

Economic Importance of Bacteria

Beneficial effects:

① In Agriculture ① Biopesticides: →

- Bacillus thuringiensis - bears Bt-gene - produces toxic cry protein
- (By cry gene) - a crystal protein - acts as insecticide - kills larva of insects.

② Nitrogen fixation: →

- Bacteria have important role in biological fixation of N_2 gas of air into nitrogenous amino compounds such as nitrate, nitrite, Ammonia and amino acids.
- Increase fertility of soil. $\Rightarrow N_2 + 4H_2 \rightarrow 2NH_4^+$

(i) Free living terrestrial: →

- Aerobic - Azotobacter paspali, Bacillus polymyxa.
- Anaerobic - Clostridium.

(ii) Free living aquatic: →

- Blue green algae or cyanobacteria → dominant in water ~~logs~~ lodged Paddy fields.
- Nostoc, Anabaena, oscillatoria.
- Spirulina, Aulosira, Plectonema.
- Chlorella, Rhodospirillum, Cylindrospermum.

(iii) Symbiotic: →

⇒ Rhizobium leguminosarum with root roots of tropical leguminous plants (members of Fabaceae family) - cowpea (Cicer arietinum)

- Root nodules (Rhizobium) have nitrogenase enzyme (a Mo-Fe Protein).
- Nitrogenase is extremely sensitive to O_2 gas.
- Leghaemoglobin (LHb) - a biochemical pigment (Pink coloured), as similar to haemoglobin of vertebrates → also remain present in root nodules → acts as O_2 -scavenger → protects nitrogenase from oxidation by O_2 gas.

→ N_2 fixation jointly controlled by Nod-gene of host and nod, nif and fix genes of bacteria.



→ Reducing agents (FAD & Nitrogenase) acts for transfer of H_2 to dinitrogen.

⇒ Cyanobacteria (Nostoc, Anabaena, Aulosira) with root of Azolla, Cycas & Anthoceros.

⇒ Zoochlorella with body wall of Hydra.

⇒ Frankia (a N_2 fixing Actinomycetes) with root nodules of Casuarina & Alnus plant.

⇒ Azospirillum lipoferum (associative Symbiont - lives on outer surface of host body) with root surface of tropical grasses like Maize.

Bacteroid ⇒ Big undividing cell elongated as thread spread to vascular tissues of host to suck more food & exchange of nutrients. cytokinin of Rhizobium & Auxin of host acts for this

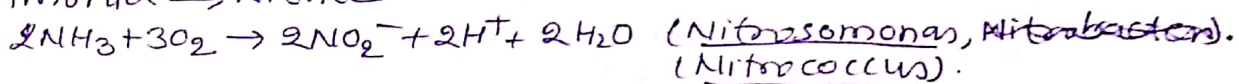
② Decay of Dead Materials → Decomposers →

- Bacteria → Also called as 'Nature's scavenger'.
 - Decay dead material - used for domestic sewage treatment.
 - Helps in cycling or recycling of materials or matter.
 - Pasteur said → Even death would be incomplete without Bacteria.
 - Decomposers perform extra-cellular digestion by secreting digestive enzymes and then absorb micromolecules.

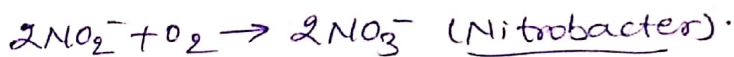
⇒ Organic matter ⇒ Nitrate, Phosphate, Sulphate

⇒ Protein → Ammonia (Ammonification) → Actinomyces

⇒ Ammonia → Nitrite



⇒ Nitrite → Nitrate (n)



⇒ Biomolecules → Methane (Methanococcus, Methanobacterium)
(gas). → Anaerobic sewage bacteria.
- foul, bad smell.

① Sewage decomposition → Chlorella provides much O_2 for rapid sewage decomposition by Bacteria.

③ Producers of Aquatic Ecosystem

→ Oscillatoria, Spirulina are phytoplanktons of aquatic ecosystem.

④

② In Industry:-

① Preparation of double bread → Bakery

→ Bacillus sps gave softness and cheesy appearance, CO₂ released by fermentation creat doughiness.

in Dairy

② Making curd:-

→ Streptococcus lactis, Lactobacillus - conversion of lactose sugar into lactic acid and degradation of protein.

③ Making Butter:-

→ Lactobacillus also converts cream into Butter.

④ Making cheese:-

→ Lactobacillus & Streptococcus → produces lactic acid which separates & condenses Caesin protein of milk.

⑤ Ripening of cheese (Hard cheese):-

→ Lactobacillus & Streptococcus in long duration forms complex protein and unique aroma and taste by combination of acetic acid & lactic acid into cheese.

in Tobacco

⑥ Curing of tobacco leaves:-

→ Mycrococcus, Bacillus megatherium ferment tobacco leaves to produce specific colour, texture and taste.

on Tea

⑦ Curing of Tea leaves and coffee powder:-

→ Clostridium sps., Micrococcus candidans ferment carbohydrate into ~~vit~~ vit-B₁₂, alcohol and acetone to provide specific colour, smell and taste to tea leaves & coffee powder.

Natural
in Fibre

⑧ Retting of fibres of Jute, Hemp, Flax:-

→ Clostridium butyricum, Clostridium pectinovorum - secretes organic acids to hydrolyse pectin & dissolve all living components of the cells of fibrous plants. to isolate fibres.

in wine

① Alcohol production

→ Clostridium zymomonas converts sugar into ethyl alcohol and Butyl alcohol (a commercial solvent).

② Production of monosodium glutamate - a flavouring agent.

③ Acid production

in
organic
acid.

① Inorganic acids

→ Chromatium, Chlorobium converts H₂S into sulphuric acid.
$$\text{CO}_2 + \text{H}_2\text{O} + \text{H}_2\text{S} \longrightarrow \text{H}_2\text{SO}_4 + \text{C}_6\text{H}_{12}\text{O}_6$$

② Organic acids

→ Acetobacter aceti, Bacillus aceti, Bacterium acetum & Mycoderma aceti converts Hexose or lactose sugar into ethyl alcohol and finally into organic acids.

→ Lactic acid - used for ~~beverage~~ ~~flavouring~~ ~~Tanning~~ Tanning.

→ Citric acid - used for beverage flavouring.

→ Acetic acid → used as vinegar.

④ Acetone production

→ Clostridium acetobutylicum converts acetic acid into acetone (used as ingredients of explosives).

③ In Scientific researches:-

① In physiological research

→ Calvin used *Chlorella* for experiments of photosynthesis.

② In space research

→ *Chlorella* - used as food and air purifier in space craft.

③ In Genetic research → In genetic engineering bacterial cell is used as factory cells.

→ *Escherichia coli*, *Diplococcus pneumoniae*, *Agrobacterium tumefaciens* (a good vector in genetic engineering)

→ Transformation, Transduction, Ultra structure of DNA & RNA, DNA - a genetic material are observed firstly in bacterial cell.

④ As medicine

① Vitamins:-

→ *Clostridium butylicum*, *Pseudomonas denitrificans*, *E. coli* converts sugar into Riboflavin (vit B, B₁₂) - also used in sweets & food stuff.

② Protein:-

→ *Chlorella* used as food capsule because it has 50% protein.

→ *Spirulina* also contains 25% protein.

③ Organic compounds (Hormones):-

→ Single ~~cell~~ human ^{cell} protein produced outside human body is Human Insulin (a recombinant protein) - produced by Transgenic *Escherichia coli*.

④ Digestive helper:- production of Enzymes: → *Bacillus subtilis* → protease
→ *E. coli* lives in intestine of human and cattle body → helps in digestion by producing cellulose digesting enzymes and also gives vit. B₁₂ & K.
→ *Streptococcus pyogenes* → streptokinase

→ *Enterobacter cloacae* → also found in human intestine & helps during digestion.

→ *Lactobacillus* also secretes cellulose digesting enzymes and cures bacterial are also used for transformation of chemical structure of drugs. Dysentery.

⑤ Vaccine

→ Vaccine is made from antigenic proteins of pathogen or chemically or thermally weakened or inactivated pathogen serum.
→ Antigen protein may be prepared from pathogen or in a transgenic organism.
→ Provides immunity for bacterial and viral diseases.

→ Firstly developed by Louis Pasteur (1920).

→ Hepatitis-B-vaccine is produced by Transgenic Yeast by Biotechnology.

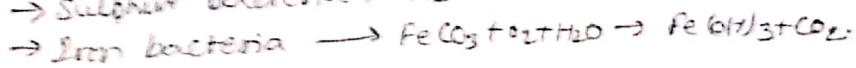
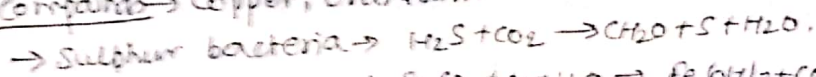
→ Leprosy vaccine is prepared with the help of Armadillo (an scaly ant eater).

→ BCG - for Tuberculosis (safety rate = 70%).
(Between 10-14 yrs.)
→ DPT - Diphtheria, Pertussis (whooping cough), Tetanus & Haemophilus influenza Type-B.
- Safety (90-99%). → Between 2, 3, 4 months.
→ TAB (Triple antigen vaccine).
→ Polio (safety-100%) → Between 2, 3, 4, " .
- used along with DPT-Hib.

④ Antibiotics

- produced by a bacteria and kills another type of Bacteria.
- Breaks cross-linking of peptidoglycan strands (dissolve polypeptide of cell wall, not cellulose) and also inhibits cell-wall formation.
- used as medicine for cure of most of the human infectious diseases.
- First Antibiotic, penicillin was firstly isolated by Alexander Flemming (1928) from a fungus *Penicillium*.
- Now, most of the antibiotics are isolated from Bacteria.
 - ✓ Streptomycin → *Streptomyces griseus*.
 - ✓ Terramycin → *Streptomyces rimosus*.
 - ✓ Aureomycin → *Streptomyces aureofaciens*.
 - ✓ Neomycin → *Streptomyces fradiae*.
 - ✓ Thyrothricin → *Bacillus brevis*.
 - Streptothricin → *Streptomyces venezuelae*.
 - Subtilin → *Bacillus subtilis*.
 - ✓ Erythromycin → *Streptomyces erycis*.
 - Chlorocyclin → *Chlorella* sps.

⑤ Extraction of metals from their ores: Chemical conversion of compounds → Copper, Uranium.



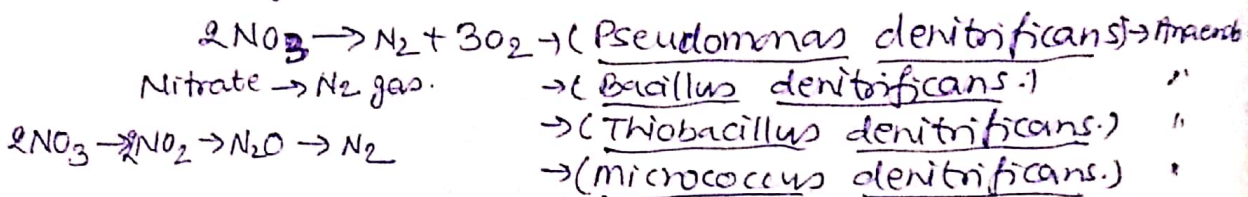
⑥ Production of biological detergents: →

- Bacterial enzymes are used as biological detergents for cleaning cloths.

Harmful effects

① Reduce soil fertility (Denitrification)

→ Denitrifying bacteria breaks Nitrate into N₂ gas and releases from soil to air.



② Spoilage of Food

→ Spoilage of cooked food & vegetable, fruit, butter → Clostridium botulinum

→ Souring of milk } → Lactobacillus (Lactose to Lactic Acid)
→ Souring of curd. }
→ Rotting of meat & fish → Achromobacter, Pseudomonas

→ Damage of ^{of Paddy} grains during storage → Helminthosporium oryzae

③ Contaminate water: - cyanobacteria produce colour, odour & fishy taste to water.

④ Destroy cotton cloth → Spirochaete cytophaga

⑤ Poisonous → Microcystis, Anabaena → produces neurotoxins.

⑥ Cause diseases to living

→ Parasitic bacteria are pathogenic or disease causing.

→ Cause infectious, contagious or communicable diseases → spread by contact.

→ Lysozyme - natural enzyme present in human tears & saliva → kills bacteria by hydrolysis of peptidoglycan.
 - recovery of leaves ill developed plant body.

⑦ Plant diseases → Bacteria cause Necrosis, stunting, wilting and excessive growth of tissues.

→ Red stripe or soft rot of sugarcane - Pseudomonas rubrilineans (detritation)

→ Citrus canker → Xanthomonas citri → on Lemon

→ Wild fire of tobacco - Pseudomonas tabaci → on Tobacco

→ With disease of potato - Pseudomonas solanacearum

→ Black rot of cabbage - Xanthomonas campestris

→ Fire blight of apple or pear - Erwinia amylovora

→ Leaf blight of rice → Xanthomonas oryzae

→ Tomato → Corynebacterium michiganense

→ Soft rot of potato → Erwinia carotovora

→ Scab disease of potato → Streptomyces scabies (Potato scab or ring disease)

→ Tundu disease of wheat → Corynebacterium tistici

→ Little leaf of Brinjal → Mycoplasma

→ Aster Yellow → "

→ Corn stunt → "

→ Sandal spike → "
→ Gall disease → Agrobacterium rubi

→ About 100 bacterial species are known to be causal organisms for plant diseases.

→ Bacterial blight of chickpeas

⑥ Human diseases

- Typhoid — Salmonella typhi, Eberthella typhosa
- Tetanus — Tetani bacilli, Clostridium tetani
- Diphtheria — Corynebacterium diphtheriae — *affects & kills neck tissues (membranes)*
- Tuberculosis — Mycobacterium tuberculosis
- Leprosy — Mycobacterium leprae
- Pneumonia — Mycoplasma pneumoniae, Diplococcus pneumoniae, Streptococcus pneumoniae (PNEU)
- Jaundice — Spiracheta
- Plague — Proteusella pestis, Yersinia pestis
- Meningitis — Haemophilus influenzae, Neisseria meningitidis
- Cholera — Vibrio cholerae
- Dysentery — Shigella dysenteriae
- Diarrhoea — Staphylococcus aureus, Brucella sp., Salmonella
- Syphilis (STD) — Treponema pallidum — *sexually transmitted disease*
- Gonorrhoea (STD) — Neisseria gonorrhoeae — *sexually transmitted disease, clinically observed by culture & Gram staining*
- Infertility of Man — T. mycoplasma (parasitises sperm)
- Food poisoning — Micrococcus aureus, Clostridium perfringens, Salmonella typhimurium, Clostridium botulinum (Botulism), Staphylococcus sp.
- Keratoconjunctivitis (Red Eye) — Haemophilus aegyptius
- Chlamydia (STD) — Chlamydia trachomatis — *affects reproductive function*
- Trichomoniasis (STD) — Trichomonas vaginalis — *affects females*
- Chancroid (STD) — Haemophilus ducreyi
- Hay fever — Bacillus subtilis
- Dental infection — Streptococcus sanguis
- Anthrax — Anthrax bacilli infestans
- Influenza — Haemophilus influenzae

Clinically observed by
- Antibody detection
- W.K.L. (General disease research laboratory)

Clinically observed by
- Gram stain
- Antigen detection
- DNA hybridisation

Clinically observed by culture & microscopic examination

Clinically observed by culture & microscopic examination

STD
→ Sexually transmitted disease.

⑦ Animal diseases

- Actinomycosis → in animals → Actinomyces bovis
- Pneumonia or Mastitis → of domestic cattle → PPLO
- Cholera → Chicken, Goat, Pig → Vibrio damsela
- Diarrhoea → Chick → Brucella avae
- Tuberculosis → cattle, birds → cured by ciprofloxacin — Tuberculosis animal
- Anthrax → Horse, goat, Sheep, Buffalo → Anthrax bacillus, also to human being. → Bacillus anthracis (cell wall of polypeptide)
- Bacteria consume O₂ of blood → animals die due to scarcity of O₂
- Bleeding foam from all natural openings → death occurs in 2-3 days.