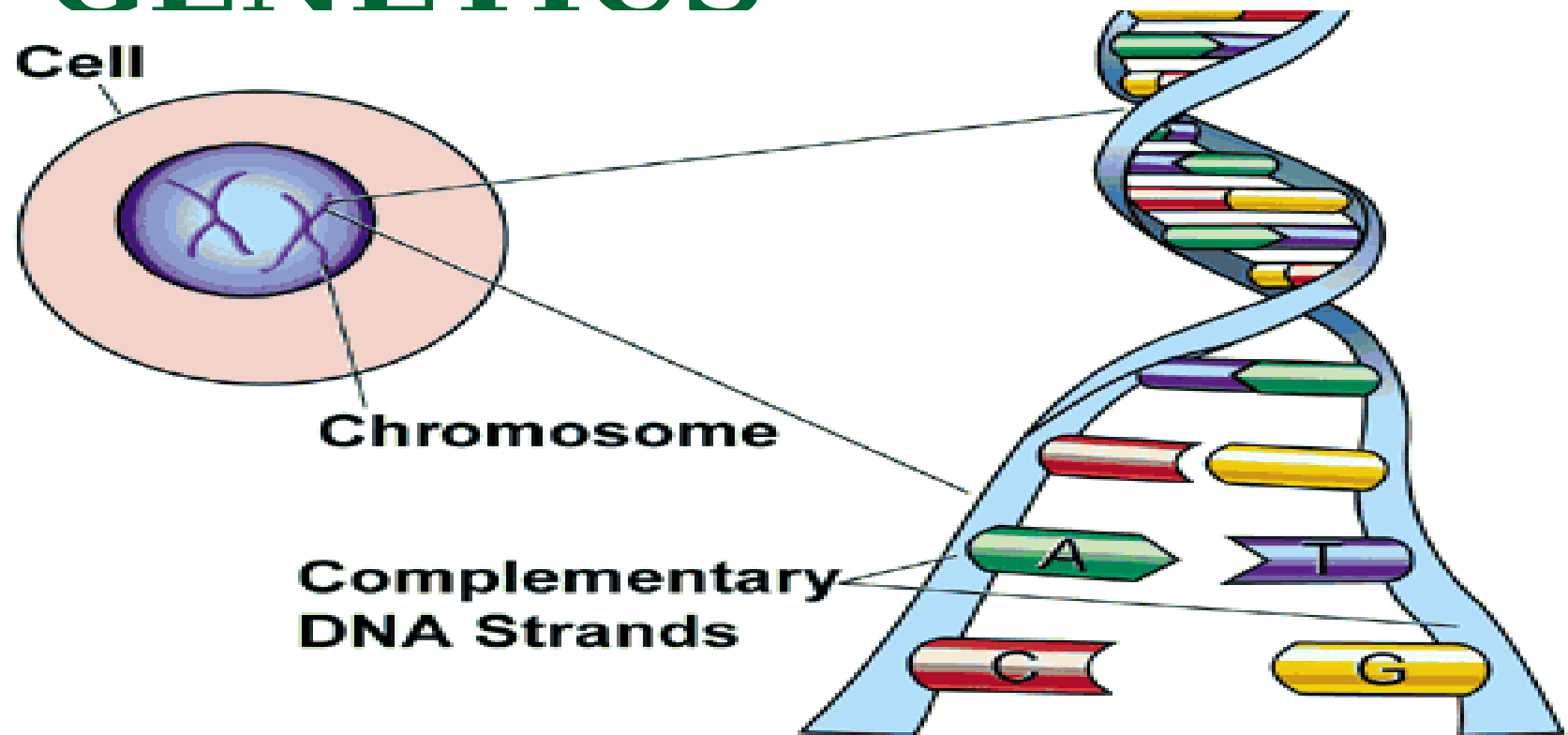


BACTERIAL GENETICS



Bacterial Genetics

- **Genetics** is the study of heredity and variation.

The unit of heredity is **gene**, which is a segment of DNA specifying for a particular polypeptide.

Introns - non coding sequences on a gene.

Exons - coding sequences on a gene translated into gene products.

- Bacterial genetics is used as a model to understand DNA replication, genetic characters, their changes & transfer to next generations.
-

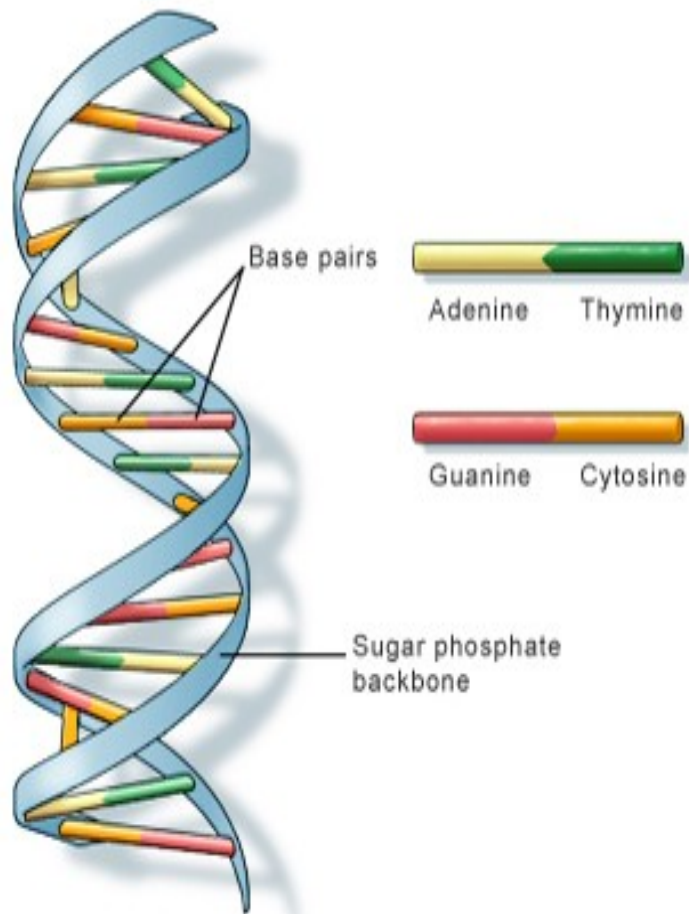
Nucleic Acids

- DNA (deoxy ribonucleic acid) : stores information for protein synthesis.
 - RNA (ribonucleic acid) : transcription & translation of information for protein synthesis.
 - Central Dogma : DNA → RNA → Protein
-

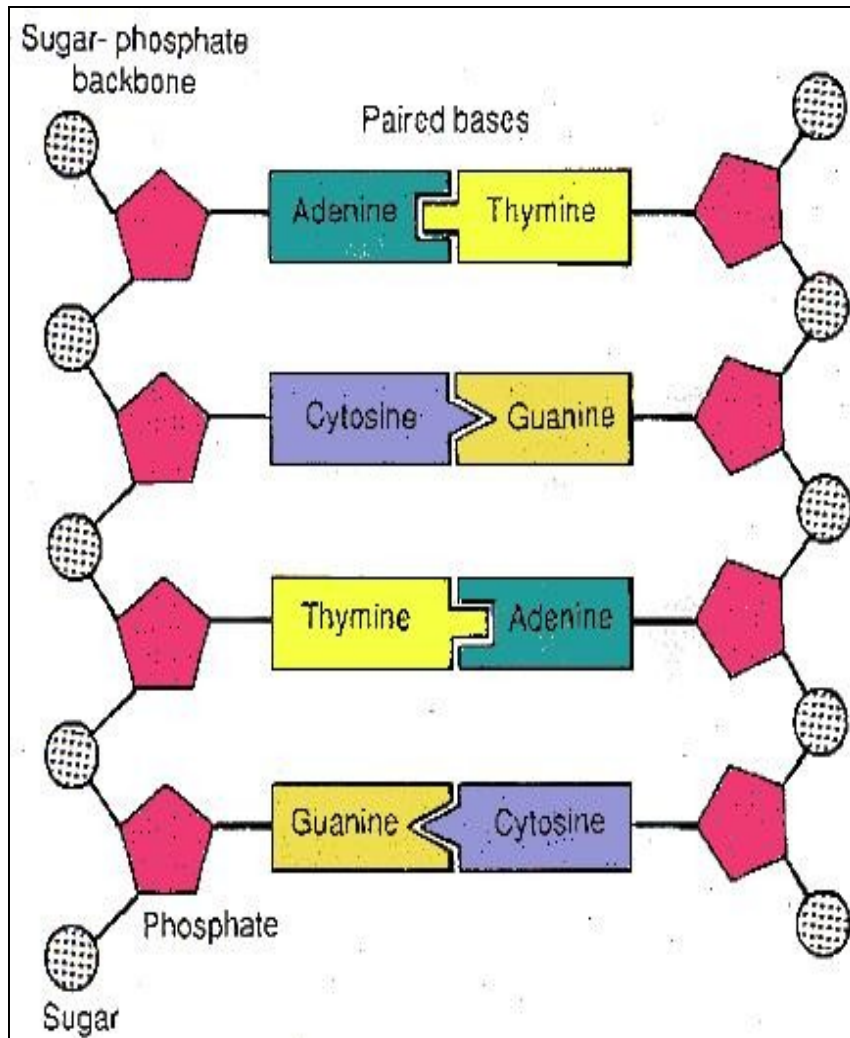
Structure Of DNA

- Proposed by **Watson & Crick**.
- Double helix model.
- Composed of 2 chains of polypeptides, each chain has a backbone of **deoxyribose sugar** and **phosphate** residues arranged alternately.
- 4 nitrogenous bases:

Adenine (A)		Purine
Guanine (G)		
Thymine(T)		Pyrimidine
Cytosine (C)		



U.S. National Library of Medicine



Double helical structure of DNA by Watson & Crick

Structure Of RNA

- Structurally similar to DNA, except for 2 major differences:
 - ❑ ribose sugar
 - ❑ uracil in place of thymine.

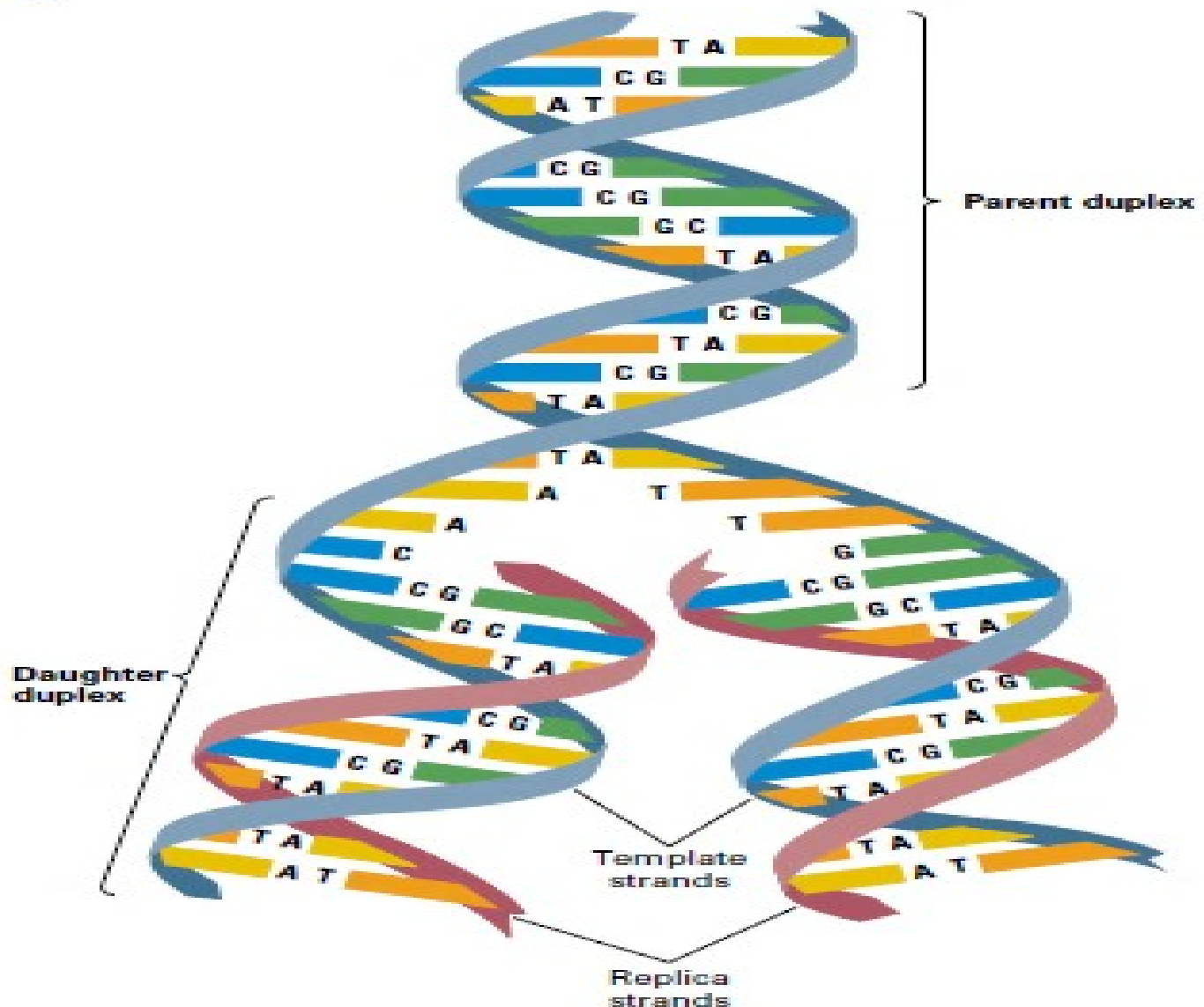
 - 3 types of RNA
 - ❑ m RNA (messenger RNA)
 - ❑ t RNA (transfer RNA)
 - ❑ r RNA (ribosomal RNA)
-

DNA replication

- One “parental” double stranded DNA molecule is converted to two identical “daughter” molecules.
 - one strand can act as a template for the production of the other strand
 - DNA replication requires enzymes.
 - When replication begins, the supercoiling is relaxed by **gyrase** and the two strands of parental DNA are unwound by helicase and separated from each other
 - Nucleotides are matched up to the exposed bases of the single stranded parental DNA.
-

Semi-conservative DNA

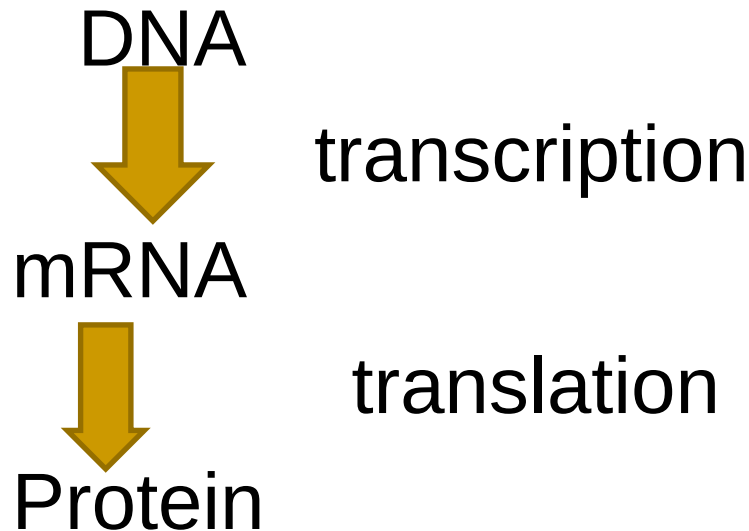
re (A) - -



Gene expression

What is gene expression?

- transcription: synthesis of RNA from a DNA template
- translation: formation of a protein (amino acid sequence) from RNA sequence
- The flow of genetic information is from:



Genetic Information In Bacteria

Chromosome

Carries properties like virulence, pathogenicity & resistance

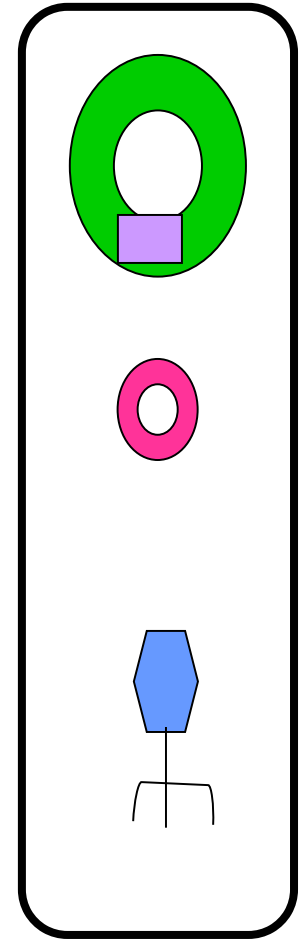
Plasmid

Extrachromosomal genetic material in the cytoplasm

Replicate independently

Bacteriophage

Virus infecting bacteria

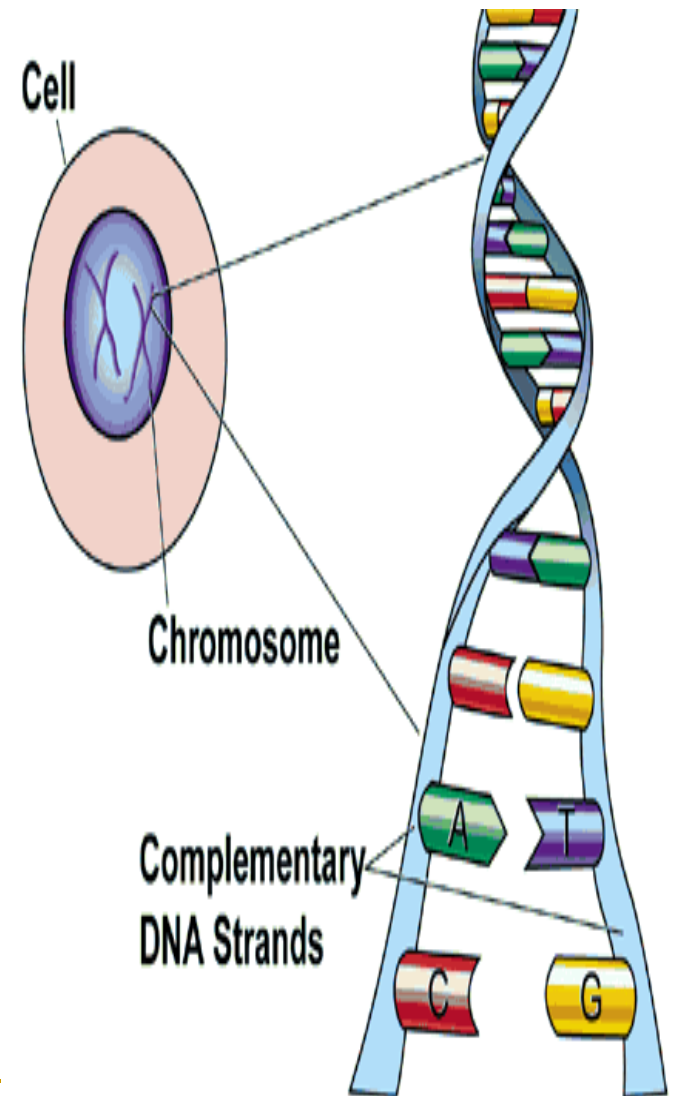


■ Chromosomes: - structures containing DNA

- ❑ Circular double stranded DNA.
- ❑ 3000 genes (3000 kilobases).
- ❑ Single copy per cell (→ haploid!)
- ❑ Highly folded in cell.

■ Plasmid

- ❑ Extra chromosomal genetic materials
- ❑ circular double strand DNA molecules present in the cytoplasm of bacteria, capable of **autonomous** replication.
- ❑ Circular double stranded DNA
- ❑ 1-100 genes (5-150 kilobases)
- ❑ 1-20 copies per cell

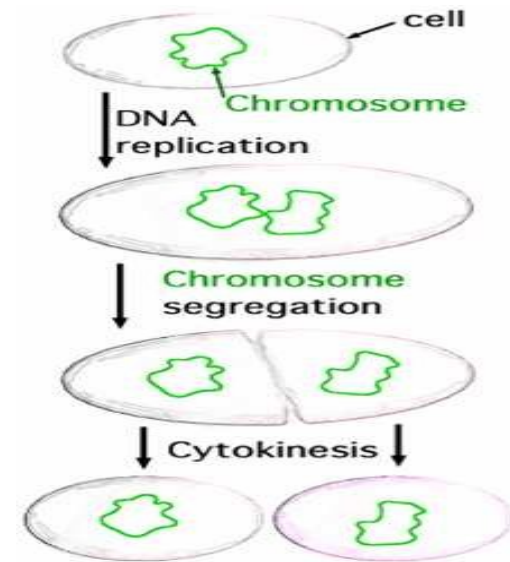


Genotypic & Phenotypic Variations

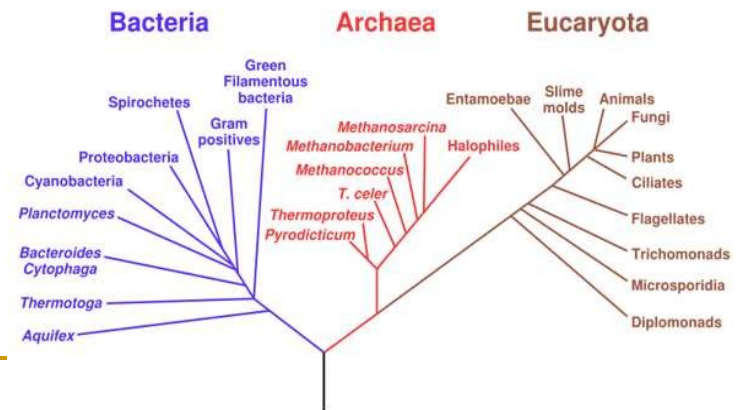
- **Genotype** – genetic constitution of a cell that is transmitted to its progeny
- **Phenotype** – physical expression of the genotype in a given environment
- **Variations**
 1. **Phenotypic variations** –
 - influenced by the environment
 - temporary & not heritable
 2. **Genotypic variations** –
 - Not influenced by the environment
 - Stable & heritable

Increasing Genetic Diversity in Prokaryotes

- Genetic information in prokaryotes can be transferred vertically and horizontally
- *Vertical gene transfer* – organisms replicate their genomes and provide copies to descendants.
- *Passing on genes to descendants.*
- *Horizontal gene transfer* – donor contributes part of genome to recipient that are not descendants; three types:
 - ❑ Transformation
 - ❑ Transduction
 - ❑ Bacterial conjugation



Phylogenetic Tree of Life

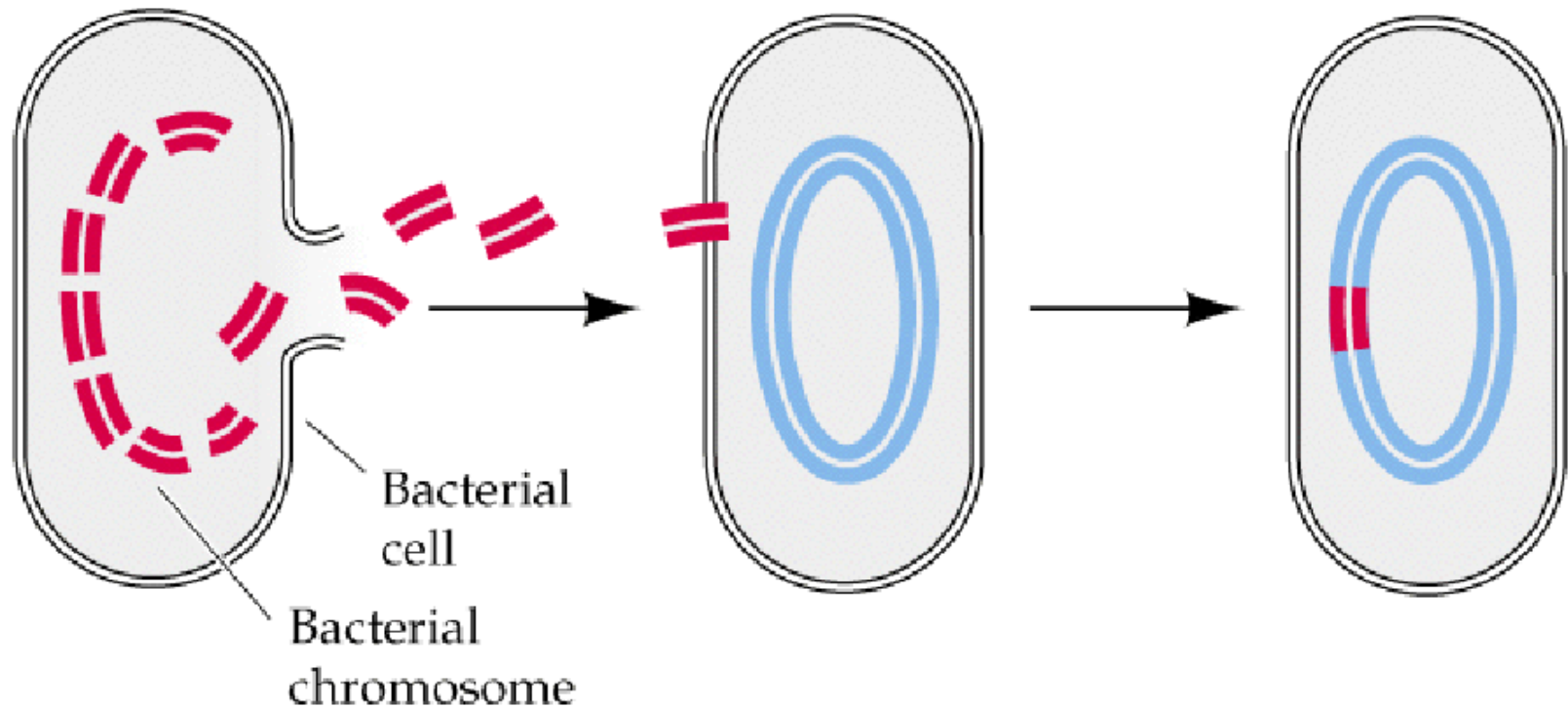


1. Transformation

- Naked DNA is transferred from one bacteria to another
- After death or cell lyses, some bacteria release their DNA into the environment.
- Other bacteria, generally of the same species, can come into contact with these fragments, take them up and incorporate them into their DNA by recombination.
- The genetically transformed cell is called a **recombinant** cell because it has a different genetic makeup than the donor and the recipient.
 - All of the descendants of the recombinant cell will be identical to it.
 - In this way, recombination can give rise to genetic diversity in the population.

Transformation

Transformation



Transduction

- Transfer of a portion of the DNA from one bacterium to another by a **bacteriophage**.
- Packaging error within the infected bacteria during the assembly of progeny phages – presence of a segment of host DNA along with the phage nucleic acid in the core of phage



Infection of another bacterium

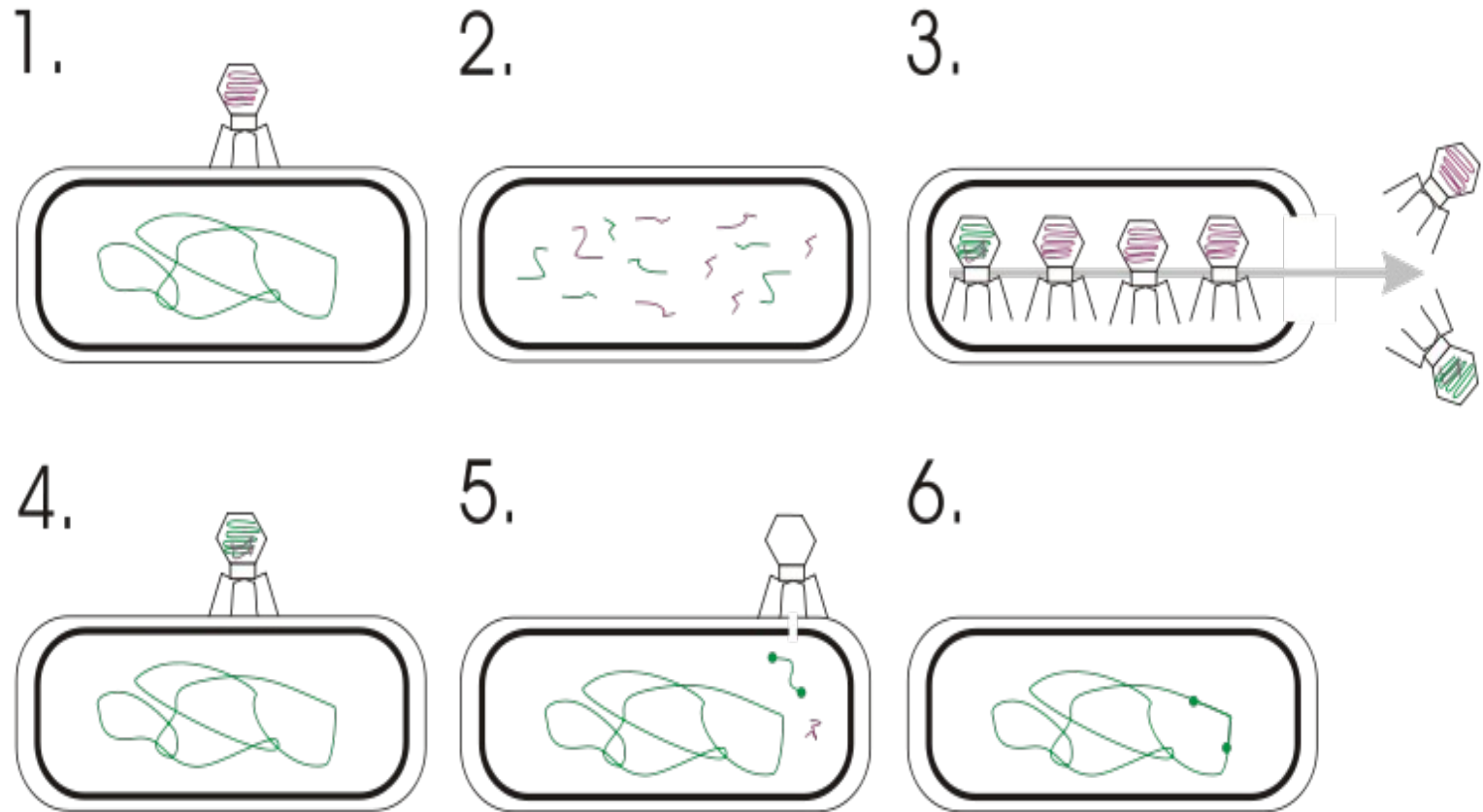


Transfer of host bacterial DNA to the new bacterium



Acquisition of new characteristics coded by the donor DNA.

Transduction

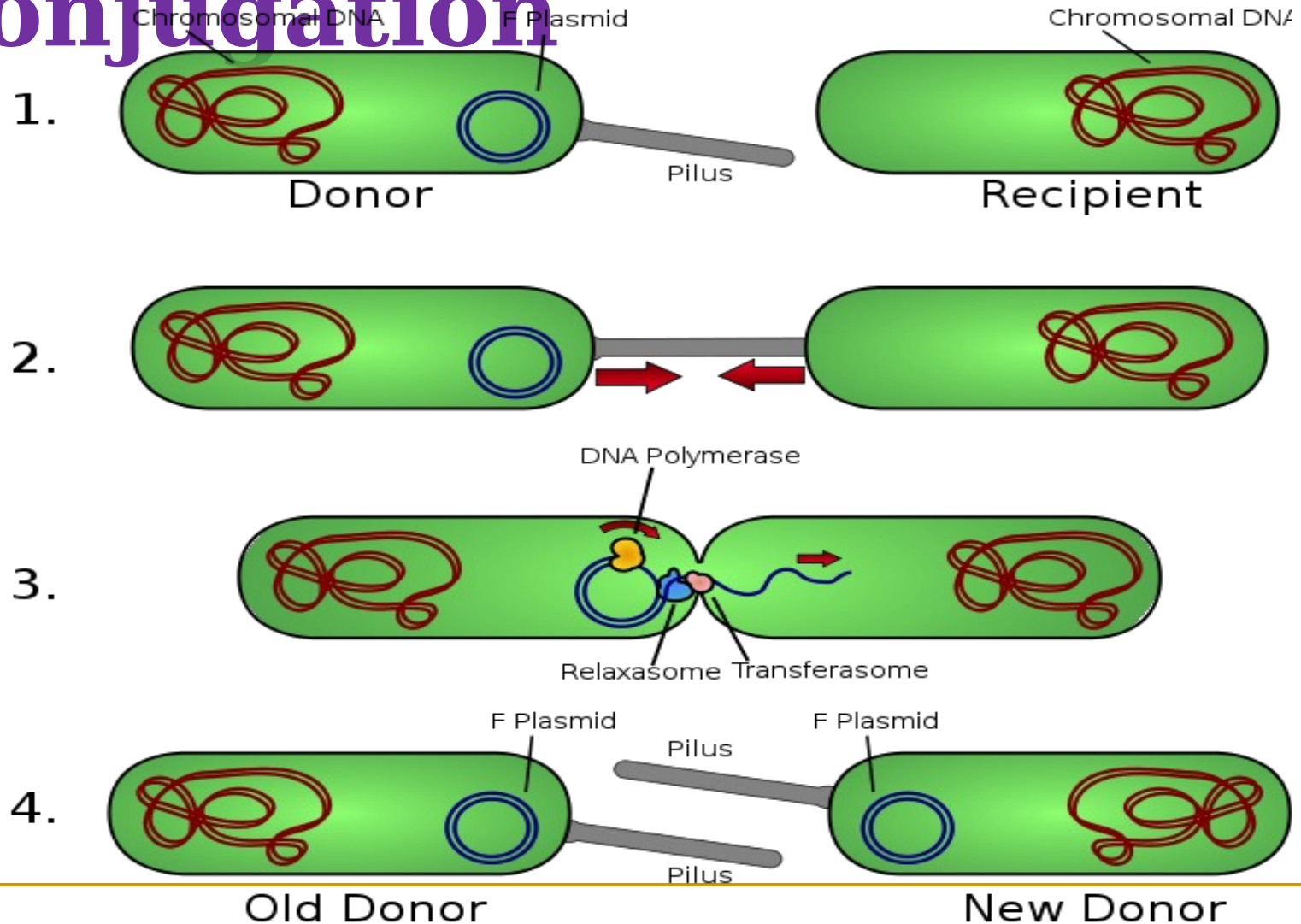


■ Bacterial DNA ■ Viral DNA

Conjugation

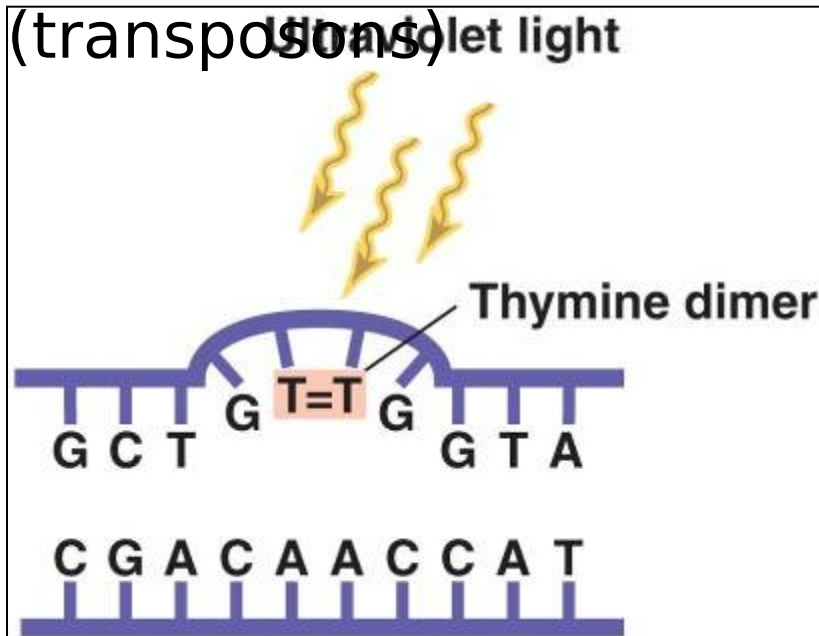
- DNA transferred from one bacteria to another by a sex pillus
- Bacteria that have a **F plasmid** are referred to as **F+ or male**.
- Those that do not have an F plasmid **are F- or female**.
- A conjugation event occurs when the male cell extends his sex pili and one attaches to the female.
- A donor or male bacterium passes DNA directly to a recipient or female bacterium by a **conjugation tube** (sex pili).
- The female bacterium attains donor status & in turn can conjugate with other female cells.
- Maleness is determined by the presence of a **plasmid** which codes for sex pili.
- The plasmid is called the **sex factor or fertility factor (F factor)**
- **R (resistance) factor** can also be transferred by conjugation

The process of Conjugation



Mutations

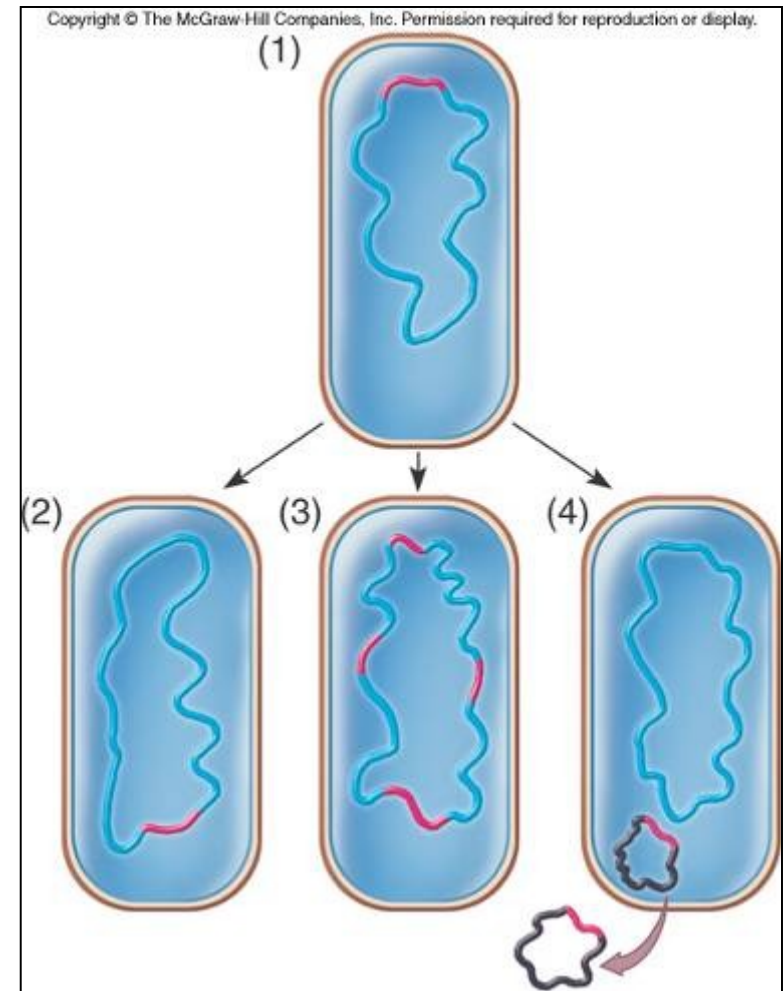
- Bases (nucleotides) are changed (base substitution)
- Bases are inserted or deleted
- Sequences of DNA move around the genome



- Result of natural processes or induced
 - Spontaneous mutations
 - heritable changes to the base sequence in DNA
 - result from natural phenomena such as radiation or uncorrected errors in replication
 - UV light is a physical mutagen that creates a dimer that cannot be transcribed properly

Transposons

- Special DNA segments that have the capability of moving from one location in the genome to another
 - “jumping genes”
- Can move from
 - one chromosome site to another
 - chromosome to a plasmid
 - plasmid to a chromosome
- May be beneficial or harmful
 - Changes in traits
 - Replacement of damaged DNA
 - Transfer of drug resistance



Mutation

- DNA is a highly stable molecule that replicates with amazing accuracy
 - ❖ Some errors of replication do occur
 - ❖ A mutation is defined as an inherited change in genetic information
 - Mutations are mistakes cells make when copying DNA.
 - Substitution, deletion, or insertion of a base pair in DNA.
 - Chromosomal deletion, insertion, or rearrangement.
 - A mutation in a gene product can result in a loss of function or a gain of function
-

Any Last questions ???

