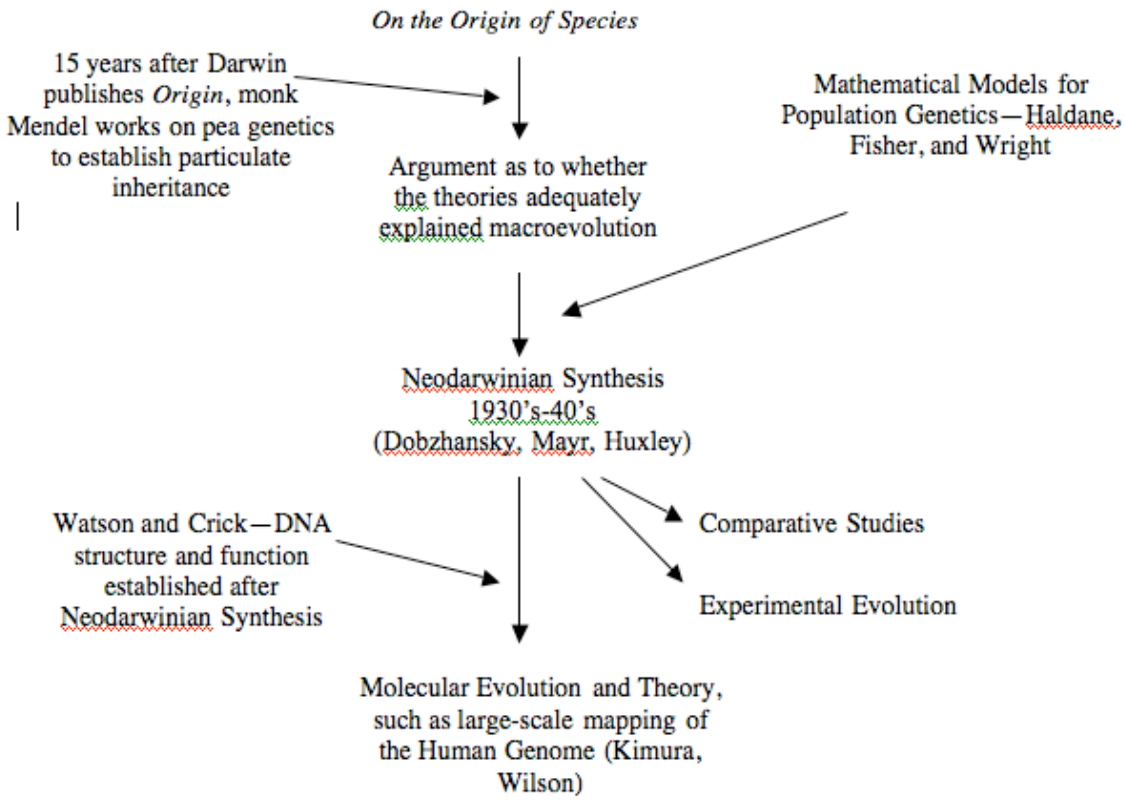
Biology 1B—Evolution Lecture 3 (March 1, 2010), Neodarwinian Synthesis

After *On the Origin*…

When Darwin and Wallace jointly published their paper on natural selection, they began a new era of evolutionary study. While their work was important, they were still wrong about inheritance, a process which they believed was the result of blending of traits.



Mendel's Principles

- Alternative forms of genes, known as alleles, account for variation
- Offspring individuals inherit two copies of parents' DNA in most cases (these are known as diploid organisms)
- If the possible alleles of a gene differ, one *may* be dominant (meaning that it would mask the phenotypic expression of the other allele)
- Two alleles for a heritable trait segregate during meiosis, usually independently of other traits (except for case of linked genes, which are close together on the chromosome)
- Dominant alleles mask all other phenotypes (known as recessive), but there is also the case of co-dominance—think of one red and one white flower making a pink flower, or look at the examples below

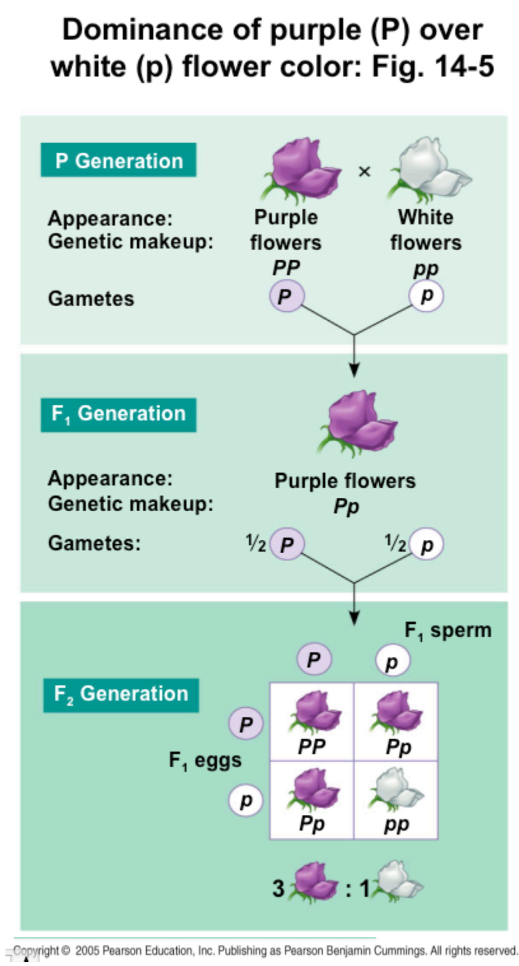


Figure 14.5 (pg. 266, 8th edition)

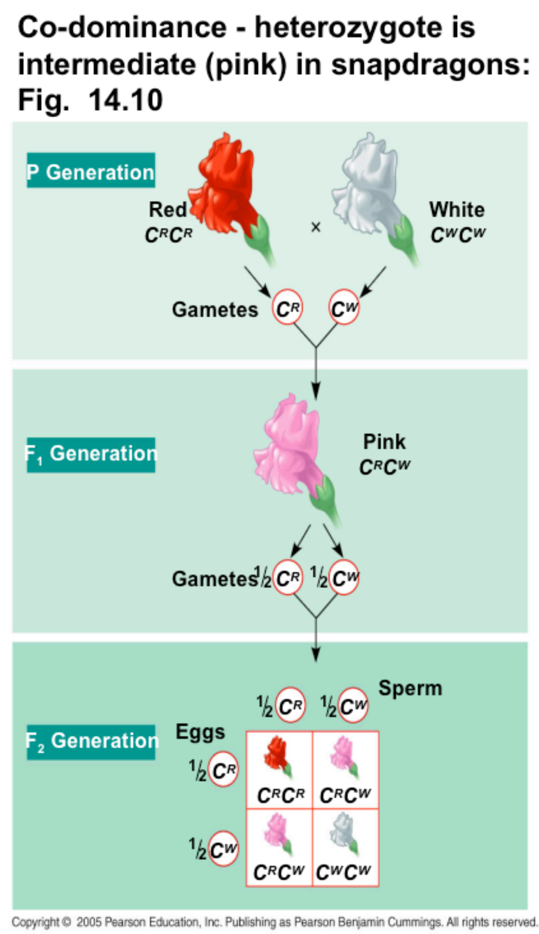


Figure 14.10 (pg. 272, 8th edition)

Alleles	Genotypes	Possible Phenotypes
A	AA	Dominant
	AB	Codominant Dominant
B	BB	Recessive

In this case, AA and BB are known as *homozygous* (same allele type) and AB is known as *heterozygous.*
Examples of *recessive* traits in humans: Albinism, cystic fibrosis
Examples of *dominant* traits in humans: achondroplasia (one form of Dwarfism), Huntington's chorea
Example of *codominant* trait in humans: Sick-cell anemia

Population Genetics

- A population, in genetic terms, is a randomly breeding group of individuals that is largely isolated from others
- Key evolutionary processes: mutation (the only source of variation), sampling processes (also known as genetic drift), the various forms of natural selection, exchange of genes through migration, and non-random mating

Mathematical Models—Hardy-Weinberg Equilibrium

Example of a natural population of flowers:

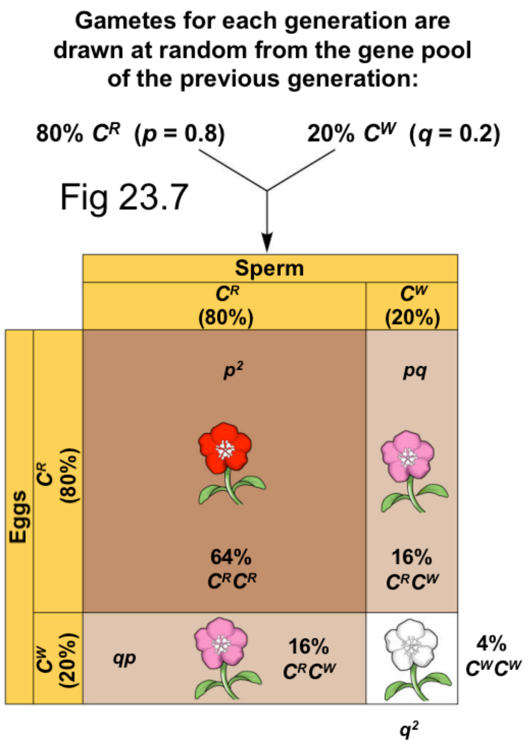


Figure 23.7 (pg. 474, 8th edition)

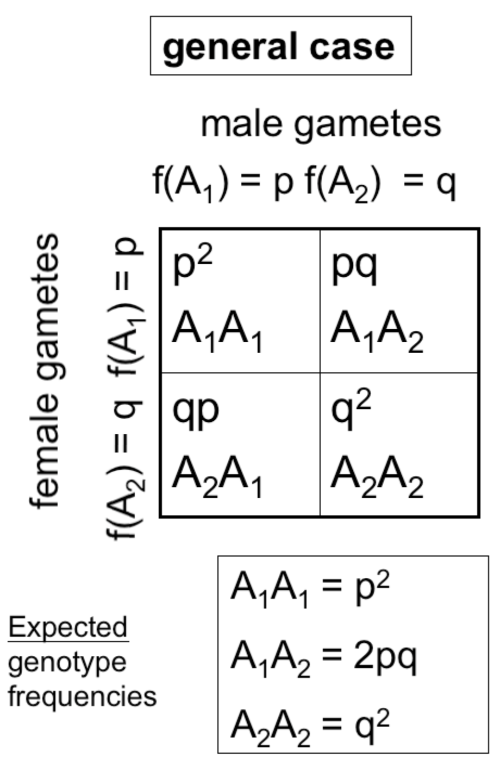
Phenotype Frequency		Genotype Frequency	
Red Flowers	320	C^RC^R	0.64
Pink Flowers	160	C^RC^W	0.32
White Flowers	20	C^WC^W	0.04

Allele Frequency

$p=f(C^R)=0.8$

$q=f(C^W)=0.2$

Now, the general case:



Expected proportions:

$p^2+2pq+q^2=1$

Also, $p+q=1$ because there are only two possible alleles

$f(A_1) = p^2+1/2(2pq) = p(p+q) = p$, meaning that the next generation will in theory have the same gene frequency as that of the parents

Conclusions from Hardy-Weinberg math: Inheritance alone does not cause the frequency of alleles to change between generations (better known as evolution)
This is because Hardy-Weinberg acts on these assumptions:

- Random mating only for this gene/trait
- No mutation or selection on population in question
- This is an isolated population with no gene flow from outside (i.e. no migration)
- This is only true for a large population with no sampling error

Based on these assumptions, we can call Hardy-Weinberg a *null hypothesis* for evolution. That means that if a population does not conform to Hardy-Weinberg Equilibrium for a certain trait, then evolution has occurred.

Example of HWE as a Null Hypothesis:
Wild Oats—

Genotype Frequency	
0.548	A_1A_1
0.071	A_1A_2
0.381	A_2A_2

Note that there are far fewer heterozygotes than HWE would predict. Some explanations for this would be that the wild oats do not practice non-random mating, or that heterozygotes are selected against in the environment the oats inhabit.