Actinomycetes

Actinomycetes belong to the group of prokaryotic, gram-positive bacteria which are having a filamentous structure. Its filamentous structure resembles the fungal mycelium, which consists of a highly dense and filamentous network. Due to the filamentous structure of Actinomycetes, it also refers as "Thread or Ray bacteria". The cell wall and the internal structure of the actinomycetes are similar to the group of bacteria. Thus, Actinomycetes also refers as filamentous Actinobacteria and acts as a connecting link between the bacteria and fungi as it shows resemblance with both.

Actinomycetes are "True bacteria", not fungus and therefore these are placed in the kingdom "Bacteria" and a class "Actinobacteria". These are ubiquitous and commonly found in soil and are soil microorganisms.
Actinomycetes also act as "Decomposers" which carry out the decomposition of organic compounds like chitin, complex sugars, hemicellulose etc. In addition to soil, these are also very common in marine habitat and considered as a treasure house of secondary metabolites. Its filamentous forms are predominantly aerobic, and few are anaerobic.
Definition of Actinomycetes

Actinomycetes can define as the prokaryotic or unicellular organisms, which are having a gram-positive cell wall. The morphology of actinomycetes is similar to fungi as it produces a filamentous, dense, branched and raised colony over the substrate. Most of its features are common to the bacteria than that of fungi and thus placed in the group of bacteria which includes members like Mycobacterium, Corynebacterium, Streptomyces, and Actinomyces etc.
A diameter of the Actinomycete is much smaller (1-2 µm) than the branches of fungi which range from 5µm-10µm. The filamentous forms of Actinomycetes are aerobic and may produce spore singly or in chains. Its colony appears as a powdery mass and are pigmented by the formation of aerial spores.

Classification:
Domain: Bacteria
Phylum: Actinobacteria
Class: Actinobacteria
Order: Actinomycetales
Family: Actinomycetaceae

Characteristics

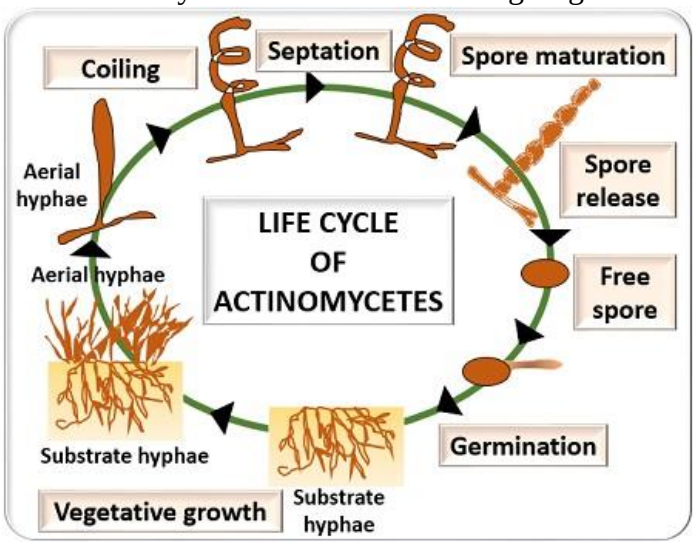
The following characteristics of Actinomycetes are given below:

1. The size of Actinomycetes is 1-2 µm in diameter.
2. These are usually rod shaped with a filamentous and branched structure. The filaments contain mumaric acid.
3. Most of the species are aerobic, but few are anaerobic to facultative aerobes.
4. Cell wall and internal structures are similar to the bacteria. The cell wall of Actinomycetes consists of mycolic acid.
5. The growth or reproduction of Actinomycetes is slower than the bacteria and fungi and hence also refers as "Slow growers".
6. These are having 60-78% of G+C content.
7. Actinomycetes are most abundant in soil (10^6-10^8g) and marine habitat.
8. These are most usually non-motile, non-capsulated and non-acid fast.

9. The growth of actinomycetes is optimal at alkaline pH.

Life Cycle

Its life cycle includes the following stages:



Germination: The spores of Actinomycetes remains free in the environment as a "Free spore". Free spore remains dormant until the stage of germination. When the spore gets the favourable condition, it germinates and forms a "Germ tube".

Vegetative Growth: The germ tube promotes a vegetative growth, which gives rise to the substrate and aerial hyphae. First, a germ tube will produce a primary mycelium i.e. Substrate hyphae, which grow within the media. After the growth of primary mycelium, it forms secondary mycelium i.e. aerial hyphae, which grow above the substratum.

Coiling: During unfavourable conditions, the aerial hyphae become spirally coiled.

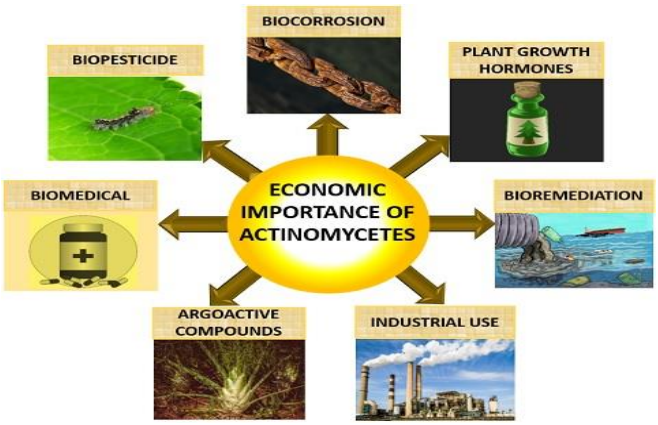
Septation: At this stage, septa forms between the vegetative hyphae.

Spore maturation: The septa forms within the vegetative hyphae maturates and forms a chain of spores. The spore thus forms by fragmentation or swelling of the hyphae.

Release of spore: During the unfavourable condition, the spores get separated from the vegetative hyphae and are free in the environment.

Economic Importance

Actinomycetes is an economically important organism which plays a fundamental role in many areas like:



Use in Bioremediation

Actinomycetes digest the complex carbohydrates like chitin, cellulose, hemicellulose etc. It also helps in the degradation of toxic compounds from an environment. Thus, it plays an essential role in the bioremediation of organic compounds. Actinomycetes survive in a harsh environment like high temperature up to 50 degrees Celsius and also crucial for the composting process.

Biomedical Use

Members of Actinomycetes produce many of the best-known antibiotics like amphotericin, neomycin, novobiocin, chloramphenicol, tetracycline etc.

- Tetracycline and erythromycin etc. target bacterial ribosomes and used to cure respiratory infections.
- Vancomycin mainly attacks the bacterial cell wall of pathogenic bacteria (Streptococcus aureus).
- Rifampicin targets bacterial RNAP (RNA-Polymerase) and used to cure tuberculosis and leprosy.
- Adriamycin use in the treatment of cancer.
- Amphotericin attacks fungal membranes and shows few side effects.
- Rapamycin enables organ transplant.

Use in Regulating Plant growth

Actinomycetes inhabit in the soil which produces phytohormones, extracellular enzymes and bioactive compounds. These compounds promote direct plant growth and protect against phytopathogens and pests by producing indole 3-acetic acid, siderophore and solubilize phosphate.

Industrial Use

Actinomycetes produce several enzymes which show a wide range of applications in different fields like:

- Lipase: Use in detergent and pharmaceuticals industries.
- Cellulases: Use in the animal feed industry.
- Catalase: Use in the detergent industry.
- Amylase: Use in food, textile and paper industries.
- Chitinase: Use in biochemical industries.

Use as Agroactive compounds

Actinomycetes produce Agroactive compounds as these are extensively present in the rhizospheric zone of the plant. Thus, it can actively colonize itself with the plant root and protects it from the pathogenic fungi and other phytopathogens. Frankia is an example of Actinomycetes which acts as “Symbionts” and promotes root nodule formation and thus helps in the nitrogen fixation.

Prevents Biocorrosion

Actinomycetes produce secondary metabolites which act as AMSs (Antimicrobial substances). These antimicrobial substances attack pathogenic and phytopathogenic microorganisms, which can cause biocorrosion.

Use as Biopesticide

Actinomycetes also used as Biopesticide which attacks insects like *Musca domestica*, *Culex quinquefasciatus* etc. It kills 90% of insects at their larval and pupal stage.