRNA , produced ; |
| 7 | molecule(s) produced are double-stranded | single-stranded molecule produced; |
| 8 | occurs, in late interphase / S-phase / prior to mitosis | occurs throughout interphase / AW ; |
| 9 | important in, mitosis / meiosis A cell / nuclear, division | important in, protein / polypeptide, synthesis ; |
| 10 | AVP ; <br> e.g. Okazaki fragments / breaking and joining (of DNA) required | mRNA produced as continuous molecule |

[Total: 12]

4 (a) (i) box drawn round one phosphate, sugar and base ;
(ii) label P to circle; A phosphate / no label but clear a circle is intended
(b) 1 DNA (double helix), unwinds / AW ; A uncoil

2 hydrogen bonds between (complementary) bases broken ;
ignore DNA unzips
3 complementary, base / nucleotide, pairing ; A A-T and C-G
4 phosphodiester bonds;
5 both strands used as templates; A both strands are copied
6 produces two identical DNA molecules ; A 'DNAs’
7 semi-conservative / each new DNA = one 'old' and one 'new' strand ;
8 ref to DNA polymerase ;
9 correct ref to other named enzyme ; e.g. helicase (unwinds), topoisomerase (cuts backbone), ligase (formation of phosphodiester bonds)
10 ref to Fig. 5.1; e.g. described dotted lines as H bonds that need to be broken look for annotations on Fig. 5.1
11 AVP ; e.g. replication fork(s), replication bubble(s), antiparallel nature, Okazaki fragments, activated nucleotides (3 phosphate groups)
(c) 1 tRNA carries amino acid to ribosome ;

2 ref to specificity of amino acid carried;
3 anti-codon on tRNA complementary to codon on mRNA ;
A example for complementary, e.g. AUG and UAC
4 ref to two sites / P(eptidyl) and A (mino-acyl) sites, of ribosome ;
5 peptide bond is formed between amino acids ; R 'polypeptide bond'
6 tRNA, can be re-used / collects another amino acid ;

