GCE AS Level Biology

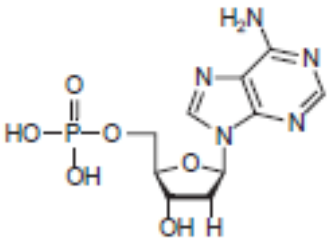
S21-B400U10-1

Assessment Resource 3

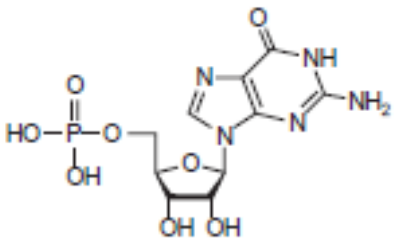
Basic Biochemistry and Cell Organisation Resource C

1. Nucleic acids and related molecules are found in all forms of life on Earth. The diagrams below show the structural formulae of three molecules called nucleotides.

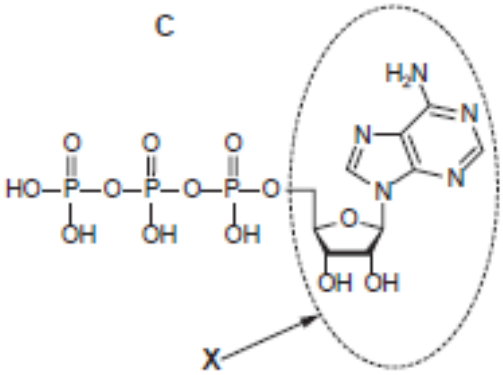
A



B



C



(a) (i) Identify the **type** of nitrogenous base found in all three molecules. [1]

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(ii) Explain why molecule C is sometimes referred to as the *universal energy currency*. Include reference to the structure of the molecule in your answer. [3]

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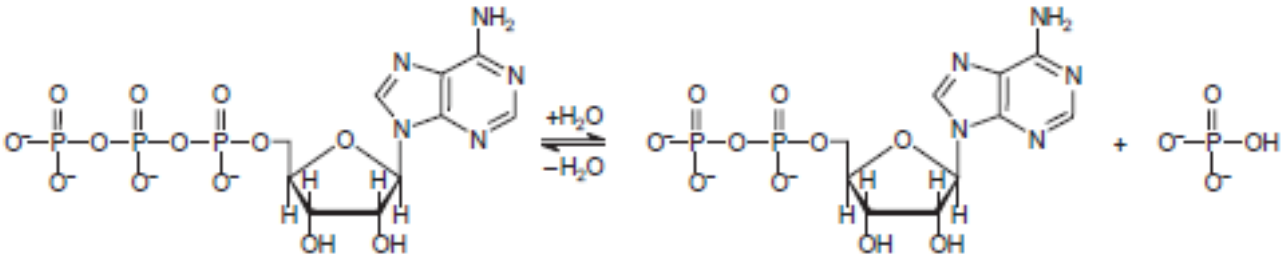
(iii) Name the **region** of molecule C labelled **X** on the diagram. Use this information to identify the base found in molecule B. [2]

X .....

Base in molecule B .....

(b) Molecule C is mainly synthesised in two organelles found in eukaryotic cells as shown in the equation below.



(i) Name two organelles which synthesise molecule C. [1]

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(ii) State whether the synthesis of molecule C is endergonic or exergonic. Explain your answer. [1]

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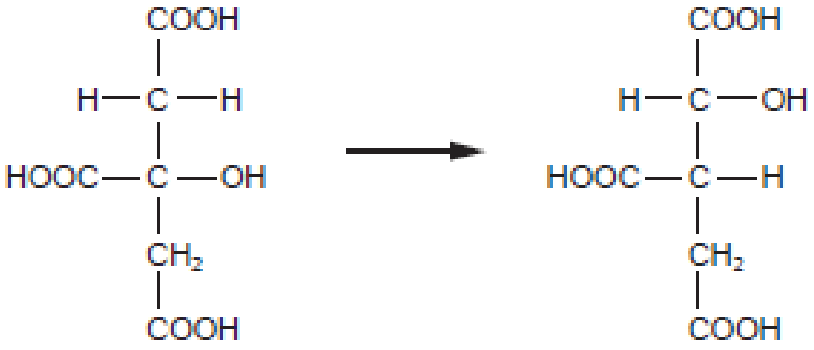
(iii) The removal of all three phosphate groups from molecule C one after the other would release a total of 75.4 $kJ\,mol^{-1}$ of energy. Assuming the removal of the first and second phosphate groups yield the same quantity of energy, calculate the available energy stored in the bond between the third phosphate and the pentose sugar. [1]

Available energy = ... $kJ\,mol^{-1}$

9

2. Citrate and isocitrate are two of the molecules found in a metabolic pathway in mitochondria. The structures of these molecules are shown below.



Citrate Isocitrate

(a) Explain why these molecules are termed **structural isomers.** [1]

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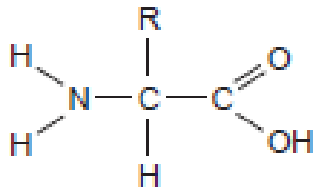
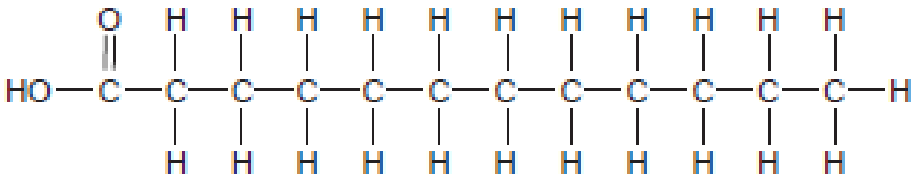
The –COOH group is found in several different biological molecules. Two of these molecules are shown below.

X



Y



(b) (i) Name the type of molecules **X** and **Y**. [1]

X .....

Y .....

(ii) State what is represented by –R in molecule **X**. [1]

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Molecule Y is found as a component of a group of molecules that are involved in energy storage and thermal insulation in many organisms.

(iii) Name this group of molecules and describe how you would test for their presence in a sample of food. [3]

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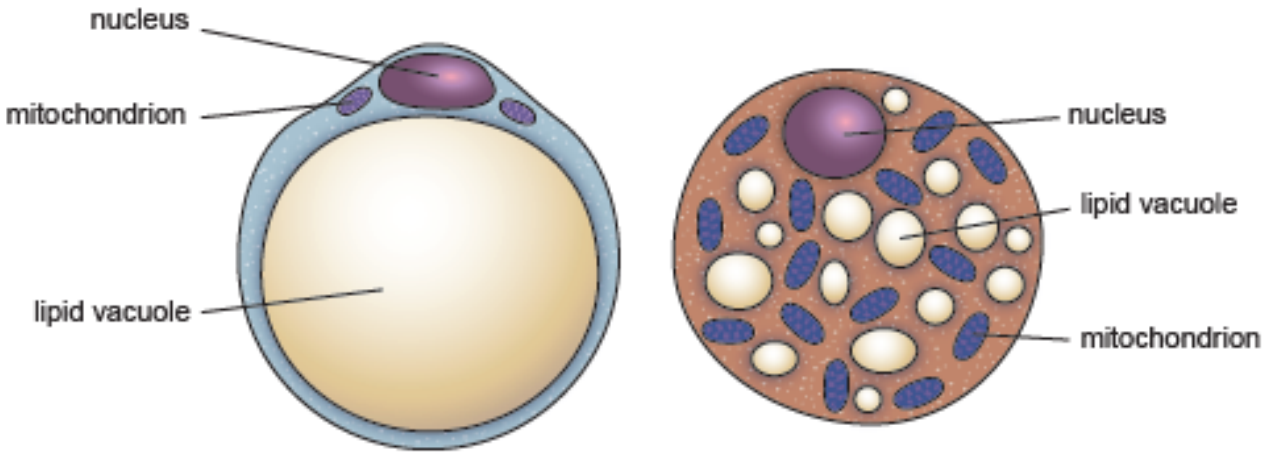
Adipose tissue is found in mammals in two different forms: white adipose tissue and brown adipose tissue. The distribution of each form varies depending upon the species. Seals, which live in cold water, have a thick layer of white adipose tissue under their skin. In addition, other areas of a seal's body have a high proportion of brown adipose tissue.

Drawings of the cells that make up each type of adipose tissue are shown below.



white fat cell **brown fat cell**

(iv) The diameter of the lipid vacuole in the white fat cell measured 80 µm. Calculate the volume of the lipid vacuole located in the white fat cell. Use the formula given. [2]

Volume= $\frac{4}{3}\pi r^3$

$\pi = 3.14$

Volume = ... μm^3

(v) Brown and white fat cells in seals help them survive in **cold** water. Using the information provided, suggest how the structure of each type of fat cell is an adaptation for the survival of the seal. Explain your answer. [2]

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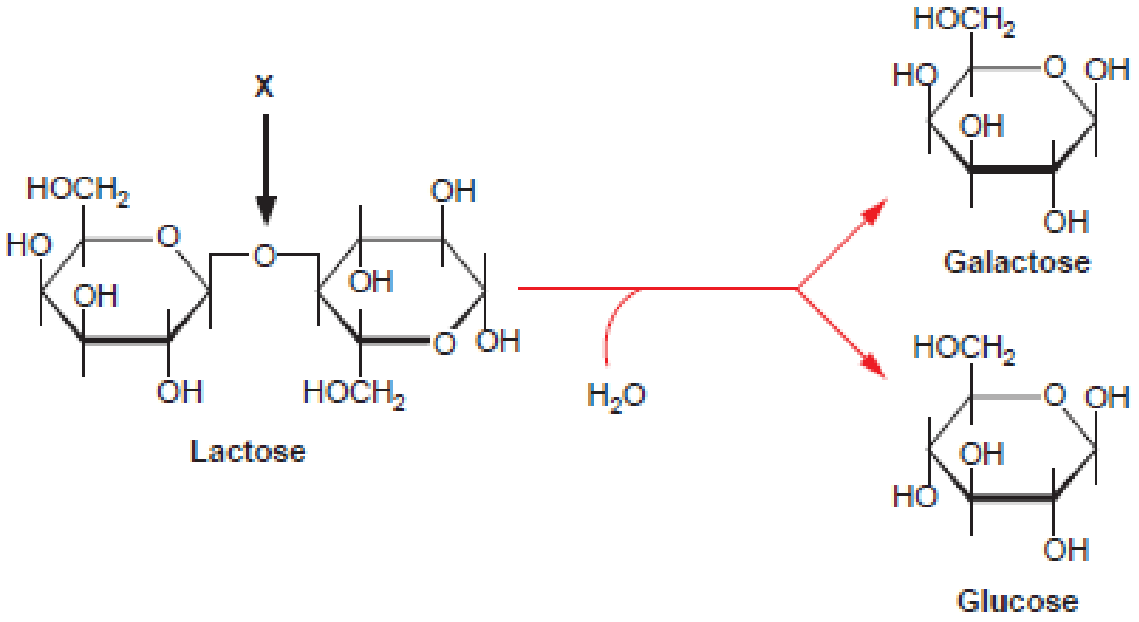
3. Some people cannot drink cow's milk as they are lactose intolerant. They lack the enzyme lactase that catalyses the breakdown of lactose into galactose and glucose.



(a) (i) If lactase is present, bond **X** is broken in this reaction. Name this type of bond and the type of reaction that breaks this bond. [2]

Bond X .....

Reaction .....

(ii) Explain how you can identify that the isomer of glucose shown in the diagram above is β-glucose. [1]

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(b) (i) The rate of enzyme activity can be altered by the presence of inhibitors.

Explain why galactose can act as a competitive inhibitor of lactase. [1]

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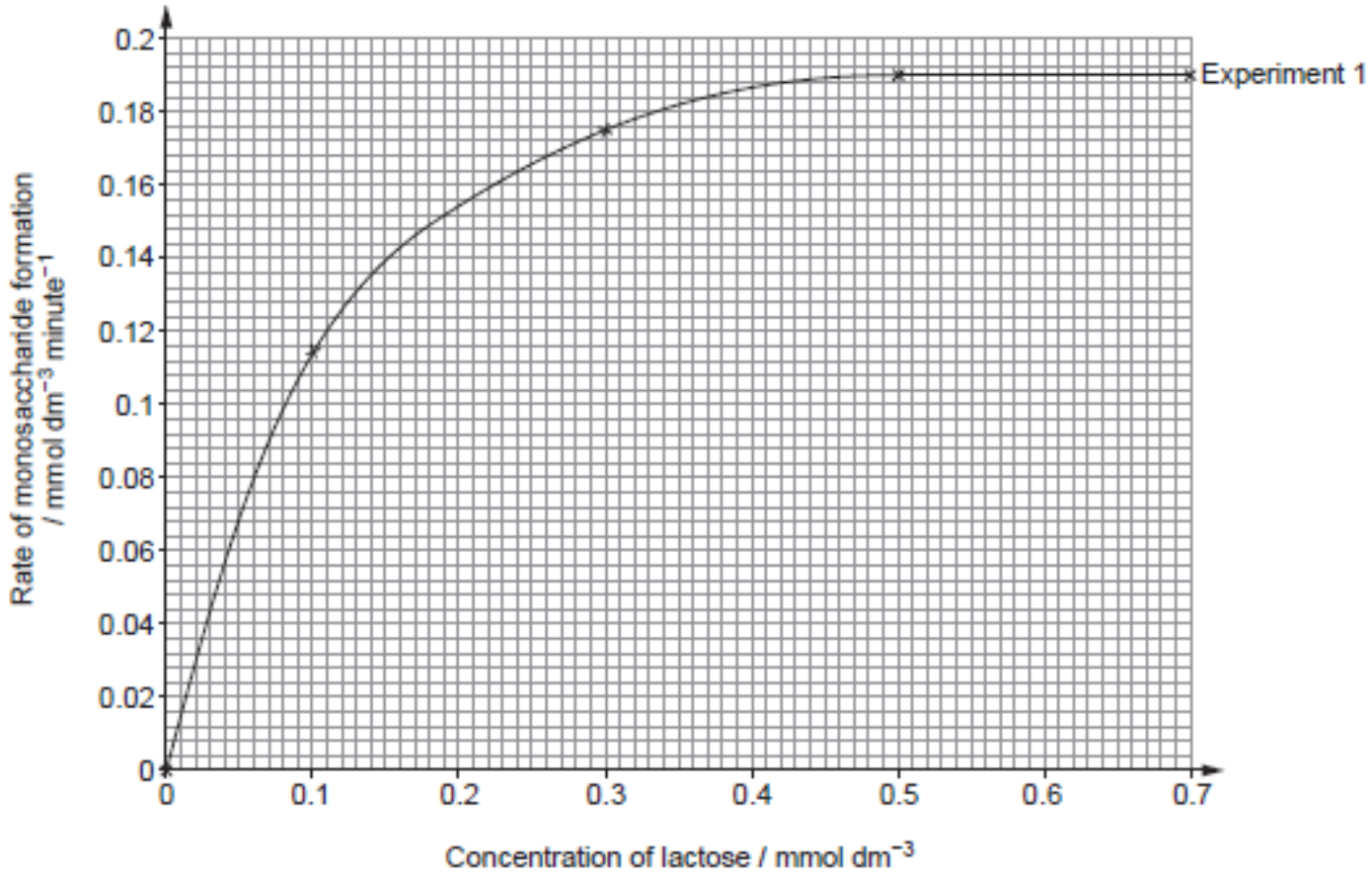
Students investigated the effect of inhibition of lactase by galactose.
They added a fixed concentration of lactase to different concentrations of lactose solution and measured the rate of monosaccharide formation. The experiment was repeated with a fixed concentration of galactose added to the lactose solutions. All volumes used were controlled for each solution in both experiments.

The results are shown below.

Concentration of lactose / mmol dm^{-3}	Rate of monosaccharide formation / mmol dm^{-3} $minute^{-1}$	
	Experiment 1 (without galactose)	Experiment 2 (with galactose)
0.00	0.000	0.000
0.10	0.115	0.050
0.30	0.176	0.130
0.50	0.190	0.180
0.70	0.190	0.190

(ii) The results for Experiment 1 have been plotted on the graph paper below.

Plot the results for Experiment 2 **on the same axes.** [2]



(iii) Explain how the results show that galactose acts as a competitive inhibitor of lactase. [2]

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(iv) Describe how the graph would look if galactose was a non-competitive inhibitor of lactase. [1]

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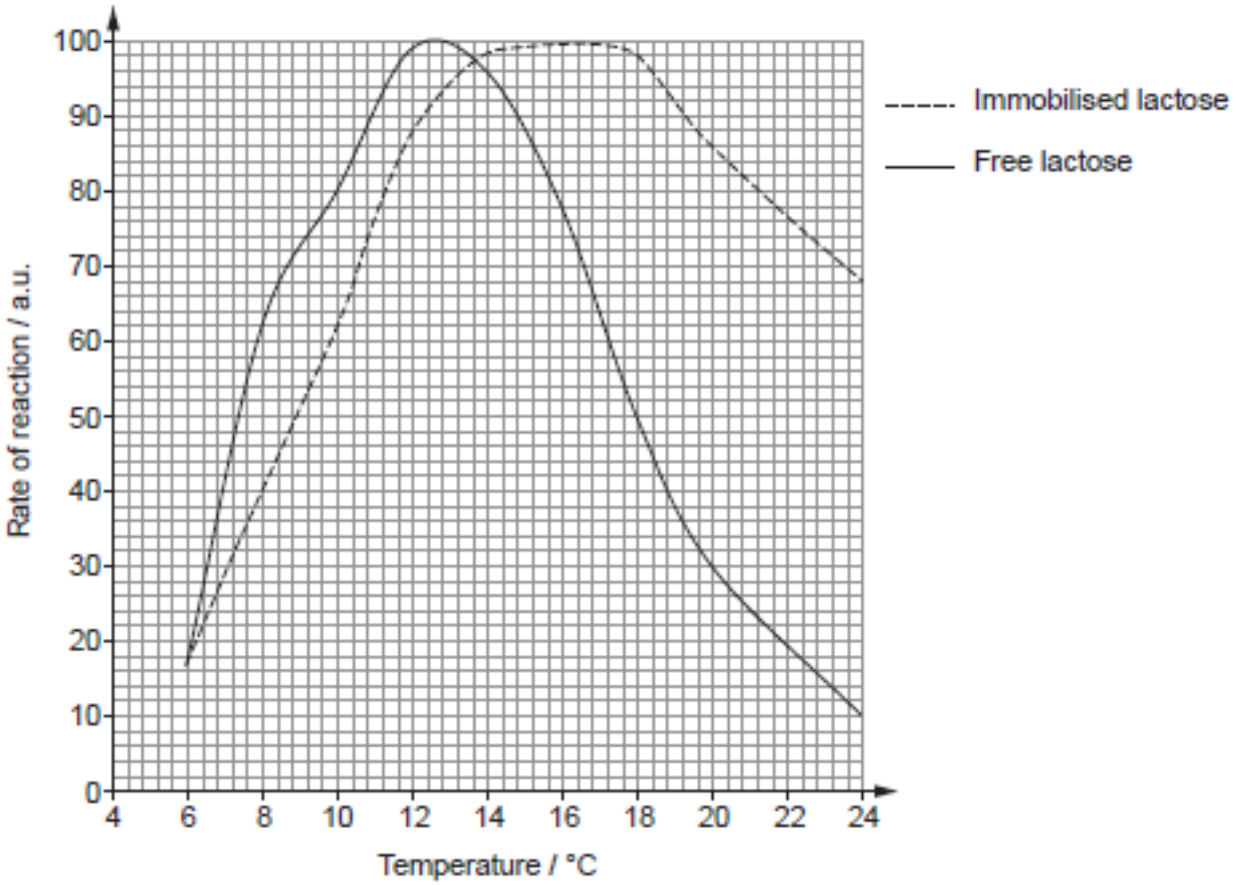
(c) Lactose free milk can be produced using bacterial lactase which has been immobilised in beads made from an inert substance, such as alginate.
An experiment was carried out to compare the activity of free and immobilised lactase at different temperatures. The results are shown in the graph below.



(i) Explain why the immobilised lactase works at its maximum rate over a wider range of temperatures than the free lactase. [2]

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(ii) Explain why the substance used to immobilise the lactase must be inert. [1]

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4. Brown seaweeds of many types grow on rocks around the shores of the UK. One of these species is called *Fucus vesiculosus*.

It is classified in the Kingdom Protoctista even though its cells contain chlorophyll.

(a) Name the domain to which *F. vesiculosus* belongs and list the **other** Kingdoms of organisms found in this domain. [2]

Domain .....

Other Kingdoms in this domain .....

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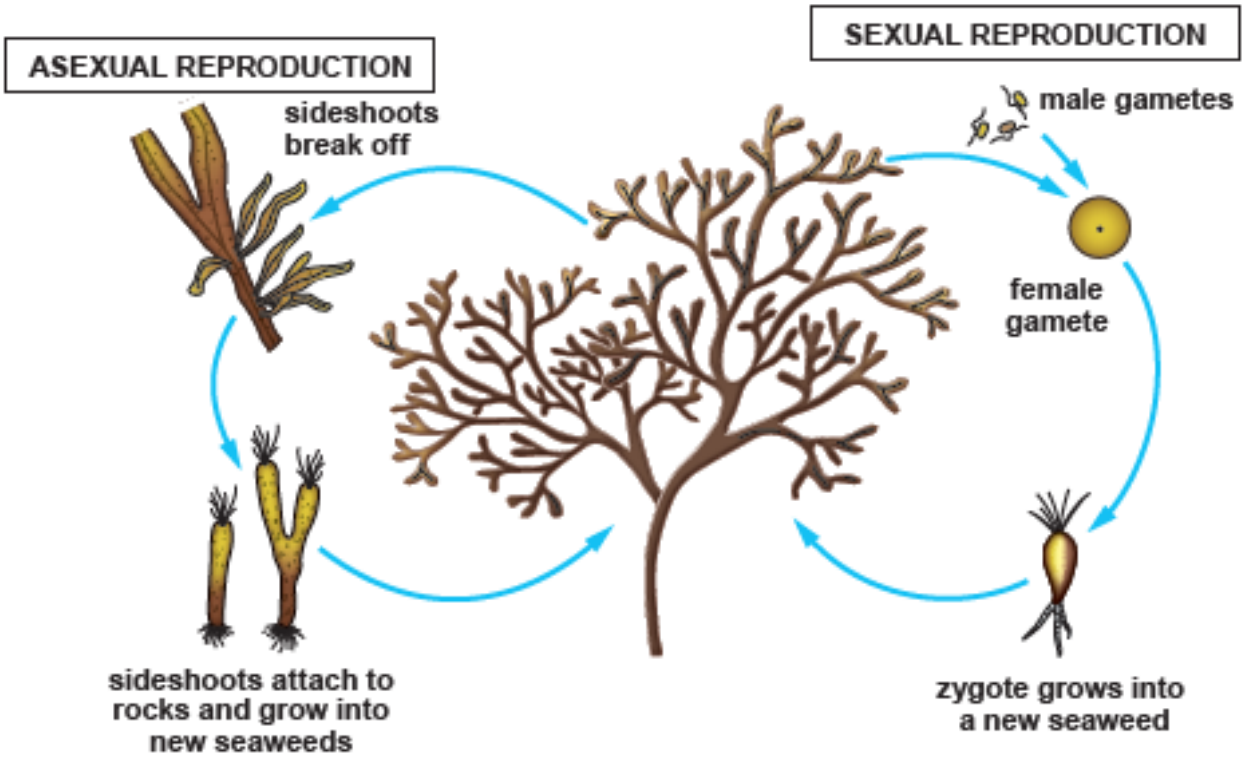
(b) This type of seaweed can reproduce both sexually and asexually as shown in the diagram below.



During sexual reproduction gametes are produced in specialised structures.
The process involves both meiosis and mitosis:

- In the production of female gametes, one cell divides first by meiosis which is followed by a single mitotic division.
- In the production of male gametes, one cell divides first by meiosis which is followed by four mitotic divisions.

(i) Calculate the number of male and female gametes produced from one cell. [2]

Number of female gametes = ...

Number of male gametes = ...

(ii) Suggest why gamete production in *F. vesiculosus* involves both meiosis and mitosis. [2]

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(iii) Explain why new seaweeds produced by sexual reproduction would be genetically different to each other and different to those produced by asexual reproduction. [3]

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