

## CUET (UG) Biology Notes: Microbes in Human Welfare

### 1. Microbes in Household Products

- Curd: Micro-organisms such as Lactobacillus and others commonly called Lactic Acid Bacteria (LAB) grow in milk and convert it to curd. During growth, LAB produce acids that coagulate and partially digest the milk proteins.
- +2
  - Nutritional Benefit: It improves nutritional quality by increasing Vitamin B12. LAB in our stomach also play a beneficial role in checking disease-causing microbes.
  - +1
- Dough: The dough used for making foods such as dosa and idli is fermented by bacteria. The puffed-up appearance of dough is due to the production of CO<sub>2</sub> gas. Dough used for making bread is fermented using baker's yeast (*Saccharomyces cerevisiae*).
- +1
- Toddy: A traditional drink of some parts of southern India made by fermenting sap from palms.
- Cheese: Different varieties of cheese are known by their characteristic texture, flavor, and taste, depending on the microbe used.
  - Swiss Cheese: The large holes are due to the production of a large amount of CO<sub>2</sub> by a bacterium named *Propionibacterium sharmanii*.
  - Roquefort Cheese: Ripened by growing a specific fungi on them, which gives them a particular flavor.

### 2. Microbes in Industrial Products

For industrial-scale production, microbes are grown in very large vessels called fermentors.

#### A. Fermented Beverages

- Brewer's Yeast: *Saccharomyces cerevisiae* is used for fermenting malted cereals and fruit juices to produce ethanol.
- Distillation Differences:
  - Wine and beer are produced without distillation (lower alcohol content).

- Whisky, brandy, and rum are produced by distillation of the fermented broth (higher alcohol content).

#### B. Antibiotics

Antibiotics are chemical substances produced by some microbes that can kill or retard the growth of other (disease-causing) microbes.

- Penicillin: The first antibiotic to be discovered. Discovered by Alexander Fleming by chance while working on *Staphylococci* bacteria. He observed a mold (*Penicillium notatum*) growing in an unwashed culture plate around which the bacteria could not grow.
- +1
- Full Potential: Established much later by Ernest Chain and Howard Florey, who used it to treat American soldiers in World War II. Fleming, Chain, and Florey shared the Nobel Prize in 1945.

#### C. Chemicals, Enzymes, and Bioactive Molecules

This is one of the most frequently tested tables in the CUET Biology paper.

Microbe (Scientific Name)	Type of Microbe	Commercial Product & Application
<i>Aspergillus niger</i>	Fungus	Citric acid
<i>Acetobacter aceti</i>	Bacterium	Acetic acid
<i>Clostridium butylicum</i>	Bacterium	Butyric acid
<i>Lactobacillus</i>	Bacterium	Lactic acid
<i>Saccharomyces cerevisiae</i>	Yeast (Fungus)	Ethanol (Commercial alcohol)
Microbes (General)	Various	Lipases: Used in detergent formulations to remove oily stains from laundry.
Microbes (General)	Various	Pectinases & Proteases: Used

		to clarify bottled fruit juices.
Streptococcus	Bacterium	Streptokinase: Modified by genetic engineering; used as a "clot buster" to remove blood clots from patients who have undergone myocardial infarction.
Trichoderma polysporum	Fungus	Cyclosporin A: Used as an immunosuppressive agent in organ transplant patients.
Monascus purpureus	Yeast (Fungus)	Statins: Used as blood-cholesterol lowering agents. They competitively inhibit the enzyme responsible for cholesterol synthesis.

### 3. Microbes in Sewage Treatment

Sewage contains large amounts of organic matter and microbes (many pathogenic). It is treated in Sewage Treatment Plants (STPs) to make it less polluting before disposal into rivers.

- **Primary Treatment (Physical):** Involves the physical removal of large and small particles through filtration and sedimentation.
  - Floating debris is removed by sequential filtration.
  - Grit (soil and small pebbles) is removed by sedimentation. All solids that settle form the primary sludge, and the supernatant forms the effluent.
- **Secondary Treatment (Biological):** The primary effluent is passed into large aeration tanks.
  - Constant agitation allows vigorous growth of useful aerobic microbes into flocs (masses of bacteria associated

with fungal filaments to form mesh-like structures).

- These microbes consume the major part of the organic matter, significantly reducing the BOD (Biochemical Oxygen Demand).
- **BOD Concept:** The amount of oxygen required to oxidize all organic matter in 1 liter of water. Higher BOD = Higher polluting potential.
- **Activated Sludge:** Once BOD is reduced, the effluent is passed into a settling tank where flocs settle down. This sediment is called activated sludge. A small part of this is pumped back to serve as the inoculum, while the rest goes to large anaerobic sludge digesters.
- +2
- **Biogas Production:** In the digesters, anaerobic bacteria digest the bacteria and fungi in the sludge, producing a mixture of gases (Methane, Hydrogen Sulfide, and CO<sub>2</sub>), which forms biogas.



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### 4. Microbes in Production of Biogas

Biogas is a mixture of gases (predominantly methane) produced by the microbial activity of Methanogens.

- **Methanogens:** Bacteria that grow anaerobically on cellulosic material, producing large amounts of methane
  - Example: Methanobacterium.
- **Occurrence:** Commonly found in the anaerobic sludge of STPs and in the rumen (a part of the stomach) of cattle, where they help break down cellulose.
- **Gobar Gas Plant:** Cattle dung (gobar) is rich in these bacteria. The biogas plant consists of a concrete tank (10-15 feet deep) where bio-wastes are collected and a slurry of dung is fed. A floating cover is placed over the slurry, which keeps rising as gas is produced.



### 5. Microbes as Biocontrol Agents

Biocontrol refers to the use of biological methods for controlling plant diseases and pests, reducing dependence on toxic chemicals and pesticides.

Biocontrol Agent	Target Pest / Disease	Key NCERT Characteristics
Ladybird & Dragonflies	Aphids and Mosquitoes	Familiar beetles with red and black markings (Ladybird) and dragonflies are useful for getting rid

		of these specific insects.
Bacillus thuringiensis (Bt)	Butterfly caterpillars	Available as sachets of dried spores. Sprayed onto vulnerable plants (like brassicas and fruit trees). In the gut of the larvae, the toxin is released, killing the caterpillar but leaving other insects unharmed.
Trichoderma	Several plant pathogens	Free-living fungi commonly found in root ecosystems. Very effective biocontrol agents of several root-borne pathogens.
Baculoviruses (Genus: Nucleopolyhedrovirus)	Insects and other arthropods	Excellent for species-specific, narrow spectrum insecticidal applications. They have no negative impacts on plants, mammals, birds, fish, or non-target insects. Crucial for IPM (Integrated Pest Management).

### 6. Microbes as Biofertilisers

Biofertilisers are organisms that enrich the nutrient (nitrogen, phosphorus) quality of the soil. The main sources are bacteria, fungi, and cyanobacteria.

- **Bacteria:**
  - Rhizobium: Symbiotic association in the root nodules of leguminous plants. They fix atmospheric nitrogen into organic forms used by the plant.
  - +1
  - Azospirillum & Azotobacter: Free-living bacteria in the soil that also fix atmospheric nitrogen, enriching soil nitrogen content.

- Fungi (Mycorrhiza): Symbiotic association of fungi with plants.
  - Many members of the genus *Glomus* form mycorrhiza.
  - Function: The fungal symbiont absorbs phosphorus from the soil and passes it to the plant. It also provides resistance to root-borne pathogens, tolerance to salinity and drought, and overall increases plant growth.
- Cyanobacteria: Autotrophic microbes widely distributed in aquatic and terrestrial environments, many of which fix atmospheric nitrogen.
  - Examples: *Anabaena*, *Nostoc*, *Oscillatoria*.
  - In paddy fields, cyanobacteria serve as an important biofertiliser. Blue-green algae also add organic matter to the soil and increase its fertility.

