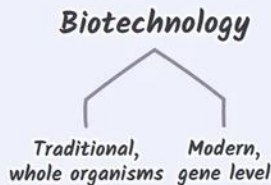


putting living things to work, from curd in a pot to a gene moved between species

What biotechnology is *

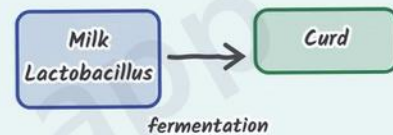
- **biotechnology** is the use of living organisms, or parts of them, to make products useful to us
- it is far older than the word: curd, bread, cheese, vinegar and brewing are all biotechnology
- the **traditional form** uses whole organisms and their natural processes, mostly fermentation
- the **modern form** works at the level of the **gene**, moving specific instructions between organisms
- so the difference is one of **precision**: the old way selects and encourages, the new way edits directly
- **both are in use today**, and a question asking for an example may want either kind



the field splitting into its two halves: the older branch has been practised for thousands of years without any knowledge of genes, and the newer one works directly on the instructions themselves

Traditional uses

- **dairy**: curd from *Lactobacillus*, and cheese and buttermilk from related bacteria
- **baking**: yeast produces carbon dioxide which raises the dough, and the alcohol evaporates in the oven
- **brewing**: the same yeast, but here the **alcohol is the product** and the gas is incidental
- **idli and dosa batter** ferment overnight, which both raises them and improves the nutrition
- **composting and biogas**: microbes break down waste into manure and methane
- **sewage treatment**: microbes digest the organic matter so that the water can be returned safely



milk and the bacterium on the left and set curd on the right: the organism converts the milk sugar into lactic acid, which both sets the milk and gives it the sour taste. No knowledge of genes is needed anywhere in this arrow

Modern biotechnology

- **genetic engineering** moves a chosen gene from one organism into another
- the steps are: **cut out the wanted gene**, **insert it into a vector** such as a bacterial plasmid, and **put that into a host cell** which multiplies and makes the product
- **restriction enzymes** are the scissors that cut DNA at particular sequences, and **ligase** joins it
- an organism carrying a gene from another species is **transgenic**
- **tissue culture** grows a whole plant from a few cells on a nutrient medium, giving many **identical** plants quickly
- the plants produced are **clones**, so a chosen variety is reproduced exactly rather than reshuffled

