

Reproduction and growth of bacteria

The ability of microbes to self-multiply is known as “Reproduction”. There will be increase in the number of individuals per unit volume during reproduction. Due to the synthesis of cellular material, the mass of bacterial cytoplasm is increased indicating the growth of microorganisms.

Method of Reproduction:

Bacteria reproduce by simple binary division; vegetative reproduction occurs in different planes and produces many kinds of cells (clusters, chains, pairs, packets etc.). They also reproduce by budding, by conjugation, fusion of the chromatin matter of two related species of bacteria.

Actinomycetes and many fungi reproduce by sporulation. One mother bacterial cell divides by the binary division in two equal daughter cells, representing a constant separation of daughter cells from the mother cell. After a certain number of generation, the mother cells age and die. This explanation does not support the concept of 'bacterial immortality'.

1. Lag Phase:

Lag phase represents a period of active growth during which bacteria prepare for reproduction, synthesizing DNA, various inducible enzymes, and other macromolecules needed for cell division. Therefore, during this phase, there may be increase in size (volume) but no increase in cell number. The lag phase may last for an hour or more, and near the end of this phase some cells may double or triple in size.

2. Log or Exponential Growth Phase:

Bacterial cells prepared for cell division during lag phase now enter into the log phase or exponential growth phase during which the cells divide at a maximal rate and their generation time reaches a minimum and remains constant.

3. Stationary Phase:

Since the bacteria are growing in a constant volume of medium of batch culture, and no fresh nutrients are added, the growth of bacterial population eventually ceases and the growth curve becomes horizontal. Such a phase of growth in bacteria is attained at a population level of around 10^9 cells per ml.

4. Death or Decline Phase:

After a while, the number of dying cells begins to exceed the number of new-born cells and thus the number of viable bacterial cells present in a batch culture starts declining. This condition represents the death or decline phase which continues until the population is diminished to a tiny fraction of more resistant cells, or it may die out entirely. Like exponential growth, death is also exponential, but inverse, as the number of viable bacterial cells decreases exponentially.

Reproduction types

- **Vegetative reproduction**
- **Asexual reproduction**
- **Sexual reproduction**

Vegetative reproduction- Budding

- In this case, a small protuberance, called bud develops at one end of the cell.
- Genome replication follows, and one copy of the genome gets into the bud.
- Then the bud enlarges, eventually Become a Daughter cell and finally gets separated from the parent cell.

Vegetative Reproduction-

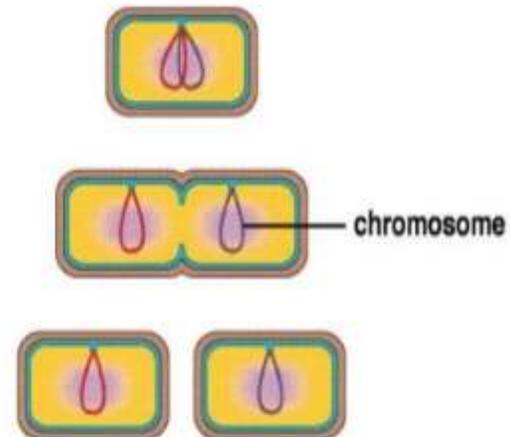
Fragmentation

- **Mostly during unfavorable conditions, bacterial protoplasm undergoes compartmentalization and subsequent fragmentation, forming minute bodies called gonidia.**
- **Under favourable conditions, each gonidium grows to a new bacterium.**
- **It becomes apparent that prior to fragmentation the bacterial genome had to undergo repeated replication so that each fragment gets a copy of it.**

Vegetative reproduction- Binary fission

- It is the commonest type of reproduction .Under favourable conditions in which cell divides into two similar daughter cells.
- During the process ,the bacterial chromosomes get attaches to cell membrane and replicates to the bacterial chromosomes.
- As the cell enlarges the daughter chromosomes gets separated.
- A cross wall is formed between the separataing daughter chromosomes.
- It divides the cell into two daughter cells.

Binary fission



Endospore Formation

- Endospore are resting spores formed in some gram positive bacteria { Bacillus and clostridium during unfavorable conditions.
- They are formed within the cells.
- During this process a part of the protoplast becomes concentrated around the chromosome.
- A hard resistant wall is secreted around it.
- The rest of the bacterial cell degenerates ; endospore are very resistant to extreme physical conditions and chemicals.
- During favourable conditions the spore wall gets ruptured and the mass gives rise to a new bacterium.

Sexual Reproduction

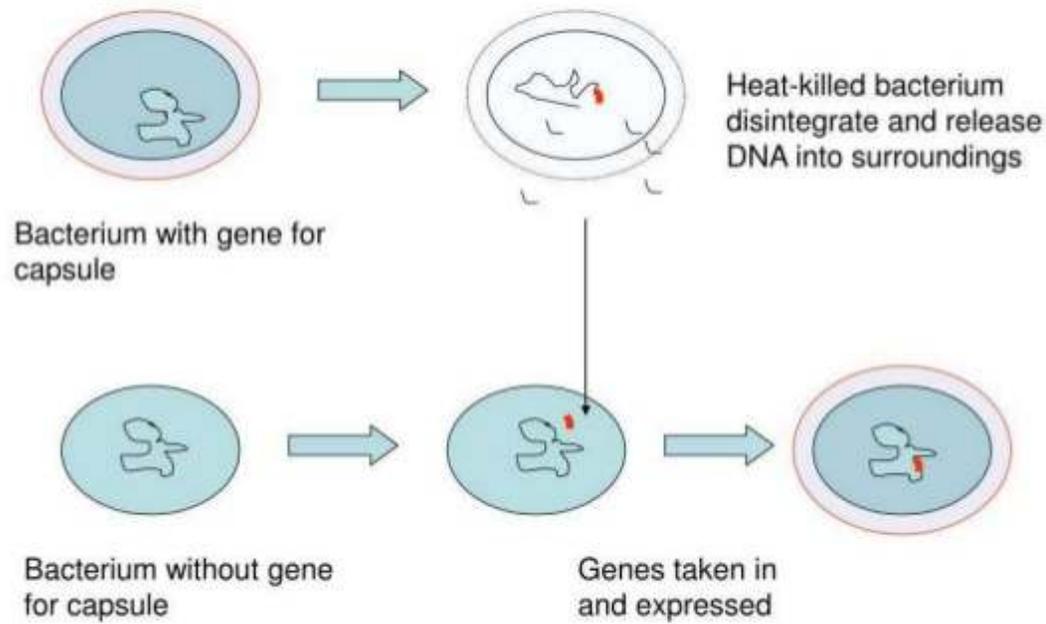
- Sexual reproduction occurs in the form of genetic recombination.
- There are three methods of genetic recombination:-
 1. Transformation
 2. Conjugation
 3. Transduction

Transformation

- This was first studied by Griffith {1928} in diplococous pneumonia.
- In transformation ,DNA from the donor cells initiates heritable change in recipient cells.
- The transformation involves only one trait,though several may be acquired independently in this way.

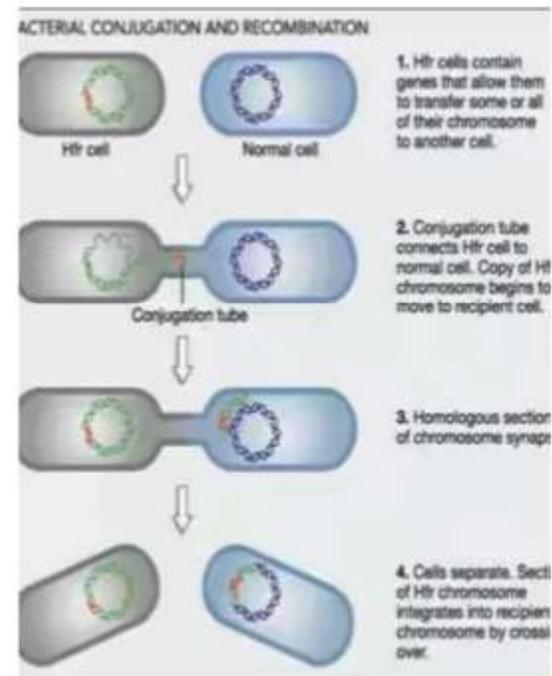
Transformation

Bacterial Transformation



Conjugation

- It was first reported by Lederberg and Tatum {1946} in E.coli bacteria.
- Cell to cell union occurs between two bacterial cells and genetic material {DNA} of one bacterial cell goes to another cell lengthwise through conjugation tube which is formed by sex pili.
- As a result the recipient cell possesses duplicate genes for a number of characters as is seen in Escherichia coli an inhabitant of human intestine.



Transduction

- It was first of all reported in salmonella typhimurium by Zinder and Lederberg.
- In this method ,genetic material of one bacterial cell goes to other bacterial cell by agency of bacteriophages or phages .
(virus, infecting bacteria)