I. Goals in Molecular Evolution
   - Molecular markers
   - Molecular evidence of phenotype evolution
   - Gene/genome evolution for its own sake

II. Evolution of DNA Sequences
   - Neutralist-selectionist debate
   - Neutralism best explains
     - Reduced consequences of mutation means greater chance of variation and divergence
     - High rates of change at the third-base positions
     - Noncoding sequences (e.g., introns)
     - Pseudogenes

III. Experiments
   - Ballard & Kreitman (1995) studied mtDNA in *Drosophila*
     - Showed that changes in frequency of certain mt haplotypes (i.e., p, q) were too fast to be explained by GD
   - Dykhuizen & Hartl (1980) studied *Escherichia coli*
     - Showed

IV. Detecting NS from DNA
   - Tajima (1989)
     - calculate \( k \)
     - Calculate \( S \)
     - \( d = k - S \)
       - \( d = 0 \) means
       - \( d > 0 \) =
       - \( d < 0 \) =
   - Hudson et al. (1987)
     - Compares two or more loci and contrasts intraspecific polymorphism with interspecific divergence
     - If polymorphism and divergence are proportional,
     - If there is more polymorphism than expected from the level of spp. divergence, then
     - If there is less polymorphism than expected from divergence, then
V. Transposable Elements

- Defn = genes that move among different sites in the genome, causing mutations in other genes as they do so (Barbara McClintock 1948)
- TEs are usually dubbed “genomic parasites”, but they can be advantageous
  - E.g., many bacteria carry TE genes for antibiotic resistance
- Selfish DNA = TEs exist to replicate themselves autonomously, not for the benefit or demise of the host genome
- TEs are held in check because of the strong selection against the mutations they cause in the host genome

VI. Evolution of repetitive elements

- Noncoding, highly repetitive DNA can account for more than 90% of eukaryote genomes, yet
- Highly repetitive sequences build up in chromosomal areas with low recombination rates where

  - The effect of these rep. sequences on fitness is still not known

VII. Evolution of novel genes

- Mutation
- Duplication
- Single gene that serves many functions
  - E.g.,

  - Exon shuffling =