**Unit II: Microbe-plant interaction: Non-symbiotic interactions and Microbe interaction: Synergism**

**Non-symbiotic interactions**

The term “nonsymbiotic” could be defined as having an interdependent relationship. Nonsymbiotic bacteria also fix atmospheric nitrogen and in association with symbiotic bacteria increase plant growth.

Nonsymbiotic nitrogen-fixing bacteria (free living, associative, and endophytes) are cyanobacteria, Azospirillum, Azotobacter, Gluconacetobacter diazotrophicus and Azocarus, etc.

Due to the inefficiency of suitable carbon and energy sources for free-living organisms, their role in nitrogen fixation is considered as minor.

Azotobacter is another aerobic bacterium with genomic content G-C of 63–67.5% and fixes nitrogen nonsymbiotically. Soil, water, and sediments are the habitat of Azotobacter. Azotobacter facilitates plant growth by synthesizing IAA and other growth-promoting substances.

On the other hand, associative nitrogen fixer, Azospirillum, located predominantly on the root surface of the plant fixes remarkable amount of nitrogen within the rhizosphere of the host plants. Even if their nitrogen-fixing amount is outstanding, the level of the nitrogen fixation is determined by several factors. Soil temperature, low oxygen pressure, availability of photosynthates, efficiency of nitrogenase enzyme, and competitiveness of the bacteria are some of the factors that limit the nitrogen fixation process.

**Synergism**

It is a relationship in which organism in association is mutually benefited with each other. This interaction is similar to mutualism but the relationships between the organisms in protocooperation is not obligatory as in mutualism.