20.106J – Systems Microbiology
Lecture 9
Prof. DeLong

- Elena & Lanski, National Review Genetics 4:457
- Marx et al. Flux Analysis
- For next lecture: Guest speaker Prof. Chris Marx from Harvard
  - Freezing generations of E. coli
  - Genetic material is not static – it's changing all the time. While it is preserved over time, there are also evolutionary mechanisms to automatically create variability.
- To cover today: Genetic Exchange in Bacteria
  - Homologous recombination
    - Promiscuous genetic exchange
  - Transformation
  - Plasmids and conjugation
  - Transposable elements
  - Transduction (virus mediated exchange)

- Three main mechanisms of gene exchange in bacteria:
  - Transformation
    - Extracellular DNA uptake
    - This was important historically in the discovery of what DNA actually is
    - DNA that's taken up can be used in different ways
  - Conjugation
    - Bacterial mating systems
    - This often involves pili
  - Transduction
    - Virally mediated gene exchange

- Slide: RecA mediated homologous recombination

- Slide: Tryptophan

- Slide: Transformation
  - Griffith's experiment in 1928: the rough morphotype can kill the mice in the presence of the dead smooth mophotype
  - Slide: experiment by Avery, MacLeod, and McCarthy (1944)
    - They repeated Griffith's experiment in fractions. They found that the DNA from the smooth morphotype was the essential part – not the protein
  - Some species undergo transformation more easily than others.
  - Slide: the binding mechanisms involved in transformation

- Conjugation

- Specialized pili involved, allowing the transfer of the DNA – the "pilus"
- Plasmids:
  - Extrachromosomal DNA, usually circular (the distinction is a little fuzzy these days
  - They encode the functions for the plasmid to replicate
  - When plasmids are lost it's generally because they fail to keep up with the cell's replication
  - There are high copy and low copy plasmids
  - Resistance can be placed on plasmids
  - Transposable elements and insertion elements
  - Plasmids are a conveniently plastic entity, which helps explain how bacteria can get so resistant to antibiotics so quickly.
  - F Plasmid
    - A lot of early studies made a lot of use of the F factor
    - It can incorporate itself into the cell's chromosome, creating an F' cell (the original origin of replication ends up in the middle)
    - It encodes for a sex pilus, allowing conjugation. $F^- \rightarrow F^+$
    - Creation of an F' strain
    - Hfr Strains
    - We can map out how long the gene transfer takes in minutes
    - High resolution Mapping using Hfr strain

- Movie: bacteriophage T4
  - Temperate phage and lysogeny
  - Phage conversion
  - In some cases phage make cells pathogenic
  - Specialized transduction (in phage lambda)
    - Picks up genes that are flanking the pro-phage
  - Generalized transduction: sometimes the phage makes a mistake and packages the E. coli DNA instead of the phage DNA

- DNA transposition and transposons
  - Mobile genetic elements
  - Bacterial transposable elements
  - Transposon formation
  - Strategy for transposon mutagenesis
  - Mobile elements