Edexcel IGCSE Biology

Topic 5: Use of Biological Resources

Notes

(Biology only in bold)

Food production

Crop plants (5.1-5.4)

Glasshouses and polyethene tunnels

- The enclosed environment protects the crops from harsh weather conditions
- Carbon dioxide levels are maintained in glasshouses to optimise the rate of photosynthesis
- Heat is trapped from the Sun, so the optimum temperature of enzymes can be reached
- The plants are protected from pests that can damage plants or carry diseases.

Factors affecting crop yield

Carbon dioxide

- Paraffin lamps can be burned to increase carbon dioxide levels
- This ensures that carbon dioxide is not the limiting factor in the rate of photosynthesis

Temperature

- The heat trapped by the Sun in the glasshouse raises the temperature
- This allows the enzymes in photosynthesis to work at the optimum temperature and so the rate of photosynthesis increases

Fertiliser

- Fertilisers contain nutrients that allow plants to grow faster
- These water-soluble minerals can be absorbed into the plant roots by active transport
- Nitrates are required to make amino acids for proteins, to allow the plants to grow
- Phosphates are required for respiration and root growth
- Potassium is needed for growth of flowers and fruit, as it allows enzyme reactions to take place.

Pest control

Pest control = using pesticides or biology control to prevent insects from eating the plants. Pesticides include fungicides, herbicides and insecticides.

Advantages

- Quick and efficient
- Can kill entire pest populations

Disadvantages

- Organisms can develop resistance
- Non-specific so kills other organisms too
- Bioaccumulation can make it toxic to others in the food chain
- Have to continuously apply

Micro-organisms (5.5-5.8)

Yeast

Yeast uses anaerobic respiration (as detailed in 2.34) in order to make bread rise:

Glucose ($C_6H_{12}O_6$) ---> Ethanol + Carbon dioxide (CO_2)

The carbon dioxide bubbles are what causes the bread to rise.

Practical: investigate the role of anaerobic respiration by yeast in different conditions

1) Dissolve sugar in boiled water
2) Mix yeast with the sugar solution in a boiling tube
3) Add a layer of oil on top in order to prevent oxygen from entering (ensuring that it is only anaerobic respiration taking place)
4) Connect the boiling tube to a test tube of lime water
5) Count the number of bubbles seen over a set time

Different conditions can be investigated, such as temperature (by using a water bath) or concentration of sugar.

Production of yoghurt

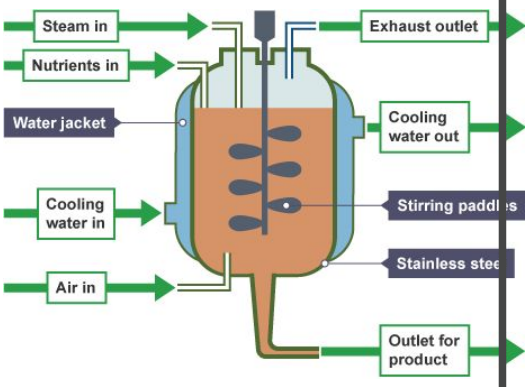
- *Lactobacillus* is a useful bacteria in making yoghurt
- Milk contains a sugar called lactose, which *lactobacillus* can break down to form lactic acid
- This acid lowers the pH of the milk, which denatures proteins to give the yoghurt texture.

The process:

1) All equipment is sterilised to kill unwanted microorganisms
2) Milk is heated to 72°C for 15 seconds to kill any microorganisms in the milk - this is called pasteurisation
3) The milk is cooled and *lactobacillus* is added
4) The mixture is incubated at around 40°C in a fermenter - here the bacteria breaks down lactose to lactic acid
5) The thickened yoghurt is produced and any flavouring, colorants or fruit are added before packaging

Industrial fermenter

Fermenters are containers that grow bacteria and fungi in large amounts. This can be useful when producing transgenic bacteria for example.
Aseptic conditions are required to ensure that no other microorganism grows and contaminates the containers.
Nutrients are needed for the microorganism to use in respiration.
Optimum temperature and pH are needed in order for enzymes to work at the high rate but are not denatured
Agitation by stirring paddles is required to ensure that the nutrients, oxygen, temperature, pH and microorganisms are distributed evenly.



Fish farming (5.9B)

Method	Explanation
Maintaining water quality	**Filter water to remove waste and harmful bacteria to prevent disease**

Controlling intraspecific predation	**This is to stop competition within the same species. Fishes are separated by size and age to prevent competition.**
Controlling interspecific predation	**This is to stop competition between species. Different species are separated by nets or tanks**
Controlling disease	**Antibiotics are given to increase chances of survival**
Removing of waste products	**Water is filtered to remove waste faeces.**
Controlling quality and frequency of feeding	**Fish are fed frequently but in small amounts so they do not overeat and to avoid food wastage**
Selective breeding	**Selective breeding to reproduce fish with desired characteristics**

Selective breeding (5.10 and 5.11)

Selective breeding is when humans choose which organisms to breed in order to produce offspring with a certain desirable characteristic (e.g animals with more meat, plants with disease resistance or big flowers).

This has been happening for many years since animals were domesticated and plants were grown for food.

1) Parents with desired characteristics are chosen.
2) They are bred together.
3) Offspring with the desired characteristics are bred together.
4) The process is repeated many times until all the offspring have the desired characteristic.

The problem with selective breeding is that it can lead to inbreeding.

- Breeding those with similar desirable characteristics means it is likely you are breeding closely related individuals.
- This results in the reduction of the gene pool, as the number of different alleles reduce (as they mostly have the same alleles).
- This means if the environment changes or if there is a new disease, the species could become extinct as they all have the same genetic make-up (so the chance of a few organisms having a survival advantage and not dying is reduced).
- Another problem is that the small gene pool leads to a greater chance of genetic defects being present in offspring, as recessive characteristics are more likely to be present.

Genetic modification (5.12-5.16)

Genetic engineering: Modifying the genome of an organism by introducing a gene from another organism to give a desired characteristic.

- Plant cells have been engineered for disease resistance or to have larger fruits

- Bacterial cells have been engineered to produce substances useful to humans, such as human insulin to treat diabetes.

Restriction enzymes = enzymes which are able to cut DNA at specific sites, leaving 'sticky ends' (short sections of exposed, unpaired bases)
Ligase enzymes = enzymes that are used to join pieces of DNA together.
The virus or plasmid DNA is then cut using the same restriction enzyme and the desired gene is placed inside and then joined by ligase enzymes.

The process of human insulin production:

1. The insulin gene for a healthy individual is 'cut out' using restriction enzymes leaving 'sticky ends'
2. A virus or bacterial plasmid is cut using the same restriction enzyme to also create sticky ends.
3. The sticky ends from the virus or plasmid and the sticky ends from the genes are then joined together by ligase enzymes
4. The combined loop is placed in a vector, such as a bacterial cell, and then allowed to multiply as it will now contain the modified gene.

Genetically modified crops

- They are engineered to be resistant to insects and herbicides.
- This will result in increased yields as less crops will die.

Transgenic = transfer of genetic material from one species to a different species.

Cloning (5.17B-5.20B)

Cloning is creating genetically identical copies of an organism.

Micropropagation (tissue culture)

- **Plant cells are taken and placed in growth medium with nutrients and hormones to stimulate growth**
- **These plants are genetically identical clones of the parent as the only cells used were from the one parent plant.**
- **This process is very important to preserve rare plant species or to make commercial quantities of genetically identical plants with desirable characteristics**
- **An older method to produce clones was cutting, where a section of the stem is cut and planted to form clones**

Cloning in animals

The first successful experiment cloning animal cells resulted in Dolly the sheep:

1) **The nucleus is removed from an unfertilised egg cell.**
2) **The nucleus is removed from an adult body cell and placed in the enucleated egg cell.**
3) **Through the stimulation of an electric shock, the egg cell begins to divide to form an embryo.**

4) The embryo is implanted into the womb of a female.
5) The offspring born is a clone of the adult body cell.

Cloning transgenic animals to make human proteins

Transgenic animals = an animal containing genes from a different species
They can be used to produce human proteins, such as antibiotics.

Advantages	Disadvantages
Clones produce identical offspring	Decreases variation in population
Large number of clones can be produced	More susceptible to disease as no variation
Can produce organs to be used in organ transplants that will not be rejected by the immune system	