

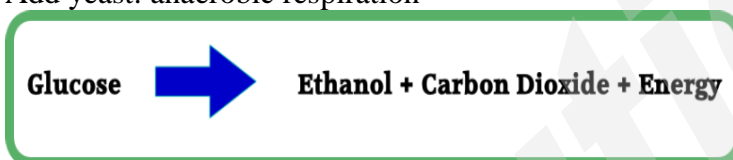
Biotechnology and Genetic Engineering

(IGCSE Biology Syllabus 2016-2018)

Biotechnology involves using living organisms to carry out processes:

○ Making biofuel

- Use plants to make sugars which yeast then breaks down to make ethanol
- Ethanol can be used as a fuel
 - Maize is treated with amylase enzyme (starch to glucose)
 - Add yeast: anaerobic respiration



- Ethanol is then extracted by distillation
- Mixed with gasoline to increase energy and can be used in cars

○ Bread making

- The dough is kept in a warm, moist environment (28°C)
- Yeast ferments sugar making carbon dioxide which creates bubbles, so bread rises
- Cooking (at 180°C): kill yeast, evaporates alcohol and hardens outer surface

○ Uses of **enzymes**

- **Pectinase**

- Fruit juices are extracted using pectinase
- Pectin helps plant walls stick together
- If pectin is broke down, it's easier to squeeze juice from the fruit
- Extraction of juice from fruit, making juice clear not cloudy

- **Washing powders**

- Biological washing powders and liquids contain enzymes that help remove stain
- The enzymes are coated with a special wax that melts in the wash releasing the enzyme
- Once the stains have been broken down, they are easier for detergents to remove
- **Proteases** break down protein in stains
- **Lipases** break down stains containing fats and oil
- **Carbohydases** break down carbohydrate-based stains

- **Lactase**

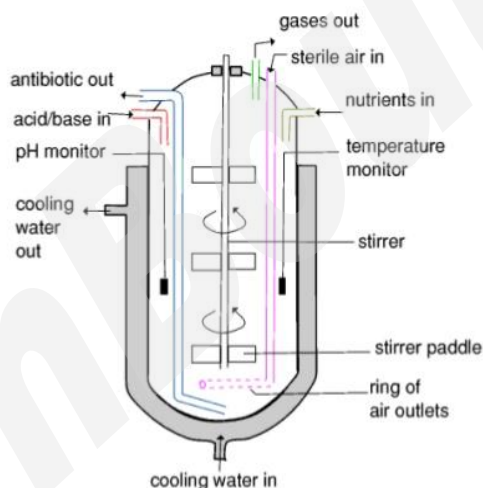
- Enzyme that breaks down lactose (sugar found in milk)
- People can stop making lactase naturally, therefore can't digest lactose
- Milk can be treated with lactase to break down lactose before a person drinks it

Why microorganisms?

- No ethical issues in using them
- Contain plasmids that can be used in moving genes from one organism's cells into other
- Easy to store
- Easy to grow in lab
- Able to produce wide range of substances
- The reproduction rate is high

Production of Penicillin

Fermenter

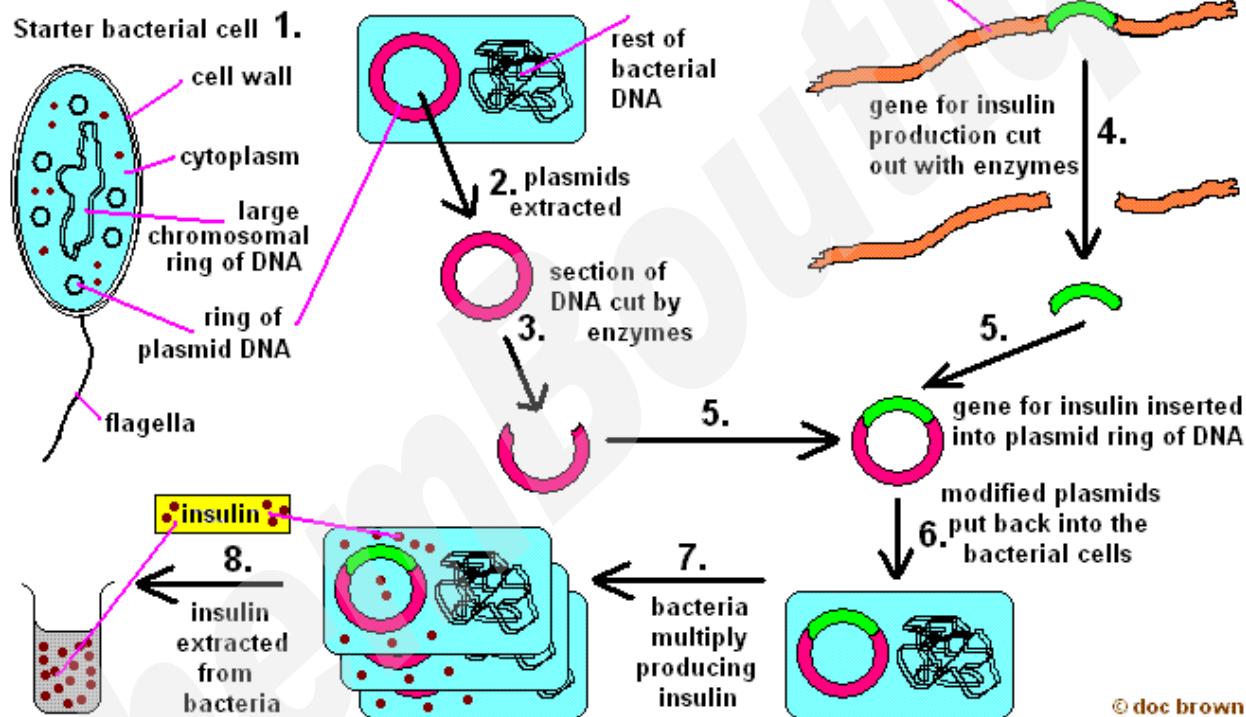


- **Penicillin:** an antibiotic produced by a fungus (penicillium)
- Stainless steel fermenter is filled with medium containing **sugars and ammonium salts**
- Penicillium is added to produce penicillin. They use sugar for respiration and ammonium salts to make protein and nucleic acids
- The fermenter consists of:
 - **Probes:** monitor temperature and pH
 - **Air:** provides oxygen for aerobic respiration
 - **Water-coated jacket:** removes heat to maintain temperature
 - **Stirrer:** keeps the microorganism suspended while maintaining an even temperature

Genetic Engineering

- Genetic engineering: changing the genetic material of an organism by removing, changing or inserting individual genes
- Examples:
 - The insertion of human genes into bacteria to produce human insulin
 - The insertion of genes into crop plants to confer resistance to herbicides
 - The insertion of genes into crop plants to confer resistance to insect pests
 - The insertion of genes into crop plants to provide additional vitamins

Insulin production - example of GENETIC ENGINEERING



- **Human insulin in bacteria**
 - Isolation of the DNA making up a human gene using **restriction enzymes**, forming **sticky ends**
 - Cutting of bacterial plasmid DNA with the same restriction enzymes, forming **complementary sticky ends**
 - Insertion of human DNA into bacterial plasmid DNA using DNA **ligase** to form a recombinant plasmid
 - **Insertion of plasmid into bacteria**
 - **Replication of bacteria** containing recombinant plasmids which make human protein as they **express the gene**

Genetically Modified (GM) Crops

Advantages	Disadvantages
<ul style="list-style-type: none">- Uniform in shape – easy to transport- Growing season shorter- Drought resistant – less water- Higher yield- Herbicides and pesticides resistant	<ul style="list-style-type: none">- Natural species may die- Taste often not as good- Lead to development of super weeds – stronger than GM- No one knows long term effect on humans