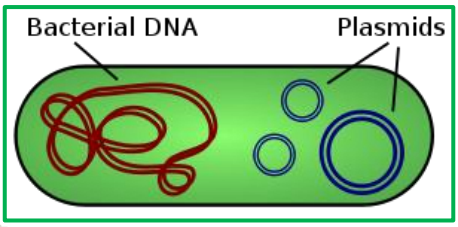
Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 05, Issue: 06 (NOV-DEC, 2025)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Plasmid Biology: Types and Phenotypic Traits

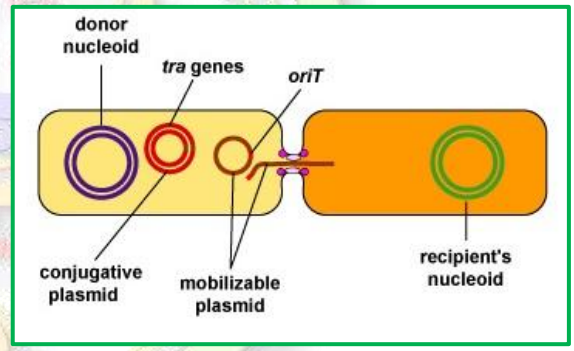
Mihir D. Joshi and *Darshan M. Parmar
Department of Plant Pathology, B. A. College of Agriculture,
Anand Agricultural University, Anand, Gujarat-388 110
*Corresponding Author's email: darshanparmar3133@gmail.com

What is Plasmid



- Plasmids are extra chromosomal genetic material found in most of bacterial cell and they play a significant role in their adaptation and evolution.
- Most plasmids are covalently closed circular structures consisting of double stranded DNA and the DNA is negatively supercoiled.
- In nature, plasmids often carry genes that may benefit the survival of the organism, for example antibiotic resistance
- The term Plasmid was coined by Joshua Lederberg in 1952.
- Plasmids are important as genetic tools, which are used to introduce, manipulate or delete certain genes from the host cell.

Types of Plasmids



1. Conjugative plasmids

- A conjugative plasmid is a type of plasmid (a small, circular DNA molecule separate from the bacterial chromosomal DNA) that can transfer itself from one bacterium to another through a process known as conjugation.
- This transfer typically occurs via a direct physical connection between the two bacterial cells, known as a conjugation pilus or sex pilus.

2. Non-conjugative plasmids

- These are the type of plasmid that cannot independently initiate the process of conjugation to transfer themselves from one bacterial cell to another.
- Unlike conjugative plasmids, they lack the necessary genes for pilus formation and DNA transfer.
- They can be transferred only with the assistance of conjugative plasmids.

3. F Plasmids (Fertility plasmids)

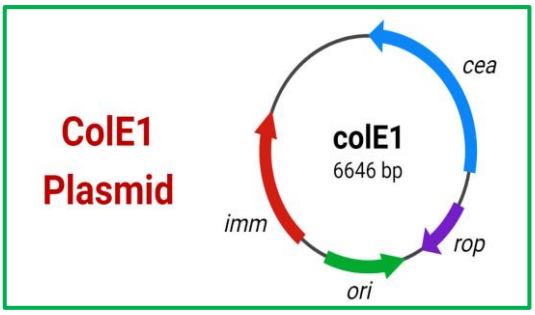
- They contain the TRA genes and hence can be transferred from one cell to another.
- They can replicate inside the bacterial cell.
- They cause the synthesis of a pilus, which is a long protein-rich structure that helps in cell-cell interaction.
- It also contains a sequence responsible for incompatibility.

4. R plasmids (Resistance plasmids)

- These plasmids contain and transmit genes for Antibiotic resistance from one cell to another.

- The antibiotic resistance gene protects the bacteria from antibiotics in human medicines and antibiotics naturally present in the soil.
- These types of plasmids are usually large in size and present in low copy numbers in the cell.

5. Col plasmid (Colicin plasmid)



- These are known as bacteriocinogenic plasmids because they produce bacteriocins.
- They found in several species of coliforms which produce extracellular colicins.
- These proteins have the ability to kill the closely related bacterial cells which lack Col plasmids.
- These plasmids are observed in *E. coli*.

6. Degradative plasmid

- Degradative plasmid is a type of plasmid found in bacteria that contains genes encoding enzymes capable of breaking down complex organic compounds.
- These types of plasmids have the ability to digest unusual substances such as toluene, camphor, salicylic acid, etc.
- These plasmids play a significant role in the biodegradation of pollutants and are often used in bioremediation processes.
- Specific examples include the TOL plasmid in Pseudomonas putida, which enables the degradation of toluene and xylene, and the OCT plasmid in *Pseudomonas oleovorans*, which allows the degradation of octane.

7. Virulence plasmid

- A virulence plasmid is a type of plasmid found in pathogenic bacteria that contains genes responsible for the bacterium's ability to cause disease in a host organism.
- These plasmids enhance the bacterium's virulence, making them more capable of infecting hosts, evading the host immune system, and causing damage.
- These plasmids produce virulence factors that enable the bacteria to infect other cells. Bacteria containing virulence plasmids can infect the plant, animal, and human cells.
- Virulence plasmids play a critical role in the biology of pathogenic bacteria and are a major focus of research aimed at controlling and preventing bacterial diseases.

Plasmid Borne Phenotypes

✓ Plasmid borne phenotypes are traits or characteristics that are encoded by genes located on plasmids.

✓ They often carry genes that can confer various advantages to the host organism. Here are some common plasmid-borne phenotypes.

1. Antibiotic Resistance

➢ Ability of bacteria to resist the effects of antibiotics, encoded by genes located on plasmid is called as Antibiotic Resistance.

➢ These genes produce proteins like.

- **Beta-lactamase production**: Provides resistance to beta-lactam antibiotics like penicillin.
- **Efflux pumps**: Actively export antibiotics out of the cell.
- **Modification enzymes**: Modify the antibiotic to render it ineffective

2. Metabolic Capabilities

➢ Metabolic capabilities can be advantageous for bacteria, allowing them to survive and thrive in various environment.

➢ Plasmid can spread many traits between bacteria, contributing their adaptability and evolution like.

- **Catabolism of unusual substrates:** Ability to break down compounds like xylene, toluene, or other hydrocarbons.

- **Utilization of alternative carbon sources:** Enables the use of sugars or alcohols not typically metabolized by the host.
- **Produce biofilms:** Complex communities of bacteria.
- **Express virulence factors:** Cause disease in hosts
- **Degrade xenobiotics:** Pollutants, pesticides

3. Virulence Factors

➢ These are genes that enable bacteria to cause disease in hosts.

- Adhere to host cells (**Adhesins**)
- Invade host cells (**Invasins**)
- Evade host immune systems (**Immunomodulins**)
- Produce toxins (**Exotoxins, Endotoxins**)
- Form biofilms (**Protective matrices**)
- Manipulate host cell signalling (**Effectors**)
- Resist host defense mechanisms (**Resistance genes**)

4. Heavy Metal Resistance

➢ It refers to the ability of bacteria to resist the toxic effects of heavy metals, such as Mercury, Lead, Cadmium, Chromium, Arsenic, Copper.

➢ These are the genes that encode proteins

- Pump heavy metals out of cell (**Efflux pumps**)
- Bind heavy metals, reducing their availability (**Metal binding proteins**)
- Convert heavy metals to less toxic forms (**Reductases**)
- Repair heavy metal damage (**Repair enzymes**)

5. Biotechnological Applications

➢ **Protein production**: Plasmids can be engineered to express recombinant proteins, such as insulin, vaccines, and enzymes.

➢ **Gene therapy**: Plasmids can be used to deliver therapeutic genes to cells, treating genetic disorders.

➢ **Bioremediation**: Plasmids can be designed to confer heavy metal resistance or degradation capabilities, cleaning up contaminated environments.

➢ **Biofuel production**: Plasmids can be engineered to enhance microbial biofuel production, such as ethanol or butanol.

➢ **Biocatalysis**: Plasmids can be used to produce enzymes for industrial applications, like detergent production.

➢ **Biosensors**: Plasmids can be designed to detect specific chemicals or toxins, enabling biosensor applications.

➢ **Synthetic biology**: Plasmids can be used to create new biological pathways or circuits, enabling novel biotechnological applications.