CONCEPT: CROSSING OVER AND RECOMBINANTS

Gamete Genotypes

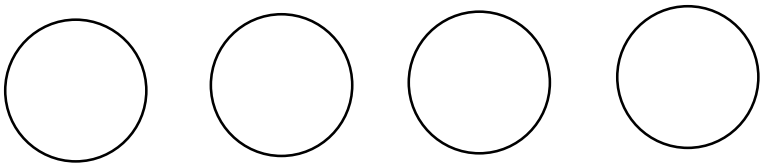
● Mendel's law of independent assortment states that the alleles of two genes assort independently

EXAMPLE:

Genotype AaBb

Phenotype Yellow Round

What are the genotypes of the gametes?



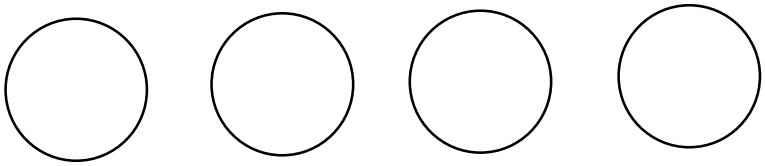
□ If the two genes are on the same chromosome, then they are physically linked and sorted into gametes

EXAMPLE:

Genotype $\frac{A \quad B}{a \quad b}$ AB/ab

Phenotype Yellow Round

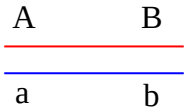
What are the genotypes of the gametes?



□ **Crossing over** is the physical breaking and rejoining of sections of homologous chromosomes

EXAMPLE:

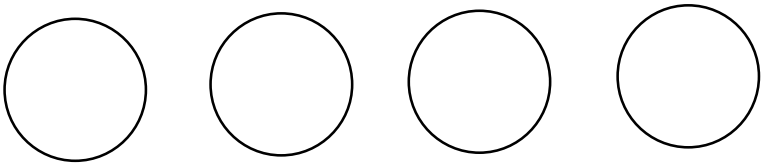
Genotype



AB/ab

Phenotype Yellow Round

What are the genotypes of the gametes?



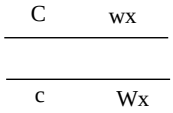
Discovery of Crossing Over

● Many studies have supported the idea of crossing over between homologous chromosomes

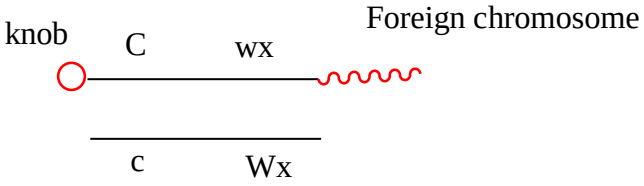
□ McClintock and Creighton studied two traits of maize (corn)

- Their corn was heterozygous for color (Cc) and starchy (Wx) / waxy (wx)

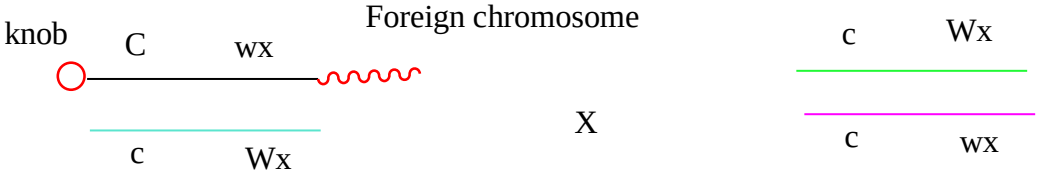
- Chromosomes were:



□ One of the plants homologous chromosomes had two added markers



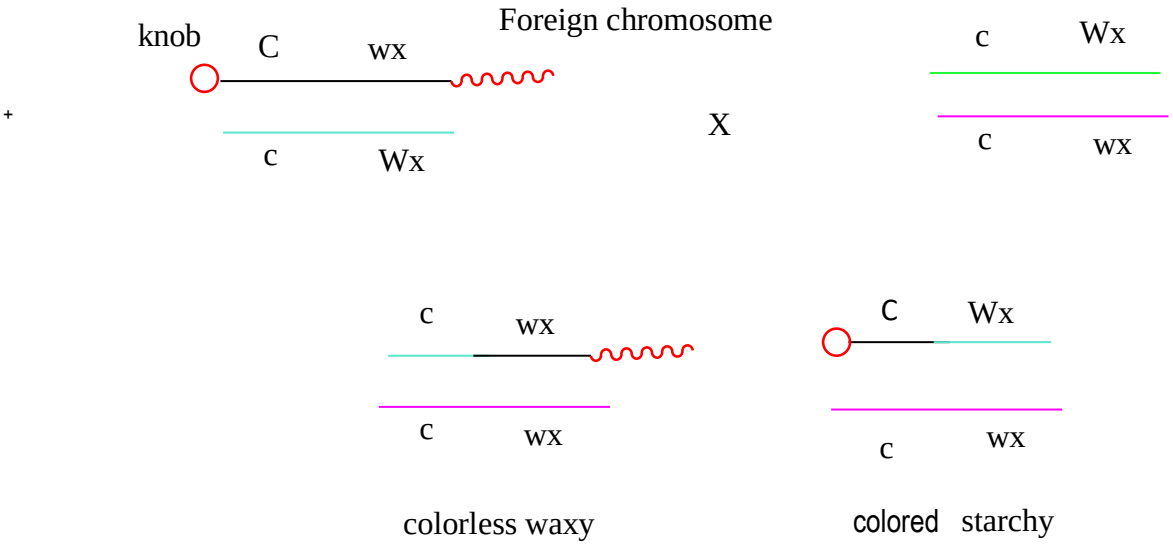
□ They mated their chromosome with a colorless, starchy plant



□ Many plants looked like the parental types, but some were **recombinant**

- **Recombinant** describes a mixing between the two parents (genotypes or phenotypes)

- The chromosomal markers identified the recombinant offspring



□ The second major study was from Thomas Hunt Morgan and Alfred Sturtevant

- The studies fruit flies with two traits: Eye color, and wing length
  - Color is red if p+ or purple if pp
  - Wings are long if vg+ but short if vg vg (vestigial)

□ Morgan's cross went like:

P: p+/p+ vg+/vg+ x p/p vg/vg

Gametes p+ vg+ p vg

F_1 p+/p vg+/vg

F_1 x tester p+/p vg+/vg x p/p vg/vg

Expected Offspring Ratios:

_____ p+ (red) _____ Long wings _____ red/long wings

_____ vestigial _____ red/vestigial

_____ p (purple) _____ long wings _____ purple/long

_____vestigial _____purple/vestigial

Observed Offspring Ratios:

Genotype	Phenotype	Offspring total (2839)	Types
p+ vg+	Red, Long wing	1339	Parental
p vg	Purple, vestigial	1195	Parental
p+ vg	Red, vestigial	151	Recombinant
pr vg+	Purple, long wing	154	Recombinant

- There was 10.7% recombinant ((151+154)/2839) instead of the predicted 50%

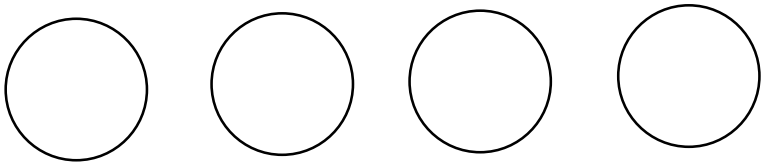
□ Alfred Sturtevant figured out why it wasn't equal

- It was because the two genes were on the same chromosome

Genotype $\frac{p+ \quad vg+}{p \quad vg}$ p+p/vg+vg F_1

Phenotype Red eyes and long wings

What are the genotypes of the gametes?



- But what is the significance of the 10.7% recombination?

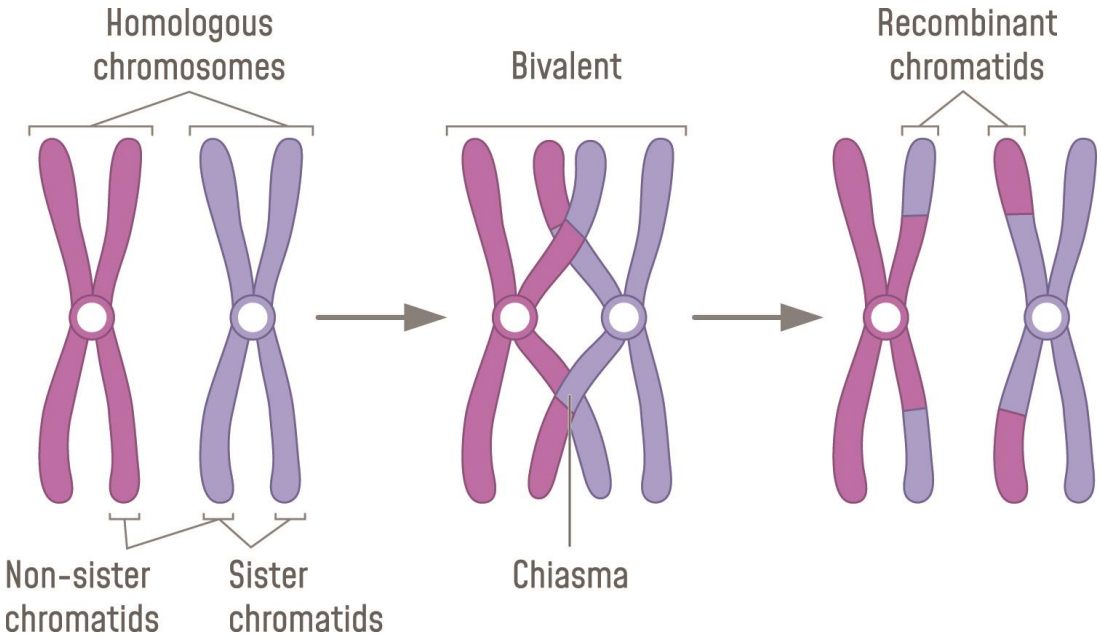
  - It is because the area between the two genes is 10.7% of the length of the chromosome

  - So we say these two genes are 10.7 **map units** apart

Crossing Over Terminology

- Crossing over occurs between two _____
  - □ Crossing over occurs between two chromatids
    - **Sister chromatids** are two copies of the same chromosome
    - **Non-sister chromatids** are two copies, one from each homologous pair
  - □ During Meiosis, homologous pairs line up and undergo crossing over
    - **Tetrads** is the term describing the four paired chromatids
    - **Dyads** is a pair of two chromatids
    - **Bivalent** refers to the pair of homologous chromosomes
    - **Chiasmata** is the structure that forms between dyads during crossing over
      - Usually between non-sister chromatids, but can also occur between sister

EXAMPLE:



□ Linked genes have certain terminology

- **Cis conformations** means that dominant alleles of two genes are on the same chromosome
    - AB/ab or ++/ab
- **Trans conformation** means that two different alleles of two genes are on the same chromosome
    - Ab/aB or +b/+a

□ Linked alleles are written differently

- Alleles on the same homolog have no punctuation between them (Ab instead of A/b)
- The "/" separates to homologs, instead of two genes
- If linkage is unknown you write like A/a · B/b

PRACTICE:

1. Which of the following gametes can be formed from the genotype AaBb if AB and ab are linked?
    a. AB, ab
    b. Ab, aB
    c. Aa, Bb

2. An experiment that was performed found the recombination frequency between two genes was 12.5%. What is the distance (in mapping units) between two genes?
    a. 25
    b. 6.25
    c. 12.5
    d. 10

3. Which of the following terms describes two copies of the same chromosome?
    a. Non-sister chromatids
    b. Sister-chromatids
    c. Bivalent
    d. Dyads