Definitions of the Gene

BIT 220
Chapter 15
A typical Gene

• **Figure 15.1**
  
  • Prokaryotic Gene
    – Initiator and terminator codon
    – All done in cytoplasm
    – Transcription and translation coupled
  
  • Eukaryotic Gene
    – Exons and introns; nucleus and cytoplasm
    – Cap and poly A+ tail
Genes

• Focus in chapter on *complementation test*: controls the synthesis of one polypeptide or one mRNA molecule

• **Figure 15.4**: Beadle and Tatum: led to one gene – one enzyme theory
  • Need only inorganic salts, simple sugar and biotin (vitamin)
Recombination

• Within a gene – Oliver in the 40s

• *Drosophila melanogaster* – fruit fly – genetic organism of choice

• Showed that genes could recombine between single nucleotide pairs (figures 15.5 and 15.6)
Colinearity

• **Figures 15.7, 15.8 and 15.9**
• Nucleotide sequence co-linear with polypeptide sequence
• First three bases in DNA is first amino acid in polypeptide, etc.
• Introns do not invalidate this colinearity
Complementation test for a Gene

- **Figures 15.10 and up**
- **Terms to know:**
  - wild-type – “normal” allele
  - Cis – same chromosome
  - Trans – opposite chromosome
  - Cis heterozygote – $a^+b^+/ab$
  - Trans heterozygote - $ab^+/a^+b$
Gene Definition

• Knew about 1 gene-1 enzyme, but how to know if a mutation was on same or different gene?

• Complementation test for function allelism (Ed Lewis, 1942)

• begin with Figure 15.11

• Position effects - + designation for wild-type
Gene Name Designation

• With Mendel, used dominant gene - e.g., Tall and short would be T and t (learned in 120)
• Now reclassified, would be S and s (named after mutant or recessive allele)
• Fruit flies - white gene, normal eye red, so called $w^+$; apricot mutation, $w^a$
• human gene designations later
Complementation

• Lewis’ experiment - **Figure 15.11**
• fruit fly important genetic organism
  – white locus (where a gene is on a chromosome)
  – apricot mutation (apr in this textbook, now proper designation is $w^a$)

$\text{apr w/apr}^+ w$ - designation for 2 chromosomes (slash mark), give red eyes.  ; $\text{apr w}^+/\text{apr}^+ w$ - light apricot eyes (go over Fig. 15.11 here)
Mutations on the same Gene

- Following looking at Figure 15.11:
- If apricot and white were on different genes, the eyes would be red
- Why? Because the wild-type allele in each case would be dominant over the mutant allele, so they eyes would be wild-type color (red), but they are not.
Lewis’ Discovery

• The *cis-trans* position effect
• This led to complementation test or *trans* test of functional allelism
• can determine if mutations with same or similar phenotypes are in the same or different genes.
Cis or Cis-trans test

- Cis test important control (Figure 15.2)
- phenotype wild-type whether mutation on same or different chromosome
- Trans test (Figure 15.13) - phenotype mutant if both mutations on same chromosome (15.13a); phenotype wild-type if mutations on 2 different genes.
Limitations

• Complementation tests only work with simple genes and normal dominant/co-dominant relationships

• Not useful in dominant mutations, or for multigenic traits
Complex Gene-Protein Relationships

- **Figure 15.8** - family of proteins from a single gene

- **Figure 15.9** - antibody genes