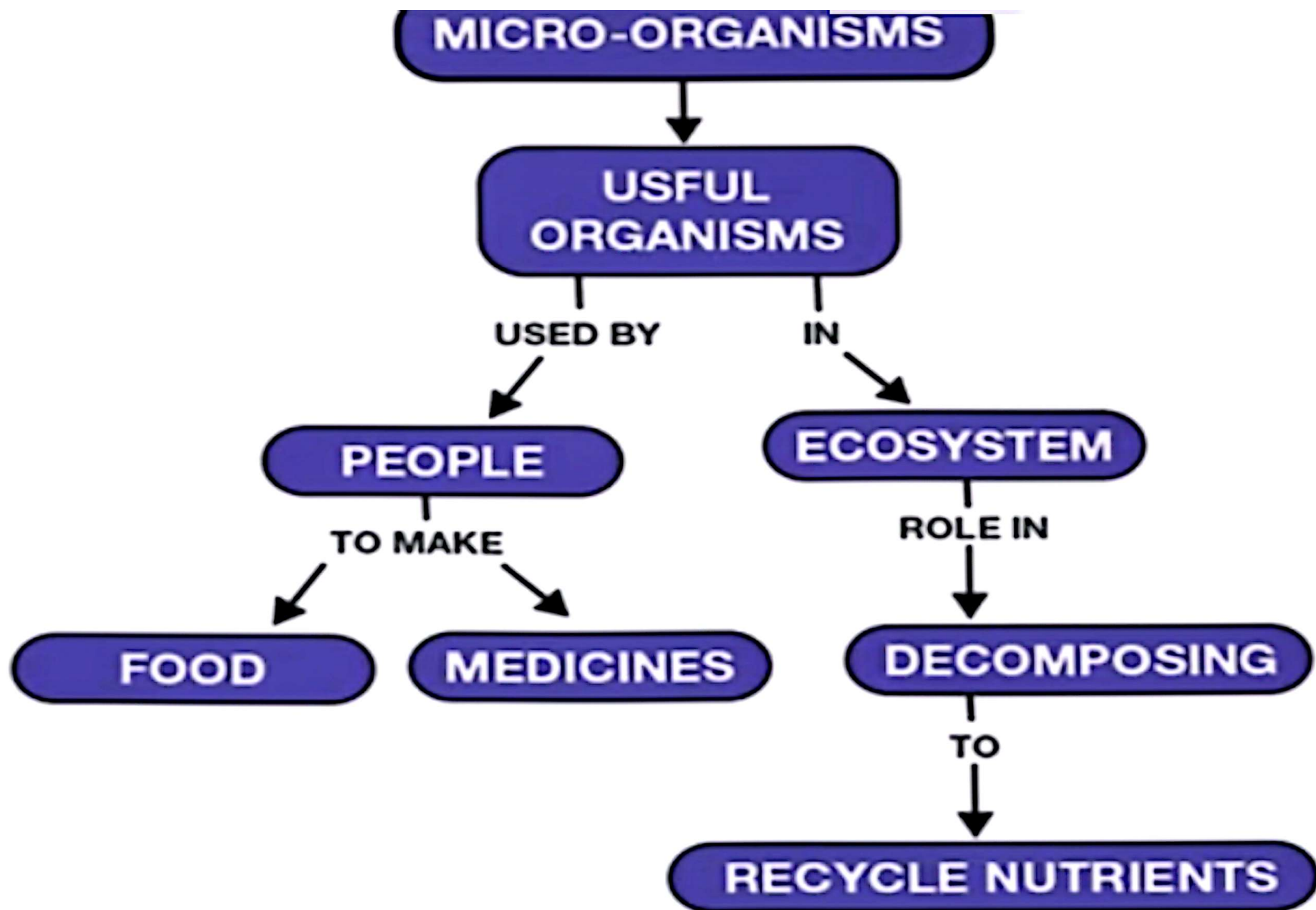


INTRODUCTION

- Microorganisms are small, living creatures which are invisible to our naked eye.
- Microorganisms play vital roles across various fields due to their diverse capabilities.
- Among all microorganisms, some are harmful and disease-causing pathogens, while others include useful microbes, which are more beneficial and harmless to humans.



USES OF MICROORGANISMS

- Microorganisms are beneficial for humans in various ways. They play an important role in human welfare and for the environment.
- These include processing and preservation of food, production of biomolecules, manufacture of pharmaceutical products, cosmetics industries, recycling the nutrients in the soil and so on.
- Listed below are some of the applications of microorganisms in human welfare.

Role of microorganisms in Medicine

- **ROLE:** Microorganisms are crucial in medical science for both their beneficial and pathogenic roles.
- **APPLICATIONS:**
 - **Antibiotic production:** penicillin, the first antibiotic, was derived from the mold *Penicillium*. Other antibiotics, such as streptomycin and tetracycline, are produced by bacteria like *Streptomyces*.
 - **Vaccines:** attenuated or killed microorganisms are used in vaccines to provide immunity against diseases like polio, measles, and influenza.
 - **Probiotics:** beneficial bacteria like *Lactobacillus* and *Bifidobacterium* are used in probiotics to maintain gut health and boost the immune system.
 - **Gene therapy:** viruses are used as vectors to deliver therapeutic genes to treat genetic disorders.
 - **Diagnostics:** microbial enzymes and antibodies are used in diagnostic tests for detecting diseases.

Role of microorganisms in Agriculture

- **ROLE:** Microorganisms enhance **soil fertility** and **plant health**, playing a key role in sustainable agriculture.
- **APPLICATIONS:**
 1. **Biofertilizers:** nitrogen-fixing bacteria like *Rhizobium*, *Clostridium* and *Azotobacter*, and phosphate-solubilizing bacteria like *Pseudomonas*, improve soil nutrient availability.
 2. **Biopesticides:** *Bacillus thuringiensis* (bt) produces toxins that are effective against insect pests, reducing the need for chemical pesticides.
 3. **Decomposition:** decomposer microorganisms break down organic matter, recycling nutrients back into the soil.
 4. **Biocontrol agents:** certain fungi and bacteria can suppress plant pathogens, reducing disease incidence and promoting healthy crop growth.

Role of microorganisms in Industry

- **ROLE:** Microorganisms are employed in various industrial processes due to their ability to produce valuable **substances**.
- **APPLICATIONS:**
- **Fermentation:** yeasts like *Saccharomyces cerevisiae* are used in the production of beer, wine, and bread. Yeast is also used in baking industries for the preparations of bread and cakes. Bacteria like *Lactobacillus* are used in the production of yogurt, curd, cheese, and sauerkraut.
- **Bioreactors:** engineered microorganisms produce enzymes, amino acids, and vitamins on an industrial scale.
- **Biofuels:** microbes like *Clostridium acetobutylicum* are used in the production of bioethanol and biobutanol, sustainable alternatives to fossil fuels.
- **Bioplastics:** bacteria like *Ralstonia eutropha* synthesize polyhydroxyalkanoates (phas), which are biodegradable plastics.

Role of microorganisms in Environment

• **ROLE:** In the environment, microorganisms play two vital roles:

- i. **enhancement of soil fertility (management)**
- ii. **Cleaning (pollution control)**

• **APPLICATIONS:**

• **COMPOSTING:** Microorganisms break down organic waste into compost, enriching soil and reducing landfill use.

• **METHANE PRODUCTION:** Anaerobic bacteria are used in biogas production, converting organic waste into methane, a renewable energy source.

• **BIOREMEDIATION:** Bacteria like *Pseudomonas* and *Mycobacterium* can degrade pollutants, such as oil spills, heavy metals, and pesticides, cleaning up contaminated environments.

CLEANERS: Microorganisms also act as cleaners. Plants and animals eventually die and their bodies are turned into nutrients which the environment can use.

• **WASTEWATER TREATMENT:** Microbial consortia are used in sewage treatment plants to degrade organic waste and reduce water pollution.

Role of microorganisms in Biotechnology

- **ROLE:** Microorganisms are foundational in biotechnology for their genetic *manipulability* and diverse metabolic capabilities.
- **APPLICATIONS:**
- **GENETIC ENGINEERING:** Bacteria and yeast are used as hosts for producing recombinant proteins, such as insulin and growth hormones.
- **CRISPR TECHNOLOGY:** The crispr-cas9 system, derived from bacterial immune mechanisms, is used for precise genome editing in various organisms.
- **SYNTHETIC BIOLOGY:** Engineering microorganisms to produce novel compounds, such as biofuels, pharmaceuticals, and specialty chemicals.
- **METABOLIC ENGINEERING:** Altering microbial metabolic pathways to enhance the production of desired metabolites.

Role of microorganisms in human health

- Bacteria are not only present outside the human body, but they also live inside the body too.
- This aggregate collection of microorganisms that is present in the human body is termed as **micro flora or normal flora**.
- Micro flora, also known as **microbiota**, refers to the community of microorganisms, including bacteria, fungi, and algae, that inhabit various environments.
- Bacteria are also present in the gut, and they **aid the process of digestion** by releasing certain enzymes. Amylase (made in the mouth and pancreas; breaks down complex carbohydrates) Lipase (made in the pancreas; breaks down fats) Protease (made in the pancreas; breaks down proteins)
- They live in a symbiotic relationship with a human.
- Other roles of micro flora are **vitamin K production**, which is crucial in enabling blood clotting.
- They also prevent the invasion of the foreign bodies, by acting against other microbes that are pathogenic to humans.