# Bacterial Genetics

**Genetics** is the science that defines and analyzes heredity and variation. It aims to understanding the structure and functions of microbial genome, its gene products and their role in infection and disease. The unit of heredity is gene.

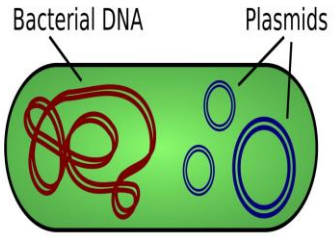
**The gene** is a segment or portion of DNA that carries in its nucleotide sequence information for a specific biochemical or physiological property, through coding for a single polypeptide sequence.

**Phenotype** refers to the observable properties (or characters) of an organism which are produced by interaction of genotype with the environment, i.e. the effect of both genes and environment. These include the structural and physiological properties of a cell or an organism (e.g. the eye color in human, resistance to an antibiotic in bacterium).

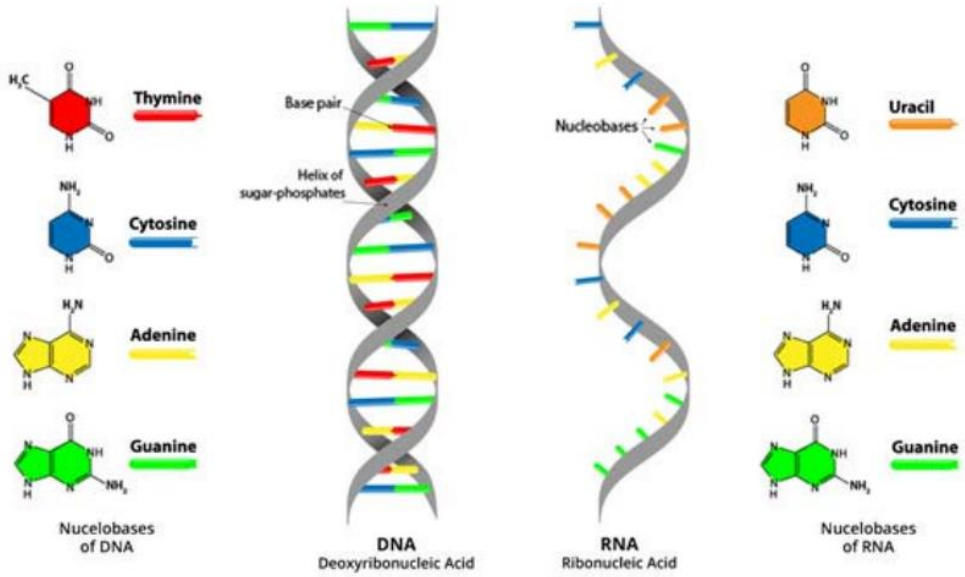
**Genotype** refers to the genetic constitution of an organism.

**Genome** is the sum of the genes of an organism, or the totality of genetic information in an organism.

Bacteria have two types of DNA that contain their genes, These are:
1 . Chromosome.
2 . Extra chromosome: Plasmid.




**DNA** : Is a long strand of nucleotides twisted together in pairs form a double helix. The two strands hold together by hydrogen bonds (complementary).
**Nucleotide DNA**:
1.Nitrogen bases (adenine ,thiamine ,Guanine ,cytosine)
2.Deoxyribose (pentose)
3.Phosphate.




**Nucleic acid:** Is a macromolecule composed of units called nucleotides. There are two types: Deoxyribonucleic acid DNA and Ribonucleic acid RNA.

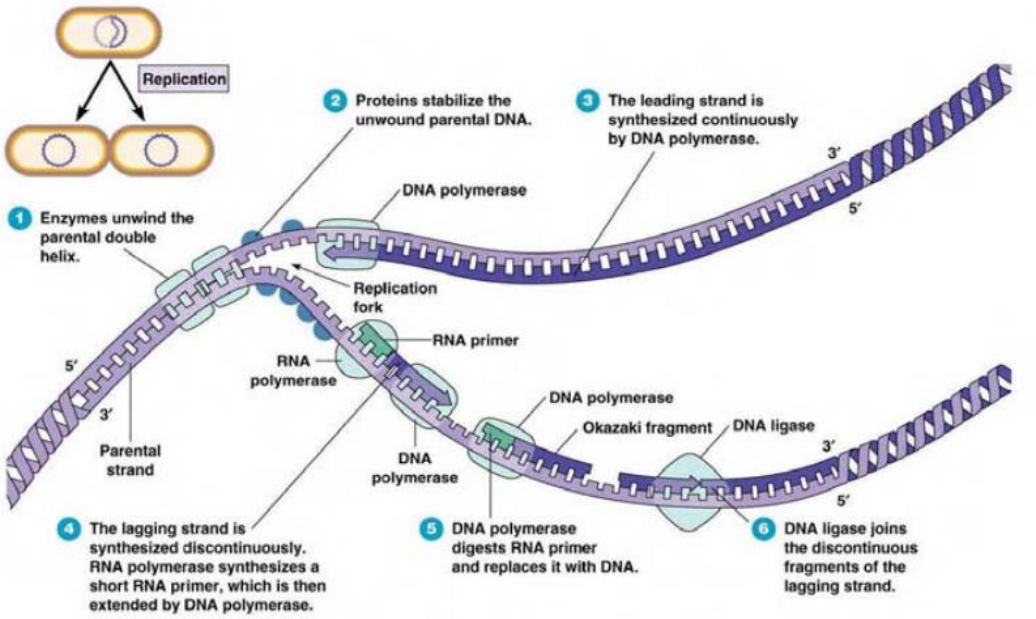
**Bacterial chromosome:** The bacterial chromosome is circular, double stranded DNA attached to bacterial cell membrane, occurs in cytoplasm. Most bacteria are defined as **haploid** with a single circular chromosome. e.g. in *E.coli*, the chromosome is circular ds-DNA molecule of approximately 4.6x106 base pairs. Although the chromosome exists free in the cytoplasm, it is compacted through super-coiling and looping of its structure. **The central function of genetics consists of expression of a gene from its locus on the chromosome or on a plasmid through transcription (production of messenger RNA) and finally translation: decoding of mRNA to produce a polypeptide.** The gene sequence and its subsequent expression through these biochemical pathways accounts for the phenotypic variation observed among bacteria.

**DNA Replication:** The two strands separate at replication fork, each strand acts as template ,synthesize by DNA polymerase and produce two new strands (semiconservative replication).The replication is in one direction or two direction.

**Features of DNA Replication:**

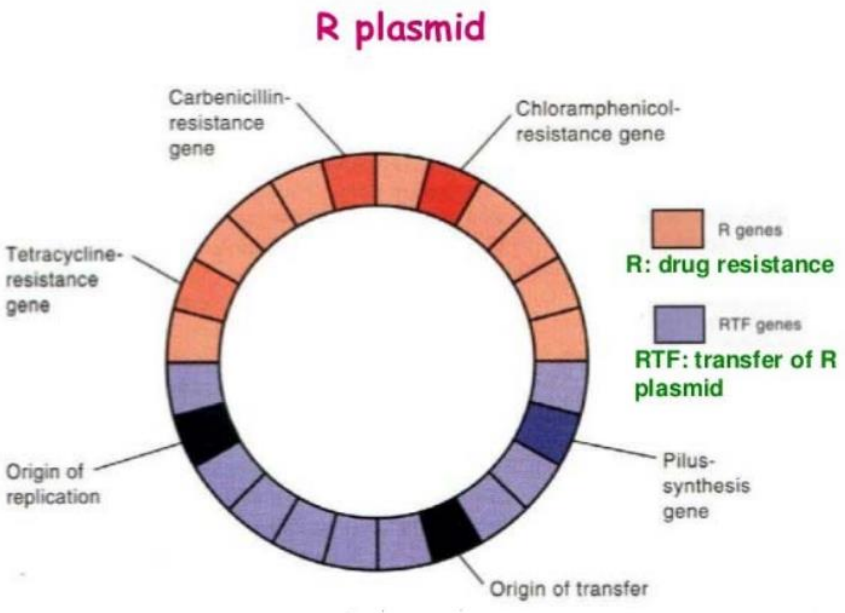
- Both strands serve as a template.
- synthesis is always 5'-3'
- leading strand synthesis is continuous, lagging strand synthesis is discontinuous.
- Each new DNA fragment requires an RNA primer.
- DNA synthesis cannot begin without a primer to add to. Some important enzymes.

- DNA Polymerase(synthesizes new DNA)
- Primase (makes RNA primers)
- DNA Ligase("stitches" fragments together)




## Extra-chromosomal DNA:

- **Plasmid:** Circular, extra-chromosomal DNA and self-replicated, found in bacteria and some fungi .They carrying genes that are not usually essential for the cell survival . Plasmids are self-replicating extra chromosomal DNA molecules. It multiplies independent of the host cell. Multiple copies of the same plasmid may be present in each bacterial cell. Different plasmids are also often present in the same bacterial cell. Plasmids code the genes of antibiotic resistance ,production of toxins and bacteriocins and degredating enzymes . The best example of plasmid is resistance factor or (R Factor) which consisting of : resistance transfer factor (RTF) , genes of plasmid replication and conjugation plus resistance genes (r-determinant) .




- **Transposons (jumping genes):** Small segment of DNA that can move from one region of the same chromosome or to a different chromosome or plasmid .They carrying genes of antibiotic resistance and toxin production.

**Mechanisms of genetic variation:**

- **Mutation:** Is a change in the nitrogenous base sequence of DNA; which leads to change in the product .The mutation may be neutral or disadvantage or beneficial.
- **Recombination:** Recombination occurs when sequences of DNA from 2 separate sources are integrated in bacteria, recombination includes an unexpected inheritable change due to introduction of new genetic material from a different cell. This genetic material can be introduce by: **Conjugation, Transduction or Transformation.**

**Transformation:** Genes transferred from one bacterium to another (naked DNA) in solution.

**Conjugation:** Requires contact between donor cell F+& Recipient cell F- .

**Transduction:** DNA is passed from one bacterium to another in bacteriophage (generalized and specialized).