



HARDY – WEINBERG PRINCIPLE

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HARDY – WEINBERG PRINCIPLE

- A population that is not changing genetically is said to be at **Hardy–Weinberg equilibrium**
 - The assumptions that underlie the Hardy–Weinberg equilibrium are
 - population is large
 - mating is random
 - There is no migration (no immigration or emigration)
 - There is no mutation of the alleles
 - natural selection is not acting on the population. (all genotypes have an equal chance of surviving and reproducing)
 - Sets up a reference point at equilibrium
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HARDY-WEINBERG & EVOLUTION

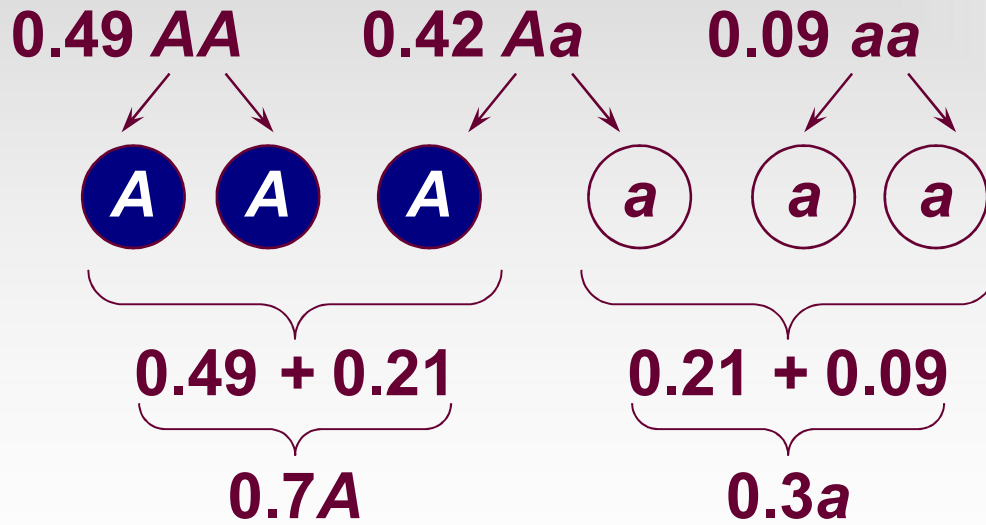
- Biologists can determine whether an agent of evolution is acting on a population by comparing the population's genotype frequencies with Hardy–Weinberg equilibrium frequencies.
- If there is no change in frequencies, there is no evolution
- Conversely, if there have been changes in the frequencies, then evolution has occurred.
- Evolution is change of allelic frequencies

HARDY - WEINBERG

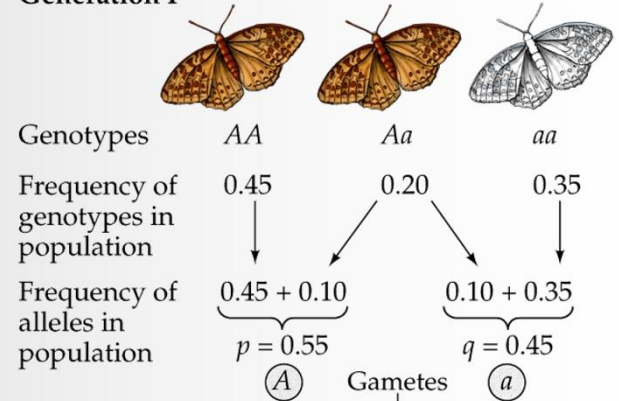
- In a population at Hardy–Weinberg equilibrium, allele frequencies remain the same from generation to generation, and genotype frequencies remain in the proportions $p^2 + 2pq + q^2 = 1$.
- Two equations
 - $p + q = 1$
 - $A + a = 1$, where A and a equal gene percentages
 - All dominant alleles plus all recessive alleles add up to all of the alleles for a particular gene in a population
 - **Allele frequencies**
 - $p^2 + 2pq + q^2 = 1$
 - $AA + 2Aa + aa = 1$
 - For a particular gene, all homozygous dominant individuals plus all heterozygous individuals plus all homozygous recess individuals add up to all of the individuals in the population
 - **Genotype frequencies**

TWO EXAMPLES OF HARDY WEINBERG

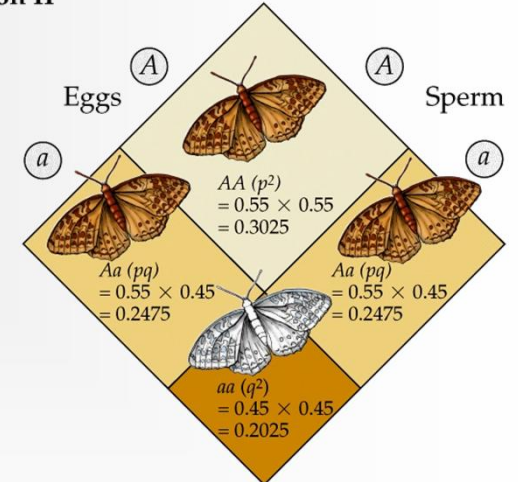
	p A	q a
p A	AA (p^2)	Aa (pq)
q a	Aa (pq)	aa (q^2)






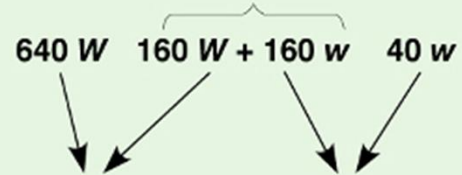
Generation I

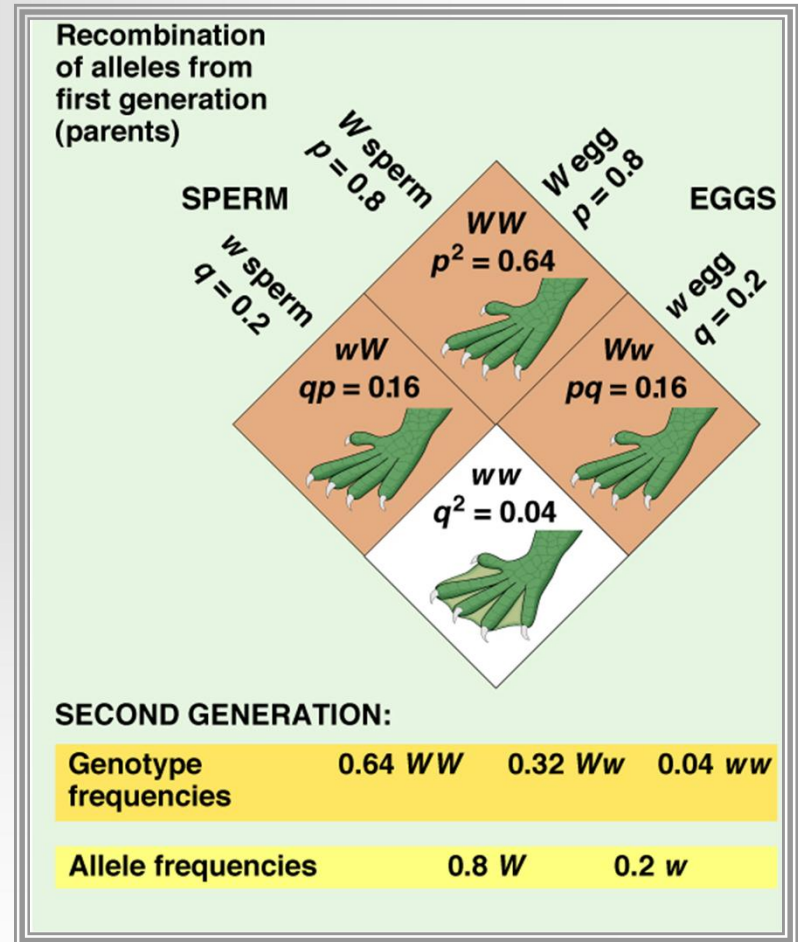


Generation II



HARDY-WEINBERG

Phenotypes			
Genotypes	WW	Ww	ww
Number of animals (total = 500)	320	160	20
Genotype frequencies	$\frac{320}{500} = 0.64$	$\frac{160}{500} = 0.32$	$\frac{20}{500} = 0.04$
Number of alleles in gene pool (total = 1000)			
Allele frequencies	$\frac{800}{1000} = 0.8 W$	$\frac{200}{1000} = 0.2 w$	



PROBLEM

- Given: In a population of 100 individuals (200 alleles), sixteen exhibit a recessive trait.

- Problem:

- Find the allele frequencies for A and a.
- Find the genotypic frequencies of AA, Aa, and aa.

- Allele frequency

- $p + q = 1$ or $A + a = 1$
- $?/200 + 32/200 = 200/200$ (You need total alleles)
- $?% + 16% = 100%$ or $16% = aa$ and $84% = AA + Aa$
- $aa = qq$ or $q^2 = .16$ or $q = .4$
- $1 - q = p$ $1 - .4 = .6$ or $A = .6$ and $a = .4$

HARDY - WEINBERG PROBLEM

- Phenotypic frequencies
 - If: $p = .6$ and $q = .4$, then
 - $p^2 = (.6)(.6) = .36$
 - $q^2 = (.4)(.4) = .16$
 - $2pq = 2(.6)(.4) = .48$
- Therefore, in the population:
 - Homozygous dominant = $36/100$ or 36%
 - Heterozygous dominant = $48/100$ or 48%
 - Recessive = $16/100$ or 16%




ANOTHER PROBLEM

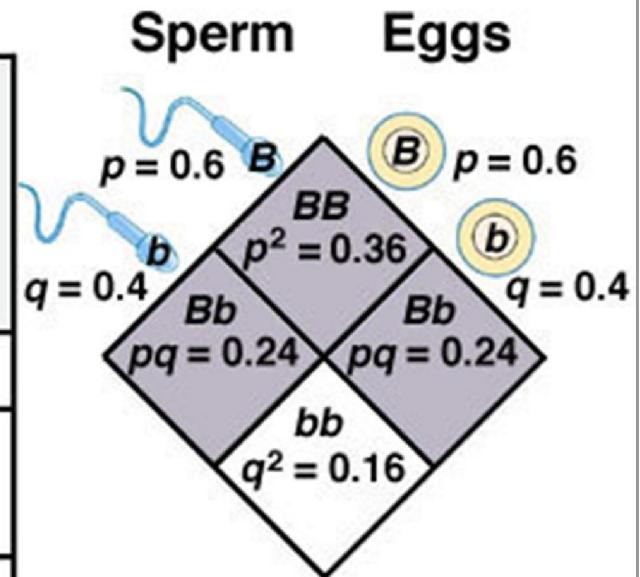
- Fraggles are mythical, mouselike creatures that live beneath flower gardens.
 - Of the 100 fraggles in a population, 91 have green hair(F) and 9 have grey hair(f).
 - Assuming genetic equilibrium:
 - What are the gene frequencies of F and f ?
 - What are the genotypic frequencies?
-

ANSWERS TO PROBLEM

- Gene frequencies:
 - $F = 0.7$ and $f = 0.3$
 - Genotypic frequencies
 - $FF = 49\%$ or 0.49
 - $Ff = 42\%$ or 0.42
 - $ff = 9\%$ or $.09$
-

HARDY-WEINBERG EQUILIBRIUM

Phenotypes			
Genotypes	<i>BB</i>	<i>Bb</i>	<i>bb</i>
Frequency of genotype in population	0.36	0.48	0.16
Frequency of gametes	$0.36 + 0.24 = 0.6B$		$0.24 + 0.16 = 0.4b$



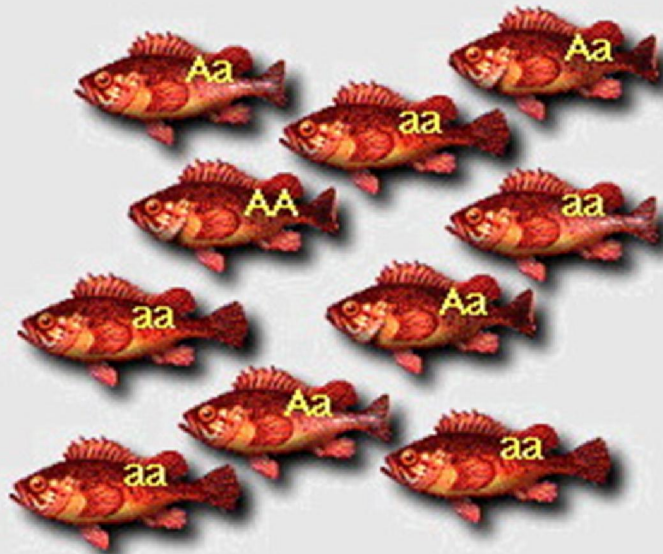
ALLELE FREQUENCY VARIATIONS

- Hardy-Weinberg applies only if there is genetic equilibrium or NO allele frequency changes
- Causes of allele frequency variations
 - Mutation
 - Migration
 - Non-random mating
 - Genetic drift
 - Natural selection
- How often in nature do **NONE** of these occur?
 - Rarely, if ever.

GENOTYPE & ALLELE FREQUENCIES

Population Genetics

A Population's Gene Pool is Characterized by its Genotype and Allele Frequencies

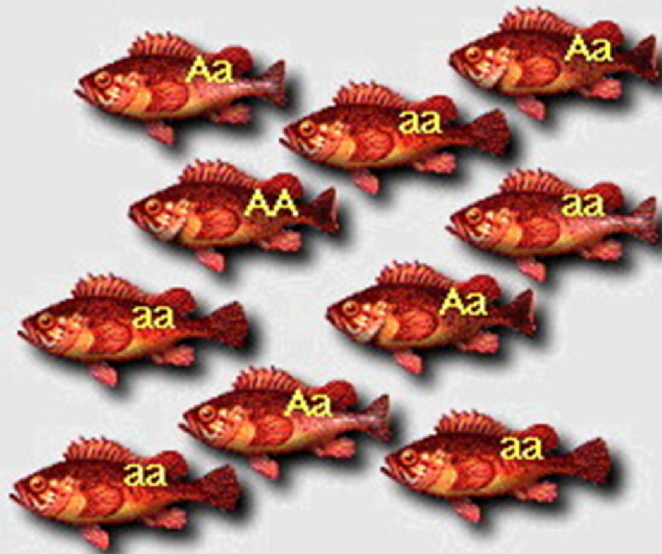


Examine the gene pool of this population and then answer the following questions by clicking on the correct answer.

GENOTYPE & ALLELE FREQUENCIES

Population Genetics

A Population's Gene Pool is Characterized by its Genotype and Allele Frequencies



1. What is the frequency of the AA genotype in this population?

10%

30%

40%

50%

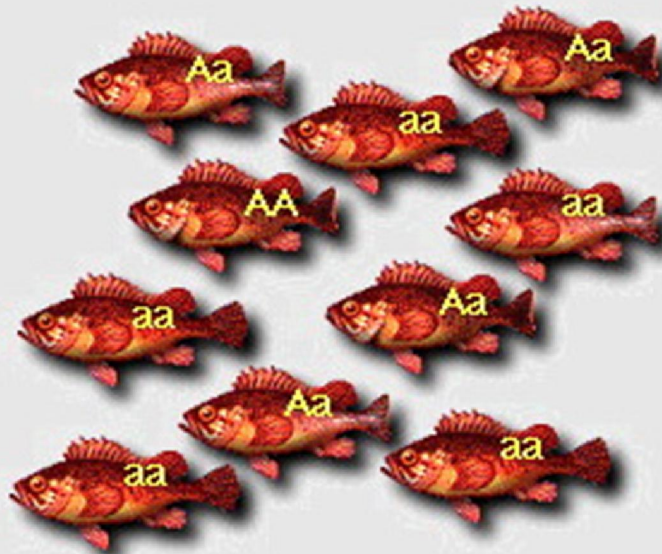
60%

70%

GENOTYPE & ALLELE FREQUENCIES

Population Genetics

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2. What is the frequency of the Aa genotype in this population?

10%

30%

40%

50%

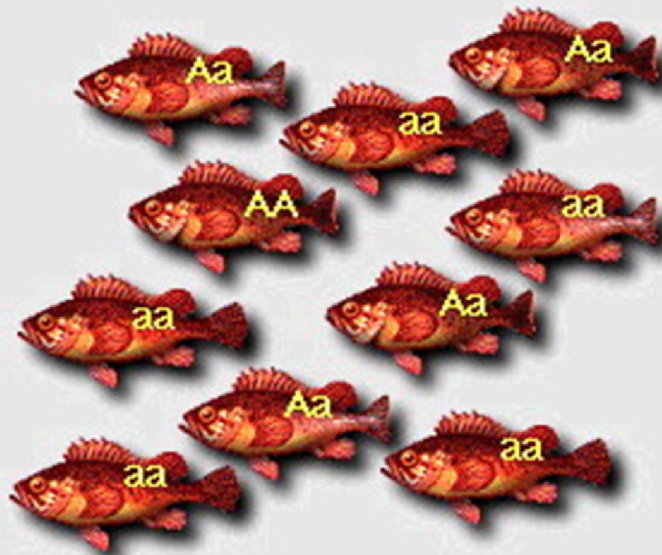
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GENOTYPE & ALLELE FREQUENCIES

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3. What is the frequency of the aa genotype in this population?

10%

30%

40%

50%

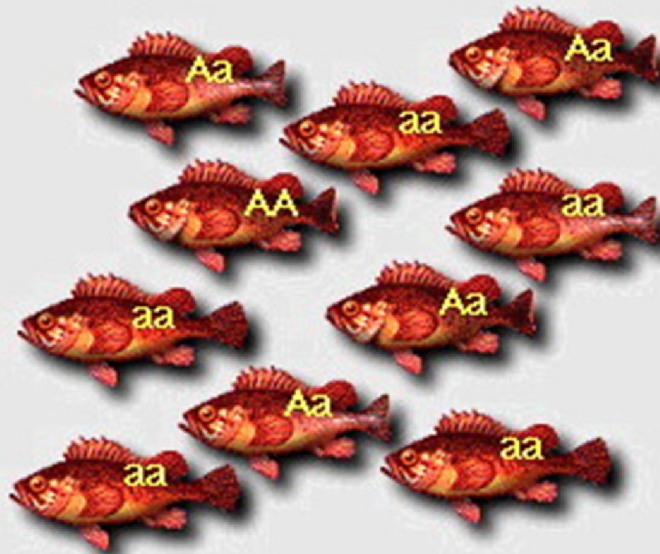
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GENOTYPE & ALLELE FREQUENCIES

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4. What is the frequency of the capital A allele in this population?

10%

30%

40%

50%

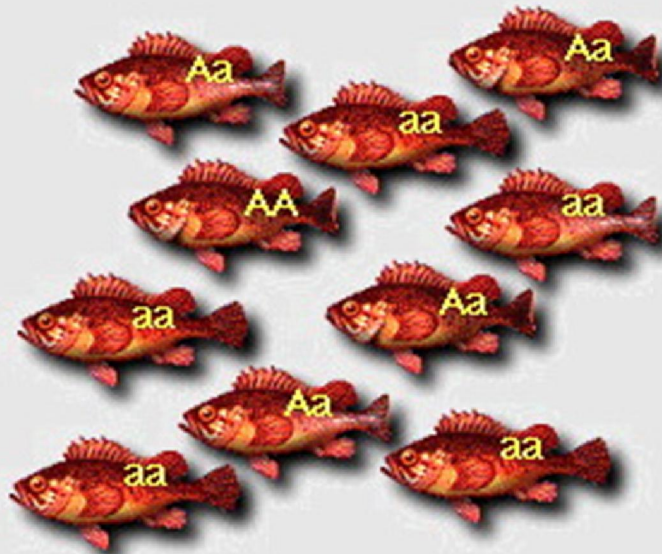
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70%

GENOTYPE & ALLELE FREQUENCIES

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5. What is the frequency of the small a allele in this population?

10%

30%

40%

50%

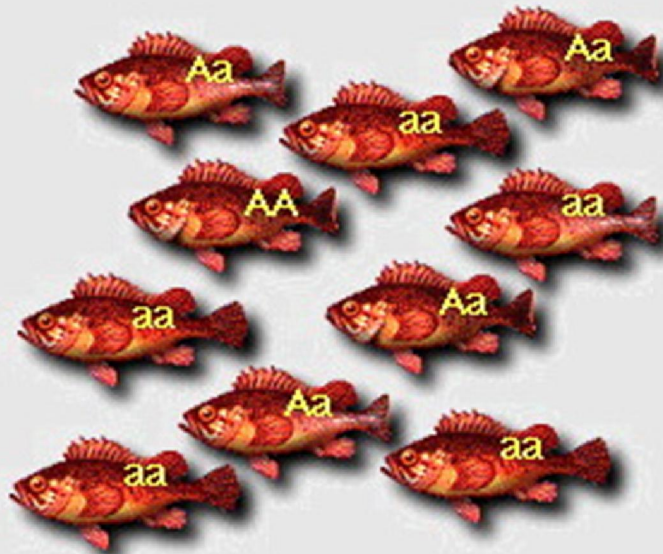
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GENOTYPE & ALLELE FREQUENCIES

Population Genetics

A Population's Gene Pool is Characterized by its Genotype and Allele Frequencies

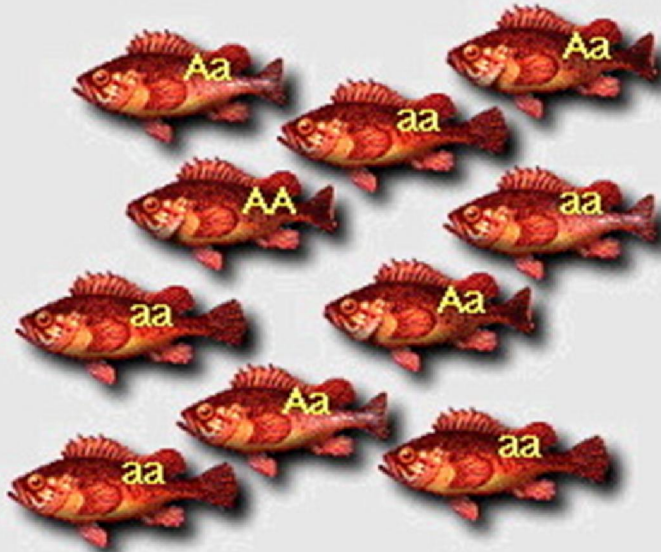


The gene pool of this population is characterized by the following genotype and allele frequencies:

Frequency of AA genotype = 10%
Frequency of Aa genotype = 40%
Frequency of aa genotype = 50%
Frequency of A Allele = 30%
Frequency of a Allele = 70%

HARDY - WEINBERG LAW

Population Genetics The Hardy-Weinberg Law



The gene pool of this population is characterized by the following genotype and allele frequencies:

Frequency of AA genotype = 10%
Frequency of Aa genotype = 40%
Frequency of aa genotype = 50%
Frequency of A Allele = 30%
Frequency of a Allele = 70%