# Bacteria

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## What are Bacteria :-

Bacteria are minute, unicellular, microscopic, simple, undifferentiated prokaryotic organisms which are usually identified by their specific activities and not by their general appearance.

⇒ General Characters of Bacteria :-

1. Bacteria are Omnipresent i.e., found in all possible habitats wherever life can exist.
2. They are basically unicellular and morphologically least complex.
3. Each bacterial cell has a rigid cell wall composed of peptidoglycan.
4. cell organelles such as endoplasmic reticulum, Golgi complex, lysosomes, mitochondria and plastids are absent.
5. True nucleus is absent. The nuclear substance consisting of naked circular DNA, called nucleoid.
6. Streaming movement lack in cytoplasm.
7. Some bacteria move by means of flagella. Flagella is made up of one kind of protein called flagellin.

8. Bacteria reproduce asexually by binary fission.
9. Genetic recombination may occur by Conjugation, transformation and transduction. True sexual reproduction is absent.
10. Bacterial mode of nutrition varies from heterotrophic (saprotrophic, parasitic) to autotrophic.

## => Morphology of bacteria :-

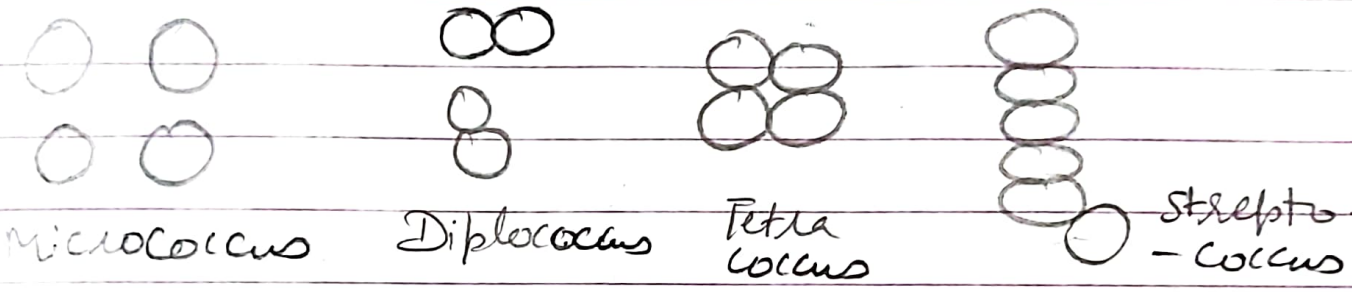
### Size of bacteria :-

- The average size of a bacterial cell ranges from 1 µm to 10 µm in length and from 0.7 µm to 1.5 µm in width.
- The size of smallest bacterium is not more than 0.1 µm while the largest reaches upto 500 µm in length.

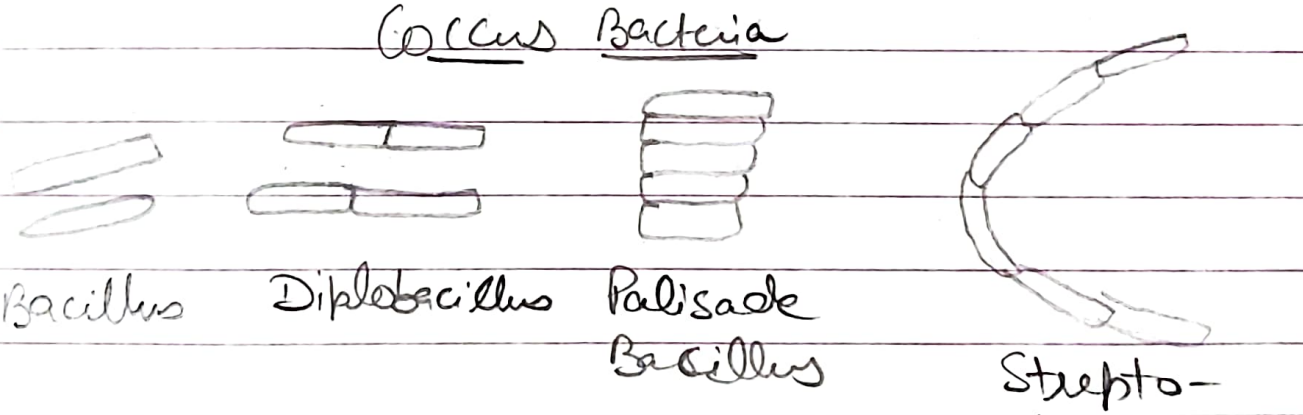
Shape of bacteria :- The bacteria possess the following forms :-

1. Coccus :- These are spherical, ellipsoidal or ovoid in shape.
2. Bacillus :- These are rod shaped or cylindrical.
3. Spirillum :- These are spiral or coiled like a cork screw. These bear two or more flagella.

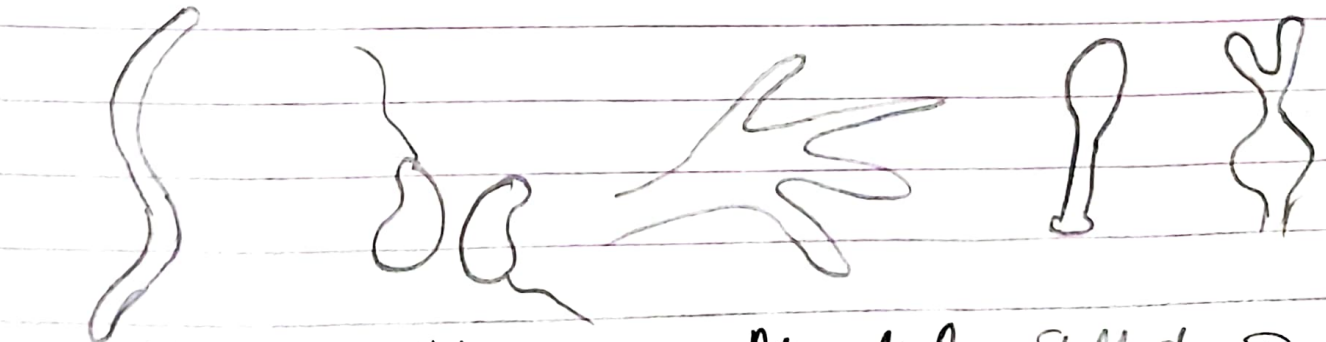
4. Vibrio :- These are C-shaped or comma shaped, having one or more flagella.
5. Filament :- The body of bacterium is filamentous like a fungal mycelia.
6. Stalked :- The body of bacterium possesses a stalk.
7. Budded :- The body of bacterium is swollen at places




Coccus Bacteria




Bacillus Bacteria




Different forms of Bacteria.

→ Bacterial Cell Structure :-

A typical bacterial cell shows the following structural features:-

1. The slime and the capsule :-

Slime is the gelatinous substance secreted by the protoplast and deposited over the cell wall in the form of a loose gelatinous sheath called slime layer. It is composed of polysaccharides.

In some bacteria with the presence of amino acids this layer becomes more thick and called the capsule.

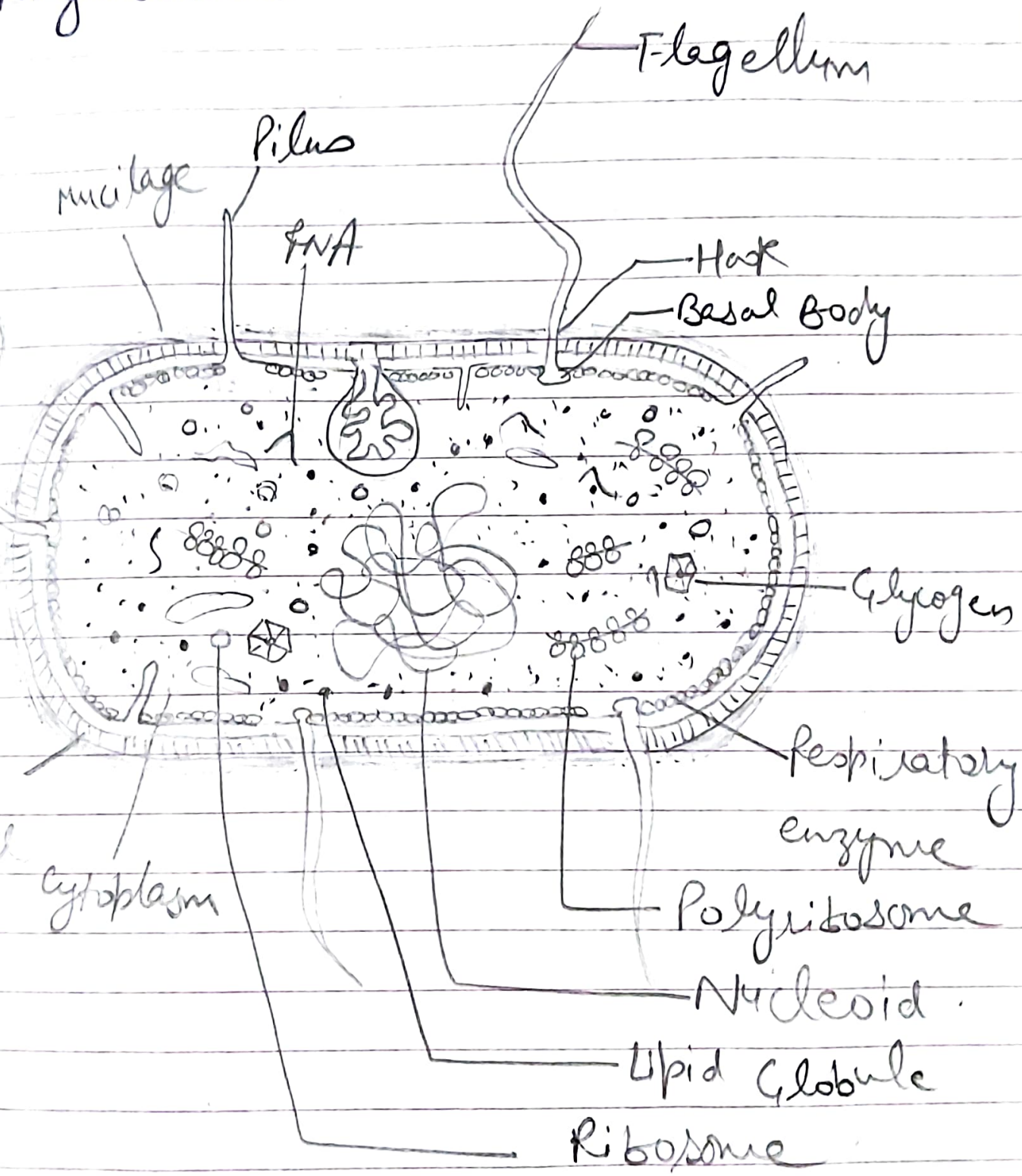
2. The cell wall :-

It is outer rigid wall or covering of the cell, which provides shape and protection to the protoplast and keeps the cell from bursting due to osmotic changes. It consists of acetyl glycosamine, acetyl muramic acid + chain of amino acids.

3. Plasma Membrane :-

It is a thin, elastic and differentially or selectively permeable membrane that allows passage of dissolved substances in and out of the cell. It is composed

of large amounts of phospholipids, proteins & polysaccharides.




Detailed structure of a typical bacterial cell.

## Structures Associated with Plasma Membrane:-

(i) Mesosome:- These are finger-like, spherical or villiform structures which may help compartmentalize the cell. It helps to form septa during cell devision.

(ii) Flagella:-

These are long thread-like structures concerned with the motility of some bacterial cells. Each flagellum measures about 4-5 μm in length and 12-15 μm in diameter.

4. Cytoplasm and cytoplasmic inclusions:-

The cytoplasm is a complex aqueous fluid or semifluid ground substance (matrix) consisting of carbohydrates, soluble proteins, enzymes, co-enzymes, vitamins, lipids, mineral salts and nucleic acids. The cytoplasm is granular due to presence of a large number of ribosomes, which occur singly or in small groups called polyribosomes. Membranous organelles are absent.

5. Nucleoid :- The true nucleus, with nuclear membrane, is absent in bacterial cell. The nuclear material, consisting of naked DNA molecule, is identified as Nucleoid. It is circular, ring like, double stranded DNA molecule with no free ends.

6. Plasmids :-

In addition to bacterial chromosomes many bacteria have accessory rings of DNA, called plasmids. The plasmid DNA replicates independently and may carry some important genes like - fertility factor (F- factor), resistant factor (R-factor) nitrogen fixing genes (Nif genes) etc.

⇒ Bacterial Reproduction:-

A) Asexual Reproduction:- Bacteria reproduce asexually by means of Binary fission.

Binary fission:- The cytoplasm and nucleoid divide equally into two, without mitosis. During the division of nucleoid, the DNA replicates while attached to mesosome. A new mesosome develops which gets attached to the daughter chromosome.

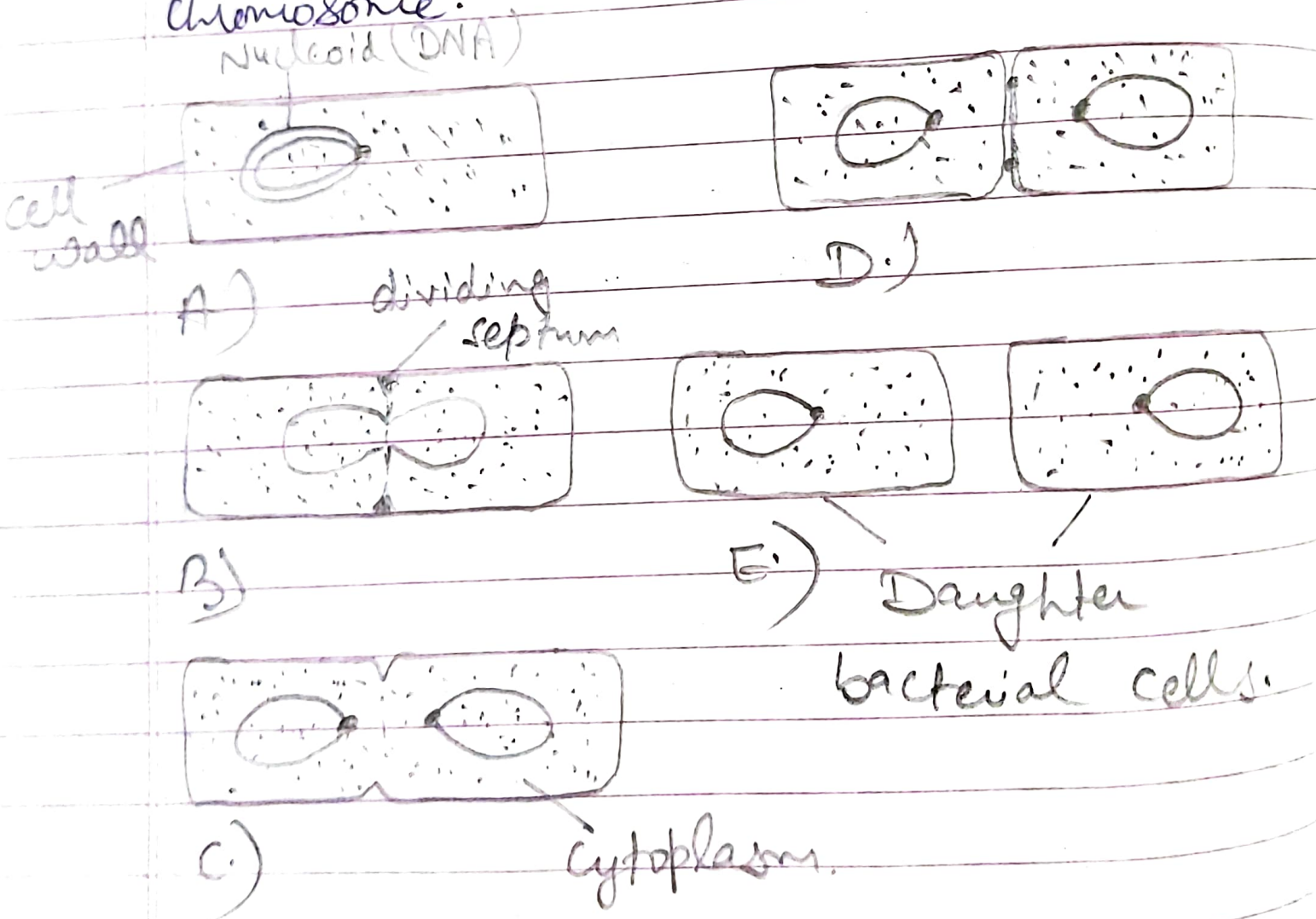



Fig:- A-E Stages showing binary fission in the bacterial cell.

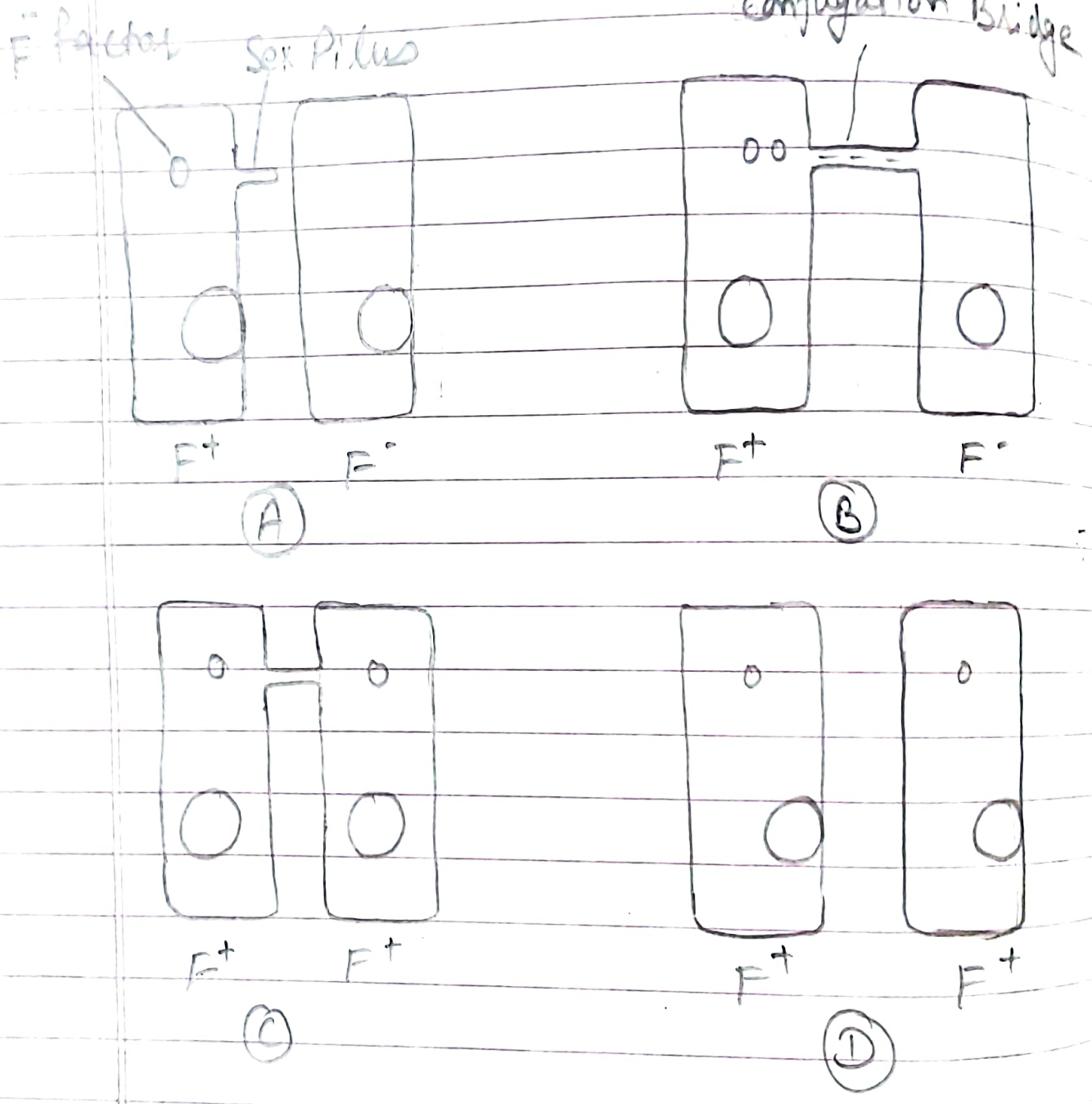
B) Sexual Reproduction :- In case of bacteria, the sex organs are not formed, meiosis and mitosis does not occur. Instead, a portion of genetic material (DNA) is transferred from a 'donor' cell (male) to a 'recipient' cell (female) making it an incompletely diploid zygote. The process is actually called 'genetic recombination' which occurs in three ways – (i) Conjugation
(ii) transformation
(iii) Transduction.

(i) Conjugation :- During the conjugation between $F^+$ (male) and $F^-$ (female) strains, the two bacterial cells come close to each other in pair.

- The $F^+$ cell sends sex pilus which gets attached to $F^-$ cell forming a conjugation bridge blw them.
- The F-factor then divides into two, out of which one remains in the donor cell and the other migrates into recipient cell through the conjugation bridge.
- As a result, the $F^-$ cell now becomes

$F^+$ cell.

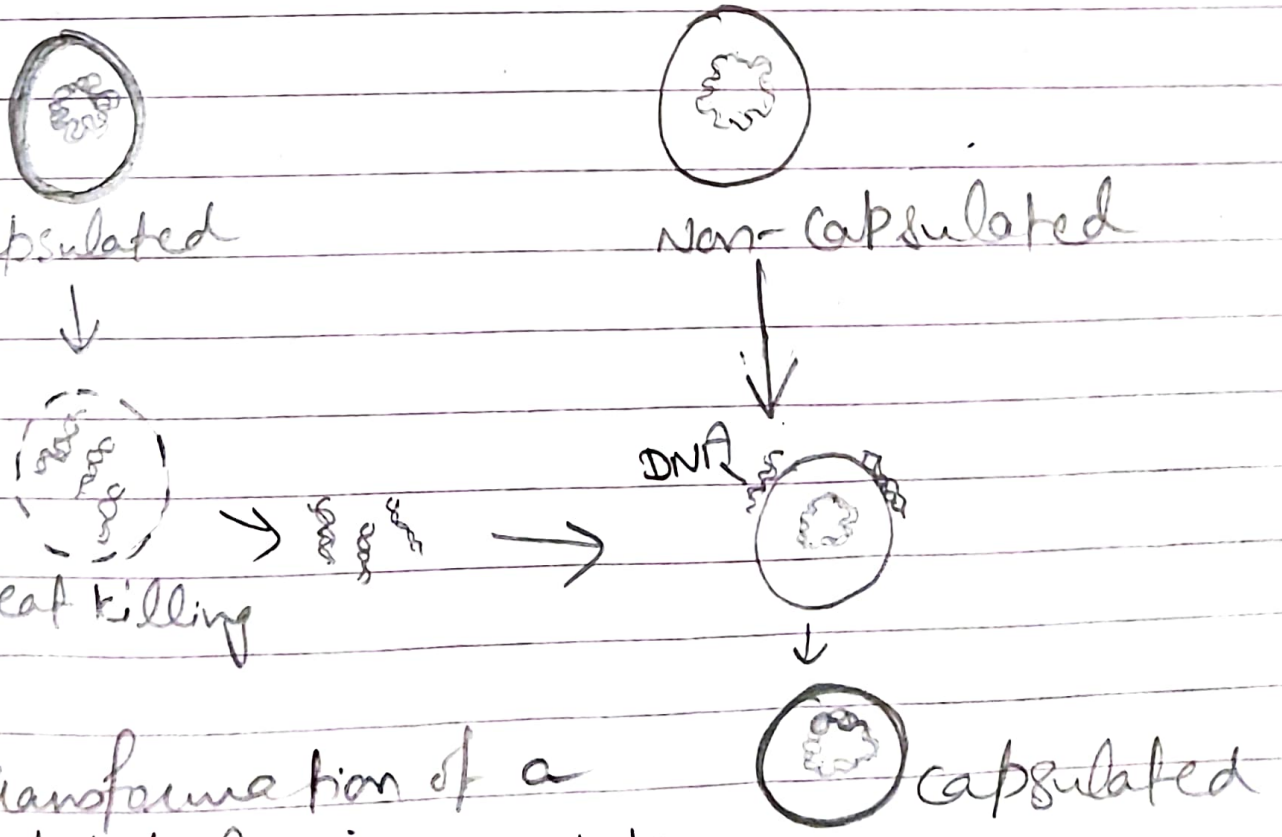
- Thus a conjugation between $F^+$ and $F^-$ strains always yields $F^+$ progeny.
  $(F^+ + F^- \rightarrow F^+)$




Conjugation between $F^+$ male and $F^-$ female of E. Coli: ($F^-$ is converted to $F^+$)

(i) Transformation:-

- Transfer of a fraction of DNA (gene or genes), extracted or otherwise liberated from a donor bacterium, to a recipient bacterium is called transformation.
- During this process a very small amount of DNA is transferred intracellularly from one bacterial cell to another bacterial cell where it gets integrated with the DNA of recipient bacterium.
- The recipient cells then acquire the characters encoded by the foreign DNA and pass it to their offsprings.




Transformation of a non-capsulated Pneumococcus into a capsulated type.

(iii) Transduction:-

Transduction is the process in which the genetic material of one bacterium is transferred to another, through the agency of bacteriophage. It involves following steps:-

(i) Attachment:- The phage attaches itself to the surface of the host cell in order to inject its DNA into the cell.

(ii) Penetration:- The phage injects its DNA into the host cell by penetrating through the cell membrane.

(iii) Transcription:-

the host cell's DNA is degraded and the cell's metabolism is directed to initiate phage biosynthesis.

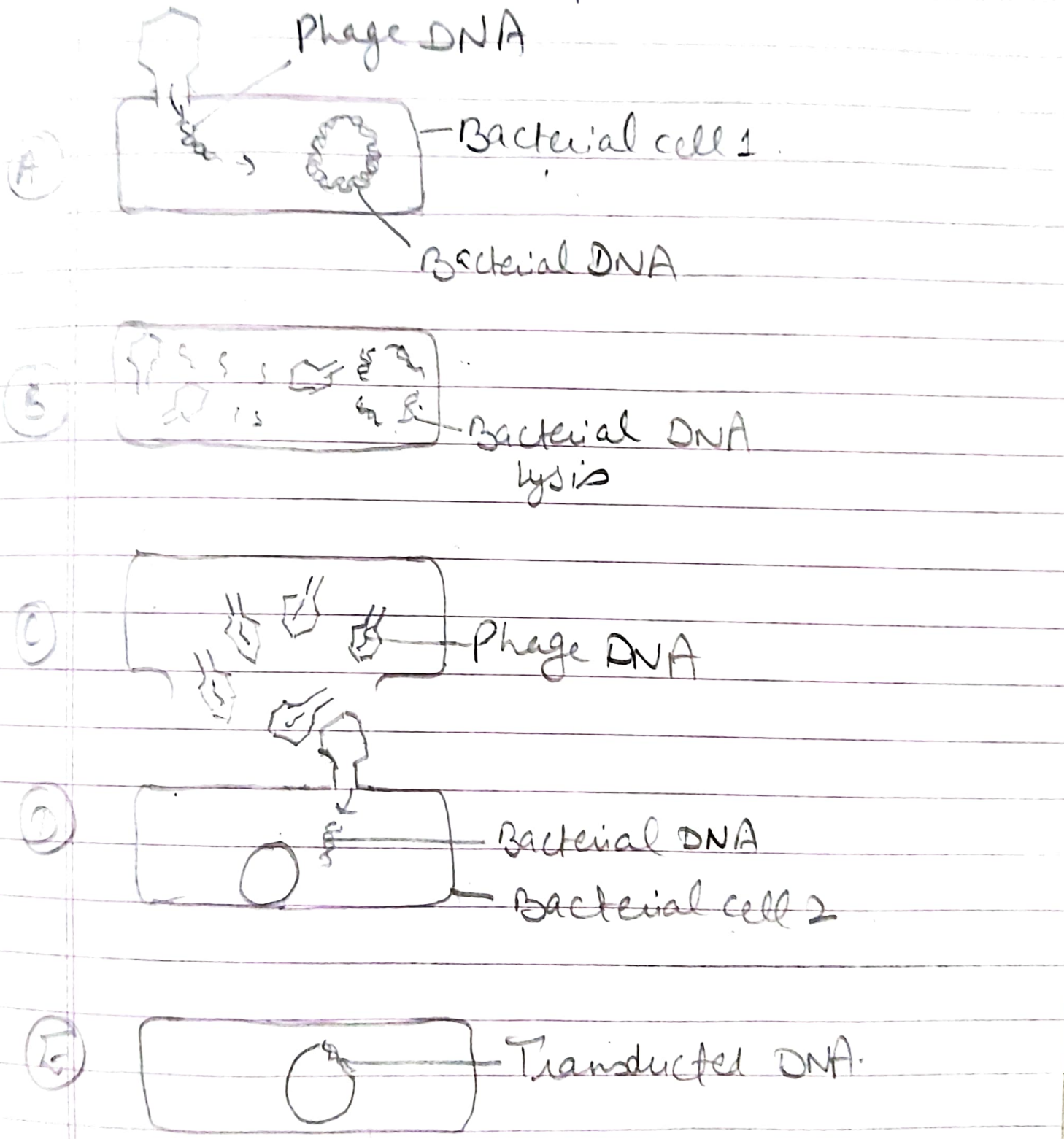
(iv) Biosynthesis:-

The phage DNA replicates inside the cell, synthesizing new phage DNA and proteins.

(V) Maturation:-

the replicated material assembles into fully formed viral phages (with head & tail)

(VI) Lysis: - the newly formed phages are released from the infected cells to seek out new host cells to infect.




Stages of Transduction with the agency of a phage.

→ Economic Importance of Bacteria:-

Useful Activities :-

1) Decay of organic wastes:-

Many saprotrophic bacteria act as natural scavengers by continuously removing the harmful organic wastes from man's environment.

2) Sewage disposal:-

Ability of anaerobic bacteria to purify the organic matter is used in the Sewage disposal system of cities.
e.g. Coliforms (E. coli), Streptococci.

3) Role in nitrogen cycle :-

Many free-living soil inhabiting bacteria such as, Azotobacter (aerobic) have ability to fix atmospheric nitrogen into ammonia.

4) Role in improving soil fertility:-

Saprotrophic bacteria present in soil perform various activities for their survival. Some of these

activities improves the fertility of soil by formation of humus, manure (composting) etc.

5.) Role in Industry:-

Useful activities of various bacteria like Lactobacillus bulgaricus are employed in the production of a number of industrial products like Lactic acid, curd, cheese and butter etc.

6.) Medicinal uses:-

Many bacteria are used in the preparation of serum and vaccines (typhoid, small pox). Production of riboflavin (Vit $B_2$) involves the activity of bacterium — Clostridium butylicum.

Harmful Activities:-

1.) Food poisoning:- Some saprotrophic bacteria cause decay of our food.

e.g. Botulism is caused by Clostridium botulinum.

2.) Spoilage of food:-

a.) Greening on meat surface is caused by Lactobacillus.

b) Black rot of eggs is caused by Proteus.

2.) Souring of milk is caused by Lactobacillus.

3.) Pollution of water! -

There are reports of epidemics of cholera, typhoid, jaundice and other infectious diseases, which were caused by polluted water.

e.g. Vibrio cholerae, Salmonella typhi etc

4.) Deterioration of textiles! -

Some bacteria like Vibrio and Cellulomonas damage cellulose of textiles.

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