Bacterial Genetics

BIT 220
Chapter 17
Bacterial Reproduction

• Reproduce asexually

• However, bacterial reproduction from one cell to another by:
  ➢ Transformation
  ➢ Conjugation
  ➢ Transduction
Crossing over in Bacteria

- Not like eukaryotes (at meiosis); no meiosis in bacteria
- Recombination not always reciprocal
- Products of genetic exchange not always recoverable
- Bacterial chromosome: 1, single main chromosome, carrying few thousand genes
Plasmids

• Extrachromosomal DNA molecule
• Transmission of plasmid DNA from one bacteria to another- produce new strains (a bacteria type is called a “strain”)
• Circular molecules with antibiotic resistance genes
• Genetic exchange can occur between main chromosome and plasmid
Recombination

• Unidirectional – material flows in one direction
• Donor strain – fragment of chromosome involved in a recombination event
• Recipient strain - strain that carries intact chromosome
• Recombination occurs in the recipient strain only – Figures 17.1 and 17.2
• Donor fragment linear; recipient chromosome circular
Terms

- **Transformation**: donor DNA molecule is taken up from the external environment and incorporated into the genome of the recipient cell
- **Conjugation**: direct contact between bacterial cells; DNA from donor to recipient
- **Transduction**: DNA goes from one bacteria to another via a phage
Growth of Bacteria

- Growth requirements: liquid media or on surface of nutrient media (agar plate)

- Colony: visible cluster of cells after several rounds of cell division

- Estimating the bacterial number: dilution series
Example

• Q: 100 colonies on a plate, diluted the bacterial suspension by a factor of $10^6$, and spread 0.1 ml on an agar plate, what was the concentration of bacteria in the original culture
Answer

- 100 cells on a plate x 10 (the number of 0.1 ml aliquots in 1 ml) x $10^6$ (the dilution factor) = $1 \times 10^9$ cells per ml

- $100 \times 10 \times 10^6 = 1 \times 10^9$
Bacterial Mutants

- **Antibiotic resistant mutants**: can grow on medium that contains antibiotic (amp, strep, tet, pen etc.) – sensitive mutants, opposite (cannot grow on antibiotic)

- **Nutritional mutants**:  
  - Prototrophic – can synthesize own nutrients from minimal media  
  - Auxotrophic - need a supplement added to media
Bacterial mutants (cont’d)

• **Carbon-source mutants**: cannot use certain substances or carbon atoms as energy sources
  – e.g., lactose mutants cannot grow on media containing the sugar lactose
  – Designation: needs arginine to grow, phenotype is Arg^- and genotype arg^- or arg
Tests for transformation/conjugation/transduction

- **Table 17.1**, page 421 and Figure 17.4
- Transformation – sensitive to DNAse treatment (DNA free in medium); DNA not free in medium in other 2 processes
- Conjugation requires (MAKE CHANGE IN YOUR COPY) cell-to-cell contact, so use U-tube; if recombination is disrupted in presence of DNAse, then cell-to-cell contact required
Transformation

- Cells must be competent (produce competent factor)
  - Calcium chloride
  - Electroporation
- Figures 17.6 and 17.7
- Called unidirectional
Conjugation

• Parasexual - mating that involves recombination of genetic information, but there is no meiosis/fertilization/zygote formation
• Genetic material - goes one way from one organism to another
• Figure 17.8 - 2 auxotrophs *E. coli* strains combine to form a phototroph
Conjugation

- Mechanism in Figure 17.8? - transformation or mating?
- NOT transformation - DNA from either strain A or B couldn’t transform other (remember transformation not normal - need competent cells)
- Proved physical contact between A and B (needed for conjugation)
F+ x F- Mating

- Strains one or other - Donor is F+; recipient is F-
- plasmid carries transferring DNA (F factor or fertility factor on plasmid)
- sex pili - appendages on bacteria surface; attach F+ cell to an F- cell
- Figure 17.9
Hfr Conjugation

- High frequency recombination
- Strain transfers many chromosomal genes to other strain, but not an F factor
- see Figure 17.10
- F factor integrates into chromosome at several sites
- facilitates transfer of genes to the recipient strain
Transduction

• (Note; skipping section on transduction and gene mapping)
• mediated by phage (bacterial virus)
• Virus injects the genes (stored in its capsid) from one bacteria to another)
• 2 types:
  – 1. Generalized - any part of the bacterial genome can be moved
  – 2. Specialized- restricted segments are transferred
Generalized Transduction

- Figure 17.17
- U-tube experiments ruled out transformation and conjugation (DNase and cell contact still produced prototrophs)
- any gene carried by the virus from one bacteria to another
- outcome successful (integration into recipient), abortive or unsuccessful
Specialized Transduction

- Figure 17.19
- Example bacteriophage \( \lambda \) (lambda) - Figure 17.18 - lytic and lysogenic cycles
- Lytic - destroys cell
- Lysogenic - integrates into genome (prophage)
Parasexual Reproduction and Disease

- Important for bacteria - to adapt to new toxins, new phage, new environments
- Bad for humans - new strains resistant to antibiotics
- 1990 - reappearance of TB in NYC - strain resistant to 7 antibiotics (related to strain in China)