



Microbes in Human Welfare





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Microbes in Human Welfare

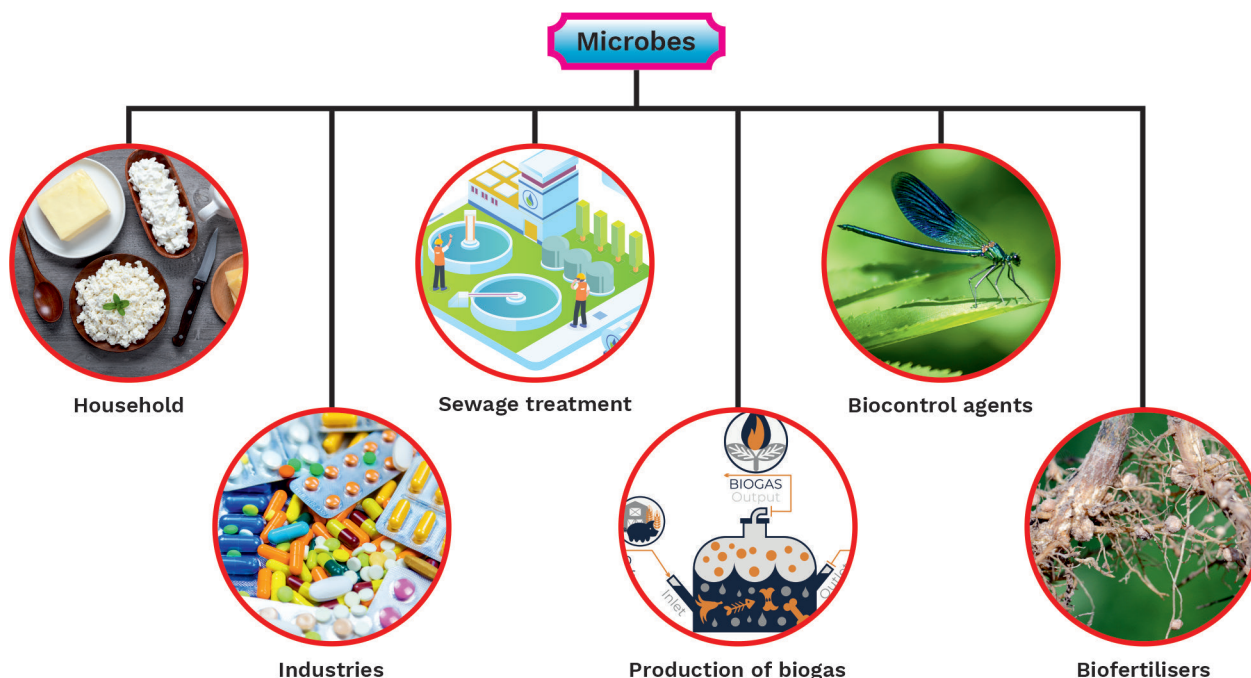
INTRODUCTION

- Organisms that are visible only under a microscope are known as microbes.
- They are present in different habitats, from deep ocean beds to high mountain areas, in plants, animals, humans, in air, water, soil, etc.
- Some different microbes are viruses, viroids, prions, bacteria, fungi, protozoans and some algae.
- Microbes are harmful to humans and also useful to mankind in many ways.

Definition

Prions: Prions are the proteinaceous, infectious agents.

IMPORTANCE OF MICROBES



Life in Extremes

Certain microbes are present in the following conditions:

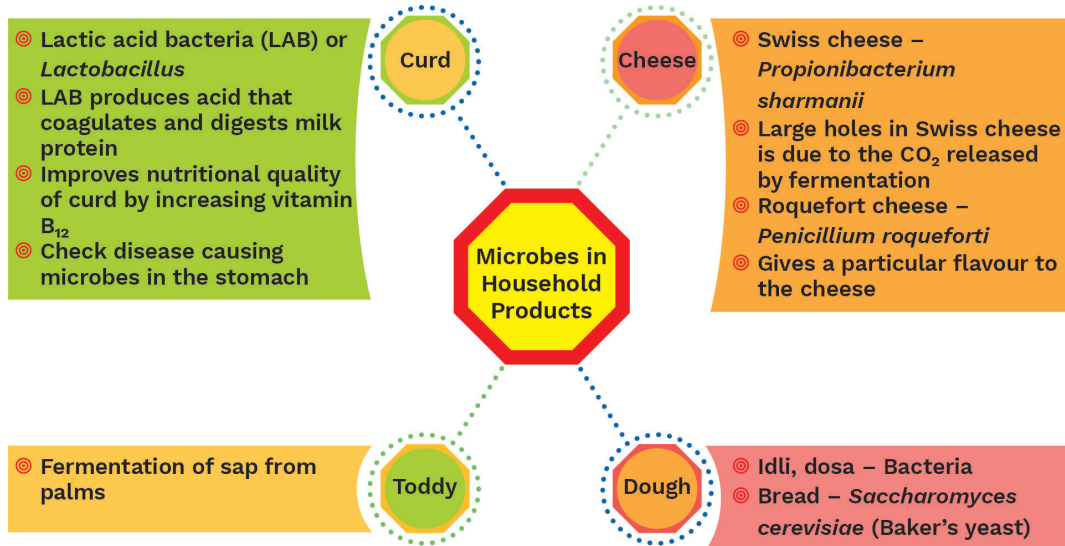
Geysers or thermal vents – *Thermus aquaticus* (pillar of molecular biology)

Snow – *Chlamydomonas*, *Glaciacola*

Acidic environment – *Thiobacillus*



MICROBES IN HOUSEHOLD PRODUCTS

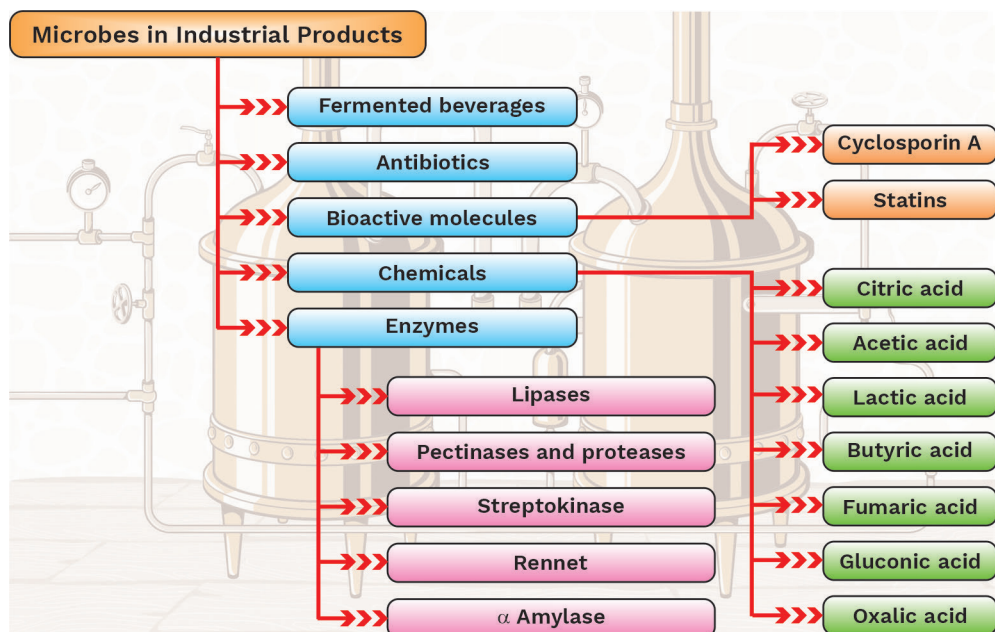


Rack your Brain



Why do we use an inoculum of curd to milk?

MICROBES IN INDUSTRIAL PRODUCTS





Beverages

- A large number of microbes are used to make beverages.
- These beverages need to be made on large scale and thus large vessels i.e., fermenters or bioreactors are used.
- Microbes are added to the fermenters along with the raw materials and then by anaerobic degradation i.e., fermentation the raw materials are digested to form the products.
- Yeast species used in the production of beverages are *Saccharomyces cerevisiae* (Brewer's Yeast), *Saccharomyces ellipsoideus* (Wine Yeast), *S. sake* (Sake Yeast), *S. pifeformis* (Ginger/Ale Yeast).
- Alcoholic drinks are produced with distillation- whisky, rum and brandy and without distillation- wine and beer.

Table. Beverages and their source of raw materials

Beverages	Raw Material
Gin	Rye, barley
Sake	Rice
Fenny	Apple
Vodka	Potato
Whisky	Cereals
Rum	Molasses
Wines and brandy	Juice

Rack your Brain



Name the metabolic pathway responsible for the puffing up bread dough when baker's yeast is added to it.

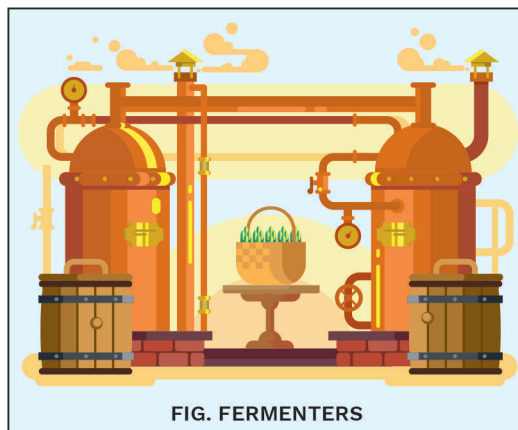


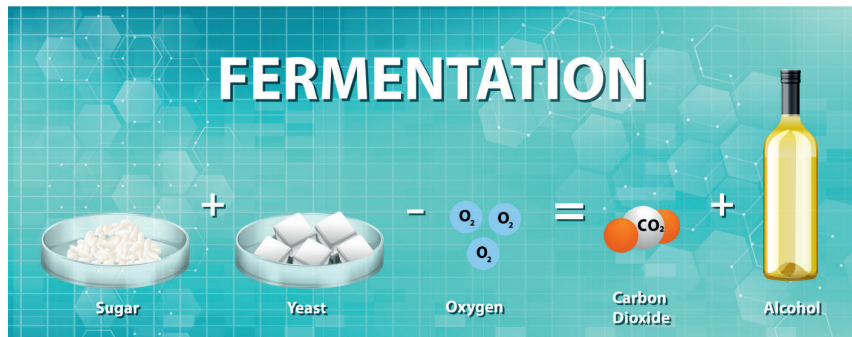
FIG. FERMENTERS

Previous Year's Question



The most common substrate used in distilleries for the production of ethanol is

- (1) molasses
- (2) corn meal
- (3) soya meal
- (4) ground gram



Antibiotics

- Word antibiotic is derived from Greek words ‘anti’–against and ‘bios’–life and thus means against life
- The term antibiotic was coined by Selman Waksman.
- Penicillin was the first antibiotic to be discovered by Alexander Fleming in *Staphylococcus*.
- He was working with the bacteria *Staphylococcus*. He grew bacteria *Staphylococcus* in a petri dish. After a few days, he saw that a mould had developed and contaminated the culture of *Staphylococcus*.
- He examined the mould and found that the mould culture prevented the growth of *Staphylococcus*.
- The mould was *Penicillium* that prevented the growth of the bacteria.
- The first antibiotic was named Penicillin after the mould *Penicillium notatum*.
- The potential of *Penicillium* as an effective antibiotic was established later by Ernst Chain and Howard Florey. All three of them shared the Nobel Prize in 1945 for this discovery.
- Penicillin is obtained from the fungus, *Penicillium notatum*.
- Antibiotics are substance produced by a microorganism, which inhibits the growth and chemical activities of pathogen without causing any harm to the host.
- Penicillin was used in the World War II to cure many soldiers.
- Antibiotics are used to treat a number of diseases like diphtheria, leprosy, pertussis (whooping cough), plague, etc.

Definition

Antibiotics: They are the chemical substances produced by certain microbes, that can kill or retard the growth of other pathogenic microbes.

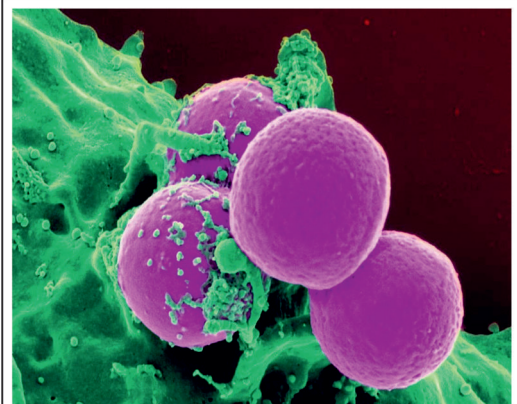
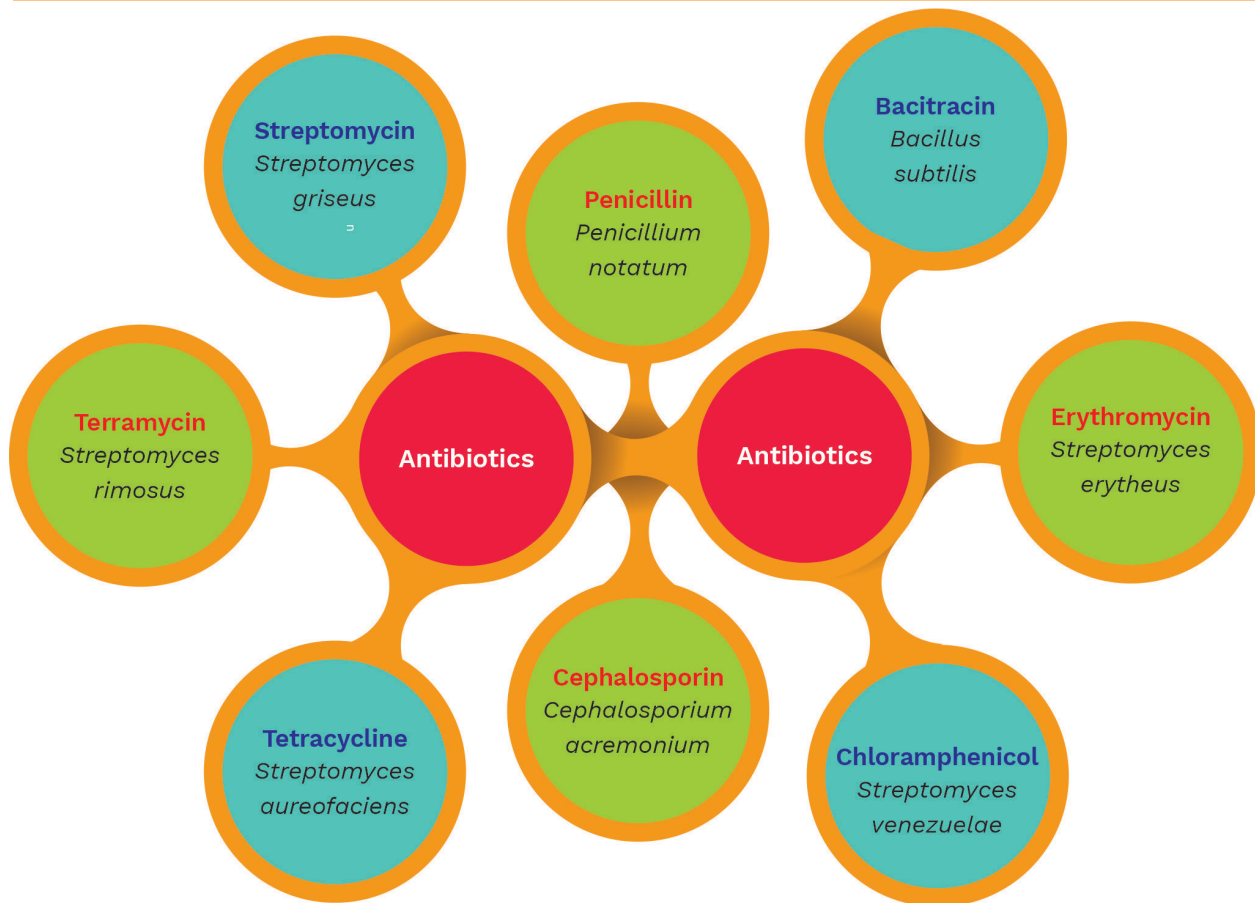


FIG. STAPHYLOCOCCUS

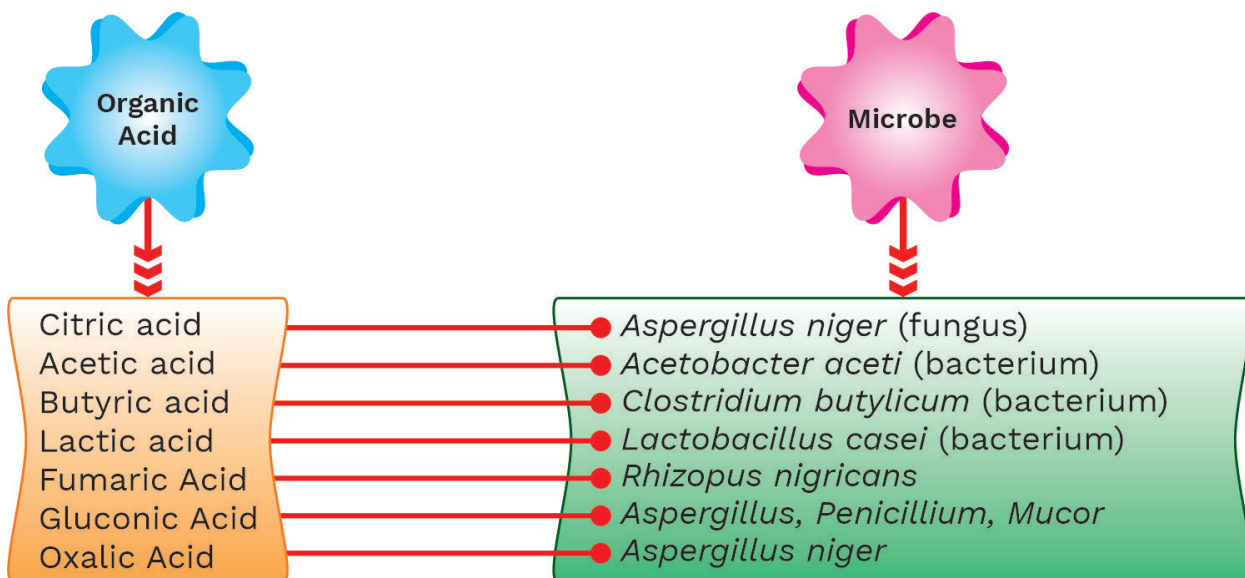


FIG. PENICILLUM



Organic Acids

- The following is a list of organic acids and the microbe used for their production-





Enzymes

- The enzymes produced with the help of microbes are:

Lipases	<i>Candida lipolytica</i>	Present in detergent. Helpful in removing oily stains from clothes.
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Pectinases and Proteases	<i>Aspergillus niger</i>	Used to clear the fruit juices during bottling. Thus home made juices are pulpy while bottled juices are clear.
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Streptokinase	<i>Streptococcus</i>	Used as 'clot buster' for removing the blood clots from the blood vessels of patients who have suffered from myocardial infarction.
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Rennet	<i>Mucor</i>	Used for manufacturing of cheese.
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Alpha Amylase	<i>Rhizopus japonicus</i>	Digestion of starch. Softening of bread.
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Bioactive Molecules

Cyclosporin A

- Produced by the fungus, *Trichoderma polysporum*.
- It is used as an immunosuppressive agent during organ-transplant.

Previous Year's Question



Which one of the following pairs is wrongly matched?

- (1) Alcohol – Nitrogenase
- (2) Fruit juice – Pectinase
- (3) Textile – Amylase
- (4) Detergents – Lipase

Rack your Brain



How has *Trichoderma* been a boon to the organ-transplant patients?

Previous Year's Question



Read the following statement having two blanks (A and B).

Drug used for A patients is obtained from a species of the organism B. The one correct option for the two blanks is

- | A | B |
|----------------------|--------------------|
| (1) heart | <i>Penicillium</i> |
| (2) organ transplant | <i>Trichoderma</i> |
| (3) swine flu | <i>Monascus</i> |
| (4) AIDS | <i>Pseudomonas</i> |



Statin

- Produced by a type of yeast, *Monascus Purpureus*.
- It is used for lowering the levels of blood-cholesterol, as it inhibits the enzyme involved in cholesterol synthesis.

MICROBES IN SEWAGE TREATMENT

- The municipal wastewater (sewage) contains large amounts of organic matter and microbes.
- The sewage is treated in sewage treatment plants (STPs) before it is discharged into water bodies to reduce the pollution level in the water bodies.
- The programmes like Ganga Action Plan and Yamuna Action Plan, initiated by the Ministry of Environment and Forests of India.
- **Ganga Action Plan:** It started on 14th January 1985 to improve the water quality by treatment of domestic wastes. This was withdrawn on 31st March 2000.
- **Ganga Action Plan II:** It started in 1993 with the aim of analysing the water quality of the river Ganga.
- **Yamuna Action Plan I:** It started in 1993.
- The YAP was funded by a loan from the Japan Bank of International Co-operation to the National River Conservation Directorate, Government of India.
- It aimed at creating public awareness about the importance of Yamuna and the major source of its pollution.
- It also aimed at reducing the organic matter and thus reducing the BOD loads at various locations in Yamuna.
- The work continued with the launch of Yamuna Action Plan II in the year 2001.
- The Sewage treatment involves two steps:
 - Primary Treatment
 - Secondary Treatment

Previous Year's Question



Which of the following is correctly matched for the product produced by them?

- (1) *Methanobacterium* – Lactic acid
- (2) *Penicillium notatum* – Acetic acid
- (3) *Saccharomyces cerevisiae* – Ethanol
- (4) *Acetobacter aceti* – Antibiotics

Rack your Brain



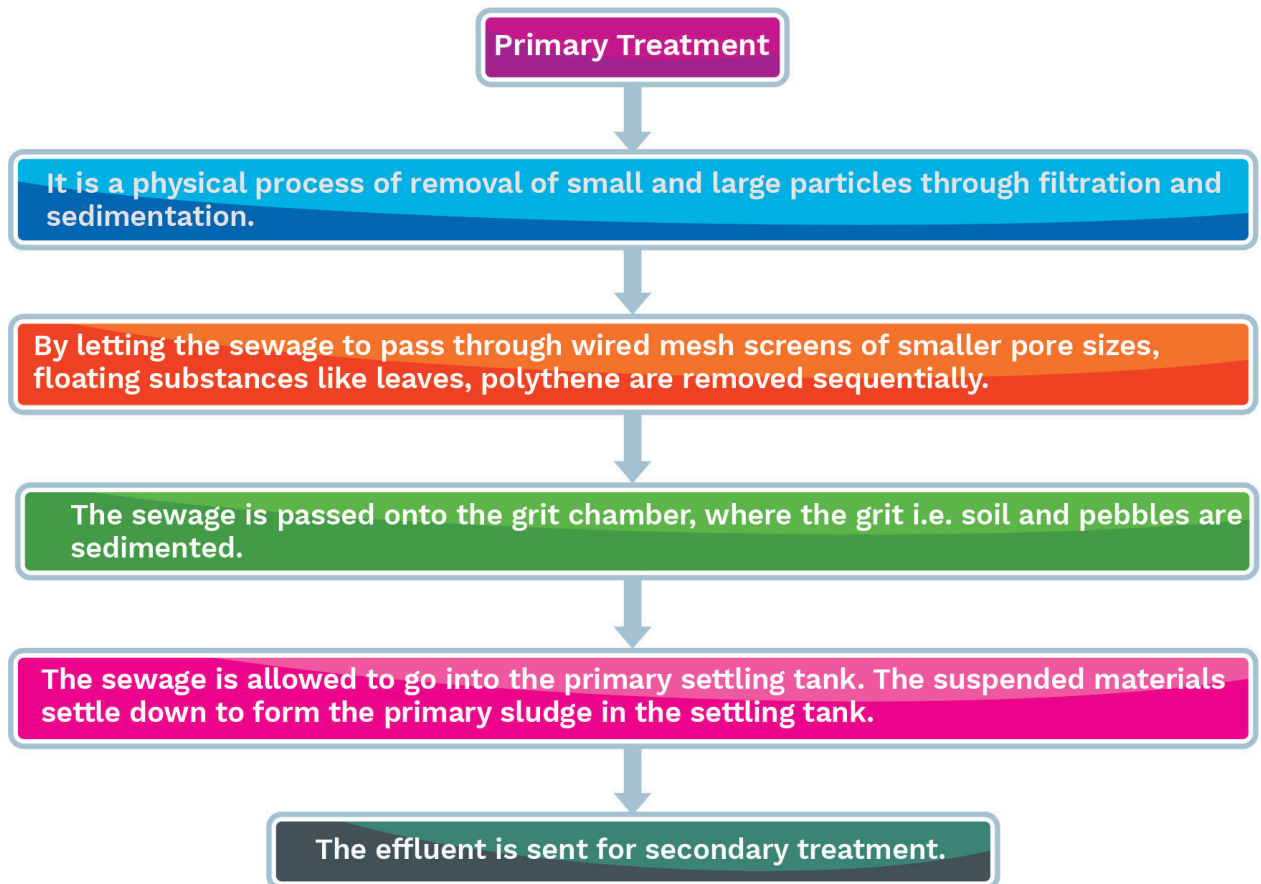
Why are some molecules known as bioactive molecules?

Previous Year's Question



Which of the following in sewage treatment removes suspended solids?

- (1) Secondary treatment
- (2) Primary treatment
- (3) Sludge treatment
- (4) Tertiary treatment



Definition

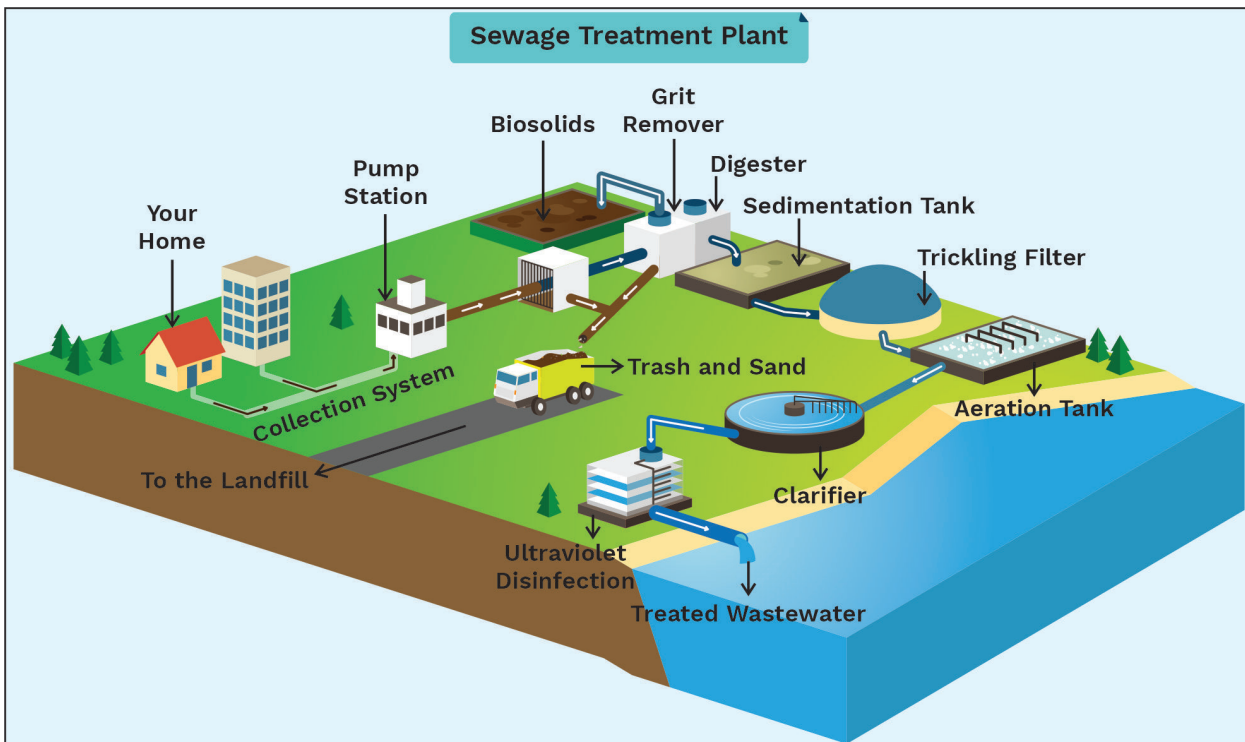
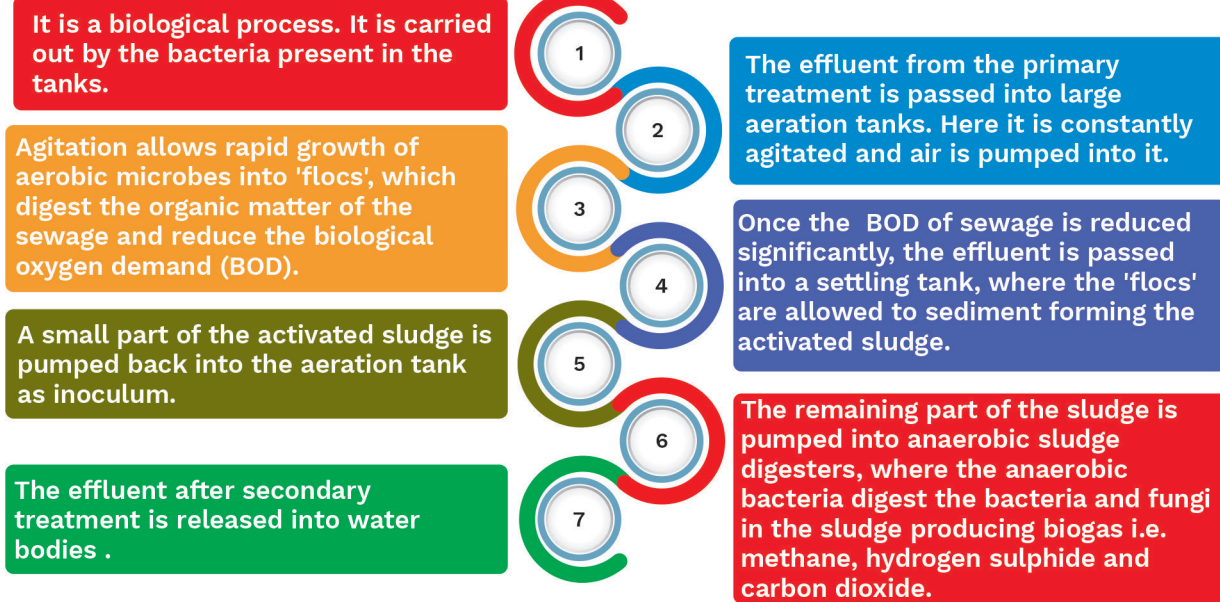
Flocs: They are masses of bacteria associated with fungal hyphae, that form mesh-like structures.

Definition

Biological Oxygen Demand (BOD): It is a measure of the oxygen needed by the aerobic decomposers in the sewage water to break down organic material present in it. It indicates the amount of organic matter present in the sewage water.



Secondary Treatment





MICROBES IN THE PRODUCTION OF BIOGAS

- Biogas predominantly contains:
 - Methane (60–70%)
 - Carbon dioxide (25–35%)
 - Hydrogen sulphide (1–5%)
 - Hydrogen
- They are present in:
 - Anaerobic sludge
 - Rumen of cattle
 - Rice fields
 - Marshy places
- Cattle dung is used for the production of biogas as it contains cellulosic materials as well as methanogens.
- The technology of biogas production was developed in India by Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission (KVIC).
- Two types of Biogas plants are present
 - Fixed dome-shaped Biogas Plant
 - Floating gas holding Biogas Plant

Fixed Dome Shaped Biogas Plant

- The plant is constructed underground, protecting it from damage and saving space.
- It consists of a digester with a fixed, non-movable gas holder, which is present on top of the digester.
- With the production of gas the slurry is displaced into the compensation tank.
- Gas pressure increases with the volume of gas.
- There is no rusting of the parts and thus the life of the plant is enhanced.

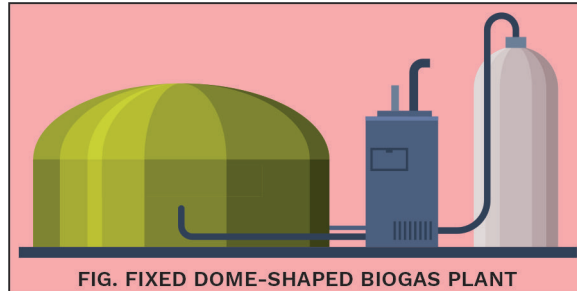
Floating Gas Holding Biogas Plant

- The biogas plant consists of a 10–15 feet deep concrete tank. The bio-wastes and slurry of the dung are fed in the tank.
- A floating cover is placed over the slurry which keeps rising as the gas is produced in the tank by the microbes.

Definitions

Biogas: It is a mixture of gases, that mainly contains methane, produced by the activity of microbes.

Methanogens: Bacteria which produce large quantities of methane during decomposition of organic matter.



Previous Year's Question



The guts of cow and buffalo possess

- (1) Methanogens
- (2) Cyanobacteria
- (3) *Fucus* sp.
- (4) *Chlorella* sp.



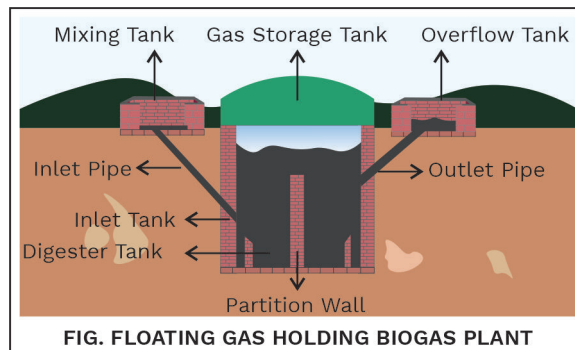
- The biogas plant has an outlet. The tank is connected to a pipe through which biogas is sent to the houses.
- There is also another outlet to remove the spent slurry. It is used as fertiliser.

Advantages of Biogas

- Biogas can be used as fuel.
- Biogas burns without smoke and thus preventing air pollution.
- Biogas can be used to light street lights and driving engines.
- The spent slurry can be used as manure.

MICROBES AS BIOCONTROL AGENTS

- Biocontrol refers to the use of biological methods for controlling plant diseases and pests. These methods rely on natural predation. Chemicals are not used in this.
- Integrated Pest Management means that we need to not eradicate the pests of the crops but limit them to a number that it does not harm the crops. The pests are kept at a manageable level by a complex system of checks and balances within the ecosystem.
- Some insects may be a pest for one crop but may be helpful in pollination and seed set of the other crops. If all the pests are eradicated then the crops for which they are useful may not be pollinated and would die.
- Some examples of Biocontrol Agents are-
 - Ladybird beetle is useful to get rid of aphids and dragonflies control mosquitoes.
 - *Bacillus thuringiensis* is a bacterium whose spores are toxic to certain insect larvae and kill them, but is not harmful to other insects and does not kill them.
- The toxin-producing genes of this bacterium are transferred through recombinant biotechnology into crop plants, which become resistant to insect pests. Example-Bt cotton.



Definition

Biocontrol: It is the use of biological methods for controlling plant pests.

Rack your Brain



Why is the influence of flocs on the BOD in the treatment of sewage?

Previous Year's Question



Biogas contains mainly

- (1) $\text{CO}_2 + \text{H}_2$
- (2) $\text{CO}_2 + \text{H}_2\text{O}$
- (3) CH_4 only
- (4) $\text{CH}_4 + \text{CO}_2$



- The fungus *Trichoderma*, is free-living in the soil and root ecosystems and is used against several plant pathogens.
- Baculoviruses are pathogens that attack many insects and arthropods. One of the baculovirus used as a biocontrol agent is *Nucleopolyhedrovirus*. They are species-specific and do not harm other pests, plants or animals.

MICROBES AS BIOFERTILISERS

- Biofertilisers are microorganisms that are used to enrich the fertility of the soil. They increase the fertility of the soil by adding certain nutrients to the soil.
- Three groups of organisms used as biofertilisers are:
 - Bacteria
 - Cyanobacteria
 - Fungi (Mycorrhiza)

Bacteria

- They are of the following types:
 - Symbiotic Bacterium
 - Loose association of nitrogen-fixing Bacterium
 - Free-living Bacterium

Symbiotic Bacterium

- *Rhizobium* shows a symbiotic association with the root nodules of leguminous plants. It fixes nitrogen into soil and increases its fertility. It forms nodules in the roots of the plants.
- The following *Rhizobium* species show symbiotic association –
 - *Rhizobium japonicum* (with soyabean)
 - *R. trifolii* (clover group)
 - *R. meliloti* (alfalfa)
 - *R. phaseoli* (bean group)
- *Frankia* is associated symbiotically with the roots of non-leguminous plants like *Casuarina*, *Alnus*.

Previous Year's Question



When a natural predator (living being) is applied on the other pathogen organism to control them, this process is called

- (1) artificial control
- (2) confusion technique
- (3) biological control
- (4) genetic engineering

Rack your Brain



Name one symbiont which serves as a biofertiliser.

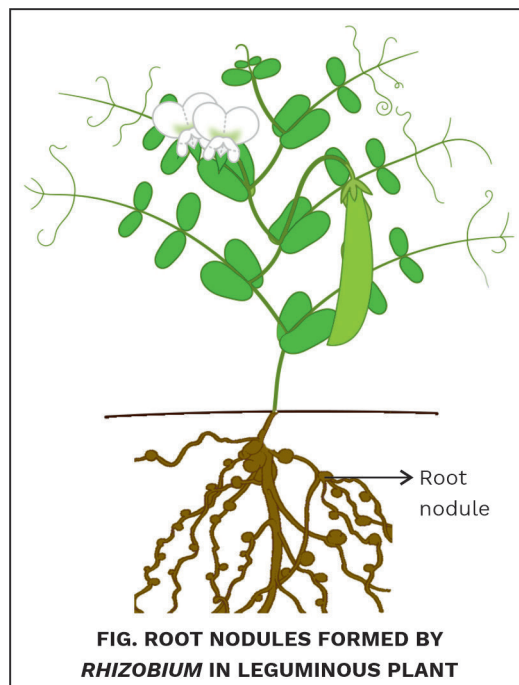


FIG. ROOT NODULES FORMED BY *RHIZOBIUM* IN LEGUMINOUS PLANT



Loose association of Nitrogen-Fixing Bacterium

- Certain bacterium live around the roots of higher plants but do not develop any relationship with the plant.
- The bacteria obtain some exudates from the plant and use it as its food.
- Example: *Azospirillum*

Free-Living Bacterium

- They live freely in the soil and fix nitrogen.
- Examples: *Azotobacter*, *Bacillus polymyxa*, *Beijerinckia*

Cyanobacteria

- They are of the following types:
 - Symbiotic Nitrogen-Fixing Cyanobacteria
 - Free-Living Nitrogen-Fixing Cyanobacteria

Symbiotic Nitrogen-Fixing Cyanobacteria

- They form symbiotic association with certain plants.
- *Azolla-Anabaena* association is an association of the leaves of the fern *Azolla pinnata* with cyanobacteria.
- *Anabaena* lives in the coralloid roots of *Cycas*.
- *Azolla* and *Nostoc* are added in the rice fields to increase the rice yield.

Free-Living Nitrogen-Fixing Bacteria

- Some cyanobacteria live free in the soil and fix nitrogen. They add organic matter and also nitrogen to the soil.
- Example: *Aulosira fertilissima* is a nitrogen fixer in the rice fields.

Fungi/Mycorrhizae

- Fungi form symbiotic association with roots of higher plants (mycorrhizae), e.g., *Glomus*.
- They are of two types:
 - Ectomycorrhizae and Endomycorrhizae

Previous Year's Question



Consider the following statements (A–D) about organic farming.

- (A) Utilizes genetically modified crops like Bt cotton.
- (B) Uses only naturally produced inputs like compost.
- (C) Does not use pesticides and urea.
- (D) Produces vegetables rich in vitamins and minerals.

Which of the above statements are correct?

- (1) B, C and D
- (2) C and D only
- (3) B and C only
- (4) A and B only

Previous Year's Question



Farmers have reported over 50% higher yields of rice by using which of the following biofertilizer?

- (1) Cyanobacteria
- (2) Legume *Rhizobium* symbiosis
- (3) Mycorrhiza
- (4) *Azolla pinnata*



Ectomycorrhizae

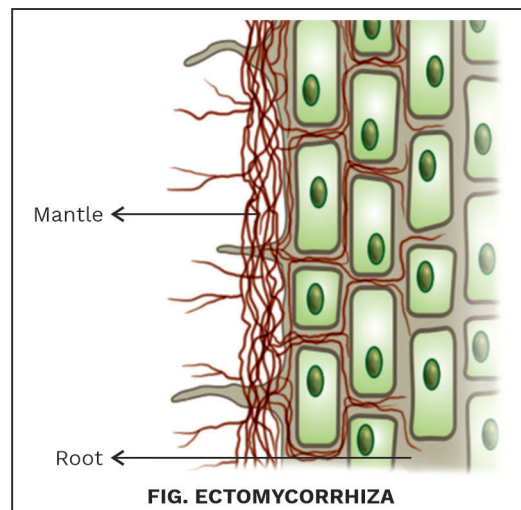
- The fungus forms a mantle on the surface of the roots.
- From the mantle the fungal hyphae penetrates the cortex of the roots and also into the soil.
- It increases the area for absorption of water and minerals.
- Solubilise some insoluble inorganic matter that can be later absorbed by the plant.
- It also secrete antimicrobial substances that prevent the growth of pathogens near the roots of the plant.
- Examples: Ectomycorrhizae have been found in oaks, pines and *Eucalyptus*.

Endomycorrhizae

- The fungal hyphae move into the cortex cells of the roots .It also show intercellular growth.
- The tip of the fungal hyphae in the cortical cell swells up and produces vesicles or finely branched masses known as arbuscules.
- Thus endomycorrhizae are also known as Vesicular Arbuscular Mycorrhiza.
- The fungus absorbs phosphorus and passes it on to the plant.
- Increase the absorption of inorganic minerals and water.
- Examples: Endomycorrhizae have been found in orchids and woody plants.

Keywords

- ♦ GAP – Ganga Action Plan
- ♦ KVIC – Khadi and Village Industries Commission
- ♦ TMV – Tobacco Mosaic Virus
- ♦ YAP – Yamuna Action Plan
- ♦ IPM – Integrated Pest Management

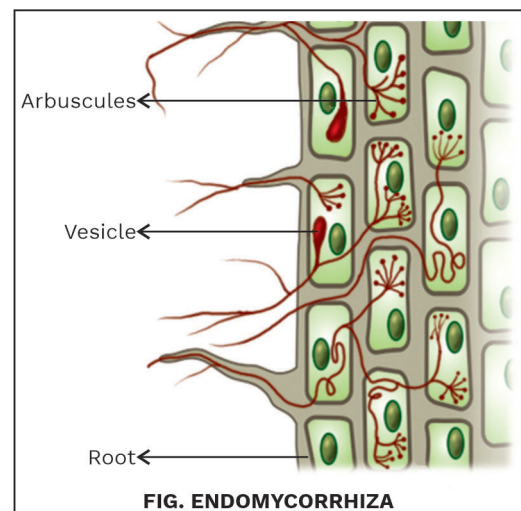


Previous Year's Question



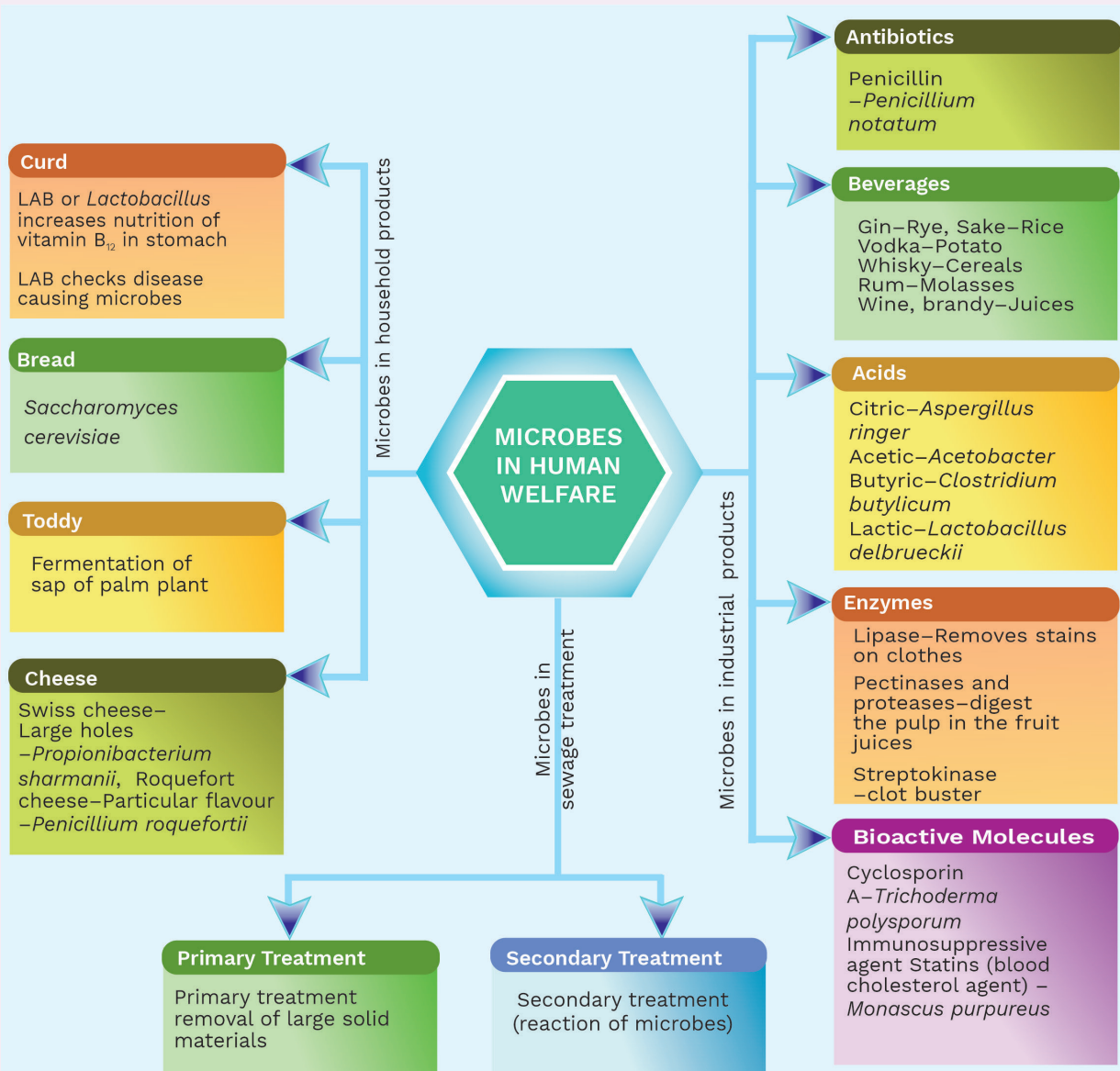
Which one of the following is not used in organic farming?

- (1) *Glomus*
- (2) Earthworm
- (3) *Oscillatoria*
- (4) Snail



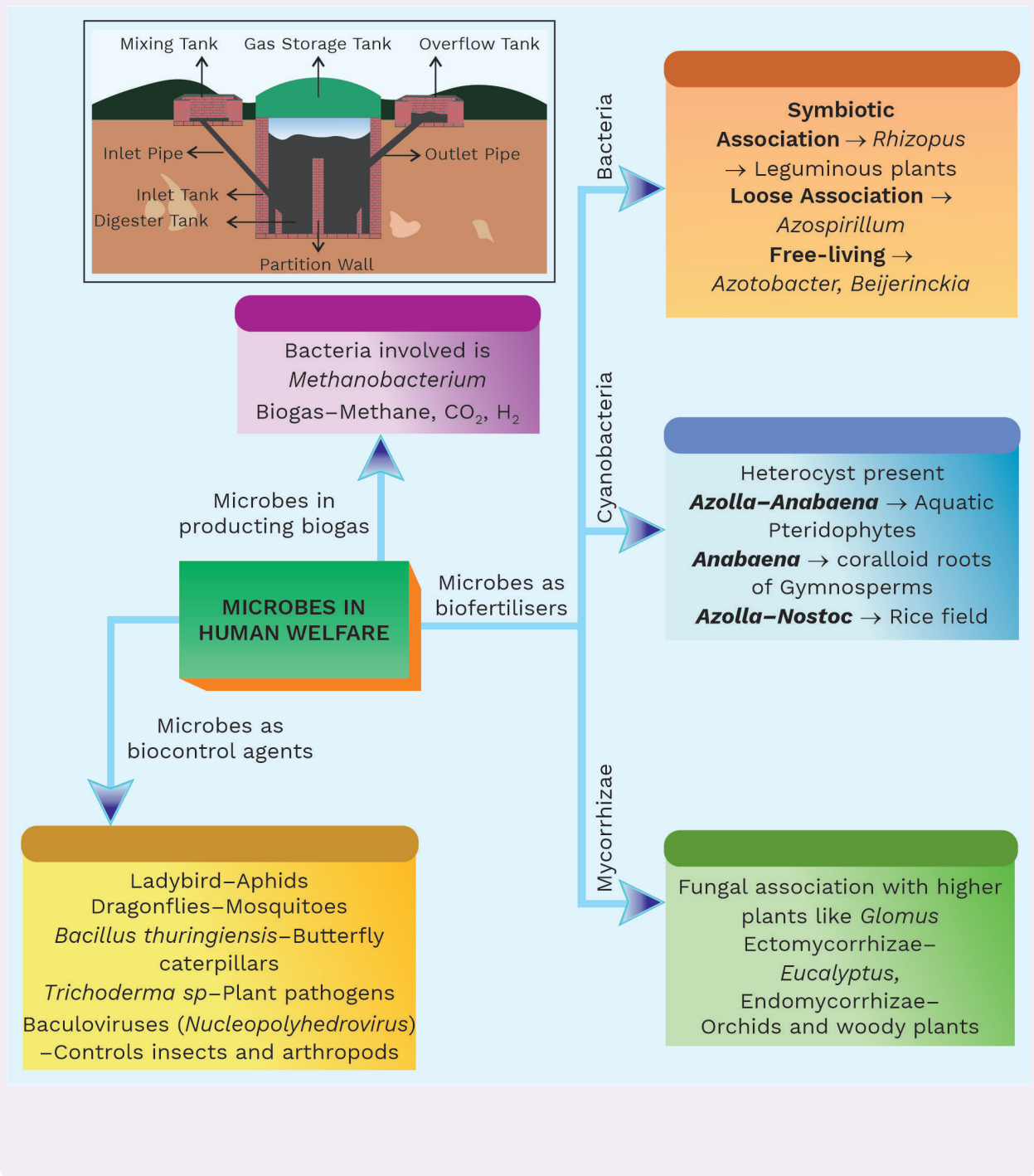


Summary





Summary





Solved Exercise

Q1

Which one of the following statements is correct?

- (1) Legumes fix nitrogen only through the specialized bacteria that live in their roots.
- (2) Legumes fix nitrogen independently of the specialized bacteria that live in their roots.
- (3) Legumes fix nitrogen only through specialized bacteria that live in their leaves.
- (4) Legumes are incapable of fixing nitrogen.

A1

- (1) Leguminous plants show symbiotic associations with leguminous plants and help in nitrogen fixation.

Q2

Citric acid is produced by

- (1) *Candida utilis*
- (2) *Azotobacter suboxydans*
- (3) *Aspergillus niger*
- (4) *Streptococcus lactis*

A2

- (3)
Aspergillus niger produces citric acid.

Q3

The biofertilisers are

- (1) *Anabaena* and *Azolla*
- (2) cow dung, manure and farmyard waste
- (3) quick growing crop ploughed under soil
- (4) none of these

A3

- (1)
Anabaena and *Azolla* are biofertilisers.



- Q4** Select the mismatch.
- (1) *Rhodospirillum* – Mycorrhiza
 - (2) *Anabaena* – Nitrogen fixer
 - (3) *Rhizobium* – Alfalfa
 - (4) *Frankia* – *Alnus*

A4 (1)
Rhodospirillum is a free-living nitrogen-fixing bacteria.

- Q5** Which of the following is non-symbiotic biofertiliser?
- (1) *Anabaena*
 - (2) *Rhizobium*
 - (3) VAM
 - (4) *Azotobacter*

A5 (4)
Azotobacter is non-symbiotic while others are all symbiotic associations.

- Q6** In gobar gas, the maximum amount is that of
- (1) butane
 - (2) methane
 - (3) propane
 - (4) carbon dioxide

A6 (2)
Methane is about 60-70% of biogas.

- Q7** A patient brought to a hospital with myocardial infarction is normally immediately given
- (1) penicillin
 - (2) streptokinase
 - (3) cyclosporin A
 - (4) statins

A7 (2)
Streptokinase is used as a clot-buster to remove clots in patients who have undergone myocardial infarctions.



- Q8** *Monascus purpureus* is a yeast used commercially in the production of
- (1) ethanol
 - (2) streptokinase for removing clots from the blood vessels
 - (3) citric acid
 - (4) blood cholesterol-lowering statins.

A8 (4)
It is used to produce blood cholesterol-lowering agent and it inhibits the enzyme responsible for synthesis of cholesterol.

- Q9** Microbe used for biocontrol of pest butterfly caterpillars is
- (1) *Saccharomyces cerevisiae*
 - (2) *Bacillus thuringiensis*
 - (3) *Streptococcus sp.*
 - (4) Dragonfly

A9 (2)
Bacillus thuringiensis is used as a biocontrol agent against caterpillars.

- Q10** Which gases are produced in anaerobic sludge digesters?
- (1) Methane and CO₂ only
 - (2) Methane, Hydrogen sulphide and CO₂
 - (3) Methane, Hydrogen sulphide
 - (4) Hydrogen sulphide and CO₂

A10 (2)
The biogas produced due to anaerobic sludge digestion are : Methane, Hydrogen sulphide and CO₂.

