

Bacteria



Bacteria

- 1st living cell - bacteria was discovered.
- Habitat - ubiquitous habitat except distilled water
- Kingdom - Monera
- it is unicellular, prokaryotic organism.
- Bacteria was 1st of all discovered by **Leeuwenhoek** (father of microscopy).
- bacteria termed by **Ehrenberg**.
- Father of bacteriology - **Robert Koch** (he made culture of *Mycobacterium tuberculosis*)
- most studied bacteria is **Escherichia coli** (E. coli)
- Ⓟ **E coli** :- **entamoeba coli** (protozoan) → symbiotic.
(without abbreviation) - commensal

Louis Pasteur

- termed Virus, father of microbiology
- He developed 3 cytological technique:-
 - a) Fermentation :- glucose $\xrightarrow{\text{zymase}}$ alcohol.
 - b) Sterilization :- germ free process.
 - c) Pasteurization :- germ free + with bacteria.
of milk $\rightarrow$ $\left[\begin{array}{l} 62.8^\circ\text{C} (30 \text{ min}) \\ 72^\circ\text{C} (15 \text{ s}) \end{array} \right.$

- theory of biogenesis
- discovered rabies vaccine.

Father of antiseptic surgery - **Joseph Lister**.

Size of bacteria:-

average size : 2 - 10 μm

@ Bengla Dish

Beggiatoa maribitidis → Oraliter pneumonites (present in nose).
(largest bacteria.) Smallest bacteria.

→ longest bacteria :- Bacillus butschilli present in cockroach.

Types of bacteria

on the basis of shape, 5 types.

on the basis of flagellation, 6 types.

Shape of Bacteria:-

1) Coccus

→ Smallest, spherical, non motile.

Eg: Streptococcus.

2) Bacillus @ BRJ → late late parix (most common).
bacillus rod shape Eg: Lactobacillus.

3) Vibrio :- C shape, common. Eg: Vibrio cholerae

4) Spirillum :- Spiral, longest. Eg: Treponema pallidum

5) Pleomorphic :- no fixed form. Eg: Azotobacter.

Note:-

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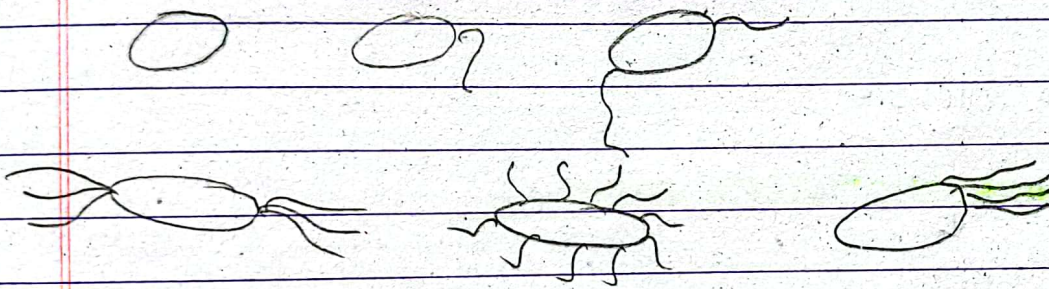
Vibrio cholera has darting type of motility.

Types of bacteria on the basis of flagellation:-

1) Atrichous :- flagella is absent

Eg: Lactobacillus

- 2) Monotrichous :- one flagella present in one end of bacteria.
Eg) Vibrio cholerae
- 3) Amphitrichous :- one flagella present at both end of bacteria.
Eg) Nitrosomonas
- 4) Lophotrichous :- group of flagella present at both end.
Eg) Pseudomonas, azotobacter @ PALO
- 5) Perritrichous :- flagella distributed all over the body.
Eg) E. coli, salmonella typhi, clostridium
- 6) Cephalotrichous :- group of flagella present at one end.
Eg) Treponema pallidum → causes syphilis.



Coccus:-

- coccus :- single coccus
- Diplococci :- 2 coccus
- Staphylococci :- bunch / cluster
- Streptococci :- chain
- pleomorphic :-

Cell Structure of Bacteria

- 1) wall layers
capsule / slime layer, cell wall, cell membrane, flagella, fimbriae / pili.
- 2) Interior - cytoplasm, nucleoid / genophore, episomes

1) Capsule / Slime layers

→ Outermost layer of bacterial cell

Chemical - Polysaccharide + amino acids.

Function - osmotic barrier

- storage - acts as reserve food material.

On the basis of capsule / Slime layer, 2 types of bacteria:-

a) S- strain / smooth strain - capsule present

→ virulent and pathogenic

b) R- strain / rough strain - capsule absent

→ non-virulent and non-pathogenic.

2) Cell wall - non cellulosic

Chemical:- Polysaccharide + lipoprotein

↓
Peptidoglycan / Murein / Muramic acid / Mucopolysaccharide

↓ monomer

mainly NAM + NAG

N-acetyl muramic
acid

(mainly in chitin)

N-acetyl glucosamine

On the basis of cell wall, bacteria 2 types:-

a) gram +ve bacteria :- thick and simple

b) gram -ve bacteria :- thin and complex.

Gram staining Technique

→ Christian gram took bacterial cell → added crystal violet then
all appear blue / purple / violet color then added

I_2/KI (acts as mordant/fixing) $\rightarrow$ stain fixed

decolorizing
alcohol/water
 $\swarrow$
wash

Bacteria
purple/violet/blue
(Retain)

Bacteria
colorless/red color
 $\downarrow$
gram -ve bacteria.

$\downarrow$
gram +ve bacteria.

#) Chemical used in gram staining technique :- **crystal violet + I_2/KI**

characters

	Gram +ve	Gram -ve
Color	purple, violet, blue	colorless, red color
chemical cell wall	peptidoglycan $> 80\%$ lipid $< 20\%$ simple and thick	peptidoglycan $< 20\%$ lipid $> 80\%$ thin and complex
Teichoic acid	present (it prevents from thermal injury)	absent
flagella & fimbriae	absent	present
pathogenicity	less pathogenic	more pathogenic
sensitive to antibiotics	sensitive to penicillin	resistant to penicillin sensitive to erythromycin

3) cell/plasma membrane

Chemical :- lipids + proteins
 $\rightarrow$ phospholipids.

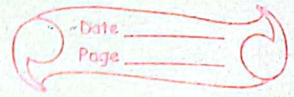
Types
membrane lipid $\rightarrow$ Phospholipids
Sterols

$\rightarrow$ lack sterols

(BP)

$\rightarrow$ provides fluidity/permeability to cell membrane.

Stress bind structure of cell membrane with protein so called membrane reinforces.



→ The infolding structure present in cell membrane is Mesosome.

Function:-

- respiration.

- DNA replication and cell division.

→ In photosynthetic bacteria, cell membrane modified into

Thylakoids. Thylakoids contains 2 pigments.

- bacteriochlorophyll.

- bacterioviolins

4) Flagella

→ chemical composition :- flagellin protein.

Note: In eukaryotic cell :- tubulin protein/ microtubule.

→ extension of cell membrane.

→ arises from blepharoplast of cytoplasm.

→ (9+2) arrangement is present

→ its function is locomotion.

5) Fimbriae/ Pili

→ chemical composition :- pili protein

→ commonly found in gram -ve bacteria.

Functions.

Pili $\left\{ \begin{array}{l} \text{Type I} - \text{attachment of host cell.} \\ \text{Type II} - \text{transfer of genetic material} \end{array} \right.$
→ also known as sex-pili.

Matrix of Bacteria.

- cytoplasm of Bacteria
- genetic material
 - extragenetic material
 - reserve food material
 - 70S ribosome

→ is present in chain called Polyosome.

→ reserve food material is volutin granules, oils and glycogen.

★ Genetic materials:-

→ single, circular, dsDNA, without histone protein. so, DNA is naked.

→ true nucleus is absent

→ genetic material of bacteria also called as incipient nucleus, genophore, nucleoid, prochromosome, genome.

Note → bacterial genome is haploid.

★ Extragenetic materials

→ bacteria contain extragenetic material capable of self replication called plasmid.

→ plasmid is small, circular, dsDNA, without histone protein.

→ Termed by Lederberg.

→ plasmid mainly used in genetic engineering.

Note: plasmid + bacterial circular DNA = episome (integrated)

→ all episome are plasmid but all plasmid are not episome.

→ sex is determined by Fertility factor (plasmid)

sex is distinguished by sex-pilli.

Note:

Agrobacterium tumefaciens - plant genetic engineer.
Escherichia coli - animal genetic engineer.

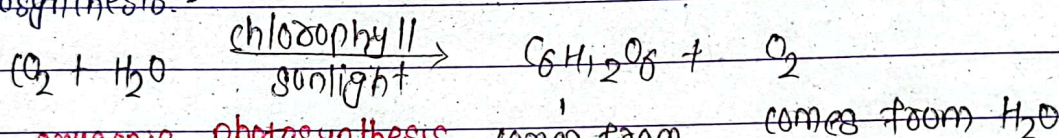
Nutrition in Bacteria

1) Autotrophic nutrition.

a) Photoautotroph

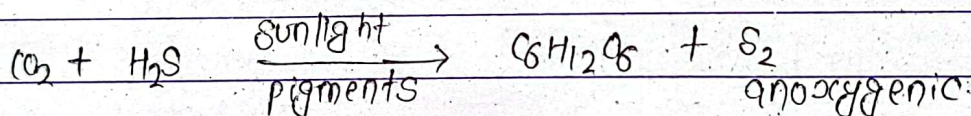
- pigments: bacteriochlorophyll and bacterioiodins.
- sunlight is necessary for photosynthesis.
- absorbs far red + infrared light for photosynthesis.

Photosynthesis:-



→ oxygenic photosynthesis
→ present in plant

But the general eqn. of photosynthesis in bacteria is



Photosystem :- Bacteria :- PS-I

BGA :- PS-I and PS-II

Eg green sulphur bacteria, purple sulphur bacteria.

b) Chemoautotroph

- gets nutrition/energy by oxidation of inorganic compound
↓
 CO_2 and H_2S
- sunlight may or may not be required.
- makes food by chemosynthesis.

Eg nitrifying bacteria, methane bacteria, sulphur bacteria, etc.
nitrifying

2) Heterotrophic nutrition

a) Saprophytic

→ obtain food from dead and decaying organism.

b) Parasitic

→ obtain food directly from host body

c) Symbiotic

→ obtain food from symbiotic relationship.

Eg, E. coli and Rhizobium.

↓
present in colon of
intestine

→ found in root nodules of leguminous
plant and help in fixation of
nitrogen.

Note:

Bacterial cell :- sex pilli present and has F-plasmid - ^{Donor} male
sex pilli with no F plasmid - ^{recipient} Female.
fertility factor

Respiration in Bacteria

→ usually bacteria are anaerobic organism but aerobic respiration is also present.

→ For aerobic respiration, mesosome is present

→ on the basis of respiration, bacteria is of 4 types:-

1) Obligate aerobes

→ survive in presence of oxygen but die in absence of oxygen.

Eg, Azotobacter

→ In bacteria, sexual reproduction is absent because there is no meiosis.

Note Sterols, Mitosis, Meiosis absent in bacteria but *Bacillus megatherium* or mitosis like. (neel)
→ genetic recombination by 3 methods:-

a) Bacterial conjugation

→ DNA transfer between two bacterial cells through sex-pilli. → sex. pilli forms conjugation tube.
→ discovered by Lederberg and Tatum. in *E. coli*.
gm -ve

b) Transformation → transfer of DNA without contact between two bacterial cell. (1928)

→ discovered by Griffith in *Diplococcus pneumoniae*.
→ later it was verified by Avery, McCarty, Macleod.
gm +ve

c) Transduction :- transfer of DNA from one bacteria to other with the help of virus.

→ discovered by Zinder and Lederberg in *Salmonella typhi*.
gm -ve

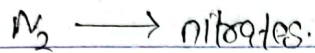
Economic importance of Bacteria.

1) Antibiotic Synthesis

Antibiotics	obt. from	Bacteria
Streptomycin	→	<i>Streptomyces griseus</i>
Erythromycin		<i>S. erythraeus</i>
Chloramphenicol		<i>S. venezuelae</i>
Neomycin		<i>S. fradiae</i> - or ho myc (neo)
Tetracycline		<i>S. aureofaciens</i>
Penicillin		<i>penicillium notatum</i> (fungi)

2) Nitrogen cycle :- its steps are:-

a) nitrogen fixation :- conversion of atmospheric nitrogen into ammonium compound (readily absorbed).



Eg) Free N_2 fixation

loose association of N_2 fixation.

Azotobacter

Azospirillum

clostridium

Symbiotic N_2 fixation

Rhizobium

b) Nitrification :- conversion of ammonia to nitrate.

Eg) Nitrosomonas, Nitrosococcus, Nitrobacter, Nitrocystis.

ammonia $\xrightarrow[\text{Nitrosococcus}]{\text{Nitrosomonas}}$ nitrites

nitrite $\xrightarrow[\text{Nitrocystis}]{\text{Nitrobacter}}$ nitrate

c) Ammonification :- conversion of protein into ammonia.

Eg. Bacillus Vulgaris

d) Denitrification :- conversion of nitrate into free atmospheric nitrogen.

Eg) Pseudomonas and Thiobacillus.

Diseases

Typhoid

Tuberculosis

Pneumonia

Whooping cough

Tetanus

Diphtheria

Gonorrhoea

Meningitis

Syphilis

ame Leprosy (Hansen's disease)

Cholera

Plague (black death)

Bacillary dysentery

Gastroenteritis

Bacteria

Salmonella typhi

Mycobacterium tuberculosis

Diplococcus pneumoniae

Bordetella pertussis

Clostridium tetani

Corynebacterium diphtheriae

Neisseria gonorrhoeae

Neisseria meningitidis

Treponema pallidum

Mycobacterium leprae

Vibrio cholerae

Pasturella pestis

Shigella

E. coli

Special points

- Lactobacillus and Streptococcus lactis, helps in conversion of milk into yoghurt, cheese and lactic acid.
- E. coli :- Escherichia coli → symbiotic.
Bacteria :- obtained food and shelter inside host body (colon)
Host body :- obtains vit B₁₂ and vitamin K from bacteria.
- curing of tea, setting of fibres.
- **Bacillus thuringiensis** used for controlling pests.
- Methanogens helps in production of biogas (gobar gas).

- Commercially, *Acetobacter aceti* ^{produces} acetic acid (vinegar).
- Clostridium acetobutylicum* → acetone, methanol, butanol.
- *Bacillus anthracis* causes Anthrax and used as bio weapons in Iraq by Saddam Hussein.
- All N_2 fixing bacteria contains *Nif* genes which contains nitrogenase enzyme → increases soil fertility.

Mycoplasma

- also called as PPLO (pleuro pneumonia like organism)
- it is the smallest living cell without cell wall.
- Note: smallest living cell with cell wall - bacteria
- smallest living particle - virion > virus
- Mycoplasma lacks cell wall and definite shape so called as joker of plant kingdom. no fix shape, change
- linear DNA without histone protein. 8721306

Diseases caused by Mycoplasma → outer covering is slime layer

- name → little leaf of brinjal.
- bunchy top of papaya My. Papa
- mulberry and clover dwarf disease.
- witch broom disease of potato.

BGA is connecting link between bacteria and algae.

Rickettsia → bacteria and viruses

Actinomyces → bacteria and fungi

Mycoplasmatales → protozoa and fungi