

Polymerisation

Question Paper 1

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Polymerisation
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 1

Time Allowed: 70 minutes

Score: /58

Percentage: /100

Grade Boundaries:

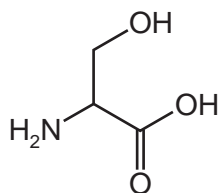
A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

1 Proteins are formed by the polymerisation of amino acids.

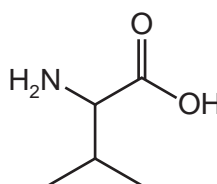
(a) State the type of chemical reaction used to form these polymer chains.

..... [1]

(ii) The amino acids serine and valine can combine together to form a dipeptide.



serine, *ser*



valine, *val*

Draw the skeletal structure of the dipeptide 'val-ser'.

[2]

(iii) Suggest how the type of amino acids in a protein determines its three-dimensional structure.

.....
.....
.....
..... [2]

(b) Using labelled diagrams or words as appropriate, explain

(i) why a particular enzyme may only catalyse a specific reaction on a specific substrate,

.....

.....

.....

..... [2]

(ii) how *non-competitive* inhibition of an enzyme-catalysed reaction can occur.

.....

.....

.....

..... [3]

[Total: 10]

2 (a) DNA fingerprinting has become a very important technique for analysing samples from living or once-living organisms.

(i) After extraction and purification, what is the first step in **analysing** a sample of DNA?

.....
..... [1]

(ii) What can be done to increase the amount of DNA for analysis?

.....
..... [1]

(iii) During electrophoresis, it is observed that amino acids can move in **different** directions or not at all, whilst DNA fragments always move in the **same** direction.

Explain these two observations.

.....
.....
.....
..... [2]

(iv) DNA fingerprinting can also be useful in archaeology.

Which of the following would **not** be suitable for analysis by DNA fingerprinting?
Put a cross (x) in the appropriate box(es).

a piece of leather from an Egyptian tomb

a sample of skin from a mummified body

a fragment of ancient pottery

a piece of wood from a Roman chariot

[1]

(b) X-ray crystallography can be used to help analyse the structure of macromolecules.

What does this technique tell us about a particular macromolecule?

.....
..... [1]

- (ii) Which element will show up most strongly in the X-ray crystallography of a biological polymer of general formula $C_vH_wP_xN_yO_z$?
Explain your answer.

.....
..... [1]

- (c) Explain what is meant by a *partition coefficient*.

.....
..... [1]

- (ii) The partition coefficient of a particular pesticide between hexane and water is 6.0.
A solution contains 0.0042 g of the pesticide dissolved in 25 cm³ of water. The solution is shaken with 25 cm³ of hexane.

Calculate the mass of pesticide that will be dissolved in the hexane layer at equilibrium.

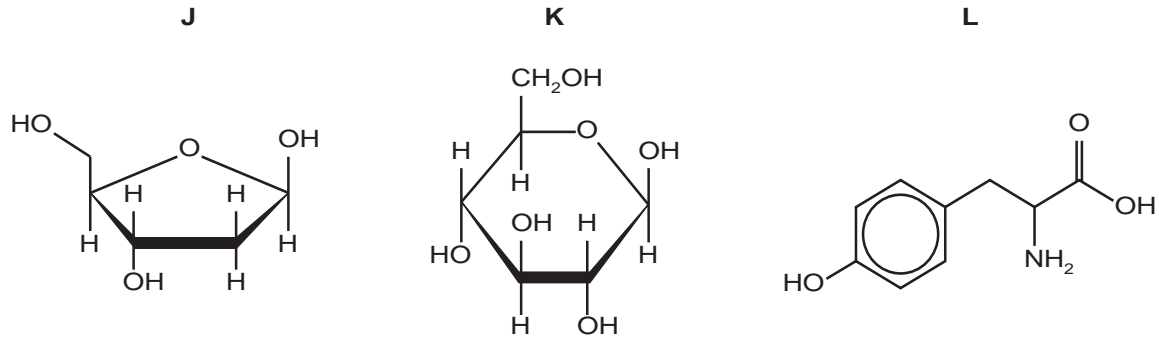
[2]

[Total: 10]

3 This question is about the structures and roles of DNA and RNA in protein synthesis.

(a) Study the structures of the three molecules below.

One of the molecules could be a building block for a protein while the other two could be building blocks for other biological polymers.



Which of the three could be a building block for a protein? Explain your answer.

.....
 [1]

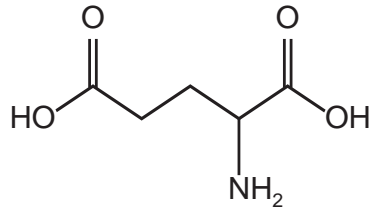
(b) Outline the **different** roles played by mRNA and tRNA in producing a protein with a specific primary structure.

mRNA.....

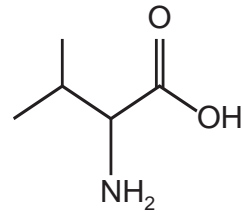
 tRNA.....

[4]

- (c) Sickle cell anaemia is a genetic-based disease in which one of the glutamic acid residues is replaced by a valine residue.



glutamic acid



valine

Suggest and explain how this change in the primary structure of the protein would affect the overall structure and function of the protein.

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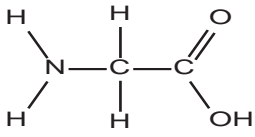
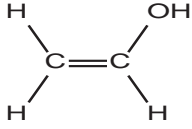
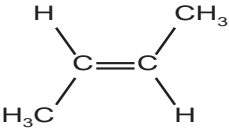
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..... [3]

[Total: 8]

4 Polymers consist of monomers joined either by addition or condensation reactions.

(a) Complete the table by placing a tick (✓) in the correct column to indicate the type of reaction that would polymerise each of the monomers.

monomer	addition	condensation	both
			
			
			

[3]

(b) Poly(ethene) bags pollute the environment for a long time because they are non-biodegradable.

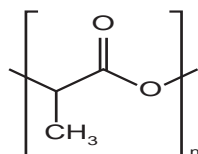
Suggest why.

.....

.....

..... [2]

(c) There has been considerable research into making biodegradable plastic bags. The repeat unit for one of the polymers used, polylactic acid (PLA), is shown.



(i) Draw the structure of the monomer for PLA.

[1]

(ii) Suggest why PLA breaks down **more** easily in the environment than poly(ethene).

.....

.....

..... [1]

(d) The table shows the melting points of three polymers.

polymer	melting point/°C
polyethene	137
polychloroethene (PVC)	212
nylon 6,6	265

Explain the differences in melting point of these three polymers in terms of the intermolecular forces between the chains.

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.....

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..... [3]

[Total: 10]

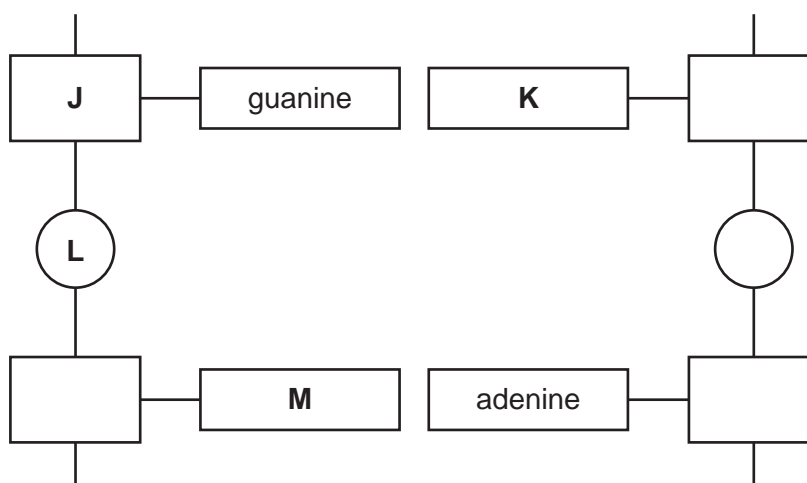
5 Proteins and deoxyribonucleic acid, DNA, are two important polymers that occur within living organisms.

(a) Proteins have a number of ‘levels’ of bonding: primary, secondary and tertiary. Complete the table to indicate the level of bonding responsible for the features described.

feature	level of bonding
formation of α -helix	
formation of disulfide bonds	
formation of ionic bonds	
linking amino acids	

[3]

(b) The diagram shows part of a DNA molecule. Study the diagram and give the correct names for the blocks labelled J, K, L and M.



block letter	name
J	
K	
L	
M	

[4]

(c) The DNA molecule is formed from two polymer strands which are held together until DNA replication occurs.

(i) What type of bonding holds the strands together?

.....

(ii) Explain why this type of bonding allows the base pairs within the strands to separate during replication at normal body temperature.

.....

.....

[2]

(d) In the polymer RNA, the identities of two of the blocks, **J**, **K**, **L** or **M**, are different.

For **one** of these blocks that are different, give its correct name in DNA and in RNA.

DNA:

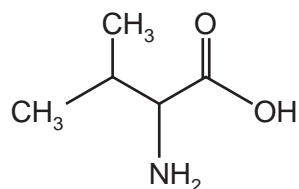
RNA:

[1]

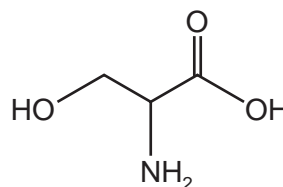
[Total: 10]

6 This question looks at the formation and breakdown of protein chains in the body.

(a) Proteins are formed from chains of amino acid monomers joined together. The structures of two amino acids, valine and serine are shown.



valine (val)



serine (ser)

(i) Draw the structure of the dipeptide val-ser, showing the peptide bond in displayed form.

(ii) What *type of reaction* has taken place in order to form this dipeptide?

.....

(iii) Identify the other molecule produced in this reaction.

.....

[4]

(b) Both DNA and RNA are involved in protein synthesis.

Complete the table to show **three** differences between the structures of DNA and RNA.

	DNA	RNA
1		
2		
3		

[3]

- (c) In protein synthesis, sections of the DNA are copied by mRNA and this, in turn, is read by the ribosome in order to assemble the amino acids for the new protein chain. Each group of three bases codes for one amino acid, with some amino acids having several codes. The codes are summarised in the table.

UUU	phe	UCU	ser	UAU	tyr	UGU	cys
UUC	phe	UCC	ser	UAC	tyr	UGC	cys
UUA	leu	UCA	ser	UAA	stop	UGA	stop
UUG	leu	UCG	ser	UAG	stop	UGG	trp
CUU	leu	CCU	pro	CAU	his	CGU	arg
CUC	leu	CCC	pro	CAC	his	CGC	arg
CUA	leu	CCA	pro	CAA	gln	CGA	arg
CUG	leu	CCG	pro	CAG	gln	CGG	arg
AUU	ile	ACU	thr	AAU	asn	AGU	ser
AUC	ile	ACC	thr	AAC	asn	AGC	ser
AUA	ile	ACA	thr	AAA	lys	AGA	arg
AUG	met/ start	ACG	thr	AAG	lys	AGG	arg
GUU	val	GCU	ala	GAU	asp	GGU	gly
GUC	val	GCC	ala	GAC	asp	GGC	gly
GUA	val	GCA	ala	GAA	glu	GGA	gly
GUG	val	GCG	ala	GAG	glu	GGG	gly

In general the amino acid chains start with the code AUG, and end with one of the three ‘stop’ codes shown in the table.

- (i) Use the abbreviations to show the sequence of amino acids in the peptide for the base sequence shown.

– AUGCUAACACCGGAGUAA –

.....

- (ii) Sometimes an error can occur in the base sequence.

What are these errors called?

.....

- (iii) This type of error can lead to the formation of a protein with a different structure from the original, as in *sickle cell anaemia*. In this case the amino acid glutamic acid (glu) is replaced by valine (val) in the protein as a result of one base being changed in a three base code.

Use the table to suggest the change of base that causes this.

.....

[3]

[Total: 10]