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((Microbiology II))

Stage 2

Lecture 10

Bacterial Genetics

By

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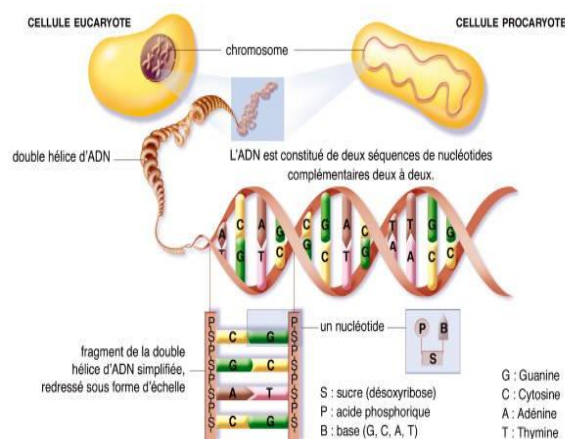
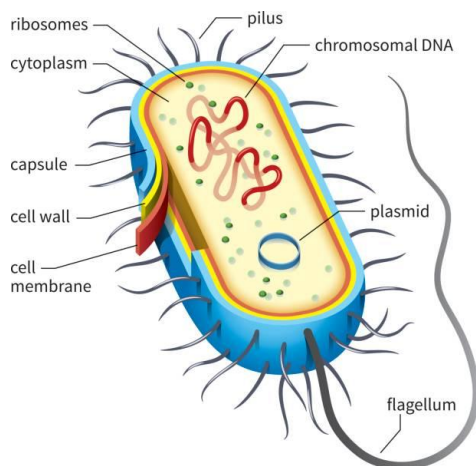
Bacterial Genetics

1. Introduction to Bacterial Genetics

- Bacteria are **haploid** organisms → one circular chromosome
- Genetics determines:
 - Metabolism
 - Antibiotic resistance
 - Virulence factors
- No nucleus → DNA in nucleoid region
- **Plasmids**: Extra-chromosomal DNA

2. Structure of Bacterial Genome

- **Chromosome**:
 - Circular, double-stranded DNA
 - No introns
- **Plasmids**:
 - Small, circular DNA
 - Replicates independently
 - Often carry antibiotic resistance genes (R plasmids), virulence genes





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3. Gene Expression in Bacteria

- **Transcription** and **translation** occur simultaneously (coupled)
- **Operons:**
 - Cluster of genes under control of a single promoter
 - Example: *lac operon*
- **Regulation:**
 - Inducible systems (e.g., *lac*)
 - Repressible systems (e.g., *trp*)

4. Genetic Variation in Bacteria

A. Mutation

- **Spontaneous or induced**
- **Types:**
 - Point mutations (silent, missense, nonsense)
 - Insertions/deletions
- **Causes:** Radiation, chemicals, replication errors

B. Horizontal Gene Transfer (HGT)

1. **Transformation** – Uptake of naked DNA from environment
 - Naturally competent bacteria: *Streptococcus pneumoniae*
2. **Transduction** – Transfer via bacteriophages
 - Generalized: Random DNA
 - Specialized: Specific genes near prophage site
3. **Conjugation** – Direct transfer via pilus
 - Requires F plasmid (fertility factor)
 - *Hfr strains*: F plasmid integrated into chromosome



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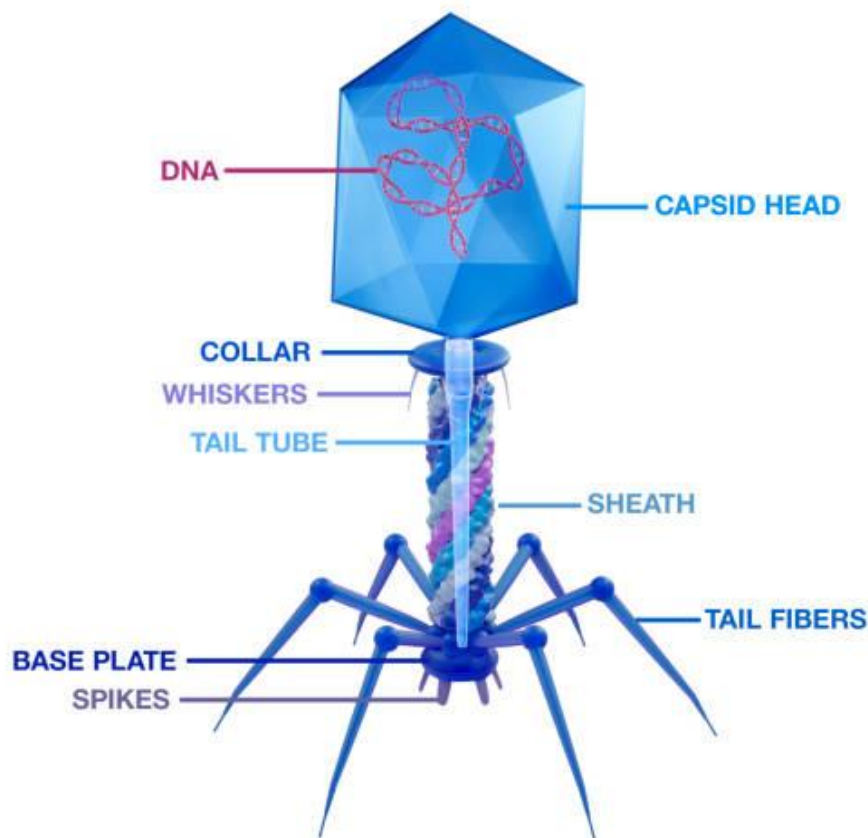


5. Mobile Genetic Elements

- **Transposons ("jumping genes"):**
 - Move within/between DNA molecules
 - May carry resistance genes
- **Integrans:**
 - Capture and express gene cassettes (common in resistance)

6. Bacteriophages & Lysogeny

- **Lytic cycle:** Virus replicates → lysis
- **Lysogenic cycle:** Viral DNA integrates (prophage)
- **Lysogenic conversion:** Prophage adds new traits to host (e.g., diphtheria toxin, botulinum toxin)





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7. Antibiotic Resistance Mechanisms

- Arise from mutation or HGT
- Mechanisms:
 - Enzyme inactivation (β -lactamases)
 - Altered targets (MRSA)
 - Efflux pumps
 - Reduced permeability
- Spread via **plasmids, transposons, integrons**

8. Practical Applications

- Genetic engineering (cloning, CRISPR)
- Gene therapy tools
- Biotechnology: insulin, vaccines
- Epidemiology: tracking resistance

9. Summary Table

Mechanism	DNA Source	Transfer Method
Mutation	Internal	Errors/Mutagens
Transformation	Environment	Naked DNA uptake
Transduction	Virus (phage)	Generalized/specialized
Conjugation	Another bacterium	Direct contact (pilus)