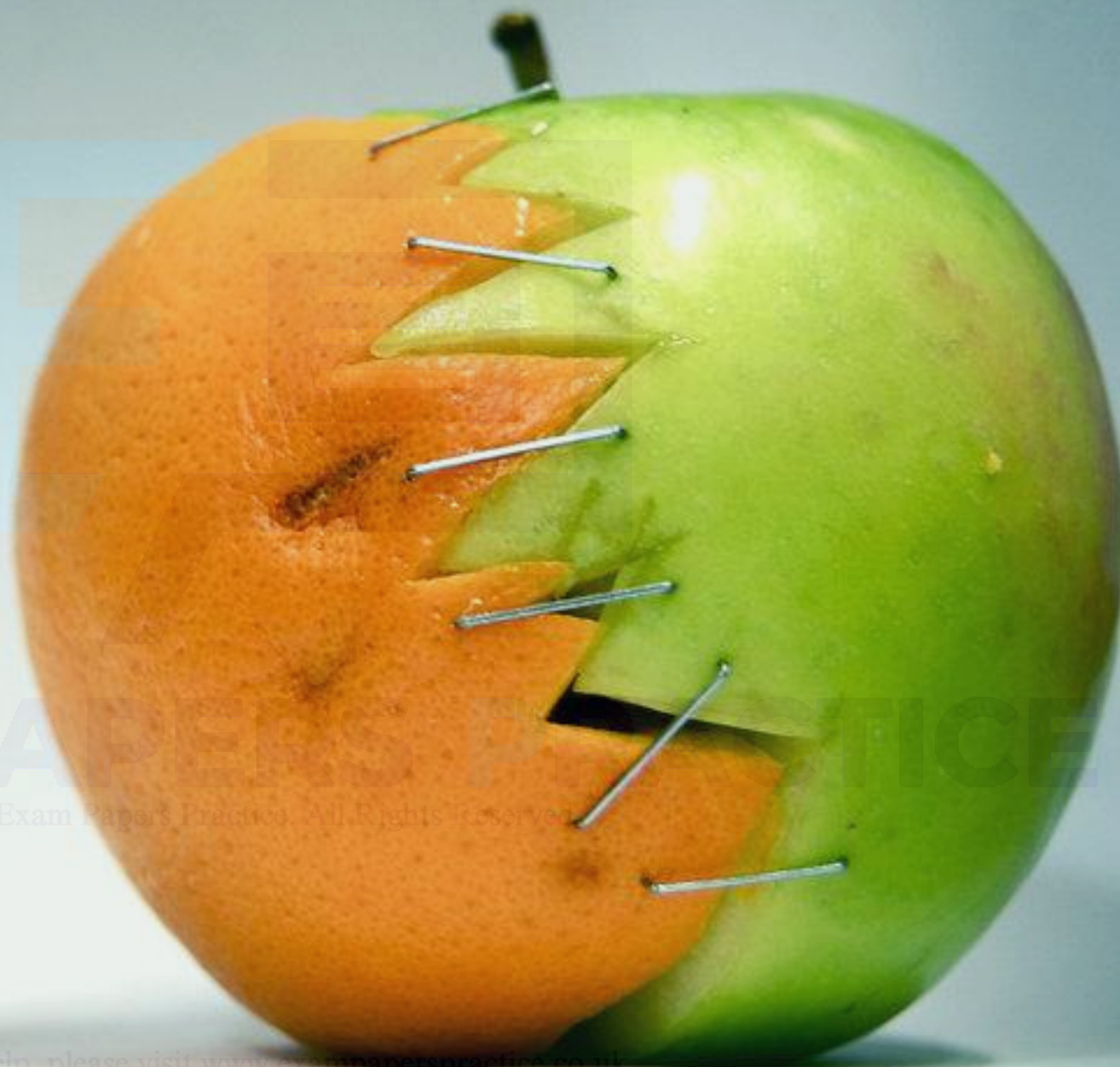




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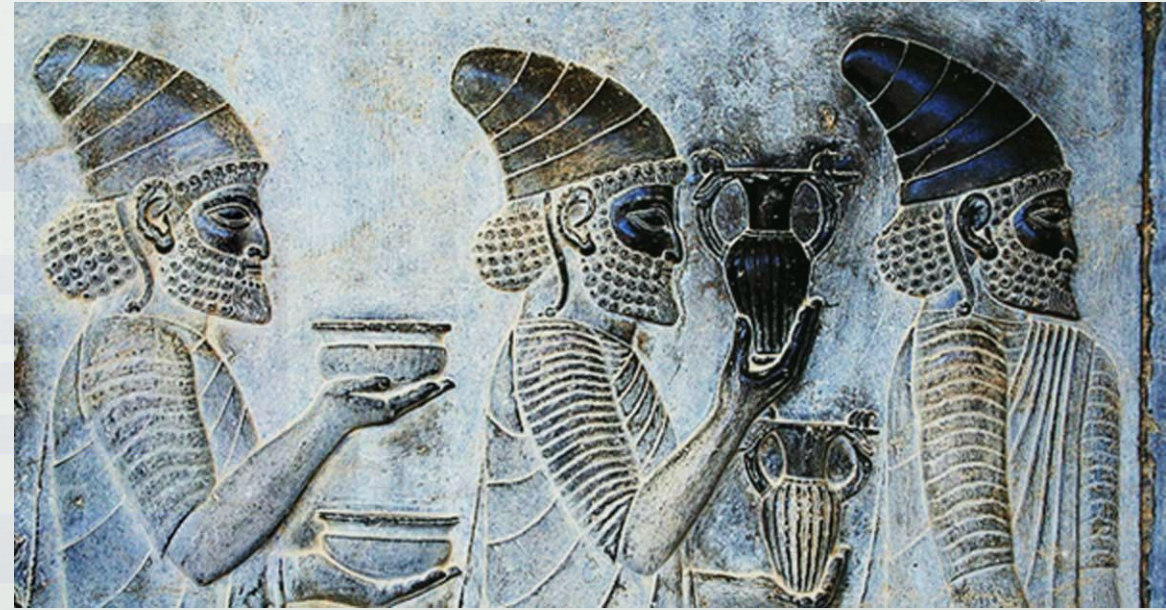
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Biotechnology

What is biotechnology

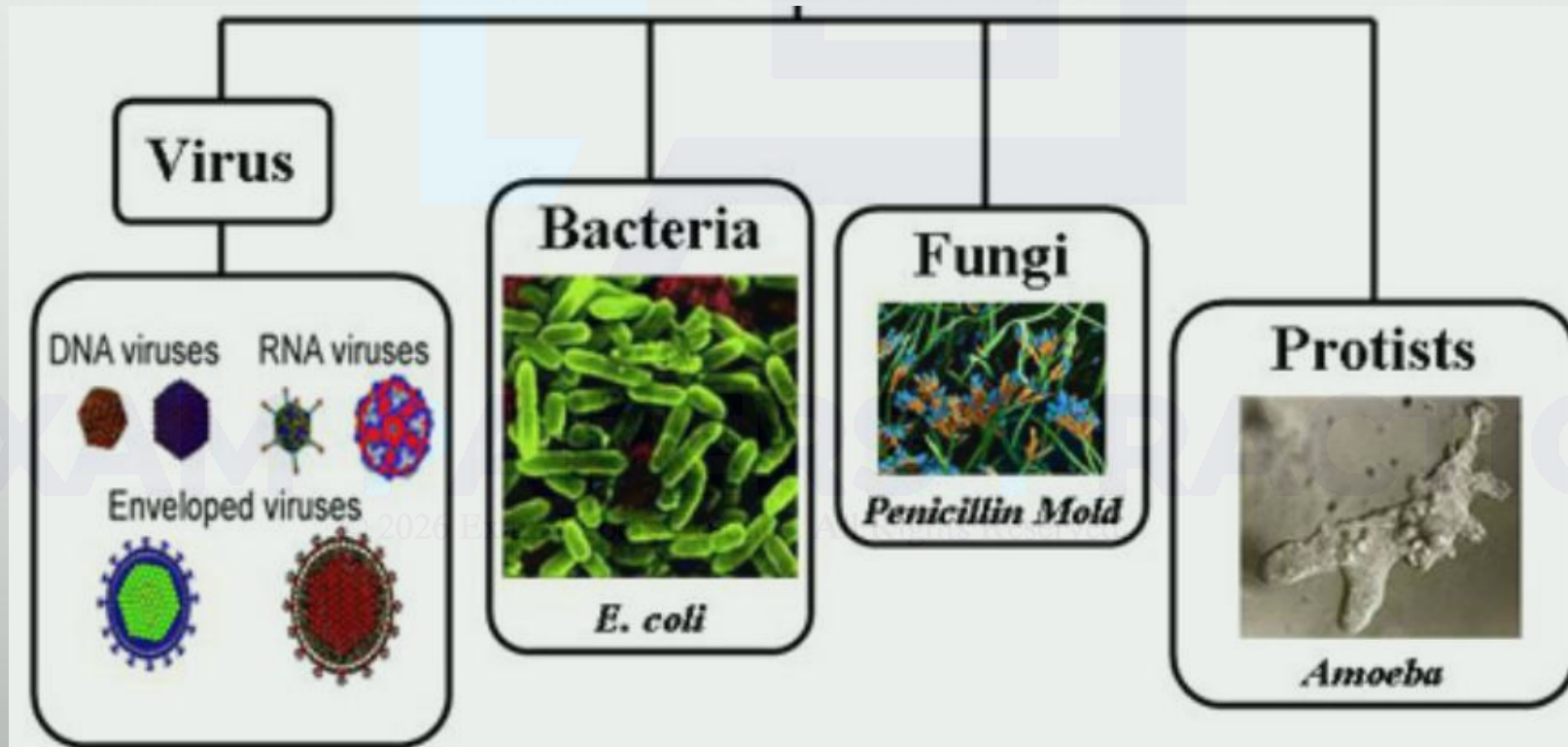
Biotechnology involves using **living organisms** (**microorganisms**, plants and animals) to carry out process that **make substances that we want**.

Take a gene from one organism and put it into a different one—— **genetic engineering** (**transgenosis**)



biotechnology 生物技术
transgenosis 转基因
Genetic engineering 基因工程

Why do scientists usually using microorganisms in biotechnology and genetic engineering ?



Biotechnology

- They are **very small**, not take up much space
- easy to grow in lab, **reproduce quickly**
- can make a huge range of different **chemicals**

no **ethical issues**

genetic code 遗传密码
ethical issue 伦理问题
plasmid 质粒

What is biotechnology

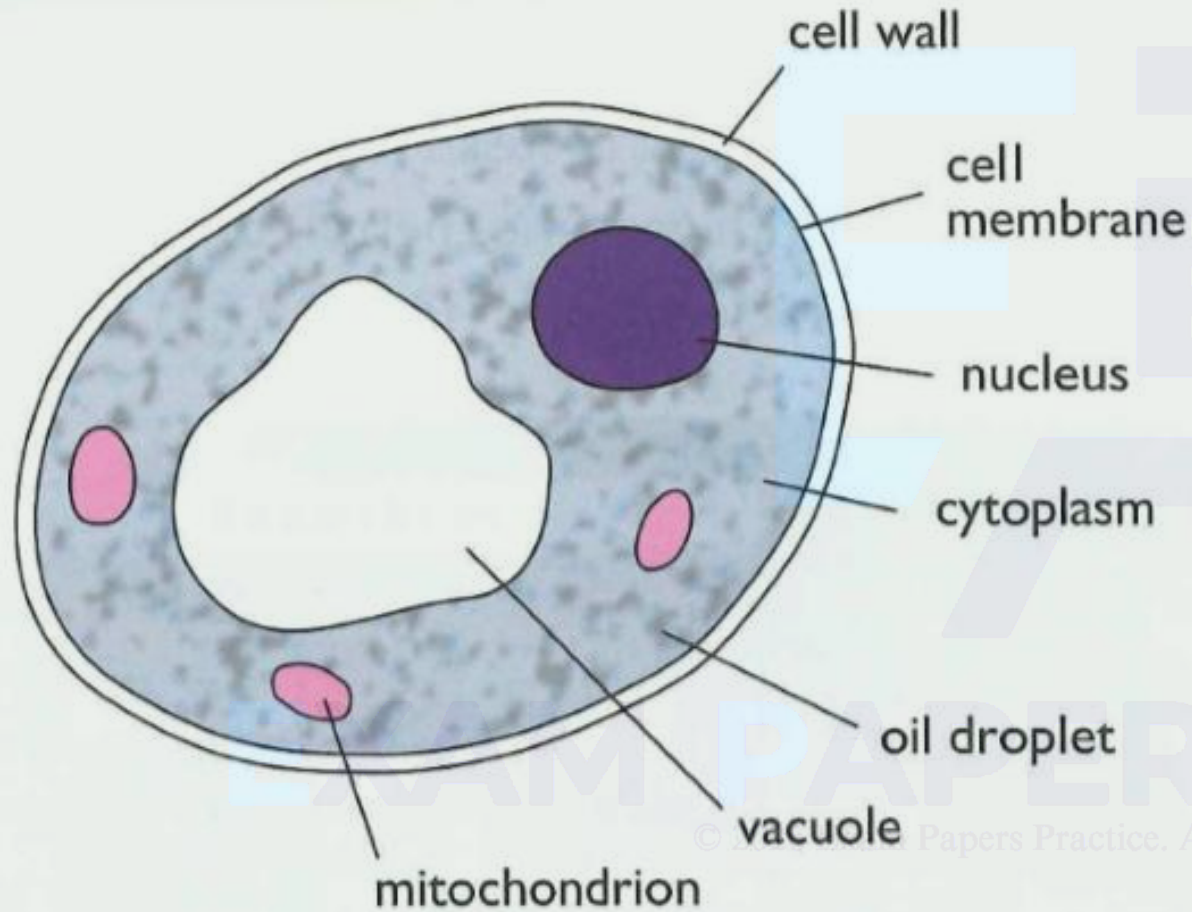
- bacterial cells share the same of genetic material, **DNA**, with humans.
- genetic code** (triplet) is same for bacteria as it is for humans
→ **transgenesis**

MICROORGANISMS

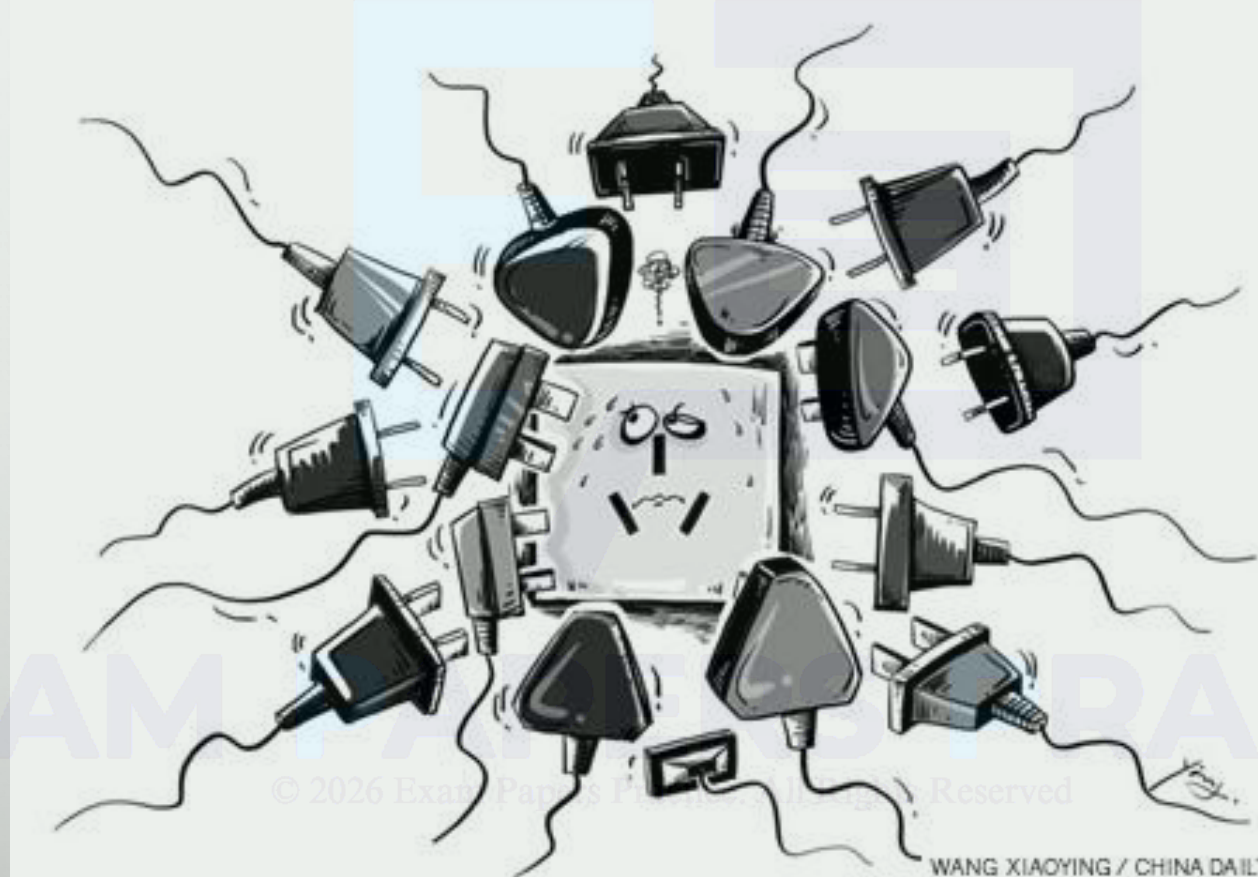


- bacterial cells have **plasmids** – little loops of DNA. These are easy to transfer from one cell to another.

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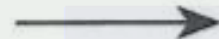
yeast 酵母菌



Energy crisis



glucose



ethanol + carbon dioxide

Yeast is able to respire anaerobically

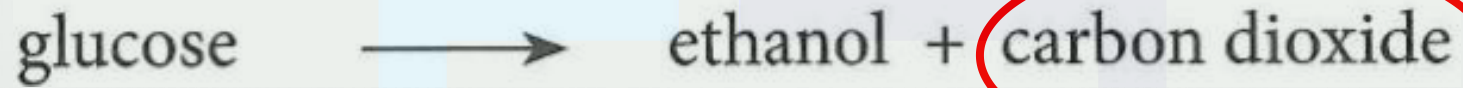
This process is also called fermentation

 sustainable
resource

anaerobic 厌氧的
aerobic 好氧的
fermentation 发酵
bioethanol 生物酒精
maize 玉米

some arguments against growing crops to make biofuels.

- the crops take up land
- put up the cereal price (expensive)



Amylase enzymes break down some of the starch in the dough to make maltose and glucose, which the yeast can use in anaerobic respiration.

Flour contains a lot of starch and protein (gluten- makes the dough stretchy)

flour 面粉
gluten 谷蛋白
dough 生面团
stretchy 有弹性的



- ♣ List three reasons why microorganisms, rather than animals, are often used in biotechnology.
- ♣ which product of anaerobic respiration is used to make biofuels?
- ♣ which product of anaerobic respiration is important in bread-making?

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biotechnology 生物技术
transgenosis 转基因
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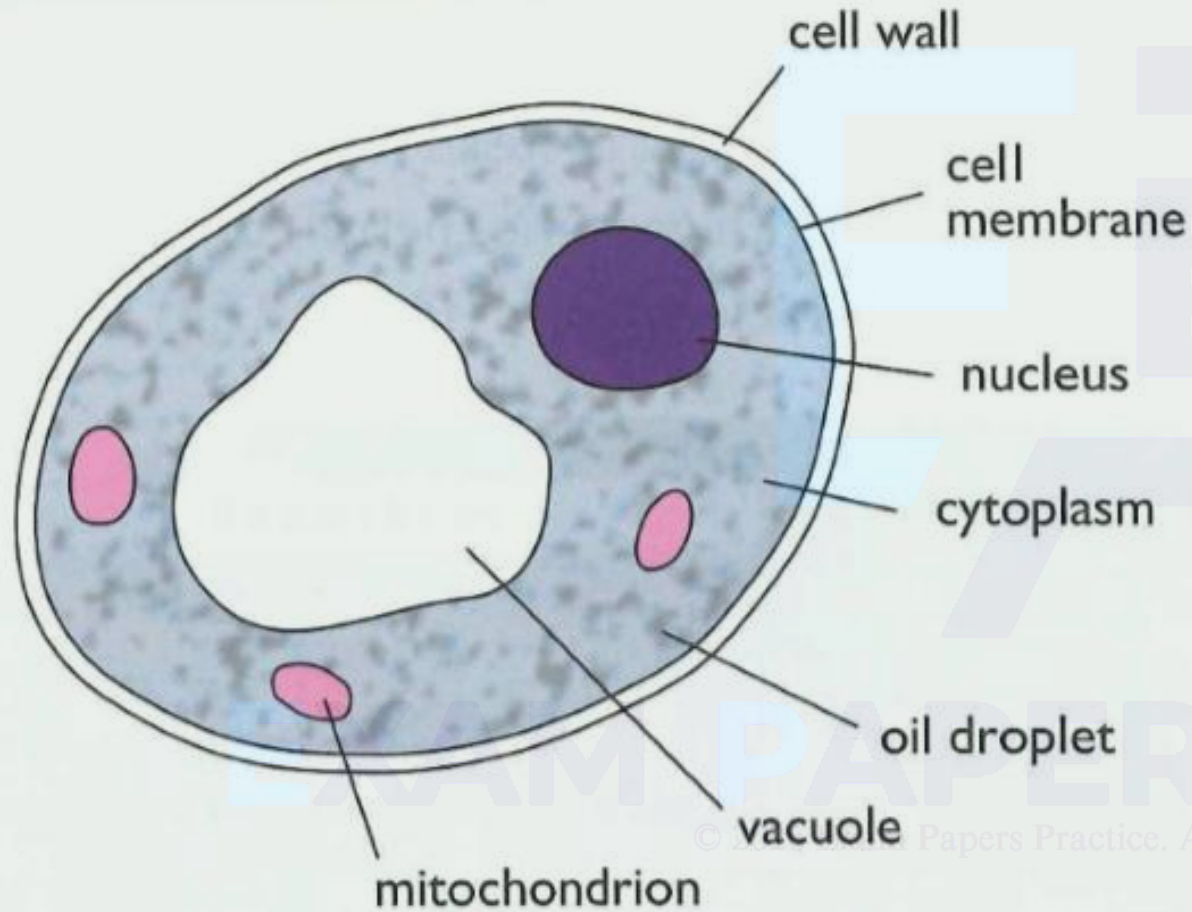
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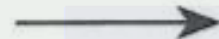
- ♣ List three reasons why microorganisms, rather than animals, are often used in biotechnology.



yeast 酵母菌



glucose



ethanol + carbon dioxide

Yeast is able to **respire anaerobically**

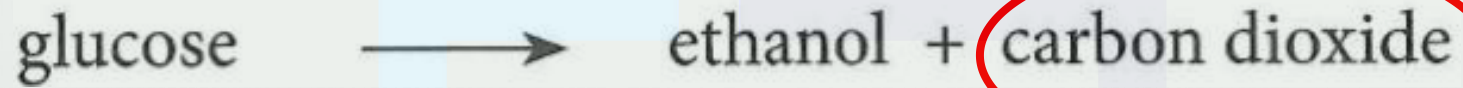
This process is also called **fermentation**

 sustainable
resource

anaerobic 厌氧的
aerobic 好氧的
fermentation 发酵
bioethanol 生物酒精
maize 玉米

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dough 生面团
stretchy 有弹性的



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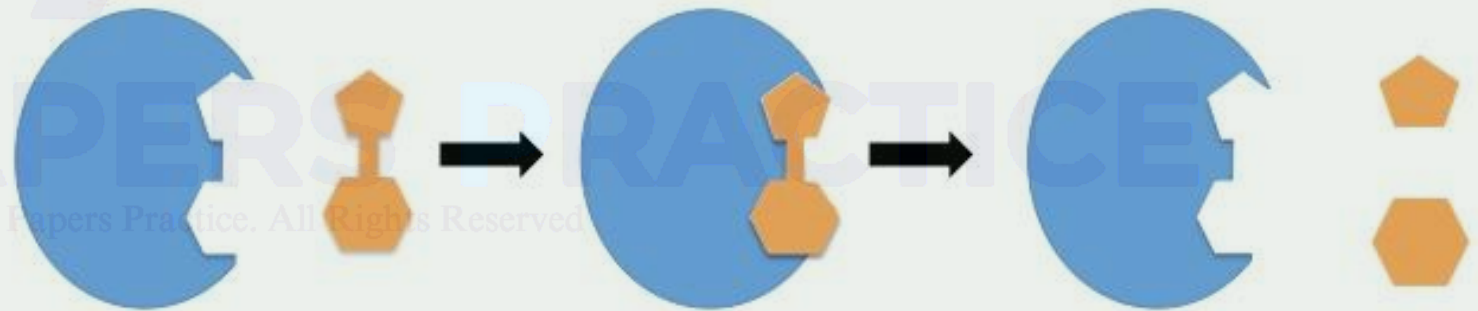
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maize 玉米

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gluten 谷蛋白
dough 生面团
stretchy 有弹性的



How to remove blood stain effectively ?

enzymes



Enzyme + Substrate

Enzyme-Substrate
Complex

Enzyme + Products

Through **fermentation**, the microorganisms can produce some **enzymes**.

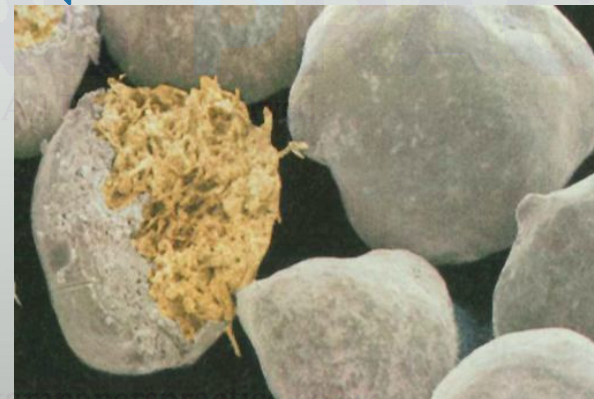
Biological washing powder

- ✦ enzymes + detergents
- ✦ **first biological washing powders** only worked in **warm, rather than hot**
- Now proteases** can work at **higher temperatures**.

detergent 去垢剂
Washing powder 洗衣粉

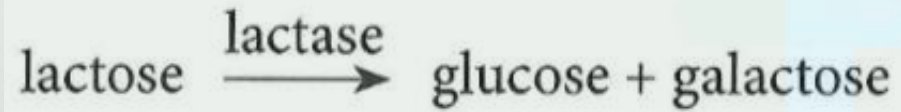
proteases

lipases



Enzymes in washing powder are packed into **microscopic capsules**. The capsules break down when that mixed with water.

lactase



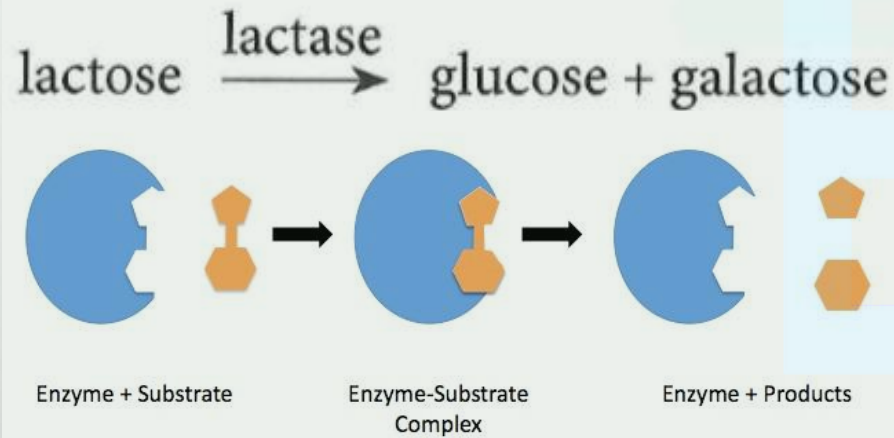
lactose

lactose 乳糖
lactase 乳糖酶
galactose 半乳糖

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Biotechnology

lactase



syringe barrel 针管
alginate bead 藻酸盐胶珠
gauze 纱布
tap 水龙头
tubing 管子
test strip 测试条
lactose-reduced milk 降乳糖牛奶

Using **lactase immobilised**.
Lactase is **trapped in tiny beads**, rather than in solution.
Enzymes do not get mixed up in lactose-reduced milk.
The little beads containing the enzymes can be **reused**.

1 Drop milk over the alginate beads. The beads contain lactase.



Biotechnology

Making use of enzymes

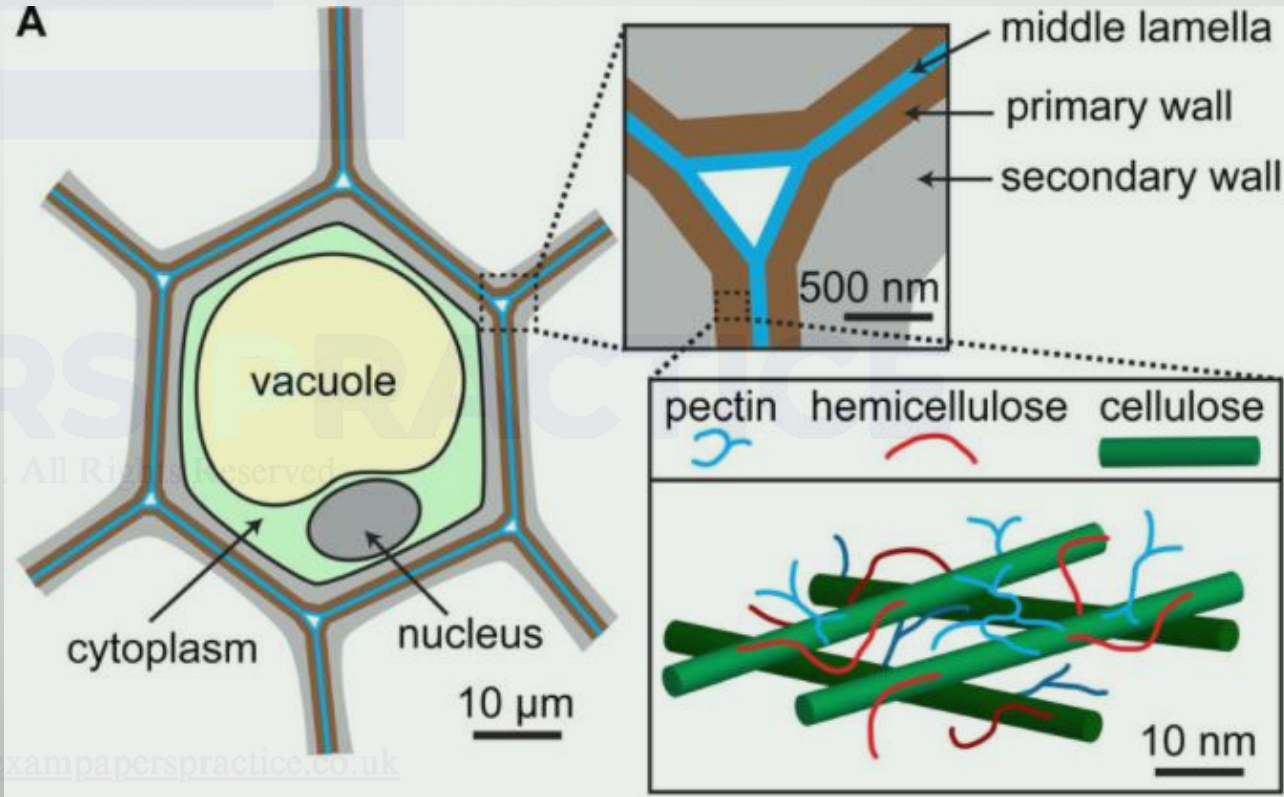
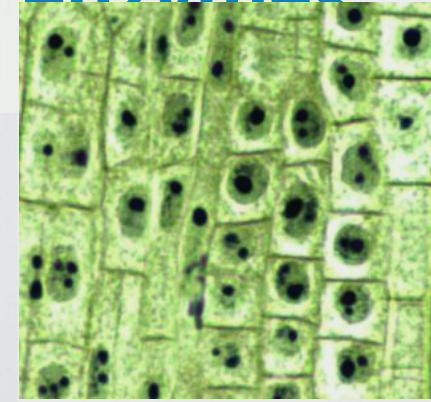
Pectinase

break down pectin

Extraction of juice from fruit and making the juice clear rather than cloudy.

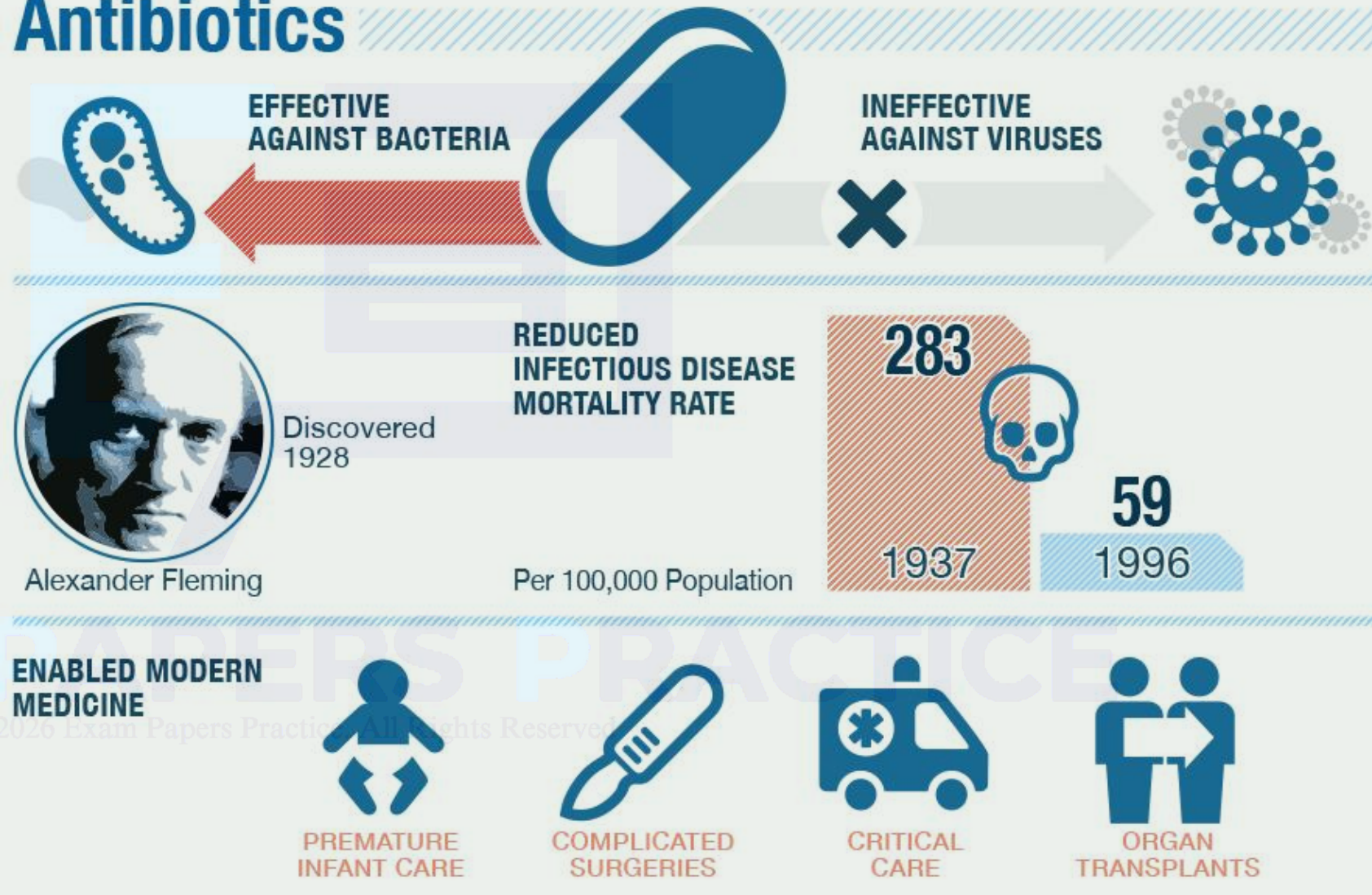


pectin 果胶
pectinase 果胶酶
extraction 提取



Antibiotics are substances which **kill bacteria** without harming human cells.
→ **bacterial infections**

Antibiotics



antibiotics 抗生素

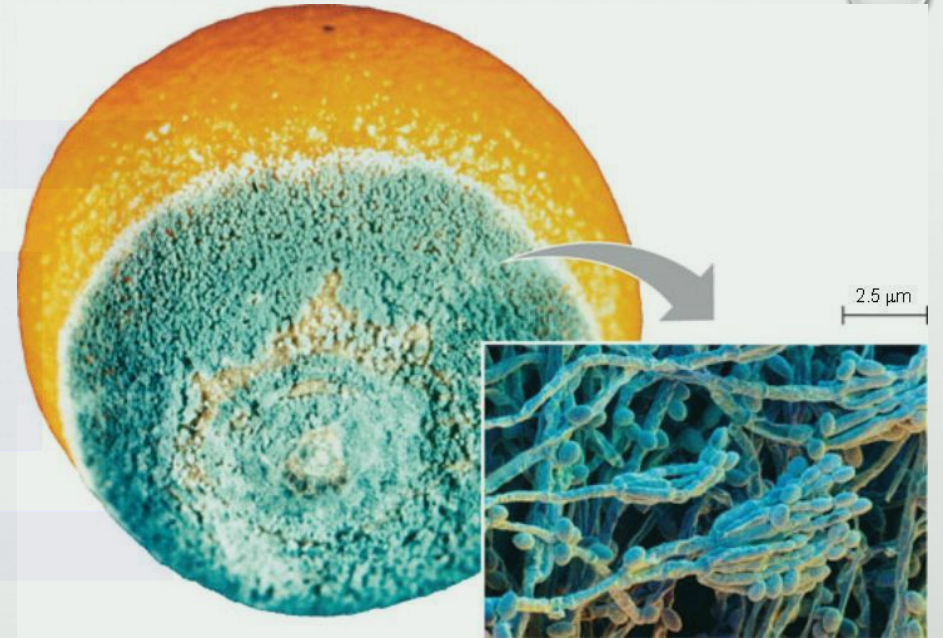
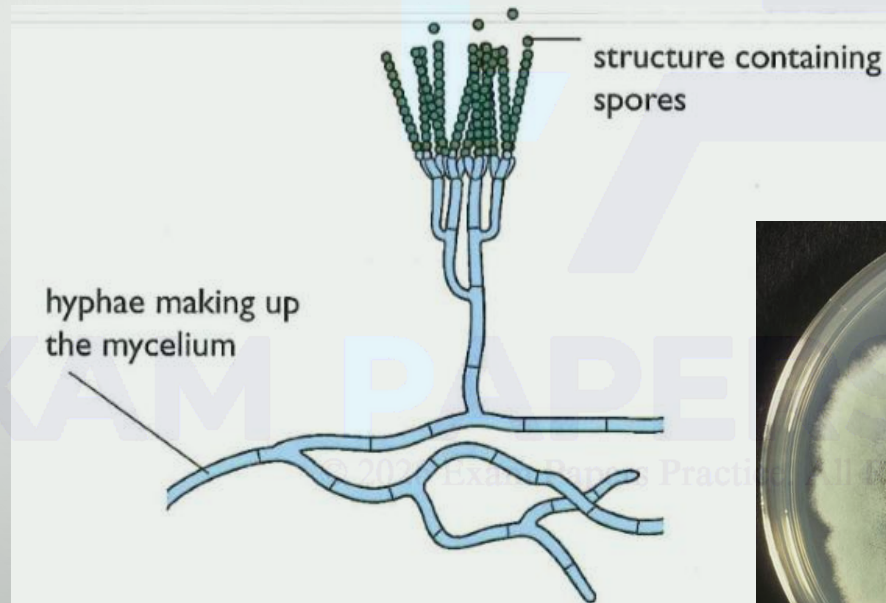
Biotechnology

Antibiotics

penicillin

made by growing the fungus *Penicillium*

hyphae , spore



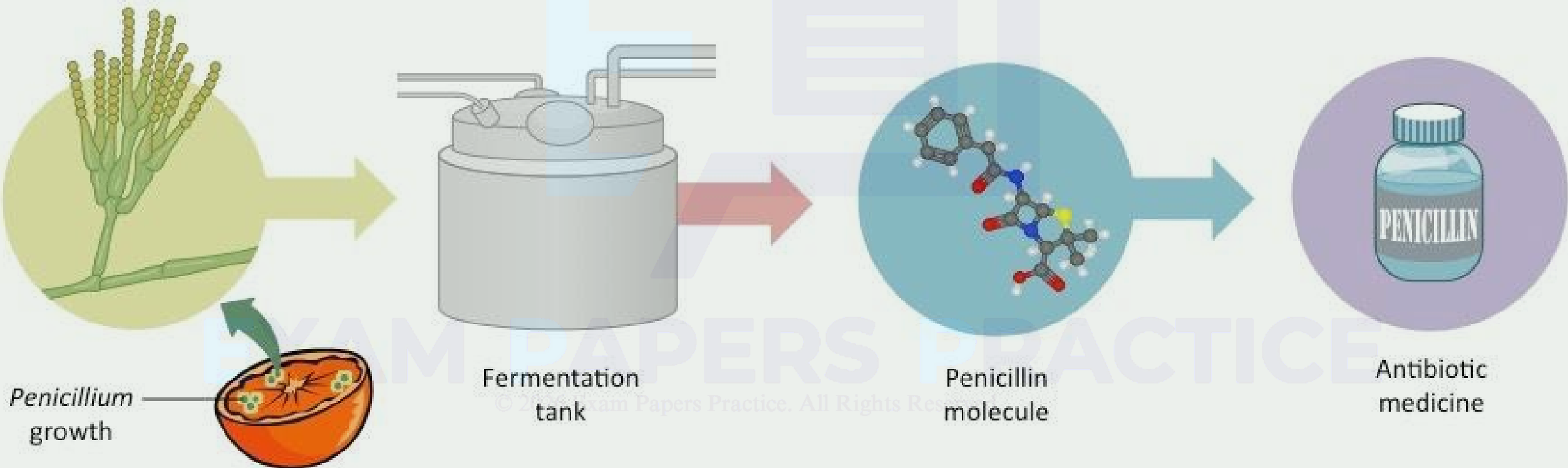
penicillin 青霉素
Penicillium 青霉菌
hyphae 菌丝
spore 孢子
mold 霉菌

- ① *Penicillium* mold produces the antibiotic penicillin

- ② Scientists grow mold in deep batch fermenters by adding sugar and other key ingredients

- ③ Scientists separate the penicillin from the mold

- ④ Penicillin is purified for use as an antibiotic medicine



fermentation 发酵
fermenter 发酵罐

Biotechnology

Penicillin fermentation

🌿 culture medium

(carbohydrate, amino acid, *Penicillium*)

🌿 stir continuously

(1. keep the fungus in contact with fresh supplies of nutrients, and mix oxygen into the culture

2. roll the fungus up into little pellets-easily separate the liquid of the culture)

🌿 small amounts of sugar have to be fed into the fermenter all the time.

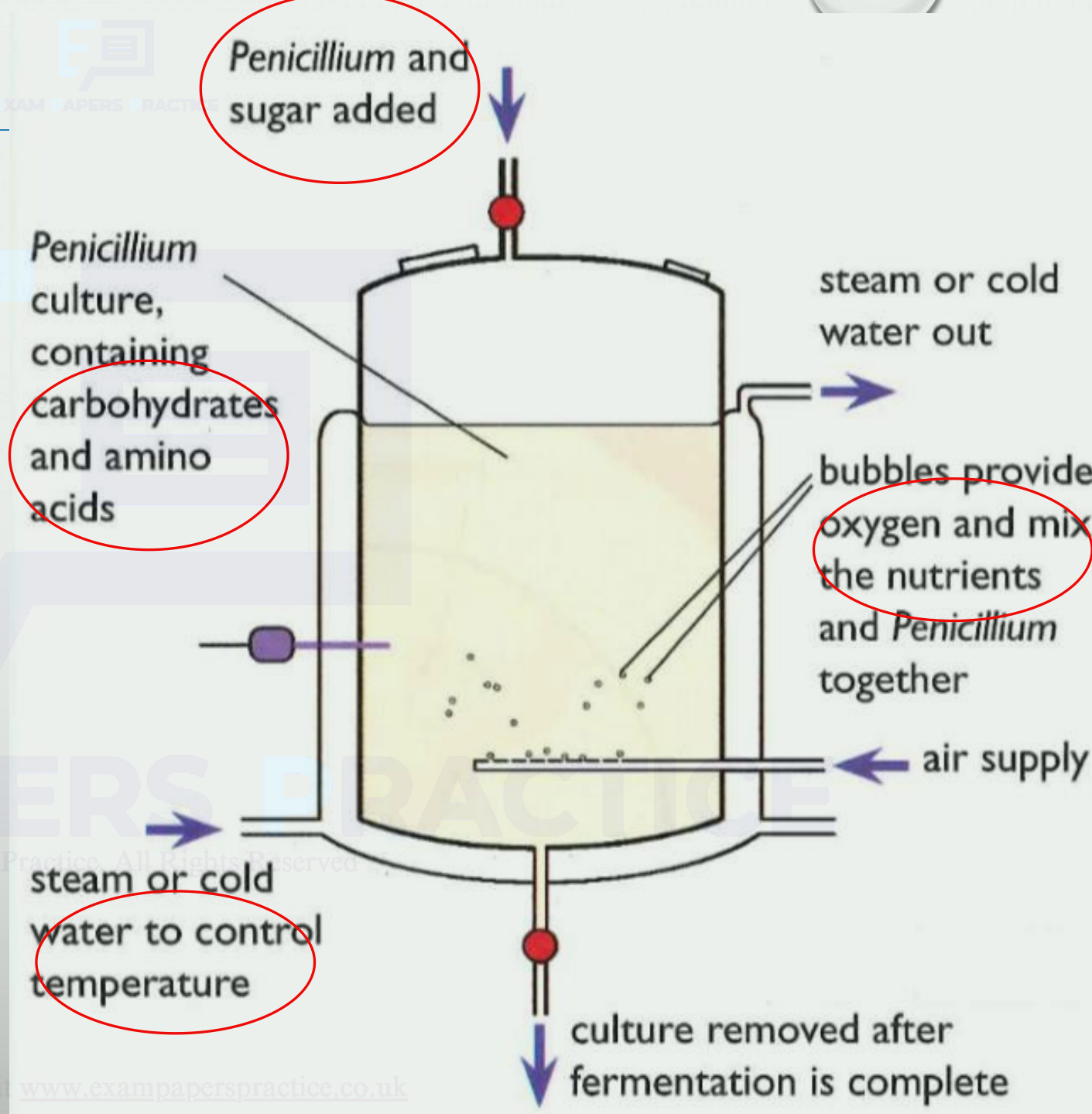
- A lot of sugar → no much penicillin

- No sugar → no penicillin

🌿 control temperature

culture medium 培养基

pellet 小球



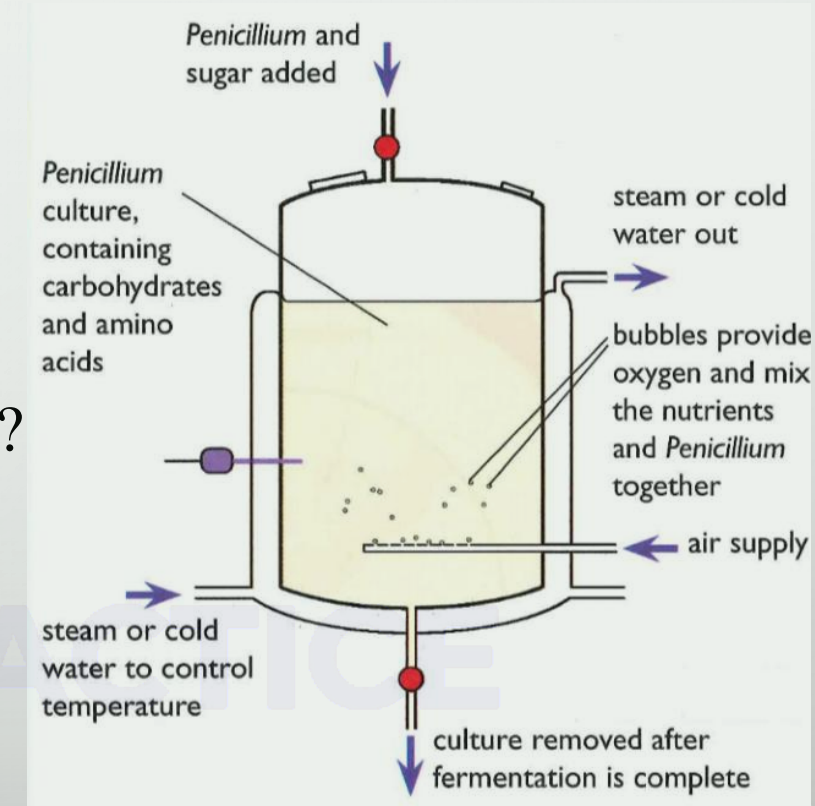
♣ how does pectinase help in the manufacture of fruit juice?

♣ look at the diagram of a fermentation in figure. Explain the reason for each of the following.

a the addition of carbohydrates and amino acids to the culture ?

b the need to control the temperature in the fermenter

c the addition of air, containing oxygen, to the fermenter



detergent
Washing powder

lactose
lactase
galactose

syringe barrel
alginate bead
gauze
tap
tubing
test strip
lactose-reduced milk



EX

Reserved

practica.co.uk

CE

[illegible]

How Crops Are Genetically Modified

Traditional Breeding



Crossing plants and selecting offspring

Almost All Crops

Mutagenesis



Exposing seeds to chemicals or radiation



RNA Interference



Switching off selected genes with RNA



Transgenics



Inserting selected genes using recombinant DNA methods



Number of Genes Affected

10K - >300K



No way to assess

1 - 2

1 - 4

Desired gene(s) inserted with other genetic material. No safety testing requirements.

Random changes in genome, usually unpredictable. No safety testing requirements.

Targeted gene(s) switched off or 'silenced'. Safety testing required.

Desired gene(s) inserted only at known locations. Safety testing required.

Genetic engineering

Changing the **genetic material** of an organism by removing, **changing** or **inserting individual genes**.

(Take genes from one organism and put the into another organism)

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Biotechnology

Genetic engineering

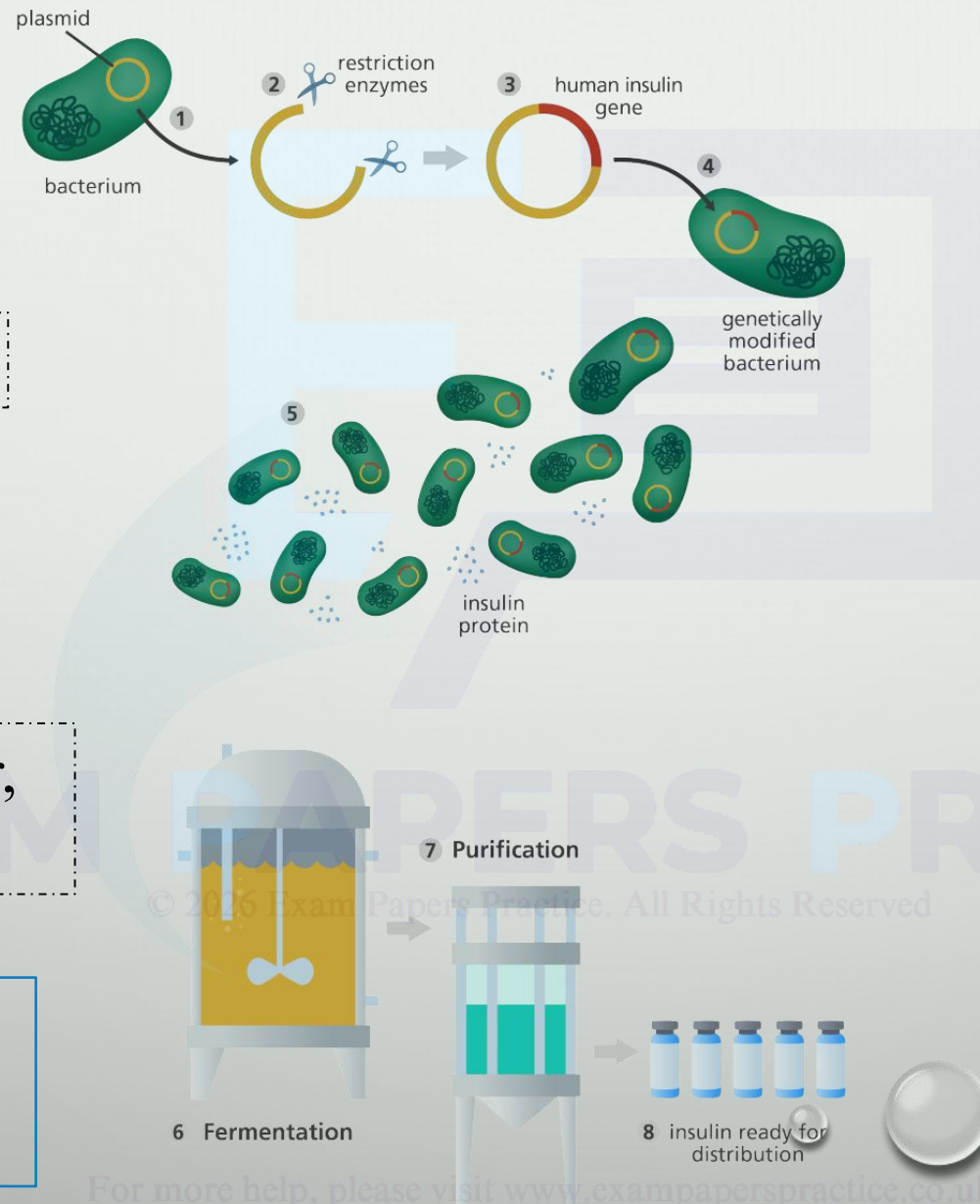
insulin

human insulin gene

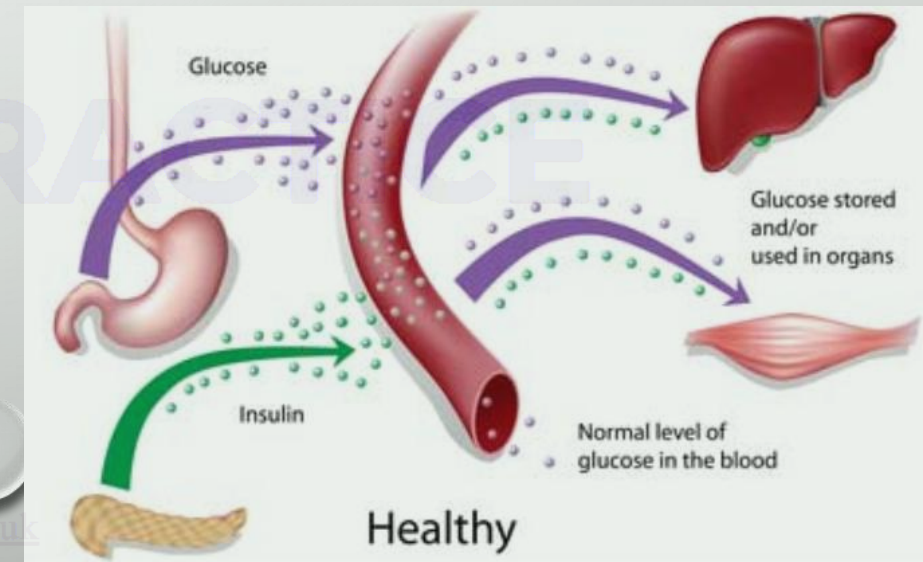
bacteria

Grow in vat, fermenter,
produce insulin

insulin 胰岛素
diabetes 糖尿病
type 1 diabetes 一型糖尿病



Lower the blood sugar



Biotechnology

Genetic engineering

Crop plants has been genetically modified



resistant to **herbicides**

resistant to **insect pests**

(cotton can produce a toxin called **Bt**)



genetically modified crop 基因改造作物

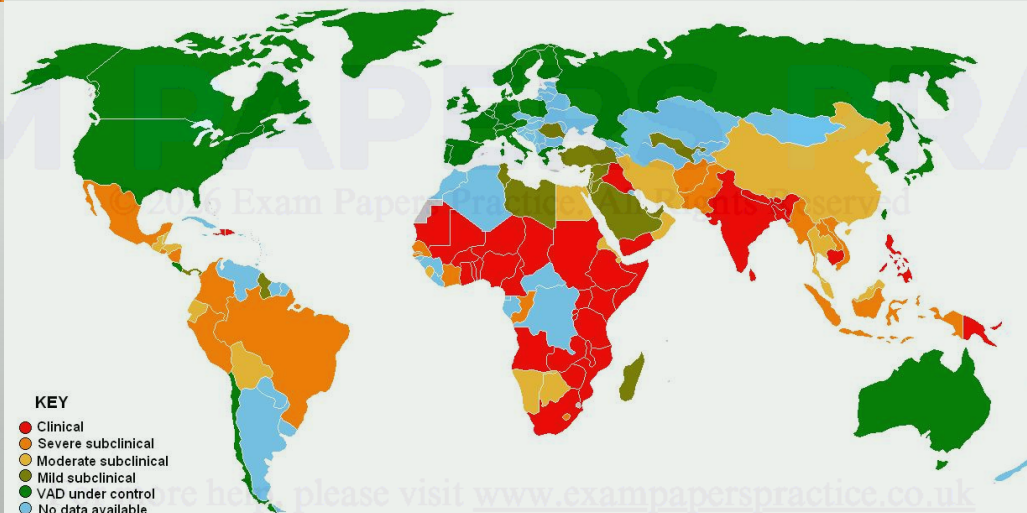
Biotechnology

Genetic engineering

Rice has been genetically modified
golden rice produce vitamin A



night blindness 夜盲症



Nutrition Facts

Serving Size
1/2 Package (142g/about 1 cup)
Servings Per Container 2

Amount Per Serving

Calories 300 **Calories from Fat** 35

% Daily Value*

Total Fat 4g **6%**

Saturated Fat 0.5g **3%**

Trans Fat 0g

Cholesterol 0mg **0%**

Sodium 10mg **0%**

Total Carbohydrate 58g **19%**

Dietary Fiber 3g **12%**

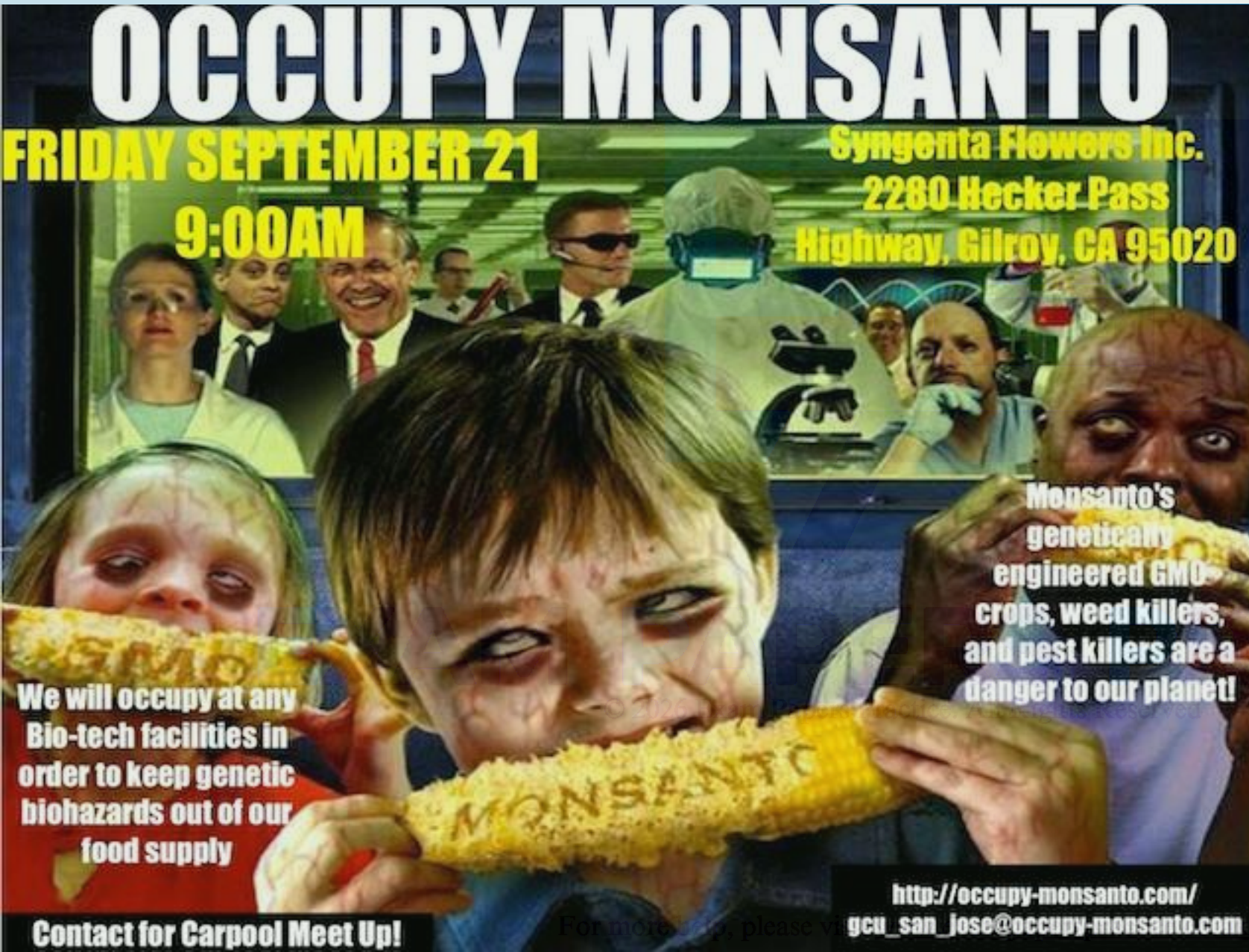
Sugars 0g

Protein 7g

Vitamin A 0% • **Vitamin C** 0%

Calcium 2% • **Iron** 8%

*Percent Daily Values are based on a 2,000 calorie diet.



GMO

yes or no

PRACTICE

yes	no
☰ resistant to herbicides reduces the number of times that farmers need to spray herbicides onto their crops. ☰ reduces the number of occasions on which the herbicide may harm to other plants ☰ reduces labour costs	☰ farmers need to pay a premium to buy the seeds, so increase the cost ☰ herbicide resistance gene might spread from the crop plants into other plants growing nearby → 'superweed' ❌
☰ benefit biodiversity, because the farmer does not have to spray the crop with pesticides.	☰ GM crops with resistance to pests. the crops contain a toxin that kill insects may harm human health and predators of insect pests. ❌
One issue e.g. Some pest insects are evolving to become resistant to the Bt toxin.	

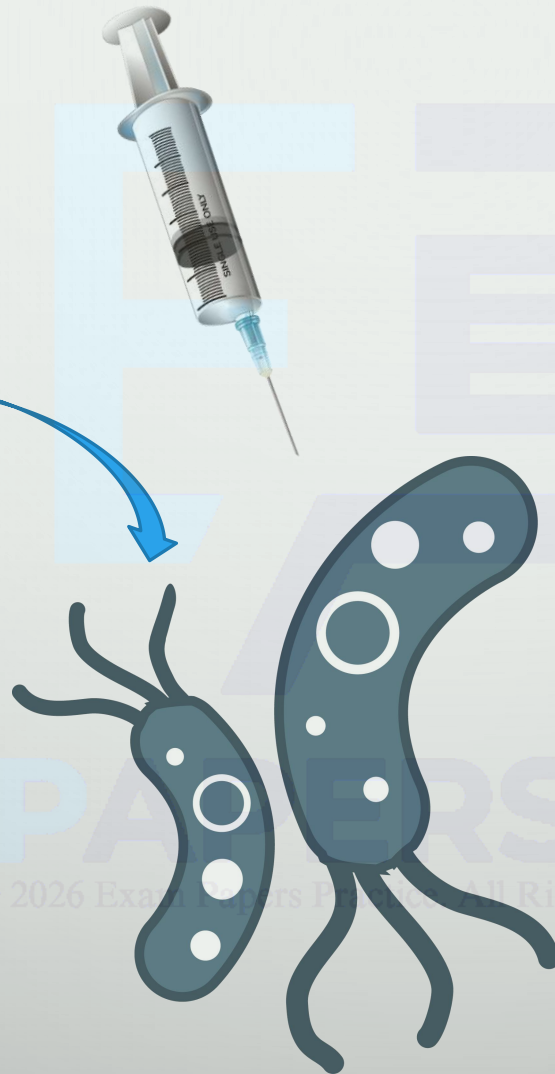
How genetic engineering is done?

transgenics

transgenics 转基因



transgenics



Hydrogen bond 氢键

Biotechnology

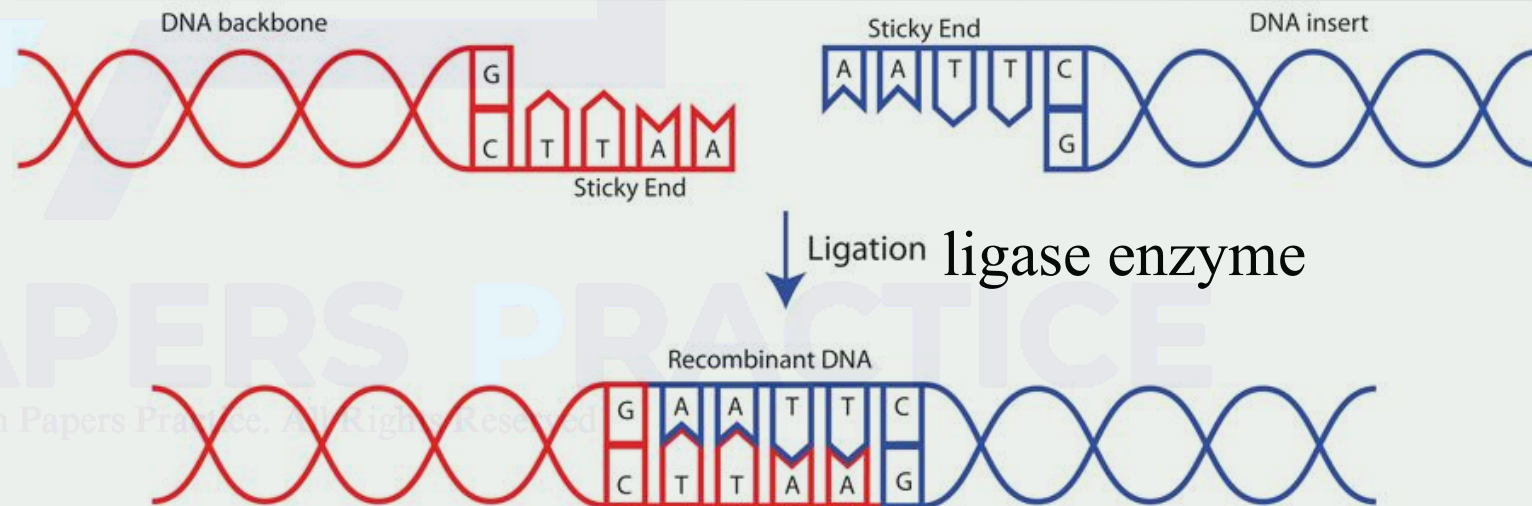
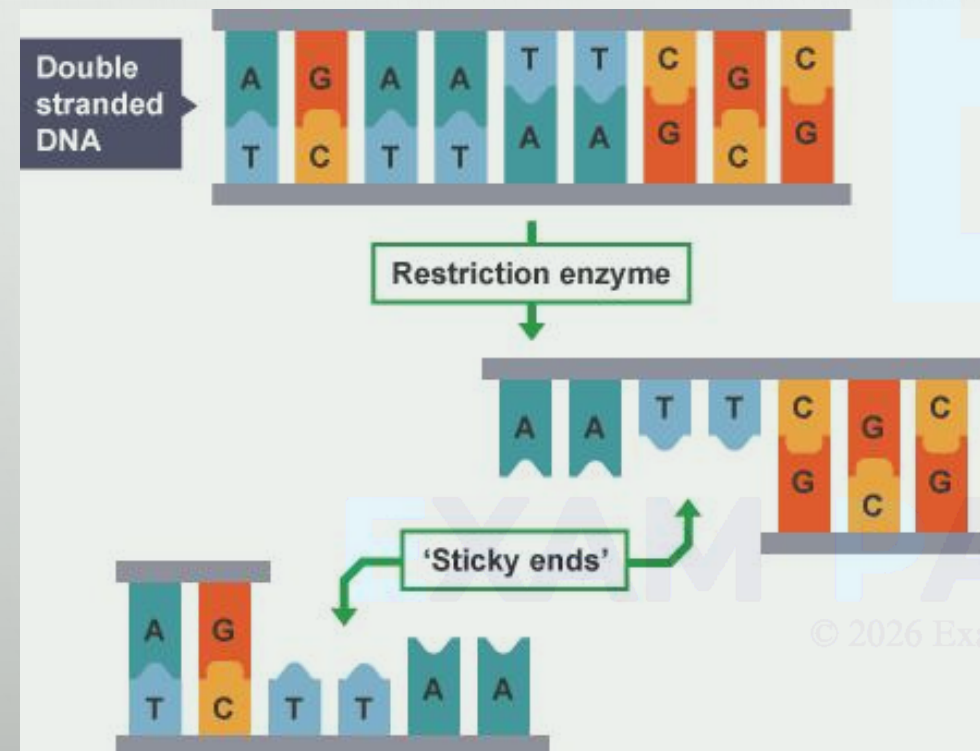
transgenics

Genetic engineering

The dog DNA and the bacterial DNA are **complementary** as they have **same sticky ends**.

They will **pair up** with the sticky ends.

DNA **ligase** will **links** the two strands firmly together.



restriction enzyme 限制性内切酶 sticky ends 黏性末端 ligase 连接酶 pair up 配对 recombinant 重组

Biotechnology

Insulin production using GE

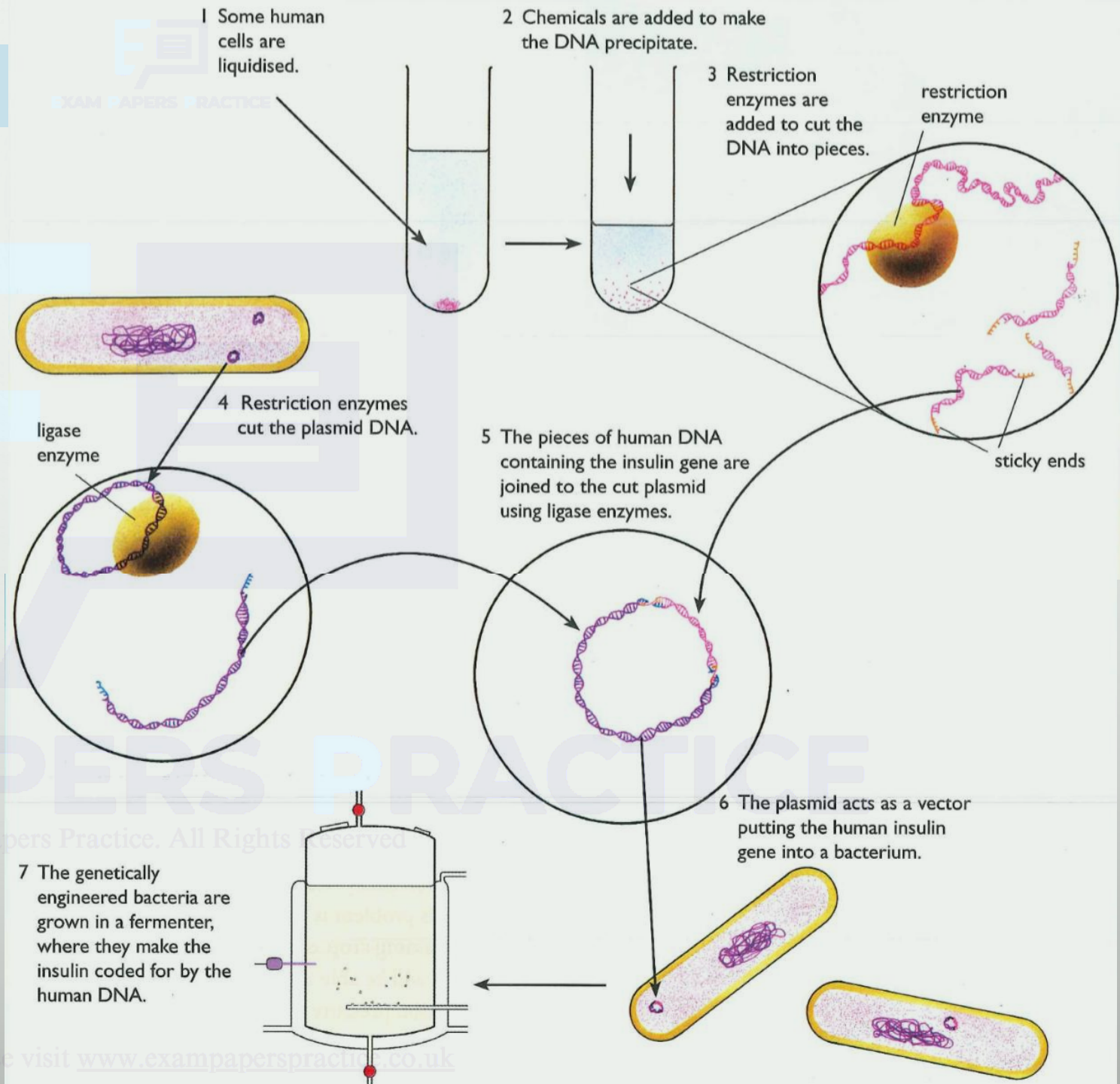
Extraction of the gene for insulin from human

Using restriction enzymes cut human gene for insulin with sticky ends

Gain plasmid from bacterium and using same restriction enzymes with same sticky ends

Pair up the insulin gene with plasmids and link the two gene strands firmly with ligase.
→ recombinant plasmid

Add the genetically modified plasmids to a culture of bacteria. Some of the bacteria are put into the plasmids into cells. These bacteria are put into fermenters → insulin (extract from the fermenters and purified)



insulin
diabetes
type 1 diabetes

genetically modified crop

transgenics

night blindness

restriction enzyme
sticky ends
ligase
pair up
recombinant

The features of microorganisms that make them useful in biotechnology

The use of yeast to make biofuel and bread

How we use enzymes in biological washing powders

The use of pectinase for making fruit juice

The use of lactase to make lactose-reduced milk

How *Penicillium* is used to make penicillin

Some examples of genetic engineering

Arguments for and against the use of genetically modified crops