



Hardy-Weinberg Equilibrium

Evolution versus Genetic Equilibrium



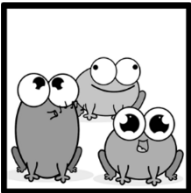
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Hardy-Weinberg Principle

- To clarify _____ evolutionary change operates, scientist find it helpful to determine when _____ takes place.
 - Biologist asks:
 - Are there any conditions under which evolution **will not** occur?
 - Is there any way to recognize when that is the case?
- The answer to those questions are provided by the Hardy-Weinberg principle, named after two researchers who independently proposed it when?



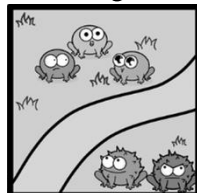
1. No Selection



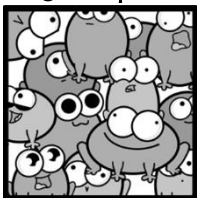
2. No Mutation



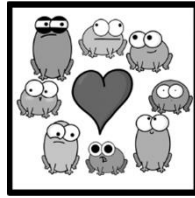
3. No Migration



4. Large Population

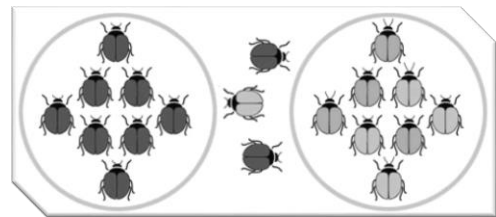


5. Random Mating



Hardy-Weinberg Principle

- What is the principle that states: allele frequencies in a population will **remain constant** unless one or more factors cause those frequencies to change.
- The situation in which allele frequencies remain constant is called what?
- If the **allele frequencies** DO NOT change, the population **will not evolve**.



5 Assumptions of Hardy-Weinberg

- Under what conditions does the Hardy Weinberg principle hold?
- PICTURED TO THE LEFT:** are the 5 conditions that are required to maintain genetic equilibrium from generation to generation.

5 Assumptions of Hardy-Weinberg

- In some populations, these conditions may be met or nearly met for long periods of time.
- If however, the conditions **are not met** the genetic equilibrium will become what, and the population **WILL** evolve.

5 Assumptions of Hardy-Weinberg

#1 NO NATURAL SELECTION

6. All genotypes must have **equal probabilities** of what?

7. No phenotype can have a what, over another?

- In other words, there can be no natural selection operating on the population

5 Assumptions of Hardy-Weinberg

#2 NO MUTATIONS

8. If genes mutate from one form into another, what would happen causing allele frequencies to change?



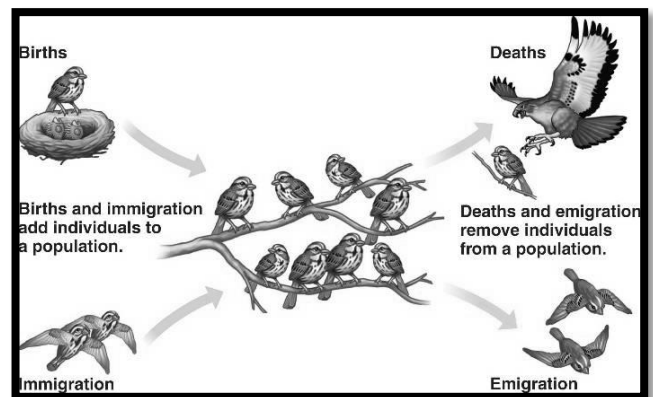
5 Assumptions of Hardy-Weinberg

#3 NO Migrations/Emigration

9. No migrations mean what?

10. Individuals may _____ into a population, therefore...there must be no movement of individuals into or out of a population.

11. In genetic terms, the what...must be kept the **same** and **separate** from others.

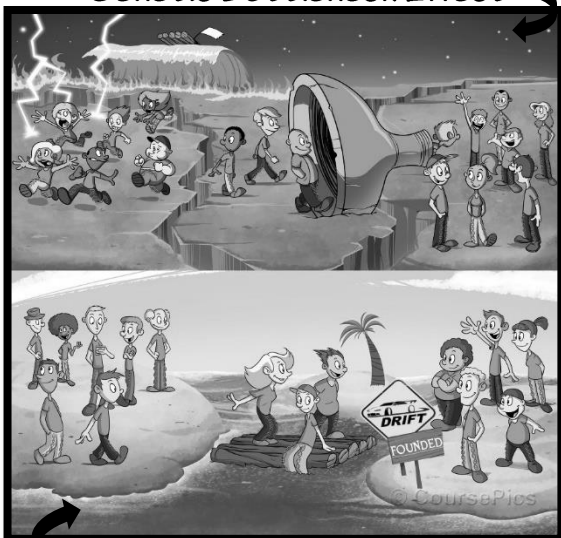


Genetic Drift

BEFORE CONTINUING...

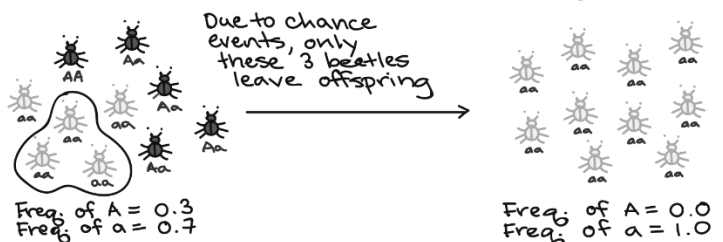
- Natural selection is not the only source of evolutionary change.
12. In small populations, an **allele** can become what?
- The smaller a population, the farther the results may be from what the laws of probability predict.

Genetic Bottleneck Effect



Founder Effect

GENETIC DRIFT



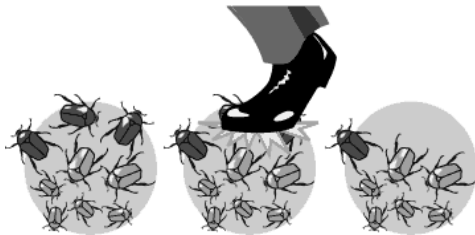
Genetic Drift

13. This kind of random change in allele frequency is called what?

- How does it take place?

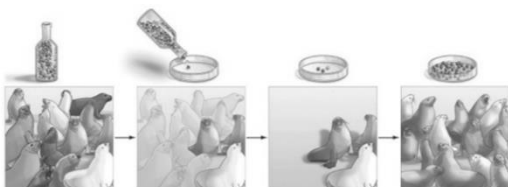
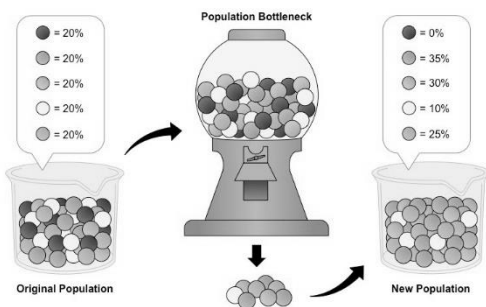
14. In small populations, individuals carry a particular allele may do what, than other individuals just **by chance**.

- Over time, a series of **chance occurrences** of this type can cause an allele to become more common in a population.



Genetic Drift: Bottleneck Effect

18. Genetic _____ happens when some factor (**disaster or catastrophic event**) reduces the population to a small number and then the population recovers and expands again, but from a limited gene pool.



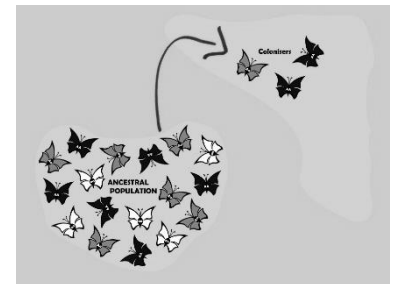
Genetic Drift: Founder Effect

15. Genetic drift may occur when a small population does what in a new habitat?

16. These individuals do what, than the larger population in which they came from.

- So if the population that they found will be genetically different than the original (parent) population.
- Alleles are in one or more founding individuals.

17. A situation in which allele frequencies change as a result of migration of a small subgroup of a population is known as what?

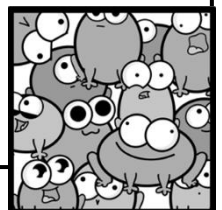


5 Assumptions of Hardy-Weinberg

#4 LARGE POPULATION

- A large population size is important to maintaining genetic equilibrium.

19. What has less effect on large populations than on small ones?



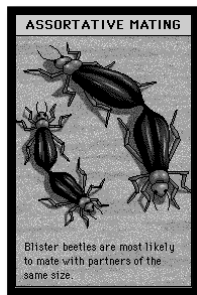
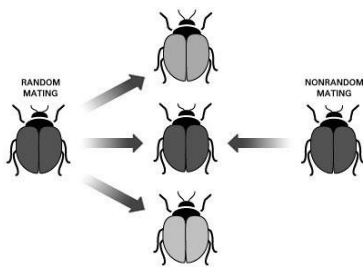
5 Assumptions of Hardy-Weinberg

#5 RANDOM MATING

20. All members of the population must have what?

21. This ensures that each individual has an equal chance of doing what?

- Do natural populations not mate randomly? If so, non-random mating means that genes for those traits are not in equilibrium but under **strong natural selection pressure**.



Hardy-Weinberg Equilibrium

frequency of homozygous dominant genotype	$p^2 + 2pq + q^2 = 1$	frequency of homozygous recessive genotype
		frequency of heterozygous genotype

Where:

p = the frequency of allele _____

q = the frequency of allele _____

p^2 = the frequency of individual _____

q^2 = the frequency of individual _____

$2pq$ = the frequency of individual _____

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

p = freq. of A q = freq. of a

$p = 0.3$
 $q = 0.7$

$$p^2 = (0.3)^2 = 0.09$$

9% AA

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

Freq.
of AA



Freq.
of Aa



Freq.
of aa



$$2pq = 2(0.3)(0.7) = 0.42$$

42% Aa

$$q^2 = (0.7)^2 = 0.49$$

49% aa

$$p + q = 1$$

$$0.3 + 0.7 = 1$$

Calculations need to equal as close
to 1 as possible