

Chapter 10

Microbes in Human Welfare

Complete Notes + Important Questions

Board	Subject	Chapter	Marks Weight
CBSE / State	Biology	Ch. 10	~5–8 Marks

1. Introduction to Microbes

Microbes (microorganisms) include bacteria, fungi, protozoa, algae, viruses, viroids and prions. They are found in every habitat — from hot springs to deep ocean floors. Microbes play enormous roles in human welfare through food production, medicine, agriculture and industry.

Key groups of microbes:

Group	Examples & Relevance
Bacteria	Lactobacillus (curd), Acetobacter (vinegar), Rhizobium (N-fixation)
Fungi	Saccharomyces (bread/beer), Penicillium (antibiotic), Aspergillus
Cyanobacteria	Nostoc, Anabaena — fix atmospheric nitrogen, biofertilisers
Algae (Microalgae)	Spirulina — single-cell protein; Chlorella
Viruses	Baculovirus — biocontrol agents
Protozoa	Amoeba, Paramecium — decomposers in soil

2. Microbes in Household Products & Food Processing

Fermentation by microorganisms has been used since ancient times to produce food and beverages.

Product	Microorganism	Process / Note
Curd (Dahi)	Lactobacillus, Streptococcus thermophilus	Lactic acid fermentation; also increases Vit B12
Bread	Saccharomyces cerevisiae	CO ₂ released causes dough to rise (leavening)
Idli / Dosa	Leuconostoc mesenteroides + Yeast	Mixed fermentation; CO ₂ gives fluffy texture
Cheese	Propionibacterium (Swiss), Penicillium roqueforti (Roquefort)	Ripening gives flavour
Toddy	Natural yeasts on palm sap	Ethanol fermentation
Vinegar	Acetobacter aceti	Oxidises ethanol to acetic acid
Soya sauce	Aspergillus oryzae + bacteria	Fermented soya beans

■ **Note:** *Lactobacillus produces lactic acid that partially digests milk protein casein. Curd is nutritionally richer than milk due to elevated Vitamin B12.*

3. Microbes in Industrial Products

3a. Fermented Beverages

Saccharomyces cerevisiae is the workhorse of alcoholic fermentation. Beer and wine are produced without distillation ($\leq 13\%$ alcohol). Whisky, brandy and rum require distillation of the fermented broth.

3b. Antibiotics

Antibiotic	Source Organism
Penicillin	Penicillium notatum (discovered by Alexander Fleming, 1928)
Streptomycin	Streptomyces griseus
Chloramphenicol	Streptomyces venezuelae
Erythromycin	Saccharopolyspora erythraea
Tetracycline	Streptomyces aureofaciens

■ **Note:** *Penicillin was the first antibiotic discovered. Fleming noticed that Penicillium mould inhibited bacterial growth on an agar plate — this is called the 'chance observation'.*

3c. Chemicals, Enzymes & Other Products

Product	Microorganism / Use
Citric acid	Aspergillus niger — food additive
Acetic acid	Acetobacter aceti
Butyric acid	Clostridium butylicum
Lactic acid	Lactobacillus
Ethanol	Saccharomyces cerevisiae
Lipases	Fungi/bacteria — detergent industry (stain removal)
Pectinases & Proteases	Fungi — clarification of fruit juices, cheese processing
Streptokinase	Streptococcus — clot buster (thrombolytic agent)
Cyclosporin A	Trichoderma polysporum — immunosuppressant in organ transplant
Statins	Monascus purpureus — cholesterol-lowering drug

4. Microbes in Sewage Treatment

Municipal wastewater (sewage) contains large amounts of organic matter and pathogens. Sewage treatment plants (STPs) use microbes to reduce Biological Oxygen Demand (BOD) before releasing water into natural water bodies.

Stages of Sewage Treatment:

Stage	Process & Microbes Involved
Primary Treatment (Physical)	Filtration + sedimentation → removes large solids & floating debris. No microbes yet.
Secondary Treatment (Biological)	Aerobic bacteria decompose organic matter in aeration tanks → reduces BOD by ~90%.
Floc formation	Bacteria + fungi form flocs (mesh-like masses). Protozoa graze on bacteria → cleaner effluent.
Anaerobic sludge digestion	Anaerobic bacteria digest sludge in digester tanks → biogas ($\text{CH}_4 + \text{CO}_2 + \text{H}_2\text{S}$) produced.
Tertiary Treatment (Chemical)	Chlorination / UV treatment to kill remaining pathogens before release.

■ **Note:** BOD (Biological Oxygen Demand) measures the amount of O_2 consumed by microbes to decompose organic matter. Higher BOD = more polluted water.

5. Microbes in Production of Biogas

Biogas is a mixture of gases produced by anaerobic microbial decomposition of organic matter. It consists mainly of methane (CH₄ ~65%), CO₂ (~30%), H₂S and water vapour.

Key organisms — Methanogens:

Methanobacterium is a strictly anaerobic archaebacterium that produces methane. These bacteria are found in the gut of ruminants (cattle) and are responsible for flatulence and methane release in ruminant digestion.

Biogas Plant (Gobar gas plant):

Component	Function
Mixing tank	Cattle dung + water slurry is prepared
Digester (underground tank)	Anaerobic fermentation; methanogenic bacteria act on slurry
Gas holder (dome)	Collects biogas produced
Outlet	Spent slurry used as manure

■ **Note:** IARI (Indian Agricultural Research Institute) and KVIC (Khadi and Village Industries Commission) have contributed significantly to biogas plant development in India.

6. Microbes as Biocontrol Agents

Biocontrol uses living organisms (mainly microbes) to control pest populations, reducing dependence on chemical pesticides.

Agent	Mode of Action / Target Pest
Bacillus thuringiensis (Bt)	Produces Cry proteins (crystal proteins) → toxic to lepidopteran larvae. Used in Bt cotton, Bt brinjal.
Baculoviruses (e.g., Nucleopolyhedrovirus)	Narrowly specific; kill target insects without harming non-target organisms. Excellent for IPM.
Trichoderma (fungi)	Biocontrol of soil-borne plant pathogens; free-living fungus in root ecosystem.
Cryprolaemus montrouzieri	A ladybird beetle; biocontrol of mealy bugs (not a microbe but in biocontrol context).
Dragonflies	Biocontrol of mosquitoes in aquatic habitat.

7. Microbes as Biofertilisers

Biofertilisers are organisms that enrich the nutrient quality of the soil. They are cost-effective, eco-friendly alternatives to chemical fertilisers.

Biofertiliser	Organism(s)	Function
Rhizobium	Symbiotic bacteria in root nodules of legumes	Biological N-fixation
Azospirillum	Free-living bacterium	N-fixation in non-legume root zone
Azotobacter	Free-living bacterium (aerobic)	N-fixation; improves soil texture
Anabaena / Nostoc / Oscillatoria	Cyanobacteria (BGA)	N-fixation in paddy fields; add organic matter
Mycorrhiza (Glomus sp.)	Symbiotic fungi with plant roots	Enhance phosphorus absorption, drought resistance
Azolla	Water fern with Anabaena symbiont	Floating biofertiliser for paddy; used in SE Asia

■ **Note:** Mycorrhizal fungi form a network (hyphae) that massively increases the root surface area available for mineral and water absorption. The plant provides sugars; fungi provide minerals — a classic mutualistic association.

8. Quick Summary — At a Glance

Area	Key Microbe(s)	Product / Benefit
Food	Lactobacillus, Saccharomyces	Curd, Bread, Wine, Vinegar
Antibiotics	Penicillium, Streptomyces	Penicillin, Streptomycin
Enzymes	Aspergillus, Streptococcus	Lipases, Streptokinase, Statins
Sewage	Aerobic + Anaerobic bacteria	Reduces BOD, Biogas
Biogas	Methanobacterium	CH ₄ (cooking fuel)
Biocontrol	Bt, Baculovirus, Trichoderma	Pest control w/o chemicals
Biofertiliser	Rhizobium, Azotobacter, Cyanobacteria, Glomus	N-fixation, P-absorption

IMPORTANT QUESTIONS

Microbes in Human Welfare — All Types

Section A — 1 Mark Questions (VSA)

Q1.

Name the microorganism used in the production of biogas.

[1 Mark]

Ans: Methanobacterium (a methanogenic archaeobacterium).

Q2.

What is BOD? Why is it significant?

[1 Mark]

Ans: Biological Oxygen Demand — the amount of O₂ consumed by microbes to decompose organic matter in water. High BOD indicates high pollution.

Q3.

Name the antibiotic produced by *Penicillium notatum*.

[1 Mark]

Ans: Penicillin.

Q4.

Which microorganism is responsible for the large holes seen in Swiss cheese?

[1 Mark]

Ans: *Propionibacterium shermanii* — produces large amounts of CO₂.

Q5.

Name the free-living nitrogen-fixing cyanobacterium used as a biofertiliser in rice fields.

[1 Mark]

Ans: *Anabaena* / *Nostoc* / *Oscillatoria* (any one).

Q6.

What is the active ingredient in Bt that kills insect larvae?

[1 Mark]

Ans: Cry proteins (crystal proteins / δ -endotoxins) encoded by cry genes.

Q7.

Name the immunosuppressant drug produced by a fungus and state the fungus.

[1 Mark]

Ans: Cyclosporin A — produced by *Trichoderma polysporum*.

Q8.

What is the role of flocs in secondary sewage treatment?

[1 Mark]

Ans: Flocs are mesh-like masses of bacteria and fungi that consume organic matter, reducing BOD; protozoa in flocs graze on bacteria, clarifying the effluent.

Q9.

Name the organism and the process by which toddy is made.

[1 Mark]

Ans: Natural wild yeasts; fermentation of palm sap (saccharification + alcoholic fermentation).

Q10.

Which statin-producing microorganism is used to lower blood cholesterol?

[1 Mark]

Ans: *Monascus purpureus* (yeast).

Section B — 2 Mark Questions (SA-I)

Q11.

Distinguish between primary and secondary treatment of sewage.

[2 Marks]

Ans: Primary (physical): removes floating debris and suspended solids by filtration/sedimentation; no microbial activity. Secondary (biological): aerobic bacteria decompose dissolved organic matter in aeration tanks, reducing BOD significantly.

Q12.

What are mycorrhiza? How do they benefit the host plant?

[2 Marks]

Ans: Mycorrhizae are symbiotic associations between fungi (e.g., *Glomus*) and plant roots. Benefits: (i) greatly enhanced absorption of phosphorus and other minerals; (ii) increased resistance to drought and soil pathogens.

Q13.

Explain the role of *Rhizobium* in nitrogen fixation.

[2 Marks]

Ans: *Rhizobium* lives symbiotically in root nodules of leguminous plants. It reduces atmospheric N_2 to ammonia (NH_3) using the nitrogenase enzyme. The plant supplies carbohydrates; *Rhizobium* fixes nitrogen — a mutualistic relationship that enriches soil nitrogen.

Q14.

Why is *Saccharomyces cerevisiae* called a versatile microorganism?

[2 Marks]

Ans: It is used in: (i) bread-making — CO₂ released causes dough to rise; (ii) beer and wine production — ferments sugars to ethanol; (iii) whisky and rum production; (iv) single-cell protein production. Its metabolic flexibility makes it industrially indispensable.

Q15.

What is biocontrol? Mention two advantages over chemical pesticides.

[2 Marks]

Ans: Biocontrol is the use of living organisms (bacteria, viruses, fungi) to control pest populations. Advantages: (i) eco-friendly, no toxic residues; (ii) target-specific — do not harm non-target organisms or beneficial insects.

Q16.

Write a note on Baculoviruses as biocontrol agents.

[2 Marks]

Ans: Baculoviruses (e.g., Nucleopolyhedrovirus) infect and kill specific insect pests. They are highly species-specific, do not affect plants, mammals or birds. Ideal for Integrated Pest Management (IPM) and in areas requiring conservation of natural enemies.

Section C — 3 Mark Questions (SA-II)

Q17.

Describe the secondary treatment of sewage with the help of a diagram description.

[3 Marks]

Ans: Sewage enters aeration tanks → aerobic heterotrophic bacteria oxidise organic matter → flocs (bacteria + fungi mesh) form. Flocs settle in settling tanks as activated sludge. Part of sludge returned to aeration tank (inoculum); rest sent to anaerobic sludge digesters. Anaerobic bacteria in digester produce biogas (CH₄ + CO₂ + H₂S). Clarified effluent released or given tertiary treatment.

Q18.

Give an account of microbes used as biofertilisers.

[3 Marks]

Ans: 1. Rhizobium — symbiotic N-fixation in legume root nodules. 2. Azotobacter / Azospirillum — free-living/associative N-fixers. 3. Cyanobacteria (Nostoc, Anabaena) — fix N, add organic matter in waterlogged paddy fields. 4. Mycorrhizae (Glomus) — symbiotic fungi enhancing phosphorus and water uptake. 5. Azolla — aquatic fern with Anabaena symbiont; used as biofertiliser in SE Asian rice paddies.

Q19.

How is Penicillin produced and what is its mechanism of action? State its discovery.

[3 Marks]

Ans: Discovery: Alexander Fleming (1928) observed that *Penicillium notatum* contaminating a bacterial culture inhibited bacterial growth. Production: *Penicillium* is grown in large submerged fermenters; penicillin secreted into culture medium, then extracted and purified. Mechanism: It inhibits cell wall synthesis in bacteria by blocking peptidoglycan cross-linking → bacteria burst due to osmotic pressure.

Q20.

Explain how microbes are used in the production of industrial enzymes, giving two examples with their applications.

[3 Marks]

Ans: Microbes secrete extracellular enzymes during fermentation: (i) Lipases — produced by bacteria/fungi; used in detergent industry to remove fat stains. (ii) Pectinases & Proteases — from fungi; used to clarify bottled fruit juices and in cheese making. (iii) Streptokinase — from *Streptococcus*; used as a 'clot-buster' to dissolve blood clots in myocardial infarction patients.

Q21.

What is activated sludge? How is it utilised in sewage treatment?

[3 Marks]

Ans: Activated sludge is the sediment formed in the settling tank of an STP; it is rich in aerobic heterotrophic bacteria. A small portion is pumped back into the aeration tank as inoculum to seed incoming sewage with efficient decomposers. The remaining sludge is transferred to anaerobic sludge digesters, where methanogenic bacteria break it down, releasing biogas.

Section D — 5 Mark Questions (LA)

Q22.

Give a detailed account of the role of microbes in the food industry.

[5 Marks]

Ans: 1. Curd: *Lactobacillus* & *Streptococcus thermophilus* ferment milk → lactic acid → curd; Vit B12 increases. 2. Bread: *Saccharomyces cerevisiae* ferments sugars → CO₂ causes dough to rise. 3. Idli/Dosa: *Leuconostoc* + yeasts ferment batter; CO₂ makes it fluffy. 4. Cheese: Ripened by *Propionibacterium* (Swiss) or *Penicillium roqueforti* (Roquefort/blue cheese). 5. Alcoholic beverages: Beer/wine — *Saccharomyces* without distillation; Whisky/rum — with distillation. 6. Vinegar: *Acetobacter aceti* oxidises ethanol to acetic acid. 7. Soya sauce: *Aspergillus* + bacteria ferment soya beans. Microbes thus enhance flavour, shelf life, nutrition and produce diverse food products.

Q23.

Describe the construction and working of a biogas plant. What is the importance of biogas?

[5 Marks]

Ans: Construction: A biogas plant has (i) a mixing tank where cattle dung + water slurry is prepared; (ii) an underground cylindrical digester tank sealed from air; (iii) a floating gas holder (dome) on top to collect gas; (iv) an outlet for spent slurry. Working: Slurry fed into digester → anaerobic methanogenic bacteria (Methanobacterium) act → organic matter broken down → biogas ($\text{CH}_4 + \text{CO}_2$) rises into gas holder. Spent slurry = nutrient-rich manure. Importance: (i) renewable fuel for cooking and lighting in rural India; (ii) spent slurry is excellent manure; (iii) reduces dependence on wood/coal; (iv) reduces greenhouse gases vs open burning; (v) good for cattle-rearing households.

Q24.

Write an essay on microbes as biocontrol agents, with suitable examples.

[5 Marks]

Ans: Biocontrol uses microbes to suppress pest populations naturally. Advantages: eco-friendly, species-specific, no chemical residues. 1. *Bacillus thuringiensis* (Bt): Produces Cry proteins (δ -endotoxins) — toxic to lepidopteran larvae; spores+crystals sprayed on crops. Transgenic Bt crops (Bt cotton, Bt brinjal) carry cry genes. 2. Baculoviruses (Nucleopolyhedrovirus, NPV): Infect and kill specific arthropods; safe for non-targets; used in IPM especially in areas needing conservation of pollinators. 3. Trichoderma: Free-living fungi parasitising soil-borne plant pathogens (e.g., *Fusarium*, *Pythium*). 4. Protozoa: Some parasitise insect pests. 5. Viruses of insects: Selective and environmentally safe. Conclusion: Biocontrol reduces chemical load in agroecosystems, preserving biodiversity and soil health.

Q25.

What are biofertilisers? Describe in detail the role of bacteria, cyanobacteria and fungi as biofertilisers.

[5 Marks]

Ans: Biofertilisers are living microorganisms that increase soil nutrient availability. Bacteria: (i) *Rhizobium* — symbiotic in legume root nodules; nitrogenase enzyme reduces $\text{N}_2 \rightarrow \text{NH}_3$; fixes ~100–300 kg N/ha/yr. (ii) *Azotobacter* — free-living aerobic; fixes N_2 , produces growth hormones. (iii) *Azospirillum* — associative symbiont of roots of non-legumes. Cyanobacteria (Blue-Green Algae): *Nostoc*, *Anabaena*, *Oscillatoria* — fix N_2 ; add organic matter; *Anabaena* in *Azolla* used in paddy fields of SE Asia; reduce need for chemical fertiliser. Fungi (Mycorrhizae): *Glomus* forms extensive hyphal networks on/in roots → enhance surface area for P absorption; improve tolerance to drought, salinity and root pathogens; provide growth-promoting substances. Overall benefit: reduce chemical fertiliser use, improve soil structure, eco-friendly and sustainable agriculture.

Section E — Assertion–Reason Questions

Instructions: Choose the correct option: (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is NOT the correct explanation of A. (c) A is true but R is false. (d) A is false but R is true.

Q26.

Assertion: Curd is more nutritious than milk. Reason: Lactobacillus increases the Vitamin B12 content during fermentation.

[1 Mark]

Ans: (a) — Both are true and R correctly explains A.

Q27.

Assertion: Baculoviruses are preferred biocontrol agents in ecologically sensitive areas. Reason: Baculoviruses are narrowly host-specific and do not harm non-target organisms.

[1 Mark]

Ans: (a) — Both are true and R correctly explains A.

Q28.

Assertion: Primary treatment of sewage removes dissolved organic matter. Reason: Secondary treatment is biological and reduces BOD.

[1 Mark]

Ans: (d) — A is false (primary treatment removes physical solids, not dissolved organics); R is true.

Q29.

Assertion: Methanobacterium is used as a biofertiliser in paddy fields. Reason: Methanobacterium fixes atmospheric nitrogen.

[1 Mark]

Ans: (d) — A is false (Methanobacterium produces biogas, not used as biofertiliser); R is also false.

Section F — Case-Based / Source-Based Questions

Read the following passage and answer the questions:

A sewage treatment plant receives 10 million litres of raw sewage every day. The plant subjects this sewage to primary treatment by passing it through bar screens and grit chambers. The clarified water is then pumped into large aeration tanks where it is constantly agitated. After several hours the aerated mixture is passed into settling tanks where the sludge settles out. The settled sludge is transferred to anaerobic sludge digester tanks. Gas produced in these tanks is used to generate electricity for the plant itself.

Q30.

What type of microbes are primarily responsible for the biological breakdown of organic matter in the aeration tanks?

[1 Mark]

Ans: Aerobic heterotrophic bacteria (e.g., Pseudomonas, Bacillus etc.).

Q31.

Name the gas produced in the anaerobic sludge digester. What is its major component?

[1 Mark]

Ans: Biogas. Major component: methane (CH₄) — approximately 65%.

Q32.

What are flocs? What is their significance in sewage treatment?

[2 Marks]

Ans: Flocs are mesh-like aggregates of bacteria (and fungi) formed during secondary treatment. They are significant because: (i) they have a large surface area for organic matter decomposition; (ii) protozoa grazing on bacteria within flocs further reduce bacterial count; (iii) they settle out easily, carrying away most of the microbial biomass.

Q33.

Define BOD. How does secondary treatment reduce the BOD of sewage?

[2 Marks]

Ans: BOD (Biological Oxygen Demand): the amount of dissolved O_2 needed by microorganisms to decompose organic matter in water. Secondary treatment: aerobic bacteria in aeration tanks oxidise dissolved organic matter $\rightarrow CO_2 + H_2O \rightarrow$ organic content drops \rightarrow BOD falls by $\sim 90\%$.

Section G — Previous Years' CBSE Board Questions

Q34.

(2023) Explain the role of microbes in the production of biogas. Draw a labelled diagram of a biogas plant.

[5 Marks]

Q35.

(2022) How do mycorrhizae help the host plant? Name an example of mycorrhizal fungus.

[2 Marks]

Ans: Mycorrhizal fungi (e.g., Glomus) enhance absorption of phosphorus and water, increase drought resistance and resistance to soil pathogens. Example: Glomus mosseae.

Q36.

(2022) Mention any two advantages of using microbes as biopesticides over chemical pesticides.

[2 Marks]

Ans: (i) Target-specific — do not harm beneficial insects or non-target organisms. (ii) Eco-friendly — leave no toxic chemical residues in soil or food.

Q37.

(2020) Name the source organism and the therapeutic use of (i) Cyclosporin A (ii) Streptokinase.

[2 Marks]

Ans: (i) Cyclosporin A — Trichoderma polysporum; immunosuppressant in organ transplant patients. (ii) Streptokinase — Streptococcus; thrombolytic (clot-buster) in heart-attack treatment.

Q38.

(2019) (a) Name the organism used in production of statin. (b) What is the mode of action of statin?

[2 Marks]

Ans: (a) *Monascus purpureus*. (b) Statins competitively inhibit HMG-CoA reductase, the enzyme involved in cholesterol synthesis in the liver, thereby lowering blood cholesterol levels.

Q39.

(2018) Explain the role of *Bacillus thuringiensis* as a biocontrol agent.

[3 Marks]

Ans: *Bt* produces proteinaceous crystal (Cry protein / δ -endotoxin) during sporulation. When ingested by susceptible lepidopteran larvae, the alkaline gut pH solubilises the crystal → active toxin → binds to epithelial cells of midgut → creates pores → cell swelling → larval death. *Bt* spores+crystals are sprayed as biopesticide. Cry genes inserted into transgenic crops (*Bt* cotton) provide in-plant protection.

Q40.

(2017) Differentiate between primary and secondary sewage treatment on the basis of (i) type of process, (ii) end product.

[2 Marks]

Ans: (i) Primary — physical (filtration, sedimentation); Secondary — biological (microbial decomposition).
(ii) Primary — effluent with reduced solids, primary sludge; Secondary — effluent with low BOD, activated sludge + biogas.

MULTIPLE CHOICE QUESTIONS

Microbes in Human Welfare — 40 MCQs with Answer Key

Set 1 — Microbes in Food & Household Products

Q1. Which bacterium is primarily responsible for curd formation from milk?

- (a) *Acetobacter aceti*
- (b) *Lactobacillus*
- (c) *Streptomyces griseus*
- (d) *Clostridium butylicum*

✓ Answer: (b) *Lactobacillus* — *Lactobacillus* converts lactose → lactic acid, coagulating milk proteins.

Q2. The large holes in Swiss cheese are produced by:

- (a) *Penicillium roqueforti*
- (b) *Lactobacillus acidophilus*
- (c) *Propionibacterium shermanii*
- (d) *Saccharomyces cerevisiae*

✓ Answer: (c) *Propionibacterium shermanii* — *Propionibacterium* produces large amounts of CO₂ during ripening.

Q3. Which microorganism is used in the production of bread?

- (a) *Aspergillus niger*
- (b) *Saccharomyces cerevisiae*
- (c) *Rhizopus stolonifer*
- (d) *Penicillium camemberti*

✓ Answer: (b) *Saccharomyces cerevisiae* — *S. cerevisiae* releases CO₂ during fermentation, causing dough to rise.

Q4. Roquefort cheese is ripened by:

- (a) *Lactobacillus bulgaricus*
- (b) *Propionibacterium*
- (c) *Penicillium roqueforti*
- (d) *Acetobacter aceti*

✓ Answer: (c) *Penicillium roqueforti* — *Penicillium roqueforti* gives blue-veined cheese its distinctive flavour.

Q5. Toddy, a traditional beverage, is made by fermenting:

- (a) Grapes
- (b) Barley malt
- (c) Palm sap
- (d) Apple juice

✓ **Answer: (c) Palm sap** — Natural wild yeasts on palm sap ferment sugars to alcohol.

Q6. Vinegar is produced by the action of which organism on ethanol?

- (a) *Saccharomyces cerevisiae*
- (b) *Acetobacter aceti*
- (c) *Aspergillus oryzae*
- (d) *Lactobacillus*

✓ **Answer: (b) *Acetobacter aceti*** — *Acetobacter* oxidises ethanol → acetic acid (vinegar).

Q7. Which vitamin increases in curd compared to milk?

- (a) Vitamin A
- (b) Vitamin C
- (c) Vitamin D
- (d) Vitamin B12

✓ **Answer: (d) Vitamin B12** — *Lactobacillus* synthesises Vitamin B12 during fermentation.

Q8. Idli and dosa batter fermentation is caused by:

- (a) *Saccharomyces cerevisiae* only
- (b) *Leuconostoc mesenteroides* and yeasts
- (c) *Lactobacillus* only
- (d) *Aspergillus niger*

✓ **Answer: (b) *Leuconostoc mesenteroides* and yeasts** — Mixed fermentation by *Leuconostoc* and wild yeasts produces CO₂ for texture.

Set 2 — Industrial & Pharmaceutical Products

Q9. Penicillin was first discovered by:

- (a) Ernest Chain
- (b) Alexander Fleming
- (c) Howard Florey
- (d) Louis Pasteur

✓ **Answer: (b) Alexander Fleming** — Fleming observed in 1928 that *Penicillium* mould inhibited bacterial growth.

Q10. Which microorganism produces the antibiotic Streptomycin?

- (a) Penicillium notatum
- (b) Aspergillus niger
- (c) Streptomyces griseus
- (d) Bacillus subtilis

✓ **Answer: (c) Streptomyces griseus — Streptomyces griseus was the source of streptomycin, effective against TB.**

Q11. Cyclosporin A, used as an immunosuppressant, is produced by:

- (a) Monascus purpureus
- (b) Trichoderma polysporum
- (c) Penicillium notatum
- (d) Streptomyces venezuelae

✓ **Answer: (b) Trichoderma polysporum — Trichoderma polysporum produces cyclosporin A used in organ transplant patients.**

Q12. Statins that lower blood cholesterol are produced by:

- (a) Saccharomyces cerevisiae
- (b) Aspergillus niger
- (c) Monascus purpureus
- (d) Rhizopus nigricans

✓ **Answer: (c) Monascus purpureus — Monascus purpureus (a yeast/fungus) produces lovastatin, a statin.**

Q13. Streptokinase, used as a clot-buster, is produced by:

- (a) Streptomyces griseus
- (b) Streptococcus
- (c) Staphylococcus
- (d) Bacillus thuringiensis

✓ **Answer: (b) Streptococcus — Modified Streptococcus produces streptokinase used in heart attack treatment.**

Q14. Citric acid used in the food industry is produced by:

- (a) Lactobacillus acidophilus
- (b) Clostridium butylicum
- (c) Aspergillus niger
- (d) Acetobacter aceti

✓ **Answer: (c) Aspergillus niger — Aspergillus niger produces citric acid via fermentation.**

Q15. Lipases produced by microbes are used in which industry?

- (a) Paper industry
- (b) Detergent industry
- (c) Textile industry
- (d) Fertiliser industry

✓ **Answer: (b) Detergent industry — Lipases break down fat stains — added to biological detergent formulations.**

Q16. Butyric acid fermentation is carried out by:

- (a) Clostridium butylicum
- (b) Acetobacter aceti
- (c) Aspergillus niger
- (d) Lactobacillus

✓ **Answer: (a) Clostridium butylicum** — Clostridium butylicum produces butyric acid under anaerobic conditions.

Set 3 — Sewage Treatment & Biogas

Q17. BOD stands for:

- (a) Biochemical Oxygen Demand
- (b) Biological Oxygen Demand
- (c) Both (a) and (b) are used interchangeably
- (d) Bacterial Organic Decomposition

✓ **Answer: (c) Both (a) and (b) are used interchangeably** — BOD (Biological/Biochemical Oxygen Demand) — both forms are accepted.

Q18. Which of the following is NOT removed during primary sewage treatment?

- (a) Floating debris
- (b) Large suspended solids
- (c) Dissolved organic matter
- (d) Sand and grit

✓ **Answer: (c) Dissolved organic matter** — Primary treatment is physical; dissolved organic matter is removed in secondary treatment.

Q19. Flocs formed in secondary sewage treatment are composed of:

- (a) Only bacteria
- (b) Bacteria and fungi
- (c) Algae and protozoa
- (d) Viruses and bacteria

✓ **Answer: (b) Bacteria and fungi** — Flocs are mesh-like aggregates of bacteria and fungal filaments.

Q20. Activated sludge is:

- (a) Primary sludge from grit chambers
- (b) Bacteria-rich sludge returned to aeration tank as inoculum
- (c) Chemically treated sludge
- (d) Biogas-producing sludge

✓ **Answer: (b) Bacteria-rich sludge returned to aeration tank as inoculum** — A part of settled sludge (activated sludge) is pumped back to seed the aeration tank.

Q21. Biogas produced in anaerobic sludge digesters mainly contains:

- (a) CO₂ and H₂S
- (b) Methane and CO₂
- (c) H₂ and N₂
- (d) Ethane and propane

✓ **Answer: (b) Methane and CO₂ — Biogas is ~65% CH₄ and ~30% CO₂, with traces of H₂S and water vapour.**

Q22. Which archaeobacterium is responsible for methane production in biogas plants?

- (a) Lactobacillus
- (b) Methanobacterium
- (c) Rhizobium
- (d) Azotobacter

✓ **Answer: (b) Methanobacterium — Methanobacterium is a strict anaerobe that reduces CO₂ using H₂ to produce CH₄.**

Q23. Methanogens are also found in the gut of ruminants. This causes:

- (a) Nitrogen fixation in cattle
- (b) Release of methane (flatulence)
- (c) Improved cellulose digestion only
- (d) Vitamin B12 synthesis

✓ **Answer: (b) Release of methane (flatulence) — Methanobacterium in ruminant gut ferments organic matter → CH₄ release.**

Q24. The main purpose of the tertiary treatment of sewage is to:

- (a) Remove large solids
- (b) Reduce BOD
- (c) Kill remaining pathogens
- (d) Produce biogas

✓ **Answer: (c) Kill remaining pathogens — Tertiary treatment uses chlorination/UV radiation to disinfect the effluent.**

Set 4 — Biocontrol Agents & Biofertilisers

Q25. Bacillus thuringiensis is used as a biocontrol agent against:

- (a) Fungal pathogens
- (b) Nematodes
- (c) Lepidopteran insect larvae
- (d) Aphids

✓ **Answer: (c) Lepidopteran insect larvae — Bt produces Cry proteins toxic specifically to lepidopteran (moth/butterfly) larvae.**

Q26. The insecticidal protein produced by Bt is called:

- (a) Cyclosporin
- (b) Cry protein (delta-endotoxin)
- (c) Streptokinase
- (d) Insulin

✓ **Answer: (b) Cry protein (delta-endotoxin) — Cry proteins (crystal proteins / δ -endotoxins) are encoded by cry genes in Bt.**

Q27. Baculoviruses are preferred biocontrol agents because they are:

- (a) Broad-spectrum killers
- (b) Narrowly host-specific and safe for non-targets
- (c) Cheap chemical alternatives
- (d) Active against soil fungi only

✓ **Answer: (b) Narrowly host-specific and safe for non-targets — Baculovirus (e.g., Nucleopolyhedrovirus) infects only its target arthropod species.**

Q28. Which fungus is used as a biocontrol agent against soil-borne plant pathogens?

- (a) *Aspergillus niger*
- (b) *Penicillium notatum*
- (c) *Trichoderma*
- (d) *Rhizopus*

✓ **Answer: (c) *Trichoderma* — *Trichoderma* is a free-living fungus that parasitises plant-pathogenic fungi.**

Q29. *Rhizobium* fixes nitrogen in association with:

- (a) All crop plants
- (b) Leguminous plants only
- (c) Paddy
- (d) Wheat

✓ **Answer: (b) Leguminous plants only — *Rhizobium* lives symbiotically in root nodules of legumes (peas, beans, soybean, etc.).**

Q30. Which cyanobacterium is found in symbiosis with the water fern *Azolla*?

- (a) *Nostoc*
- (b) *Anabaena*
- (c) *Oscillatoria*
- (d) *Spirulina*

✓ **Answer: (b) *Anabaena* — *Anabaena azollae* lives inside leaf cavities of *Azolla*, fixing N₂ in paddy fields.**

Q31. Mycorrhiza enhances plant growth primarily by improving absorption of:

- (a) Nitrogen
- (b) Potassium
- (c) Phosphorus
- (d) Calcium

✓ **Answer: (c) Phosphorus** — Mycorrhizal hyphae have high affinity for phosphate ions, greatly boosting P uptake.

Q32. Which free-living aerobic bacterium fixes atmospheric nitrogen in soil?

- (a) Rhizobium
- (b) Clostridium
- (c) Azotobacter
- (d) Methanobacterium

✓ **Answer: (c) Azotobacter** — Azotobacter is a free-living aerobic N₂-fixer that also improves soil structure.

Q33. KVIC stands for:

- (a) Khadi and Village Industries Commission
- (b) Karnataka Veterinary and Irrigation Council
- (c) Kerala Vegetable and Industrial Corporation
- (d) Krishi Vigyan Innovation Centre

✓ **Answer: (a) Khadi and Village Industries Commission** — KVIC (Khadi and Village Industries Commission) promoted biogas plant development in India.

Q34. The enzyme responsible for biological nitrogen fixation is:

- (a) Amylase
- (b) Nitrogenase
- (c) Protease
- (d) Lipase

✓ **Answer: (b) Nitrogenase** — Nitrogenase catalyses: $N_2 + 8H^+ + 8e^- \rightarrow 2NH_3 + H_2$

Q35. Single-cell protein (SCP) for human consumption is produced by:

- (a) Aspergillus niger
- (b) Penicillium
- (c) Spirulina
- (d) Rhizobium

✓ **Answer: (c) Spirulina** — Spirulina (a cyanobacterium/microalga) is rich in protein, vitamins and minerals — used as SCP.

Q36. Which of the following is an example of a symbiotic nitrogen fixer?

- (a) Azotobacter
- (b) Azospirillum
- (c) Rhizobium
- (d) Nostoc

✓ **Answer: (c) Rhizobium** — Rhizobium lives inside root nodules of legumes — a true symbiotic N₂-fixer.

Q37. Blue-green algae (cyanobacteria) are particularly useful as biofertilisers in:

- (a) Wheat fields
- (b) Paddy (rice) fields
- (c) Cotton fields
- (d) Sugarcane fields

✓ **Answer: (b) Paddy (rice) fields — Waterlogged paddy fields are ideal for cyanobacterial N-fixation.**

Q38. Which of the following statements about mycorrhiza is INCORRECT?

- (a) They are symbiotic associations between fungi and roots
- (b) They enhance absorption of phosphorus
- (c) Glomus is a common example
- (d) They are free-living soil bacteria

✓ **Answer: (d) They are free-living soil bacteria — Mycorrhizae are fungi (not bacteria) forming symbiotic root associations.**

Q39. Cry genes from Bacillus thuringiensis have been incorporated into which crop?

- (a) Bt rice
- (b) Bt wheat
- (c) Bt cotton
- (d) Bt sugarcane

✓ **Answer: (c) Bt cotton — Bt cotton (and Bt brinjal) carry cry genes making them resistant to bollworms.**

Q40. Which of the following produces the antibiotic Chloramphenicol?

- (a) Streptomyces venezuelae
- (b) Penicillium notatum
- (c) Bacillus subtilis
- (d) Saccharomyces cerevisiae

✓ **Answer: (a) Streptomyces venezuelae — Streptomyces venezuelae is the source of chloramphenicol, a broad-spectrum antibiotic.**

Quick Answer Key — All 40 MCQs

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	
(b)		(b)			(b)	(d)	(b)	(b)		(b)		(b)		(b)		(a)	(c)	(c)	(b)	(b)
)	(c)	)	(c)	(c)	)	)	)	)	(c)	)	(c)	)	(c)	)	(a)	(c)	(c)))	
Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40	
(b)	(b)	(b)			(b)	(b)		(b)	(b)				(b)			(b)	(d)			
)	)	)	(c)	(c)	)	)	(c)	)	)	(c)	(c)	(a)	)	(c)	(c)	)	)	(c)	(a)