

**Transposable Genetic Elements**

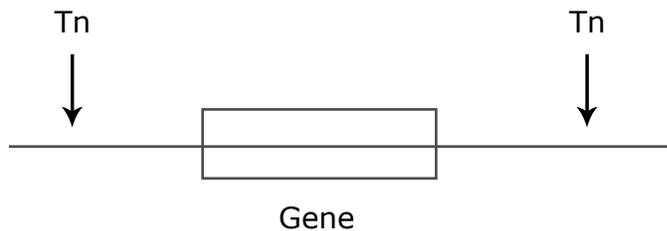
Sequences with the ability to integrate themselves into genomes. They can translocate themselves from one area of genome to another.

Properties

- Carry short, inverted (or direct) repeated sequences
- Code for transposase gene (tnp)
- Donor DNA → Recipient DNA one in every  $10^3$ - $10^8$  cell divisions a transposon will "jump"  
 → Most often highly mutagenic

Types

- 15-elements (insertion sequences)
  - ↳ Only gene is tnp
- Transposons: more genes (resistance factors or catabolic genes)

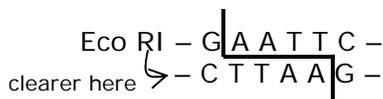


- 2 types of insertions
  - ↳ Tn "jumps" → excises itself & inserts in different location (copy of Tn "jumps")
  - ↳ Tn becomes integrated into plasmids or into temperate bacteriophage

**Viruses (in humans) & Phages (in bacteria)**

Definition: Parasites, important ecological regulatory agents → some of the main predators of bacteria.  $10^7$ - $10^8$  viruses/mL

- Infection is highly specific because viruses attach to specific surface structures (example: LPS, transporter proteins).
- Host defenses: Bacteria have restriction (RE) enzymes that chop up invading DNA pieces. REs recognize short sequence stretches. Example:



- Temperate Phages (Lysogenic): Insert themselves into genome after infection (& undergo replication with bacterial DNA). Excise & undergo the lytic cycle when host becomes stressed.

### Microbial Biology & Antibiotic Resistance

- Inhibit or kill other cells
  - Producers
  - Resistance
- Antibiotic resistance can be transferred between cells on plasmids, transposons, or phages
- Human gut:  $10^{11}$  cells/g fecal matter
 

Example:

  - Denmark 1994 – Vankomycin → 24 kg clinical  
– Ovaparicin → 24,000 kg agriculture
  - Vankomycin: one of the few antibiotics to kill *Enterococcus faecalis* & MRSA *staphylococcus aureus*.

### Mutation, Genetic exchange, Evolution

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- Mutation – heritable change in genetic material
  - Macrolesions
    - Deletions:
      - 12% of mutations
      - loss of function results
      - joining of previously disjoint genes (lateral gene transfer)
    - Duplications: One in every  $10^4$  cell doublings but typically very unstable
    - Inversions:
      - Flip orientation
      - e.coli – salmonella
    - Translocation: Rare except when transposons are involved
  - Microlesions
    - Point mutations (most deleterious but some)
    - “fine tuning” of function
    - “molecular clock” → rate of change of sequences is proportional to time

### Genetic Exchange

- Transformation = uptake of soluble DNA
- Transduction = by viruses
- Conjugation = direct transfer of plasmids

- Transformation
  - Competent cells (capable of up taking DNA).  
Example: staphylococcus ( $G^+$ )
    - density & age dependent
    - cells excrete competence factor, which is a small protein that diffuses into medium
  - Once competency is induced, cells produce a DNA binding protein and a nuclease.
  - A single strand is taken up & incorporated because less dangerous to cell is single.