Bacteria, coined by C. J. Cohn & Ehrenberg.
Microbes' named 'Sadillote.
Leuwenboek first observed them.

They are formerly grouped as 'Schizophyta.

The description of bacteria accompanied with;

① Morphological characters like shape, size, flagella arrangements of individual units, spore formation, staining characters.
② Physiological characteres : aerobic, anaerobic, both respiration, photosynthesis, fermentation, temp, pH tolerance, Habitate, association with other organism.
③ Biochemical characteristics; cell inclusion, pigment capsular characters, cell wall composition, serological properties, Nucleic acid characteristics.

Shape and Size: Different but mejority falls into

ⓐ Bacillus,
ⓑ coccus,
ⓒ spirillum

} All may also be subgrouped into mono → diplo, - Strepto, Staph

General Properties of Microorganisms:

* **The relative smaller dimensions:** It not only the original motive to be a distinct group but also confer a consequence for their morphology, activity, diversity and flexibility of metabolism ecological distribution etc.

Rubner's(1803) the "surface rule" provide a satisfied explanation for their advantage to be smaller.

* **Structurally static but metabolically flexible:** Microorganisms being smaller possesess much greater flexibility in their metabolic ~~flexibility~~ as well as physiological functions.
* **Omnipresent in nature:** They are found everywhere, even in extrime conditions where no other living form virtually can exists.
* **Unicellularis:** Most of them represent themselves as a single unit. They generally do not form multicellular organization.

Prokaryotes: The History of characterization:

Antoni van Leeuwenhoek: 1676 first to see "wee animalcules". in pepper water infusion.

Ferdinand Cohn: a contemporary of Pasteur and Koch and the founder of the field now we called Bacteriology; coined the term 'Bacteria" along apart with Ehrenberg; He was a trained botanist; discovered 'Bacillus" and described their entire life cycle, initiated the use of cotton plugs:

Louis Pasteur: Defended the spontaneous generation and devised sterilization now called 'Pasteurization'

Robert Koch: famous for his Postulates' called "Germ Theory of disease." holds the following criteria to be pathogenic for specific disease:

ⓐ The suspected microbes should be present in all cases of the disease and absent in healthy one.

ⓑ The suspected organism should be grown in pure culture.

ⓒ cells from pure culture of the suspected organism should cause disease in healthy one.

ⓓ The organism should be reisolated and shown to be same as original.

Discovered the Tuberculosis's causative agent.

He got 'Nobel Prize 1905" for physiology and medicine for his contribution on tuberculosis.

Richard Petri : Devised a double sided dishes that are now bear his name. 1887.

Fannie Hesse : the wife of Walter Hesse first suggested the use of Agar in solid media.

Martinus Beijerinck : originally trained in Botany contributed by enrichment culture method. Isolated N_2-fixing bacteria, lactobacillus, sulphur bacteria etc. initiated the concept of virus "contagium virum fluid um"

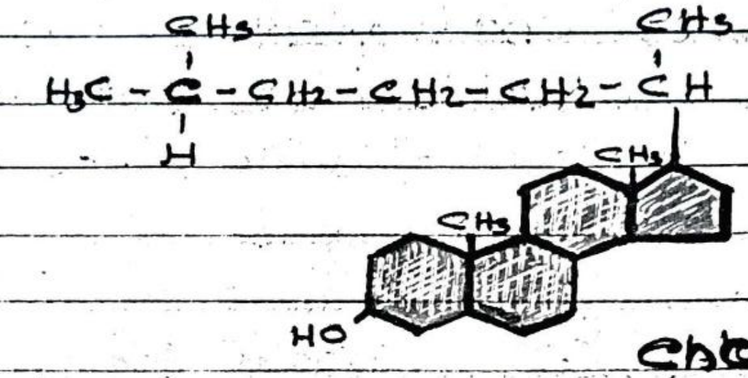
Roger Bacon (1220-52) postulated that disease is caused by invisible creatures.

Fracastoro (1478-1553) in 'De contagione' wrote disease was caused by seeds or germs.

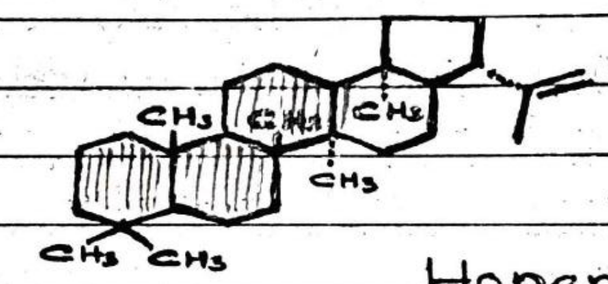
The cell wall of Bacteria :-

The gram staining nature imparted solely by the structure of cell wall which has following layers.

① The innermost cell-membrane phospholipid bilayer (instead of sterol present analogue hopanoids like diplopterne)



Cholesterol

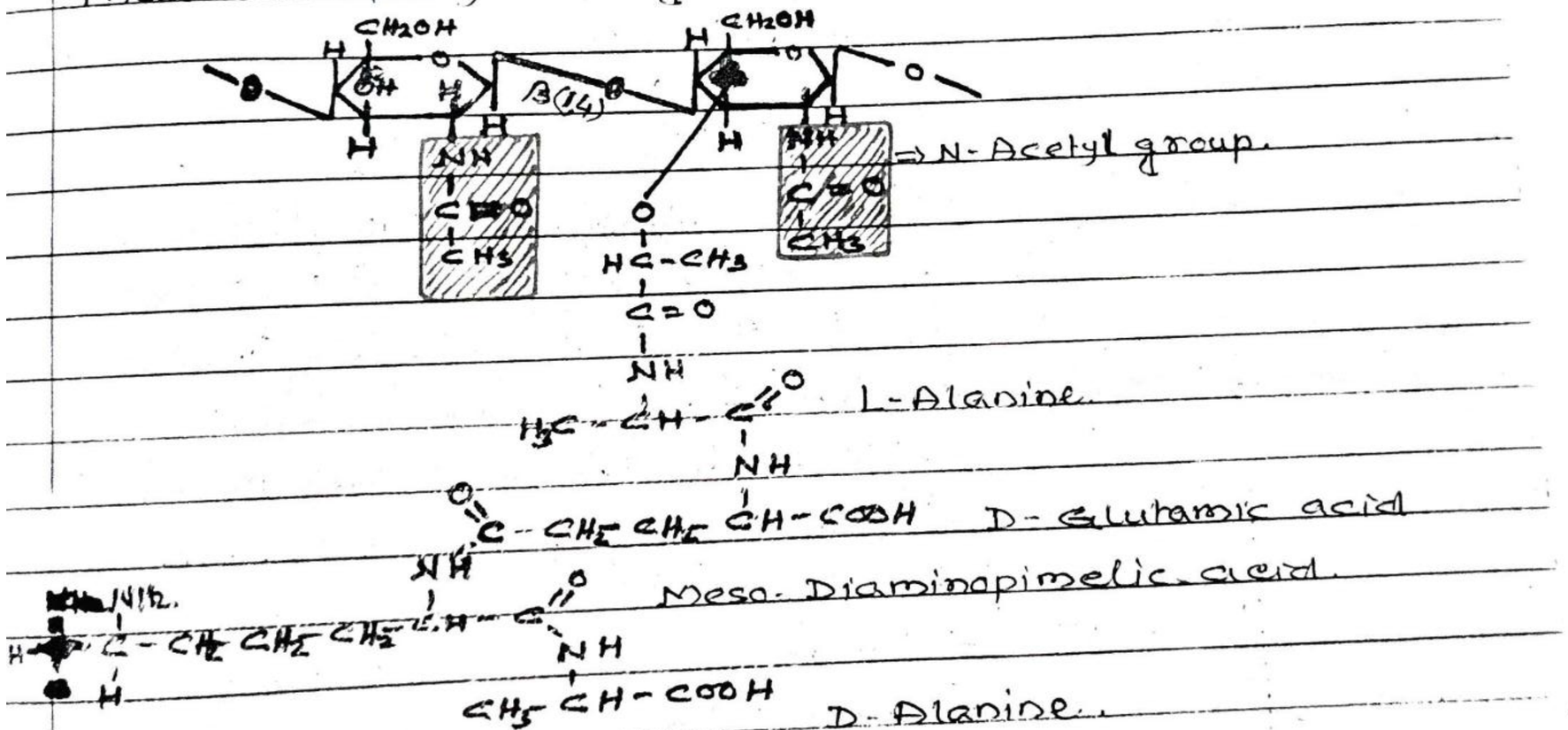


Hopanoids
Diplopterne

② The middle periplasmic layer has thin peptido glycan layer, or thick for gram positive :

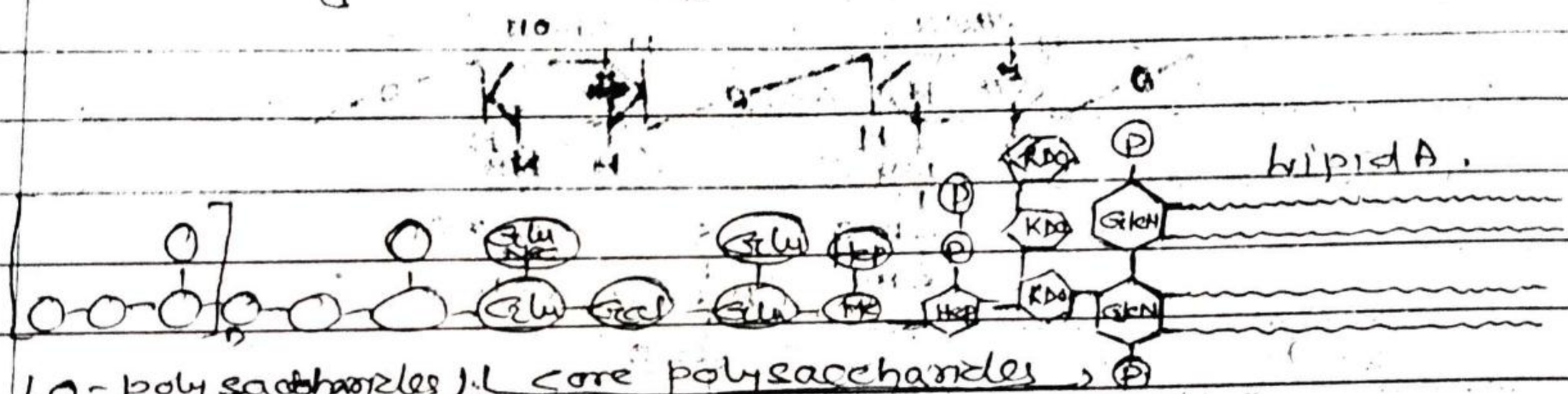
The peptidoglycan : a heteropolymer of sugar derivative namely, N- acetyl glucosamine and its lactic acid ether N- acetyl muramic acid, linked by β- 1-4 glycosidic bonds. Each muramic acid

is also attached with a short tetrapeptide chain of L-Alanine - D-glutamic acid - meso-diaminopimelic acid - D-Alanine (some variation occur by replacing 1st and 3rd with L-lysine, glycine, threonine, serine but never with branched chain, aromatic, sulphur containing or histidine arginine, proline). This tetrapeptide chain may cross-linked directly (amino group of DAP with carboxyl group of terminal D-Alanine) or interconnected by another peptide inter bridge (pentaglycine for Staphylococcus aureus)
These are 40 layered in gram-positive but few in negative strains.



Gram positive bacteria have teichoic Acid attached by phophate ester bonds. It is a polyalcohol connected with sugars and/or D-alanine.

③ Lipopolysaccharide: The outermost layer in gram-negative bacteria: The lipid bilayer has lipids attached to the disaccharide by amine ester linkage. The disaccharide also connected with a complex poly saccharide having core of Ketodeoxyochonate, hepto Glucose or other sugar meiety. The lipids are mainly caproic, Lauric, mysteric, pulmitic and stearic acids. The core polysaccharides also attached with o-specific polysaccharides of glucose, rhamnose, mannose, or other unusal sugar (dideoxy like calitose, paratose)

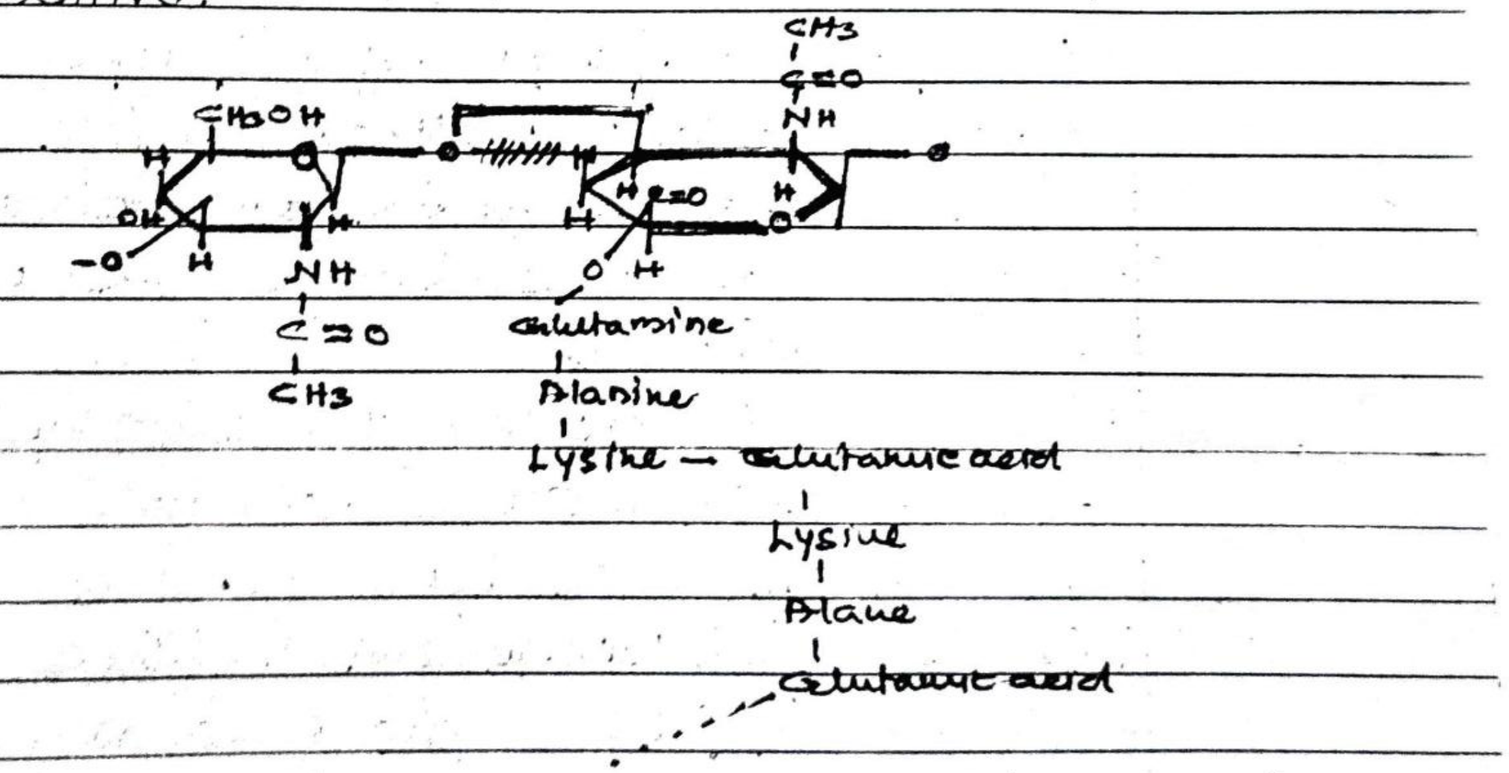


LPS

The LPS associated with several proteins to form the outer leaflet of the outer membrane. Another lipoprotein complex is found on the inner leaflet of outer membrane.

Archaeal Membranes: The archaeal membrane has lipids that are ester linked glycerol with the five carbon isoprene structure and form a lipid monolayer instead of lipid bilayer universal for membrane stru

Pseudomurin: Some archaea contains cell walls constructed by a polysaccharides very similar but distinct from peptidoglycan. It is also a heteropolymer of N-acetylglucosamine and N-acetyltalosamine uro nic acid linked by β 1,3 glycosidic bonds. It is lyso zyme insensitive.



The most common archaeal cell wall type is para crystalline surface layer consists of proteins or glycoproteins ~~with~~ with hexagonal symmetry.

GROWTH & REPRODUCTION

The major part of the genetic information of bacteria is confined to the nucleoid (genome). There also found an extrachromosomal genome called plasmid. These two part bear all information for phenotypic and genotypic expression. In all prokaryotes the growth, division, and reproduction has same consiquence as they results an increase in population of them. To increase in population they simply divide but not at all similar to Eukaryotes. The resuffling of genetic information is also accompanied but these are very distinct from eukaryotic sexual reproduction.

Vegetative Reproduction: It is of following types;

ⓐ Binary fission: coinsiding with the terms the cell divides by formation a septum through constriction. Before that the cellular nuclear equivalent become doubled and elongated along with the whole cell.

ⓑ Cysts: In Azotobacter the cell under under unfavourable condition. The whole cell transformed into cysts by secreting a coat materials outer to its cellwall.

© Budding: In α-Proteobacter the cell produce by this method in which the small protrusion at a single point appears and enlarges to form a mature cell. Here most of the wall component are newly synthesised. e.g Caullobacter.

ⓓ Fragmentation: In these process the cyanobacteria cells enlarge and subsiquent two nuclear fission results the formation of segment of filaments of 3 or multiple of three cells.

ⓔ Conidia: The Actinomycetes reproduce by means of endogenously produced chains of conidia to its conidiophore filament.

ⓕ Endospores: These structure is unique among the bacteria. The endospores are thickwalled highly refractile bodies that are produced (one per cell) by Bacillus Clostridium, Sporosarcina, Thermoactinomyceles and few others. Spilli do not form endospores at all. These structure are extraordinarily resistant to environmental stresses such as heat, UV radiation, Gamma radiation chemical disinfectant. Spore develops within the mother cell, and their position vary with different species. The stress resistance of these structure is thought to be contributed by dipicolinic acid conjugated with Ca. The structure has outer exosporium followed by outer spore coat, cortex, core wall, protoplasts or core with nucleoids and ribosome. They are metabolically less active.

Sporulation is a complex process and can account at least seven distinct phases:

Stage 0 : At the end of exponential phase of growth due to lack of nutrients. The mother cell initiate sporulation. The two nuclear bodies are fused and redistributed from end to end to form axial chromosomal thread, called axial filament. There also occur biosynthesis of enzymes and antibodies.

Stage I : Axial filament formation is followed by a specialized assymmetric partitioning in which the double layered cytoplasmic membrane infolds (deroid of peptidoglycan) to enclose part of axial filament and produce forespore septum.

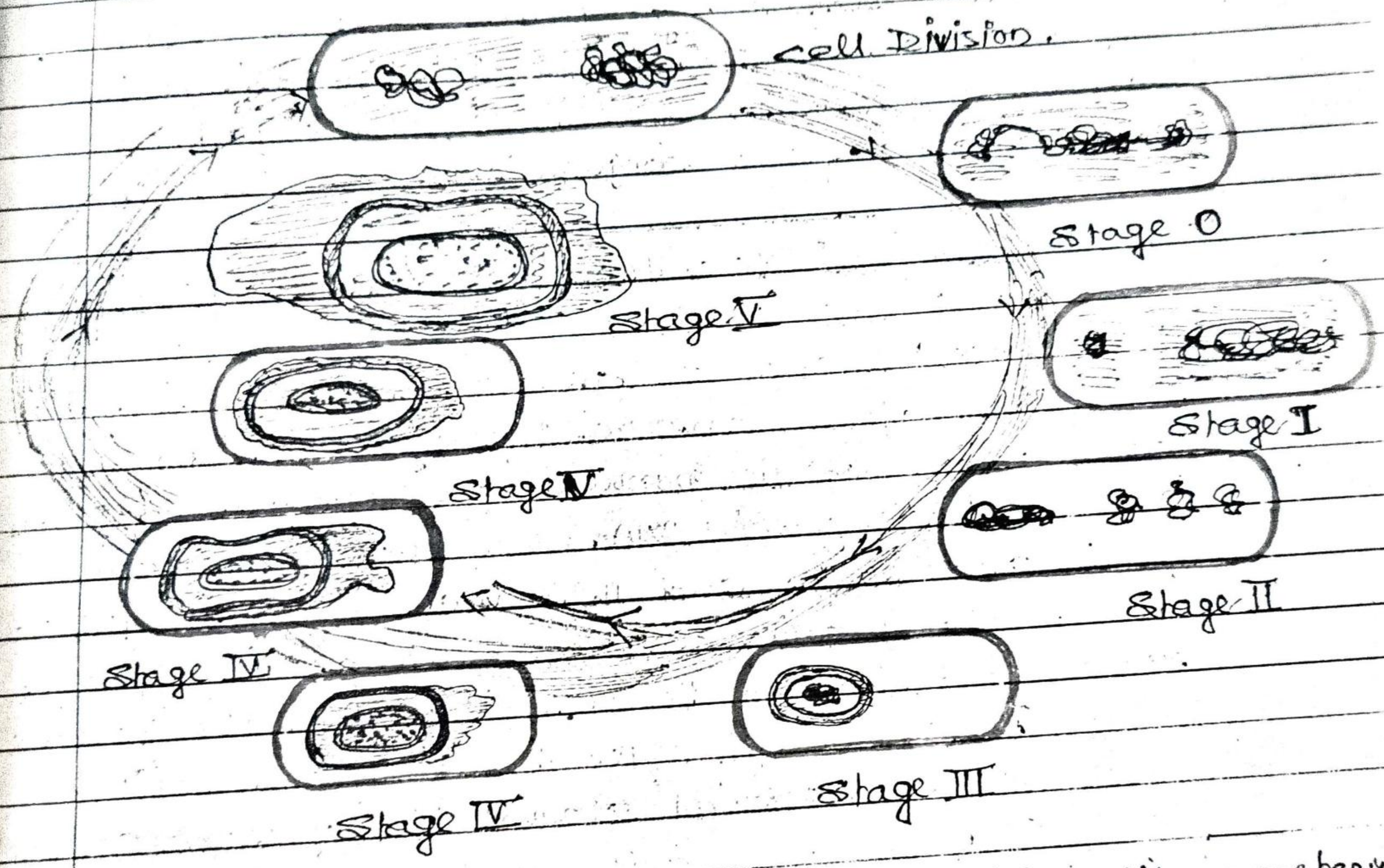
Stage II : The periphery of these septum moves towards forespore pole and finally engulf the chromosome and surrounding cytoplasm to form forespores compacted with double layer.

Stage III : New cortex is laid down in the space between two membranes and both ca-dipicolinic acid are accumulated.

Stag IV : Protein coats then are formed around the cortex

Stage V : The maturation begins by end of the protein coat synthesis and increase in refractility

Stage VI : Finally the autolysis of mother cell occurs and endospores libarated.



Stages of Sporulation of Bacillus megaterium
It take appox 10 hours

Genetic Exchange:- There is no sexual reproduction as found in eukaryotes, but the essence of sexual reproduction i.e genetic recombination is accomplished by genetic exchange. The process is an occasional exuits that occurs by three quite different mechanisms; namely transduction transformation and conjugation.

Transduction: Here the gene (either plasmid DNA or chromosomal DNA) is transferred from one prokaryote to another as a consequence of rare formation of an aberrant phage virion in which some or all of its normal complement of DNA is replaced by bacterial DNA. When such an aberrant virion attaches to and introduce this DNA into another bacterial cell, genetic exchange is effected. The conditions to be fulfilled for the process;

① The phage often being lysogenic / temperate
② The bacterial strains are of same species.
③ The donar cell is destroyed
④ The recombination is a chance factor.

These is of two types

① Generalized transduction: when there is no specificity or certainty of which gene is carried by transducing phage.
② Specialized transduction: when transducing phage carry only specific gene - specific for

phage strain & donar bacterium. It may be low frequency transducing event or high frequency transducing events.

Lederberg & Zinder 1951 discovered that.

Transformation: In transformation DNA is released from donar part (bacterium) into the surrounding medium, and recipient cells incorporate it into themselves from medium, discovered by Griffith (1928) by experimenting with Diplococcus pneumoniae. The major characteristics of these process are

① There are some basic ability / characteristics the recipient cell must have; such are called competant the indicator / active protein induce to be competant called competance factor.

② There is little specificity about the source of DNA. It may also from virus. (transfection)

③ There are at least three distinct mechanisms for transfer of DNA

@ In Pneumococcus & gram positive bacteria the DNA (double stranded) bind nonspecifically to outer wall, one strand cleared by endonuclease. Other strand are carried into the cell, then align with a homologous region of the genome and be integrated, thus transformation occurs.

ⓑ In Haemophilus influenzae and gram's negative bacteria, the transferred DNA is recognised specifically (by 11 base pair sequence 5'AAGTGCGGTCA3'). Pilin comple

aids the movement through outer membrane, peptido glycan layer. DNA binding protein (com E/EA) binds with the ds DNA. Nuclease act on the ds DNA to form SS DNA. Which enters the cytoplasm through transmembrane channel formed by channel protein (com EC) The SS DNA is then carried to the nucleoid by translocase like (com FA of B. subtilis)

② Artificial means to induce some enteric bacteria by treatment with cacls (it make membrane more permeable) to take up ds DNA. is occurred and used for cloning purpose.

④ The recombination is much confirmed.

Conjugation: In this case genetic exchange occurs between cells in direct contacts with one another by a process that is in all cases, encoded by plasmid borne genes. Usually only the plasmid itself is transferred but sometimes chromosomal genes also transferred as well.

* Discovered by Lederberg & Tatum 1946.
* Bernard Davis (1950) prove the need of physical contact.
* William Hayes (1952) demonstrated that gene transfer is polar and nonreciprocal. The donor F+ and recipient F- strains

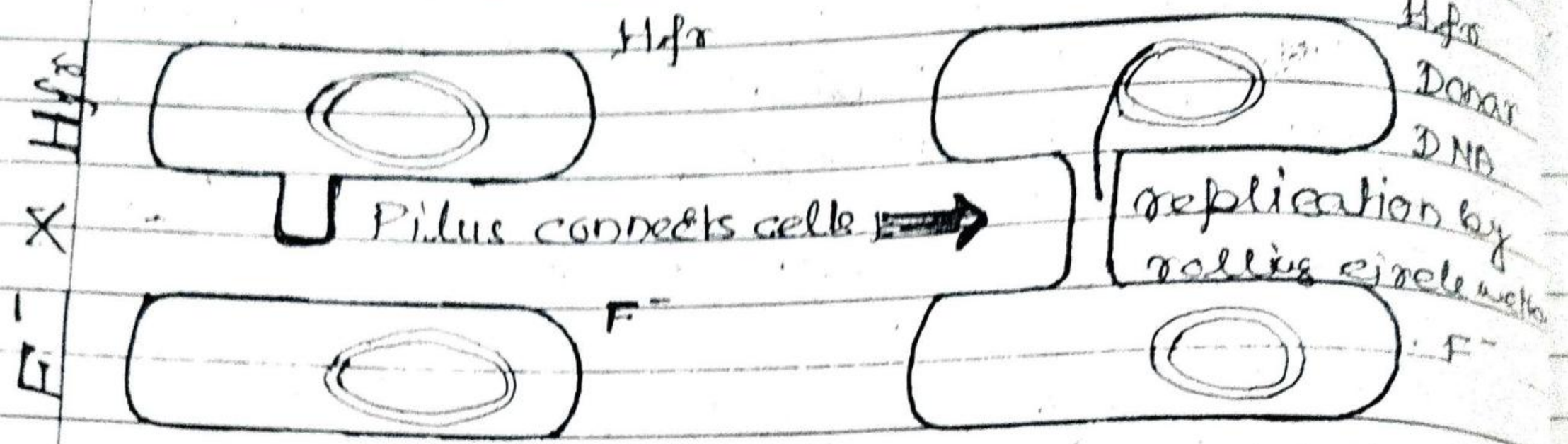
The machanism of the process and their eventual consequence are of following three types

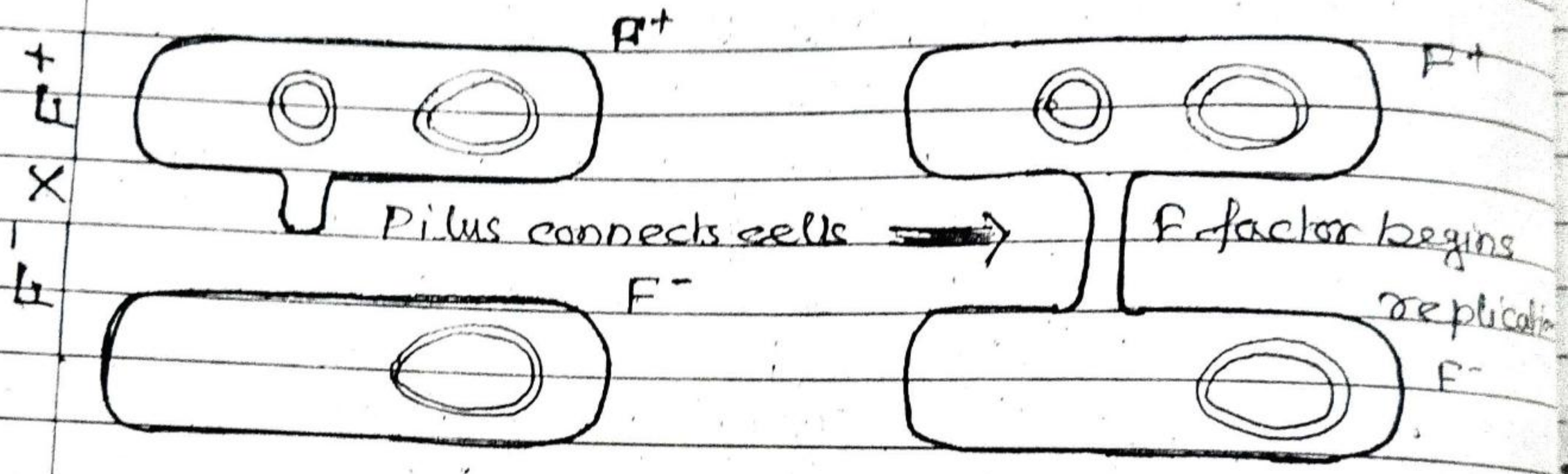
① The Normal Conjugation: ($F^* \times F^-$ mating) Here the donar cell (F^+) carry the fertility plasmid (F) and also has f plius which form a conjugation tube through which the replicated F-plasmid (through the rolling circle mechanism of replication) is transferred to the reciprent cell (F^-). To transform it two F^+ strains

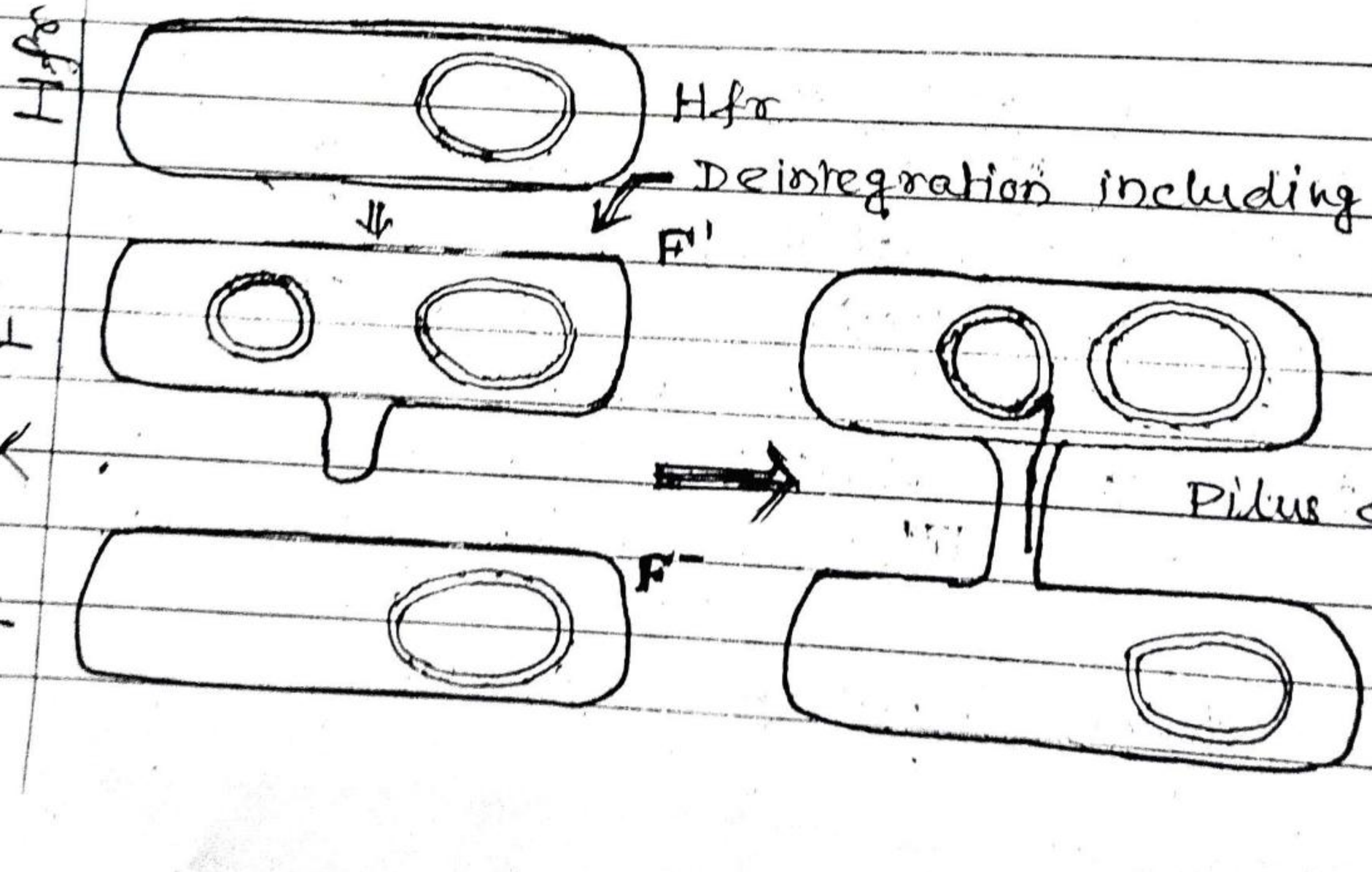
② The High frequency recombination Conjugation: (Hfr X F^- mating) In some strains or sometimes the F-plasmid become episome, and functional. As the transfer process, is associated with rolling circle mechanism of replication, some part of chromosonal gene also transferred during the process but some part of the F-plasmid fail to do so. As a consiquence the reciepient cell (F^-) become partially diplord with part of the both F-plasmid & chromosome (merozygot) and become F^* strains.

③ Sexduction associated Conjugation: ($F' \times F^-$ mating) The episomal F-plasmid in certain stains when make error in excision and pick up a part of chromosonal gene, it form F' plasmid. The stains as have both chromosonal as well as extrachromosonal part it behave as F^+ and transfers the F' plasmid only. So the reciplent become F' and is a partially diplord mero zygot. It is very rapid proces to chromosonal gene(s) transfer through F'-plasmid (thus called Sex-duction)

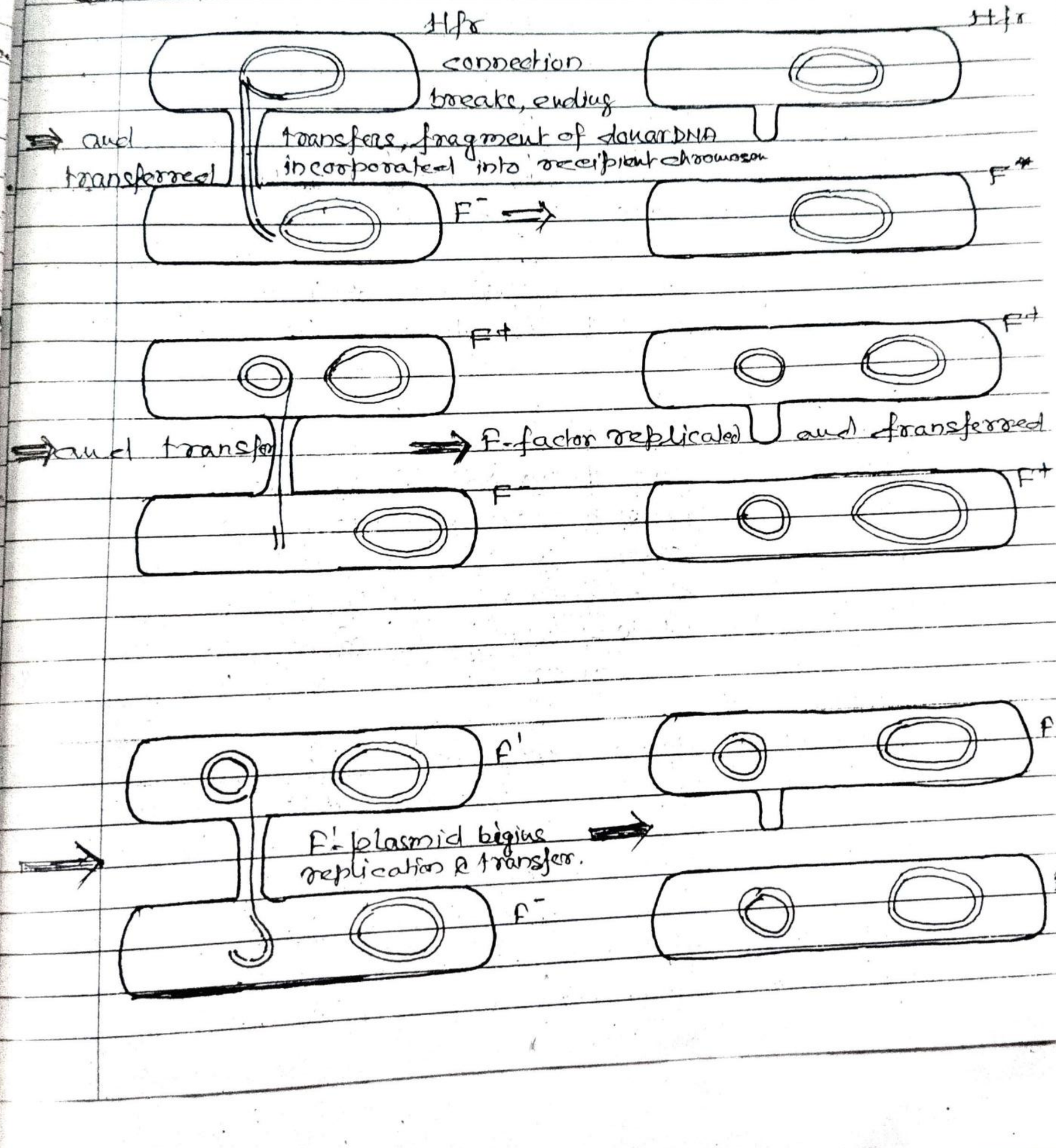
TYPES OF CON



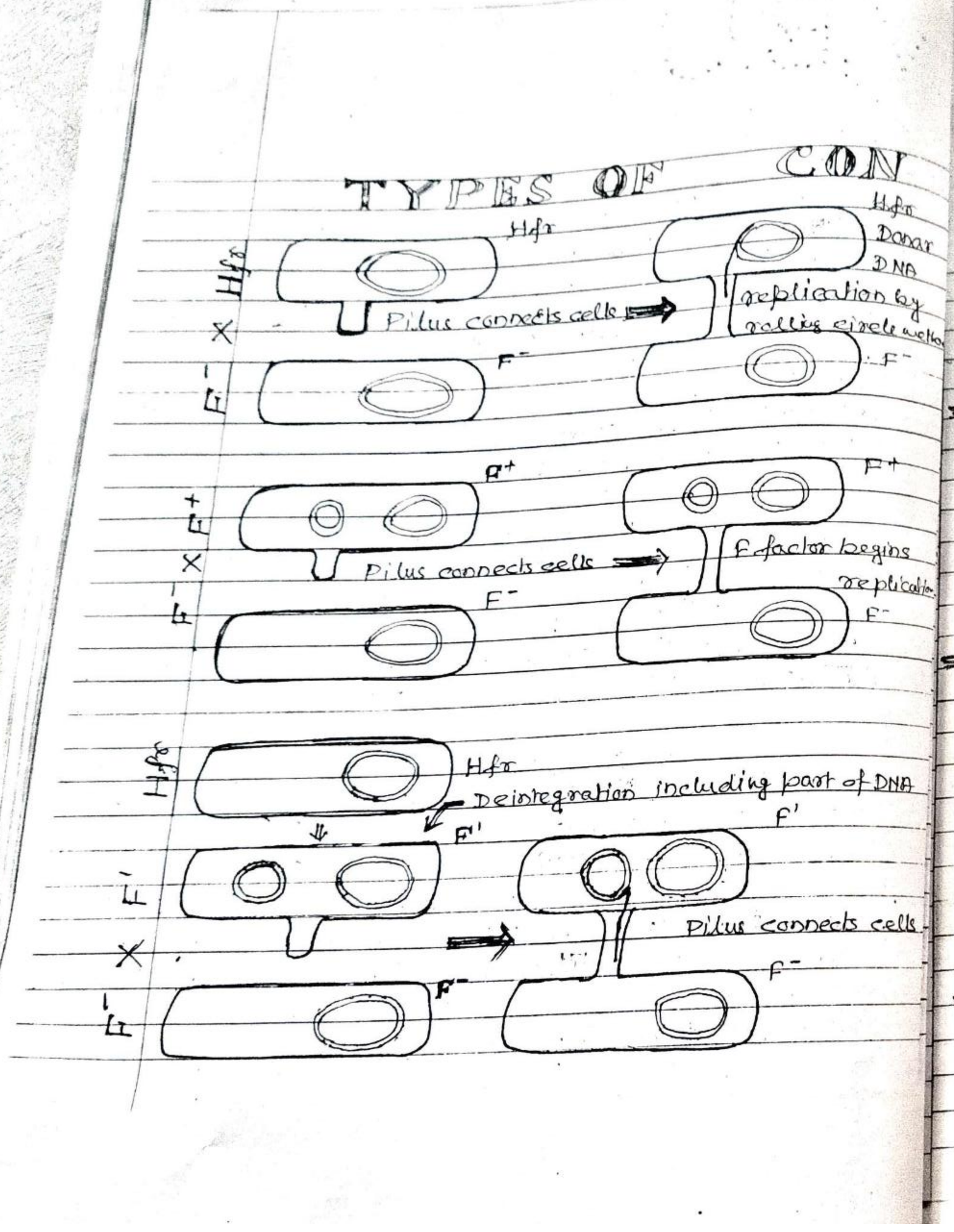


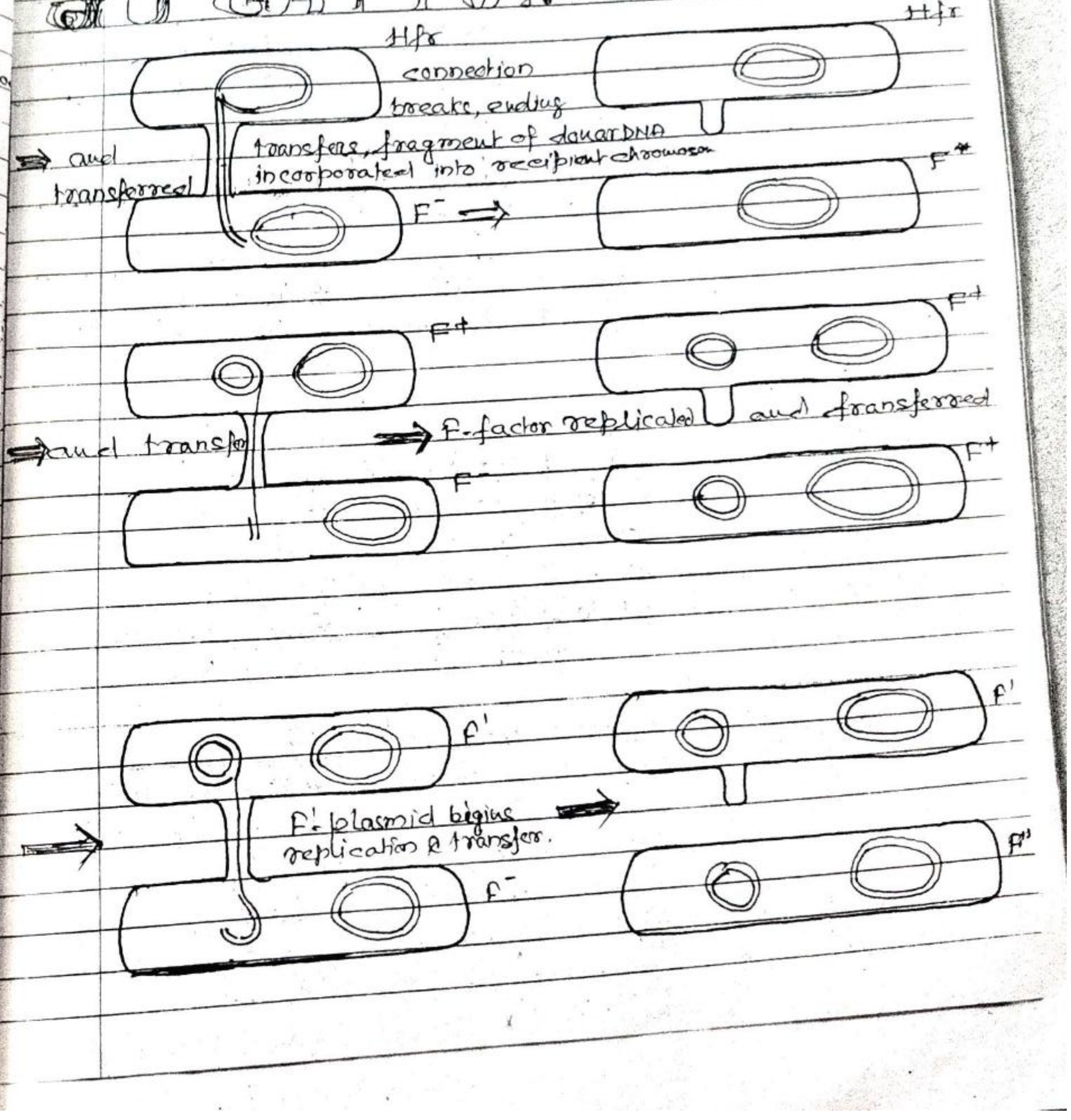


UGATION


Hfr
connection
breaks, ending
transfers, fragment of donor DNA
incorporated into recipient chromosom
and
transferred
F⁻
F*
F+
F+
F-factor replicated
and transferred
F⁻
F+
F'
F'
F' plasmid begins
replication & transfer.
F⁻
F'

TYPES OF CONJUGATION





Cyanobacteria :- The most largest & diverse group of photosynthetic bacteria (with oxygen evolution. about 24 genera and 66 species are now established.

A * The G+C content ranges from 35 - 71%.

B * They are prokaryotic, gram negative in nature, photo * Lithoautotrophs. but sometime chemöheterotrophs.

C * The pigments are chlorophyll a and phycobilisomes

D * The photosystem II is also operative.

E * The electron chain transport component & phycobilisomes are located in tubular thylakoid structure of the periphery of the cell.

* The calvin cycle is operative & reserve food is glycogen.

* Nitrogen stored as polymers of arginine and aspartic acid in; cyanophycean granule.

* We have abortive cycle of citric acid cycle as they lack α-ketoglutarate dehydrogenase.

* Pentose Phosphate pathway is more prievelant.

* Morphologically they are of chains, filament, or colonies of cells.

* They lack flagellar structures.

* They employ binary fission, budding, multiple fission, heterocysts, hormogia akinetes formation for reproduction or survival in unfavourable conditions.

* They are unique in that they can fix N_2 and have the symbiotic association with various group of plants. some produce blooms.

The Prochlorophyta are unique group of cyanobacteria
It has chlorophyll a and chlorophyll b (Unique and
the prokaryotes) but lack phycobilisomes.