

# Protein synthesis

## Mark Scheme 1

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 1

Time Allowed : 69 minutes

Score : / 57

Percentage : /100

Grade Boundaries:

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

- 1 (a) (late) interphase/phase/after G1 phase/before G2 phase ;  
    **A** after first growth phase/before prophase/before mitosis/after cytokinesis [max 1]
- (b) (i) hydrogen/H, (bonds) ; [1]
- (ii) Y, single ring structure ; **A** smaller molecule compared to **X** [1]
- (c) (i) change in, nucleotide/base, sequence of DNA ;  
    *any one from*  
    new allele formed ;  
    deletion/substitution/addition/frame shift , (mutation) ;  
    change to/ altered, mRNA ; **A** altered codon(s)  
    (causing) change in, primary structure/ amino acid sequence, of,  
    polypeptide/protein ;  
    **A** different protein/ altered function of protein/ non-functional protein [max 2]
- (ii) cell cycle shorter/interphase shorter/division more frequent ;  
    (cell cycle) checkpoints not controlled ;  
    uncontrolled (growth/division)/AW ;  
    AVP ; e.g. no differentiation (into epithelial cell)  
    **A** no cell death/apoptosis 2]

[Total: 7]

CHEMISTRY ONLINE  
— TUITION —

- 2 (a) *three from ;;;*  
*allow mps without naming DNA / RNA if already gained in previous point*  
*must be comparison statement per row*  
*mark first comparison per row unless one row left blank*

	DNA replication	DNA transcription
1	DNA, formed / AW	mRNA / pre-mRNA (transcript) , (formed)
2	two (identical) DNA <u>molecules</u> formed	one mRNA <u>molecule</u> (formed)
3	product double-stranded DNA	product single stranded (m)RNA
4	all of DNA molecule, replicated / unwinds / involved	part of DNA molecule / gene, involved
5	both strands involved	one strand (involved) <i>treat ref. to sense / antisense strands as neutral</i>
6	(involves / uses) DNA polymerase	RNA polymerase
7	(free) DNA nucleotides, required / used	RNA nucleotides
8	(process involves complementary) base pairing A–T <i>ignore C–G</i>	(complementary) base pairing A–U
9	takes place in late interphase / S-phase / synthesis phase	takes place throughout interphase
10	important in, cell division / mitosis / meiosis	for, polypeptide / protein, synthesis

[max 3]

- (b) change / alteration / AW, in sequence / order / arrangement, of, bases /nucleotides (of DNA / gene) ; change to give a new allele ;

one additional detail ;  
 (may result in) altered, changed / non-functioning / no, polypeptide / protein  
 ref. to changed genetic code / different codons  
 different sequence of amino acids / different primary structure  
 named type of mutation  
 example e.g. HbS

[max 2]

- (c) (i) ref. specificity ; *in context of the immune response*  
 qualified ; e.g. existing , (B / T) lymphocytes / B-cells / T-cells, no longer activated / no recognition ora  
**R** if T lymphocytes produce antibodies  
 existing plasma cells do not produce new antibody ora  
 existing memory cells no longer activated / AW ora  
 different / new, immune response required ora

[2]

(ii) artificial active / active artificial / active acquired artificial / acquired active artificial ; [1]

(d) *penalise once if not worded as a problem*

- 1 ref. malnourishment / poor diet, vaccine ineffective / poor immune response / insufficient protein for antibody production ;
- 2 some (healthy) people do not respond to vaccines ;
- 3 one-dose not always effective / problems administering boosters ; AW
- 4 ref. percentage cover / herd immunity, insufficient ; **A** description  
**A** idea of people in rural areas have less / no, access to vaccine  
**A** people avoid vaccine, worry about side-effects / other reason
- 5 ref. cost to authorities ; e.g. of, administering vaccination programme
- 6 people in some areas cannot afford to buy vaccine
- 7 vaccine may not be thermostable ; AW
- 8 high density of population / overcrowding, increases chance of spread ;

[max 2]

**[Total: 10]**

CHEMISTRY ONLINE  
— TUITION —

- 3 (a) (i) cells have machinery for protein synthesis / AW ;  
**A** plant / animal, cells have RER  
 (assumption that) cells will continue to produce protein at high rate ;  
 large number of / many / AW, ribosomes ;  
 available supply of / AW, amino acids ;  
 ref. to presence of tRNA molecules ;  
 ATP available ;  
 ref. to easier to harvest high levels of protein ; [max 2]
- (ii) *idea that* any added mRNA, has easier access to / can reach, ribosomes / RER ;  
 so that the cell's own, DNA / mRNA can be accessed / AW ;  
 easier to, harvest / extract, protein products ; [max 1]
- (iii) only the desired protein is produced / AW ; ora  
 unwanted protein does not have to be separated from desired protein ;  
*idea that* inefficient process if translation machinery used to produce other proteins ;  
 cell's proteins may, inhibit / affect / hinder / AW, process ; [max 1]
- (iv) ref. to ribosome function not altered ;  
**R** ref. to prokaryotic and eukaryotic ribosomes being the same  
 mechanism of translation / described, is the same in all cells ;  
 e.g. tRNA can respond to introduced mR  
 all types of cells use mRNA for protein synthesis ;  
 mRNA only has one role ;  
 genetic code / codons, are the same in all cells ;  
**A** genetic code is universal  
 mRNA, contains only exons / introns removed, so translation can occur ; [max 2]
- (b) different, structure / rRNA, (of ribosomes) ;  
 (ribosomes), larger / 80S, in eukaryotes *or* smaller / 70S in prokaryotes ;  
 (some) attached to / AW, (external surface of) RER in eukaryotes ; ora  
**A** only found in cytoplasm in prokaryotes [max 2]
- (c) other organelles / components, damaged *or* whole cell all organelles intact ;  
 some, ribosomes / RER, lost / damaged ;  
*idea that* cell-free system is disorganised ; ora  
 fewer amino acids available ; ora  
 no / reduced, respiration ; AW  
 other, components / AW, required are, lost / at lower levels ;  
 organelles / components, not replaced ; ora  
 ref. to difficulty in creating identical conditions to cell environment ;  
 may be able to use cells that can replicate (hence continuous production) ;  
 AVP ; [max 1]

[Total: 9]

- 4 (a) (i) *no mark if no units used at all*  
**L** – 3.6 kPa ; *award the mark if units only used once*  
**M** – 4.5 kPa ; **A** in range 4.45 to 4.55 [1]
- (ii) *ignore any similarities*  
 1 to the right / lower (affinity) / qualified ; e.g. lower percentage saturation  
 2 at, higher / lower, partial pressures, small(er) difference in percentage saturation (than others) ; **A** ora  
 3 comparative data quote ; *must refer to L and M*  
*allow ecf from (i)* [3]
- (b) at partial pressures in the tissues ; *where oxygen is unloaded from Hb*  
 2 haemoglobin is less saturated (than **L**) ;  
 3 because, haemoglobin / Hb, dissociates more readily ;  
**A** idea of unloading oxygen more readily *even if Hb not mentioned*  
 4 to compensate for, fewer / less effective, red blood cells / Hb ; [max 3]
- (c) haemoglobin less well saturated (in lungs at high altitude) ;  
 2 data quote from Fig. 3.1 ; **A** 80–90% saturated at ‘about 7.5 kPa’  
 3 produce more red blood cells / increase in number of RBCs ;  
 4 more haemoglobin ;  
 5 *idea* of compensates for, smaller volume of oxygen absorbed / lower saturation (of haemoglobin) ;  
*also accept the following adaptations*  
 6 increase in haematocrit / AW / decrease in plasma volume ;  
     **A** increase in RBCs per unit volume  
     **R** decrease in blood volume  
 7 increase in, breathing rate / tidal volume / heart rate / stroke volume ;  
 8 increase in, capillary density / number of mitochondria / myoglobin / respiratory enzymes, in muscle ;  
 9 ref. to (increased) secretion of, erythropoietin / EPO ;  
 10 increase in (2,3), BPG / DPG, in red blood cells ; **A** rightward shift in curve [max 4]
- (d) not caused by (named type of) pathogen / non-infectious / non-transmissible / non-communicable / AW ;  
 2 genetic / inherited / AW, disease ; **A** caused by a mutation / AW  
     **A** ‘passed down from parent(s)’  
     **R** idea of congenital diseases  
     **R** ‘you get it from your mother’  
 3 ref. to, no immune response / no antigen(s) ;  
 4 affects all red blood cells so vaccine would lead to their destruction ; [max 2]

[Total: 13]

- 5 (a) (i) *DNA because*  
RNA (has uracil) does not have thymine ; [1]
- (ii) phosphodiester ; [1]
- (iii) deoxyribose ; [1]
- (b) collects / attaches to, specific amino acid }  
or }  
takes specific amino acid / activated tRNA, to ribosome } ;
- idea of, adjacent / two, amino acids and codon-anticodon binding ;  
peptide bond formation / ref. elongation, (to form polypeptide) ; [max 2]
- (c) *accept points from a diagram*
- 1 loss of a water molecule / condensation reaction ;
- 2 OH / O<sup>-</sup>, from, carboxyl / -COOH / COO<sup>-</sup> (group) of one amino acid ;
- 3 H / H<sup>+</sup>, from, amine / NH<sub>2</sub> / NH<sub>3</sub><sup>+</sup> (group) of other amino acid ;
- 2/3 allow one mark for ref. to involvement of carboxyl and amine group
- 4 (peptide bond) links C-N ; [3]

[Total: 8]

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— TUITION —

- 6 (a) 1 important in contributing to 3-D structure of molecule / AW ;  
2 many hydrogen bonds so, gives stability / strands not easily separated / long lasting ; AW  
3 (individual) hydrogen bonds (more) easily broken (than covalent bonds) ; **A**  
hydrogen bonds weak / hydrogen bonds can be broken
- consequence*  
4 (so strands can be separated) for (DNA) replication ; **A** description  
5 (so strands can be separated) for (DNA) transcription ; **A** description
- 6 hydrogen bonds only form between, specific bases / named base pairs, so, few mistakes / faithful replication / AW ;  
7 *idea that* hydrogen bonds can easily re-form (without chemical reaction) ; [max 4]
- (b) **P** = transcription  
**Q** = translation ; [1]
- (c) (i) sequence will not (spontaneously) change / AW ; **A** decreases chance of mutation (so) gene products / proteins, produced will always be functional ; maintains all, genetic information / AW, throughout life of cell ; same, genetic information / AW, passed on to, daughter cells / offspring ; AVP ; e.g. maintains size so still enclosed within nucleus [max 2]
- (ii) translation / protein synthesis, will stop when mRNA breaks down ; allows re-use of nucleotides (for other mRNA) ; ref. to control of gene expression ; **A** prevents too much product forming ref. to control of cell activity / fast response to changing requirements ; ref. to efficiency in energy use ; [max 2]

**[Total: 9]**

CHEMISTRY ONLINE  
— TUITION —