SMART EXAM RESOURCES
TOPIC QUESTIONS: NUCLEIC ACID AND PROTEIN SYNTHESIS
SUB-TOPIC: POLYPEPTIDE- PROTEIN -FORMATION
SET-1-QP-MS

1 Switching genes on and off allows proteins to be synthesised only when required.

Processes **P** and **Q** occur when a gene is switched on, as shown in Fig. 4.1.

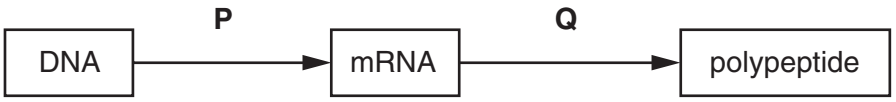

Fig. 4.1

(b) Name processes **P** and **Q**.

P .....

Q .....[1]

MARK SCHEME:

P = transcription
Q = translation ; [1]

2 Read the following passage.

> A method called *in vitro* translation is often used by scientists to produce proteins in the laboratory. The method uses extracts from animal cells, plant cells or bacteria. These are chosen because they have high levels of protein synthesis. The cells are treated so that the cell walls, if present, and cell membranes are broken down and then treated so that any of the cell's own DNA and mRNA are destroyed. When mRNA from any source is added to these extracts, it will be translated into the corresponding protein.

(a) Explain why:

(i) the cells are chosen on the basis of their high level of protein synthesis

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..... [2]

(ii) the cell walls (if present) and cell membranes need to be broken down

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..... [1]

(iii) the cell's own mRNA needs to be destroyed

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.....

..... [1]

(iv) mRNA from any source can be translated in any type of extract.

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..... [2]

(b) State **two** differences between the cell structures used in translation in prokaryotes and eukaryotes.

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..... [2]

(c) Scientists usually find that the method of *in vitro* translation is less efficient than *in vivo* translation, which occurs in cells.

Suggest a reason for this.

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..... [1]

MARK SCHEME:

(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 mRNA
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, (eternal 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]

3 Macrophages synthesise intracellular enzymes.

Fig. 2.1 is a summary diagram of events that occur in a macrophage.

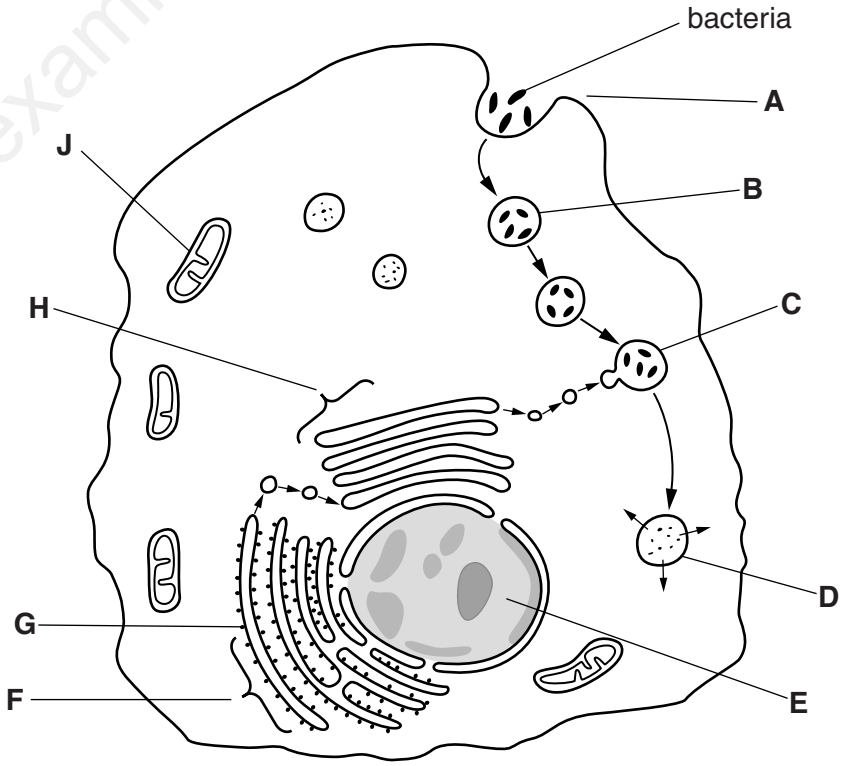

Fig. 2.1

Name the stages of protein synthesis that occur at **E** and at **F**.

E .....

F .....[2]

MARK SCHEME:

E transcription ;
F translation ; **A** post translation(al) modification [2]

4 Some plant cells produce a polypeptide called systemin.

Describe the role of DNA in the production of systemin.

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.....[2]

MARK SCHEME:

gene coding for systemin is (a length of) DNA ; **A** *idea that* a length of DNA codes for systemin transcription / production of mRNA ;	**2**

5 **(a)** Fig. 4.2 shows:

- the first seven amino acids of the β chain of haemoglobin
- the first amino acid in the sequence is valine (Val)
- the 21 base pairs in the sequence of DNA that code for these seven amino acids.

amino acid sequence	Val	His	Leu	Thr	Pro	Glu	Glu
base sequence in DNA	CAC	GTG	GAC	TGA	GGA	CTC	CTC
	GTG	CAC	CTG	ACT	CCT	GAG	GAG

Fig. 4.2

Table 4.1 shows the triplets of bases that code for seven amino acids.

Using Fig. 4.2 and Table 4.1, state what will happen to the sequence of amino acids in the first part of the β chain of haemoglobin:

(i) if the base pair at position 6 is deleted

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.....[1]

(ii) if the three base pairs at positions 7, 8 and 9 are deleted.

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.....[1]

Table 4.1

amino acid		**DNA triplets**
cysteine	(Cys)	TGT TGC
glutamic acid	(Glu)	GAA GAG
histidine	(His)	CAT CAC
leucine	(Leu)	CTT CTC CTA CTG
proline	(Pro)	CCT CCC CCA CCG
threonine	(Thr)	ACT ACC ACA ACG
valine	(Val)	GTT GTC GTA GTG
no amino acid	STOP	TAA TAG TGA

(b) DNA is involved in the processes of replication and transcription.

Complete Table 4.2 by using a tick (✓) to indicate which features apply to each of the processes. Use a cross (✗) for features that do **not** apply.

The first row has been completed for you.

Table 4.2

feature	replication	transcription
a single-stranded molecule is produced	✗	✓
hydrogen bonds are broken		
both strands of DNA act as templates		
phosphodiester bonds are formed		
DNA polymerase is used		

[4]

(c) Describe the function of ribosomes in protein synthesis.

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.....[4]

MARK SCHEME:

(a)

(i) *third triplet is a stop codon so*
only two amino acids are joined by peptide bonds / chain only 2 amino acids long ;
A will still have Val-His as the first two amino acids
very short molecule is produced / chain stops after His(tidine) ;
R frameshift / description of frameshift

max 1

(ii) *a triplet is deleted so*
(polypeptide / sequence / β chain) has one less amino acid ;
polypeptide does not have Leu (as the third amino acid) ;
I Leu is not, produced / made / synthesised

max 1

(b)

feature	DNA replication	transcription
a single-stranded molecule is produced	×	✓
hydrogen bonds are broken	✓	✓ ;
both strands of DNA act as templates	✓	× ;
phosphodiester bonds are formed	✓	✓ ;
DNA polymerase is used	✓	× ;

4

(c)

1 translation / construction of polypeptide(s) ;
2 provide binding site for mRNA / mRNA attaches to ribosome / AW ;
A entering ribosome
3 provides binding sites for (two) tRNA molecules ;
A entering ribosome
4 two amino acids are held close together ;
5 formation of peptide bond(s) ; **R** dipeptide / polypeptide, bond
6 (allows) assembly of amino acids into, sequence / primary structure ;
7 AVP ; e.g.
P and A site (and E site)
bond between amino acids catalysed by peptidyl transferase

max 4