

Biotechnology

Q:1 Ethanol (alcohol) can be mixed with petrol and used as a fuel in motor vehicles.

(a) Which type of microorganism is used to make ethanol from sugar? Draw a ring around one answer.

bacterium mould yeast

(1 mark)

(b) Read the information about ethanol and petrol.

Ethanol

One litre releases 23.5 megajoules of energy when it is burned.

It releases carbon dioxide and water when it is burned.

It can be made from crops such as sugar cane and maize.

Petrol

One litre releases 34.8 megajoules of energy when it is burned.

It releases carbon dioxide, water, carbon monoxide, sulfur dioxide and oxides of nitrogen when it is burned.

It is made from crude oil which is pumped out of the ground.

(b)(i) Use the information above to explain two advantages of using ethanol rather than petrol as a fuel in motor vehicles.

Explanation 1

Explanation 2

(4 marks)

(b)(ii) Give one disadvantage of using ethanol rather than petrol as a fuel in motor vehicles.

(1 mark)

Q:2 Read the following passage carefully.

Petrol is a mixture which includes small amounts of nitrogen and sulfur compounds.

Gasohol, a blend of ethanol with petrol, can be used in most car engines.

Brazil is the world's leading producer of gasohol, using mainly ethanol from sugar cane. Other countries make use of maize or various crop wastes, such as shoots and leaves. Ethanol evaporates more readily than petrol. It releases 23.5 megajoules of energy per litre compared with 34.8 megajoules for petrol. Burning either petrol or ethanol releases carbon dioxide and water vapour into the air. But using gasohol reduces emissions of carbon monoxide and hydrocarbons. The hydrocarbons from exhaust fumes sometimes react with sunlight to form 'photochemical smog'.

Opponents of the use of ethanol in motor fuel claim that it increases emissions of oxides of nitrogen from cars, but this effect has not been observed by air quality monitoring. Opponents also claim that ethanol takes more energy to produce than it releases. But other scientists report that making ethanol from sugar cane yields 8 units of energy for each unit used in production, while ethanol from maize gives 1.34 units.

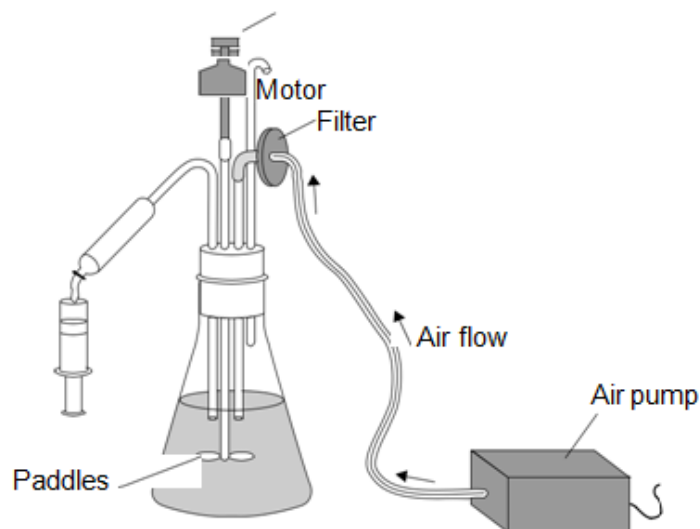
Evaluate the scientific basis for and against the blending of ethanol with petrol.

Use information from the passage and your own knowledge of biology.

Remember to give a conclusion to your evaluation.

(5 marks)

Q:3 The diagram shows a simple laboratory fermenter.



Some students grew the fungus *Fusarium* in this fermenter.

After 5 days the students measured the dry mass of the *Fusarium*.

(a) List A gives the names of three pieces of apparatus in the diagram.

List B gives four possible functions of these pieces of apparatus.

Draw one line from each piece of apparatus in List A to its correct function in List B.

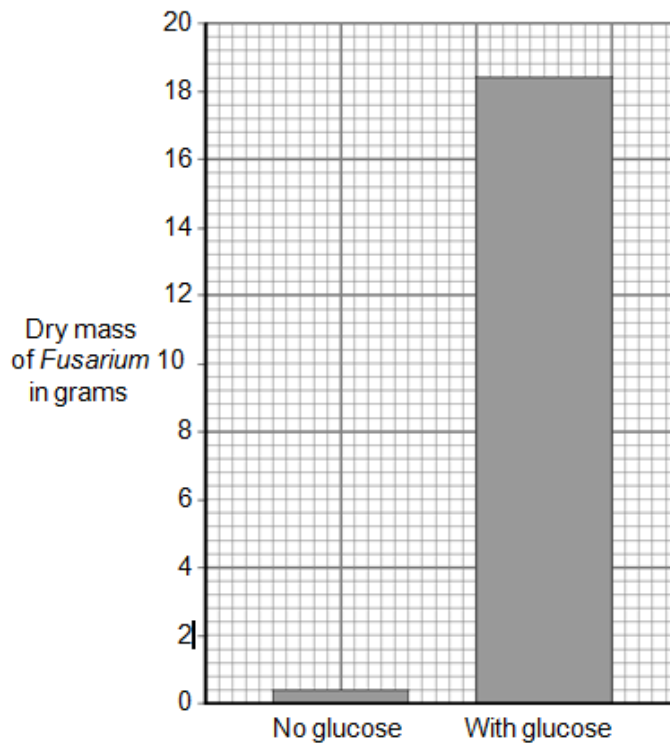
List A Apparatus	List B Function
Air pump	To stop microorganisms entering the flask
Filter	To allow gases to escape from the flask
Paddles	To supply oxygen to the fungus
	To keep the contents well mixed

(3 marks)

(b) The students grew the *Fusarium* in a culture solution of minerals dissolved in water.

The students repeated the experiment with the same concentration of minerals, but this time they also added glucose.

The bar chart shows the effect of adding glucose to the culture solution.



(b) (i) Describe, in detail, the effect of adding glucose to the culture solution.

(2 marks)

(b) (ii) Suggest an explanation for the effect of adding glucose.

(1 mark)

(c) The students repeated the investigation four more times. They used the culture solution with added glucose but each time they left out one of the minerals.

Their results are given in the table.

Mineral left out of the culture solution	Dry mass of <i>Fusarium</i> in grams
Calcium	18.50
Iron	16.80
Magnesium	1.90
Potassium	10.80

Which mineral is most important for the growth of *Fusarium*?

Draw a ring around one answer.

calcium iron magnesium potassium

(1 mark)

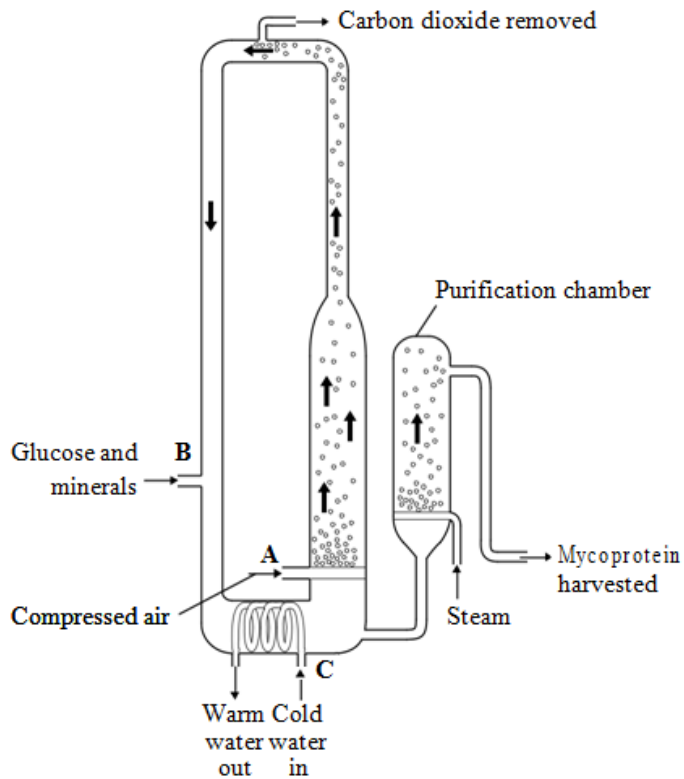
(d) Draw a ring around the correct answer to complete the sentence.

In industry, *Fusarium* is usually grown to make

- alcohol.
- biogas.
- mycoprotein.

(1 mark)

Q:4 The diagram shows a fermenter. This fermenter is used for growing the fungus *Fusarium* which is used to make mycoprotein.



(a) Bubbles of air enter the fermenter at A. Give two functions of the air bubbles.

1 _____

2 _____

(2 marks)

(b) Glucose is added to the fermenter at B. Explain why glucose is added.

(1 mark)

(c) The fermenter is prevented from overheating by the cold water flowing in through the heat exchanger coils at C.

Explain what causes the fermenter to heat up.

(1 mark)

(d) It is important to prevent microorganisms other than *Fusarium* from growing in the fermenter.

(d)(i) Why is this important?

(1 mark)

(d)(ii) Suggest two ways in which contamination of the fermenter by microorganisms could be prevented.

1 _____

2 _____

(2 marks)

(e) Human cells cannot make some of the amino acids which we need. We must obtain these amino acids from our diet.

The table shows the amounts of four of these amino acids present in mycoprotein, in beef and in wheat.

Name of amino acid	Amount of amino acid per 100 g in mg			Daily amount needed by a 70 kg human in mg
	Mycoprotein	Beef	Wheat	
Lysine	910	1600	300	840
Methionine	230	500	220	910
Phenylalanine	540	760	680	980
Threonine	610	840	370	490

A diet book states that mycoprotein is the best source of amino acids for the human diet.

Evaluate this statement.

Remember to include a conclusion in your evaluation.

(4 marks)

Q:5 The table gives information about the growth of different types of organism. The figures were obtained during the period of fastest growth for each organism.

Organism	Time taken to double in mass
Bacteria	40 minutes
Yeasts	2 hours
<i>Fusarium</i>	4 hours
Algae	5 hours
Soybeans	1 week
Cattle	8 weeks

(a)(i) Which type of organism grows the fastest?

(1 mark)

(a)(ii) How many times faster than cattle do soybeans double in mass?

(1 mark)

(a)(iii) Fusarium grows at its fastest rate in a fermenter.

Some scientists put one tonne of Fusarium into a fermenter.

Use data from the table to calculate how much Fusarium there would be in the fermenter after 8 hours. Draw a ring around one answer.

2 tonnes 4 tonnes 8 tonnes

(1 mark)

(b) Fusarium is used to make mycoprotein.

Read the information about substances found in mycoprotein.

- Protein – can be used for making cells, enzymes and antibodies.
- Fats – are rich in energy but large amounts in the diet can cause circulatory problems.
- Dietary fibre – helps to reduce the risk of colon cancer.

The table compares the composition of mycoprotein and beef.

Substance	Percentage of dry mass	
	Mycoprotein	Beef
Protein	47.2	68.3
Fat	13.5	30.1
Dietary fibre	19.2	0.0

Use the information above to answer the questions.

(b)(i) Give two reasons why it would be better to eat mycoprotein instead of beef.

1 _____

2 _____

(2 marks)

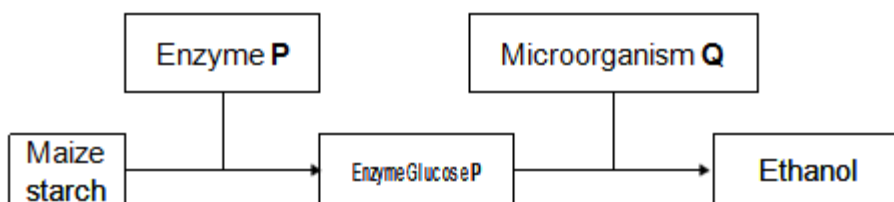
(b)(ii) Give one reason why it would be better to eat beef instead of mycoprotein.

(1 mark)

Q:6 Ethanol (alcohol) can be mixed with petrol to make gasohol. The photograph shows three gasohol pumps at a service station.



The flowchart shows one way of manufacturing ethanol.



(a) Draw a ring around the correct answer to each question.

(a) (i) Enzyme P changes starch into glucose.

What type of enzyme is P?

carbohydrase lipase protease

(1 mark)

(a) (ii) Microorganism Q changes glucose into ethanol.

What type of microorganism is Q?

bacterium mould yeast

(1 mark)

(a) (iii) The ethanol produced by microorganism Q is contaminated with water. Ethanol is separated from the mixture by

distillation fermentation filtration

(1 mark)

(b) In the long term, it may be better to use ethanol made from maize crops as a fuel for cars rather than petrol.

Explain why.

(2 marks)

TOTAL MARKS=41