Microbial Genetics

Chapter 9
Genetics – the study of heredity

1. transmission of biological traits from parent to offspring
2. expression & variation of those traits
3. structure & function of genetic material
4. how this material changes
Levels of genetic study
Levels of structure & function of the genome

- **genome** – sum total of genetic material of an organism (chromosomes + mitochondria/chloroplasts and/or plasmids)
  - genome of cells – DNA
  - genome of viruses – DNA or RNA
- **chromosome** – length of DNA containing genes
- **gene**-fundamental unit of heredity responsible for a given trait
  - site on the chromosome that provides information for a certain cell function
  - segment of DNA that contains the necessary code to make a protein or RNA molecule
DNA structure

• 2 strands twisted into a helix
• sugar -phosphate backbone
• nitrogenous bases form steps in ladder
  – constancy of base pairing
  – A binds to T with 2 hydrogen bonds
  – G binds to C with 3 hydrogen bonds
• antiparallel strands 3’to 5’ and 5’to 3’
• each strand provides a template for the exact copying of a new strand
• order of bases constitutes the DNA code
Significance of DNA structure

1. Maintenance of code during reproduction. Constancy of base pairing guarantees that the code will be retained.

2. Providing variety. Order of bases responsible for unique qualities of each organism.
Semi-conservative replication of DNA
### Types of intermicrobial exchange

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<th>Type</th>
<th>Description</th>
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<td>conjugation</td>
<td>requires the attachment of two related species &amp; formation of a bridge that can transport DNA</td>
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<td>transformation</td>
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<td>transduction</td>
<td>DNA transfer mediated by bacterial virus</td>
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conjugation

(a, b) Process of Conjugation

(a) The pilus of donor cell (top) attaches to receptor on recipient cell and retracts to draw the two cells together.

(b) An opening or pore forms between the cell walls, thereby creating a bridge to transmit genetic material.

(c) F Factor Transfer

(c) Transfer of the F factor, or conjugal plasmid. A cell must have this plasmid to transfer chromosomal genes.

(d) Hfr Transfer

(d) High-frequency (Hfr) transfer involves transmission of chromosomal genes from a donor cell to a recipient cell. The donor chromosome is duplicated and transmitted in part to a recipient cell, where it is integrated into the chromosome.
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(c) F Factor Transfer

Bridge

F factor

Donor

Recipient

F +

F -

Chromosome

F factor

F factor being copied

F +

F -

Chromosome

(d) Hfr Transfer

Donor

Recipient

Bridge broken

Partial copy of donor chromosome

Integration of F factor into chromosome

Pilus

Donated genes

F factor

Chromosome

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(c) F Factor Transfer

Donor

F factor

Recipient

Bridge

Chromosome

F⁺

F⁻
(c) **F Factor Transfer**

**Bridge**

**Donor** \(F^+\)  

**Recipient** \(F^-\)

- **F factor**
- **Chromosome**

*F factor being copied*
Transfer of the F factor, or conjugative plasmid. A cell must have this plasmid to transfer chromosomal genes.
Conjugation

Video
(d) Hfr Transfer

Donor

Recipient

F factor

Integration of F factor into chromosome

Pilus

Hfr cell

Chromosome
(d) Hfr Transfer

Donor

Recipient

F factor

Integration of F factor into chromosome

Hfr cell

Pilus

Chromosome

Partial copy of donor chromosome
High-frequency (Hfr) transfer involves transmission of chromosomal genes from a donor cell to a recipient cell. The donor chromosome is duplicated and transmitted in part to the recipient cell, where it is integrated into the chromosome.
Hfr Conjugation

Video
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(c) Transfer of the F factor, or conjugative plasmid. A cell must have this plasmid to transfer chromosomal genes.

(d) High-frequency (Hfr) transfer involves transmission of chromosomal genes from a donor cell to a recipient cell. The donor chromosome is duplicated and transmitted in part to a recipient cell, where it is integrated into the chromosome.
"My God! They're at it again..."
transformation
Transformation

Video
Generalized transduction
Donor (host) chromosome

Phage incorporating piece of host DNA

Incorporated into chromosome

Parts of phage

Separated piece of host DNA

Lysis

DNA from donor

Incorporated into chromosome

Cell survives and utilizes transduced DNA
Cell A (donor)

(1) Phage DNA

Donor (host) chromosome

Separated piece of host DNA

Parts of phage

(2)
Parts of phage

Separated piece of host DNA

Phage incorporating piece of host DNA
Phage incorporating piece of host DNA

Lysis

(3)
Lysis

DNA from donor

Cell B (recipient)
DNA from donor

Cell B (recipient)

Incorporated into chromosome

Cell survives and utilizes transduced DNA
Transduction

Video
Specialized transduction

1. Prophage within the bacterial chromosome
2. Excised phage DNA contains some bacterial DNA
3. New viral particles are synthesized
4. Infection of recipient cell transfers bacterial DNA to a new cell
5. Recombination results in two possible outcomes.
Specialized Transduction

Video
It was on a short-cut through the hospital kitchens that Albert was first approached by a member of the Antibiotic Resistance.