

# Organic Synthesis

## Question Paper 3

<b>Level</b>	International A Level
<b>Subject</b>	Chemistry
<b>Exam Board</b>	CIE
<b>Topic</b>	Organic Synthesis
<b>Sub-Topic</b>	
<b>Paper Type</b>	Theory
<b>Booklet</b>	Question Paper 3

**Time Allowed:** 68 minutes

**Score:** /56

**Percentage:** /100

**Grade Boundaries:**

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

- 1 Each of the three organic compounds, **V**, **W**, and **X**, has the empirical formula  $\text{CH}_2\text{O}$ . The number of carbon atoms in each of their molecules is shown in the table.

compound	number of C atoms
<b>V</b>	1
<b>W</b>	2
<b>X</b>	3

**V** gives a brick red precipitate when warmed with Fehling's reagent; **W** and **X** do not.

**W** is a fruity smelling liquid.

In **X**, the carbon atoms are bonded directly to one another.

**X** gives an effervescence when shaken with  $\text{Na}_2\text{CO}_3(\text{aq})$ ; **V** and **W** do not.

- (a) Give the structural formula of **V**.

[1]

- (b) (i) What functional group is present in **W**?

.....

- (ii) Give the structural formula of **W**.

[2]

- (c) When **X** is heated under reflux with acidified  $\text{K}_2\text{Cr}_2\text{O}_7$ , the product, **Y**, gives no reaction with 2,4-dinitrophenylhydrazine reagent.

- (i) Give the structural formula of **X**.

- (ii) Give the structural formula of **Y**, the compound formed from **X**.

[2]

(d) When **X** is warmed with a little concentrated sulfuric acid, a small amount of a cyclic compound, **Z**, is formed.

**Z** has the molecular formula  $C_6H_8O_4$ .

(i) Suggest a displayed formula for **Z**.

(ii) What type of reaction occurs when **Z** is formed from **X**?

.....

[2]

[Total: 7]

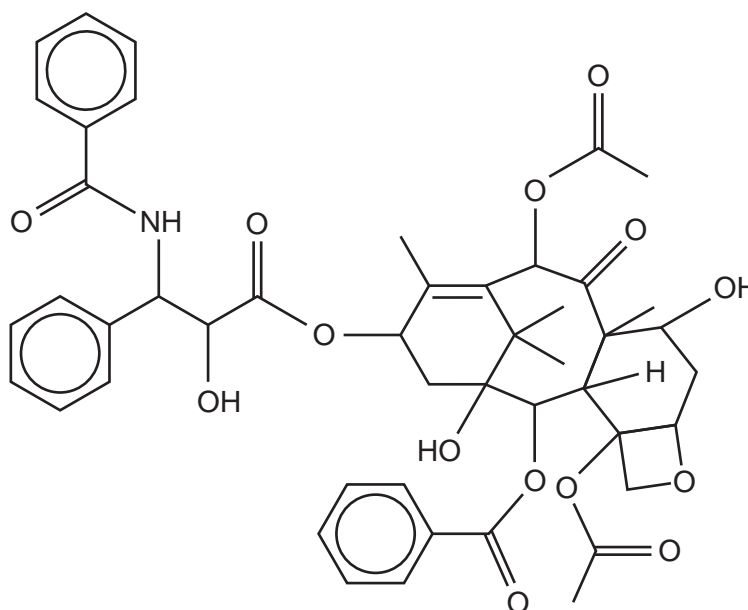
2 The nature and variety of drugs that are available to treat diseases or life-threatening conditions has never been greater. At the same time, we are much better able to deliver drugs to their targets in the body.

(a) Some drugs have to be given by injection, rather than by mouth.

**Name** a functional group in a drug molecule that might be broken down by the acid in the stomach.

.....[1]

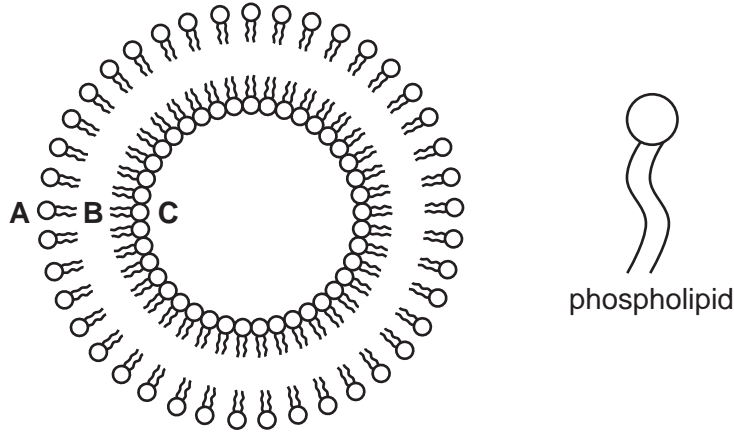
(b) The anti-cancer drug *Taxol* could be broken down if taken by mouth.



*Taxol*

Circle **two** bonds, each in a **different** functional group, that could be hydrolysed in the digestive system. [2]

- (c) One way of protecting drug molecules that are taken by mouth is to enclose them in liposomes. These are artificially created spheres made from phospholipids which have an ionic phosphate ‘head’ and two hydrocarbon ‘tails’.



- (i) State in which area of the liposome, **A**, **B** or **C**, each of the following types of drug would be carried.

**a hydrophilic drug** .....

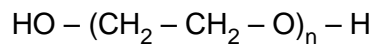
**a hydrophobic drug** .....

- (ii) For the remaining position, **A**, **B** or **C**, explain why this would **not** be a suitable area for carrying a drug.

.....  
 .....

[3]

- (d) One way of carrying drugs in the bloodstream is to attach them by a chemical bond to a polymer. One such polymer is polyethylene glycol or PEG.



- (i) Where would a drug be attached to a molecule of PEG?

.....

- (ii) Suggest why a liposome can carry more drug molecules than a molecule of PEG.

.....  
 .....

[2]

- (e) Better-targeted delivery of drugs allows smaller amounts to be used, which brings significant advantages.

Suggest **two** advantages of using smaller drug doses.

.....

.....

.....

.....[2]

[Total: 10]

3 DNA is an extremely important chemical in human cells. It has been described as the 'blueprint of life'.

(a) What **three** types of compound are linked together in DNA?

..... [1]

(b) DNA consists of two strands linked together. Draw a **block diagram** to illustrate this and showing **two** repeat units in the backbones, labelling the components and showing and labelling the bonds between the strands.

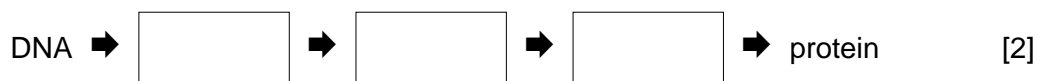
[4]

(c) DNA is used to encode for the production of a particular protein. Put the following biochemical structures in the correct sequence from the use of DNA as a template to the formation of the protein by writing their names in the relevant box below.

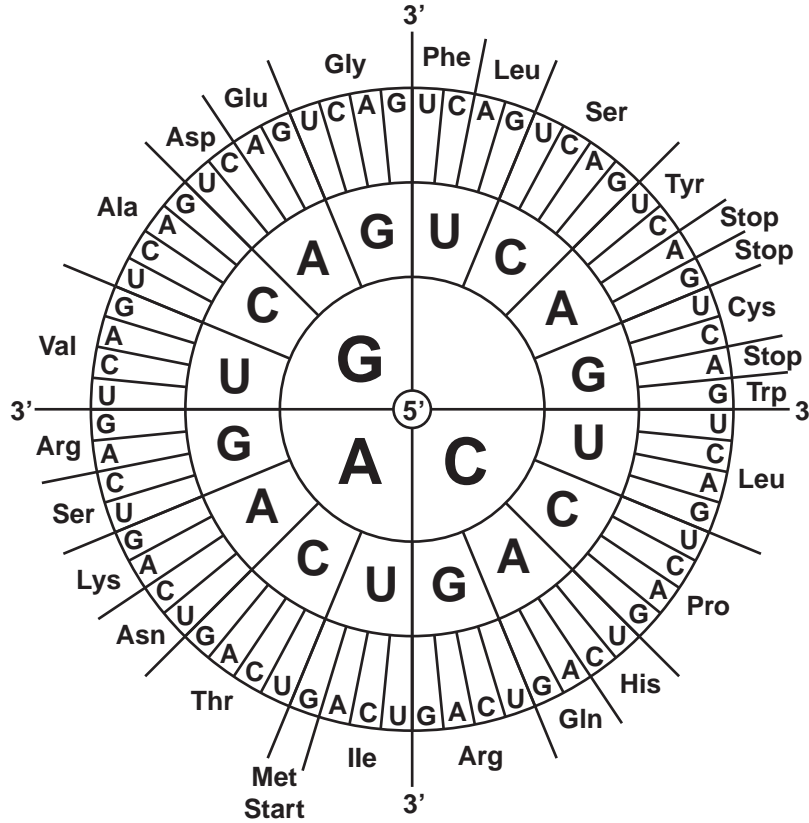
tRNA

mRNA

ribosomes



- (d) In order to produce proteins, the information stored in the DNA molecules has to be translated to produce an mRNA strand. A sequence of three bases, called a triplet, on the mRNA describes a particular amino acid. These amino acids are then combined together to form proteins. The amino acid specified by each triplet is shown below.



The sequence of three bases in a triplet is read from the middle outwards e.g. UGG specifies Trp.

- (i) There are four different bases present in mRNA. How many different triplets are possible using these four bases.

.....

- (ii) What peptide fragment would the following sequence code for when read from left to right? (Use 3-letter abbreviations for amino acids.)

5' – AUGAGCCGACUUGACGUG – 3'

- (iii) What would be the effect of changing the 11<sup>th</sup> base from U to C?

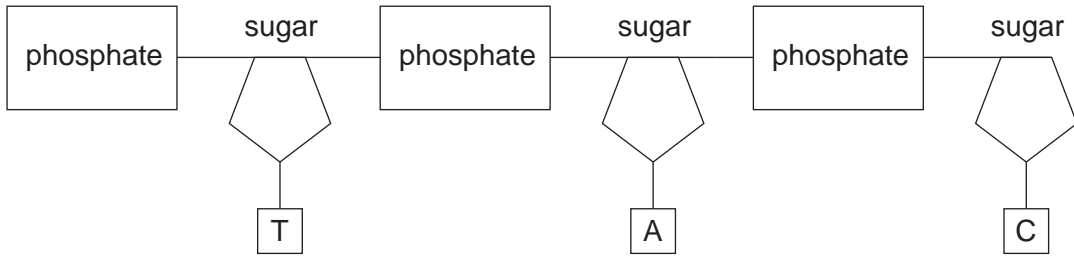
.....

[4]

[Total: 11]



- 4 (a) The diagram shows part of one strand of DNA. Draw the complementary strand, labelling the bonds formed to the original strand, and labelling the components of the strand you draw.



[3]

- (b) Briefly describe the roles of each of the following in protein synthesis.

(i) tRNA .....

.....

.....

(ii) the ribosome .....

.....

.....

[4]

(c) Some diseases, such as sickle cell anaemia, are caused by a single mutation in the DNA for a particular gene. This causes the haemoglobin produced to change the shape of red blood cells, reducing their efficiency in carrying oxygen.

(i) What is meant by a *mutation*?

.....

(ii) Explain why such a mutation could alter the bonding in haemoglobin.

.....

.....

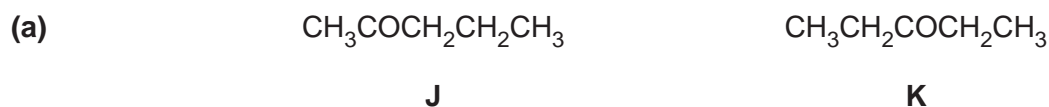
.....

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[4]

[Total: 11]

- 5 Suggest a test or simple reaction you could carry out on each of the following pairs of compounds to enable them to be distinguished.



- (i) description of test or reaction

.....  
.....

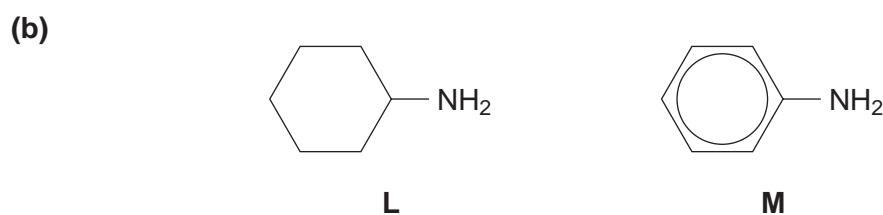
- (ii) observation with compound J

.....

- (iii) observation with compound K

.....

[2]



- (i) description of test or reaction

.....  
.....

- (ii) observation with compound L

.....

- (iii) observation with compound M

.....

[2]



**N**

(i) description of test or reaction

.....  
.....

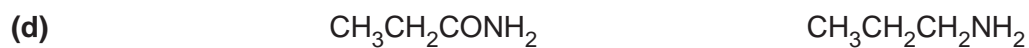
(ii) observation with compound **N**

.....

(iii) observation with compound **P**

.....

[2]



**Q**

(i) description of test or reaction

.....  
.....

(ii) observation with compound **Q**

.....

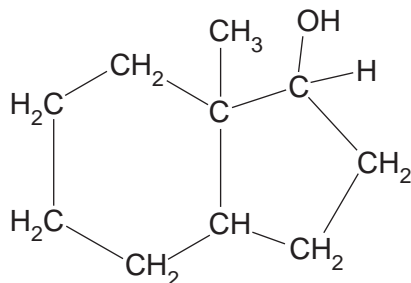
(iii) observation with compound **R**

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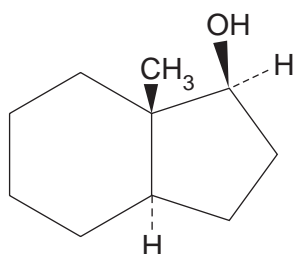
[2]

[Total: 8]

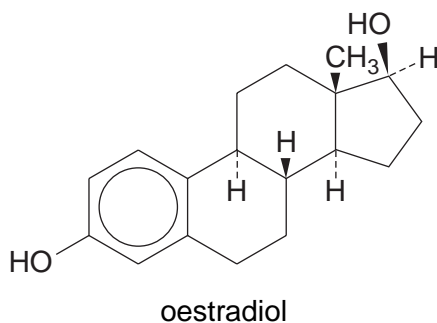
- 6 Chemists use skeletal or partial-skeletal formulae to represent larger structures. For example the structure



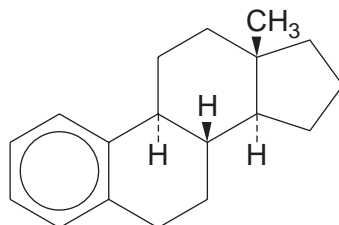
may also be represented as follows.



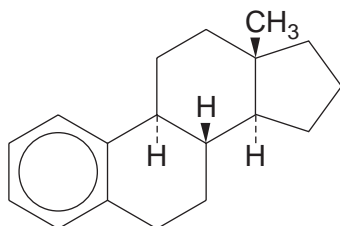
Oestradiol is one of the hormones that controls the reproductive cycle in female mammals.



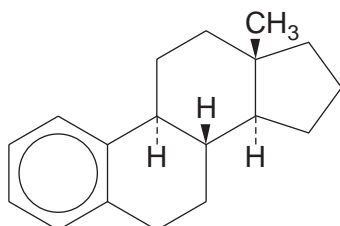
- (a) (i) On the above structure of oestradiol, circle **one** chiral centre.
- (ii) What is the total number of chiral centres in the oestradiol molecule? ..... [2]
- (b) Complete the following part-structures (which have the -OH groups removed) to show the products obtained when oestradiol (above) is reacted with the stated reagents.
- (i) sodium metal



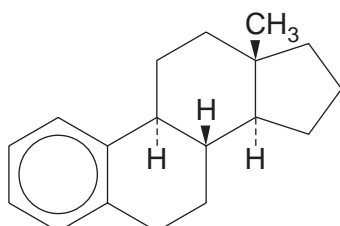
(ii)  $\text{Br}_2(\text{aq})$



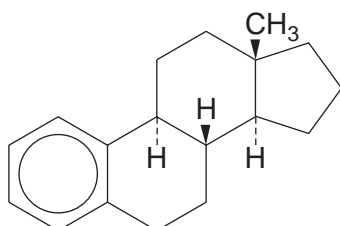
(iii)  $\text{NaOH}(\text{aq})$



(iv)  $\text{CH}_3\text{COCl}$



(v) hot acidified  $\text{K}_2\text{Cr}_2\text{O}_7$



[7]

[Total: 9]