

Natural cloning in plants

Bulbs *e.g. daffodils* Leaf bases contain stored food, buds develop internally and make new shoots.

Runners *e.g. straw-berry* Lateral stem grows, eventually withers away.

Rhizomes *e.g. marram grass* Specialised horizontal growth, stem develops buds -which becomes new plant.

Stem tubers *e.g. potatoes* Tip of underground stem becomes swollen with stored nutrients. Buds develop on that storage organs and form new shoots.

Uses in horticulture:

Can take cuttings from bulbs/runners to increase the yield because it is faster than growing seeds.

This also guarantees quality (because genetically identical).

e.g. used in sugar cane cloning.

Artificial cloning in plants

Micropropagation:

Sample taken from meristem (sterile conditions).

Sterilised. Collected tissue = **explant**.

Placed in sterile culture medium containing plant hormones. Cells form Mass of identical cells (**callus**).

Callus is divided and transferred to different medium. This stimulates the development of genetically identical **plantlets**.

Plantlets are planted in compost and grow.

Young plants planted out to grow as crops.

Artificial twinning and SCNT

Artificial twinning

Animal w/ desired trait is given hormones for super-ovulation.

Ova is fertilised in vitro or by insemination (by desired male).

Before 6 days, cells are split (still totipotent).

Each cell becomes an embryo.

Embryos are inserted in surrogates.

Develop into fetuses and born normally.

Somatic Cell Nuclear Transfer (SCNT)

Transfer nucleus from adult somatic cell into enucleated egg cell (no nucleus).

Nucleus and egg are fused with an electric shock

OR electrofusion - Cells are left next to each other with constant current running through.

+ More offsprings than usual

+ Guarantees desirable genes from sire.

+ Useful in pharming

+ Can clone rare and endangered animals

- SCNT = inefficient -- many eggs required to successfully produce one offspring.

- Cloned embryos fail to develop, produced deformed offsprings...

- Most clones have a shorter lifespan, which also means we have not been successful in cloning extinct species yet.

Biotechnology and microorganisms

Biotech Applying biological organisms / **hno-** enzymes to the synthesis / **logy:** breakdown / transfer of materials in the service of people

e.g. foods, penicillin, insulin...

Pros / cons of using microorganisms:

+ No ethics

+ Easily manipulated genetically

Biotechnology and microorganisms (cont)

+ Short life cycles

+ Simple + cheap nutrient requirements

+ Growth conditions = low temperatures / oxygen / food...

- Can produce toxins

- Have to be separated from nutrient and processed.

- Sterile conditions needed (increases cost).

- Less natural flavour.

Direct / indirect food production

Indirect food prod Use microorganisms for their effects on other foods.

e.g. bread -- yeast caused it to rise.

yoghurt -- bacteria make it sour.

Direct food prod Grow microorganisms to eat

e.g. Quorn, fusarium venetatum (grown on glucose syrup).

Brewing

Indirect food production **Yeast** anaerobically respire.

Optimum temp about 20-28°C, but can also be genetically modified to function at lower temperatures.

Malting - Barley germinates and digests starch into sugars so yeast respire.

Mashing - Malt + hot water. Enzymes break down starch, wort is formed.

Fermentation - Wort + yeast. pH lowered as yeast runs out of O₂ and produces ethanol.

Maturation - Low temperatures for about a month.

Finishing - Filtered, pasteurised and bottled with CO₂.

Baking bread

Indirect food prod Yeast feeds on sugars and ferments them into ethanol and CO₂ which makes the bread rise

Optimum temp. of 38-46°C

Optimum pH - 5.0 / 5.5

Yeast requires O₂ and sugars for fermentation.

Cheese-making

Indirect food prod **Bacteria** feed on lactose, inhibit growth of bacteria which makes milk go off.

Pasteurised - 95°C for 20 seconds.

Mixed with bacteria culture and enzymes. The milk is separated into solid curds and liquid whey.

Cheese - Curds are separated and cooked in whey, sometimes pressed and dried.

Yoghurt-making

Indirect food prod Skimmed milk powder, milk is pasteurised and cooked.

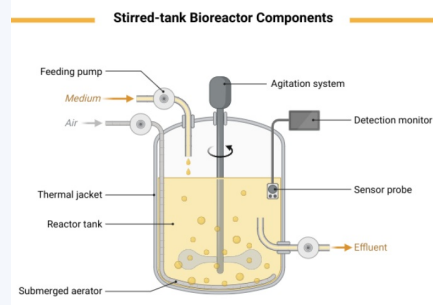
L. bulgarius / S. thermophilus **bacteria** added to the milk and milk is stored at cool temperatures.

Cultivating microorganisms

Inoculating broth Bacteria suspension, mixed with sterile nutrient broth. Incubated and shook.

Inoculating agar Inoculating loop Sterile and dipped in suspension. Streaks made across a Petri dish.

Bioreactors - making penicillin



Semi-continuous batch

Fungus grows and produces penicillin. The drug is extracted and purified.

The container is sealed to avoid contamination (asepsis).

The mixture is constantly stirred so it stays oxygenated.

Bioremediation

Microorganisms are used to break down pollutants and contaminants in soil / water.

Natural organisms Used on crude oil / sewage.

GM microorganisms Break down material they don't normally encounter (e.g. mercury in water).

Bacterial growth stages

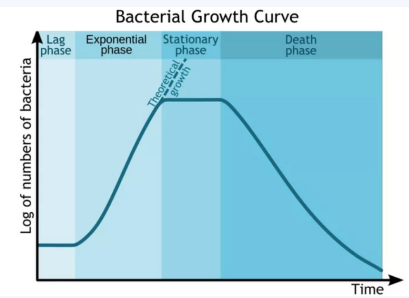
Lag phase Bacteria adapting to environment. Growing and synthesising enzymes.

Exponential phase Close to / at theoretical max.

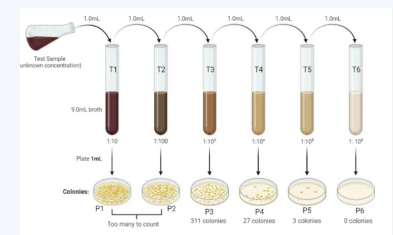
Stationary phase Growth rate = zero --> Cells formed cancelled out by cells dying.

Death phase Reproduction almost stopped, death rate increases (resources used up).

Bacterial growth graph



Serial dilutions



Immobilised enzymes

Alternative to using microorganisms is to isolate their enzymes.

Immobilised enzymes when those enzymes are fixed so substrate washes over them.

- + Reusable so cheaper, greater temperature tolerance, less downstream processing.

Surface immobilisation - Surface adsorption (sticking to the surface) to inorganic carrier.

- + Simple and cheap.
- + Activity virtually unchanged.
- Enzymes can be lost from matrix easily.

Immobilised enzymes (cont)

<i>Surface immobilisation</i>	+ Enzymes bound strongly, unlikely lost.	- Cost varies
- covalent / ionic binding to inorganic carrier.	+ Accessible to substrate.	- Active site may be modified.
	+ pH / substrate concentration = little effect on activity.	

<i>Entrapment - in matrix.</i>	+ Applicable to different processes.	- Expensive. - Difficult to entrap. - Diffusion can be slow.
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<i>Entrapment - encapsulation or semi-permeable membrane.</i>	+ Relatively simple to do. + Small effect on enzymes activity. + Applicable to different processes.	- Expensive. - Diffusion can be slow.
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