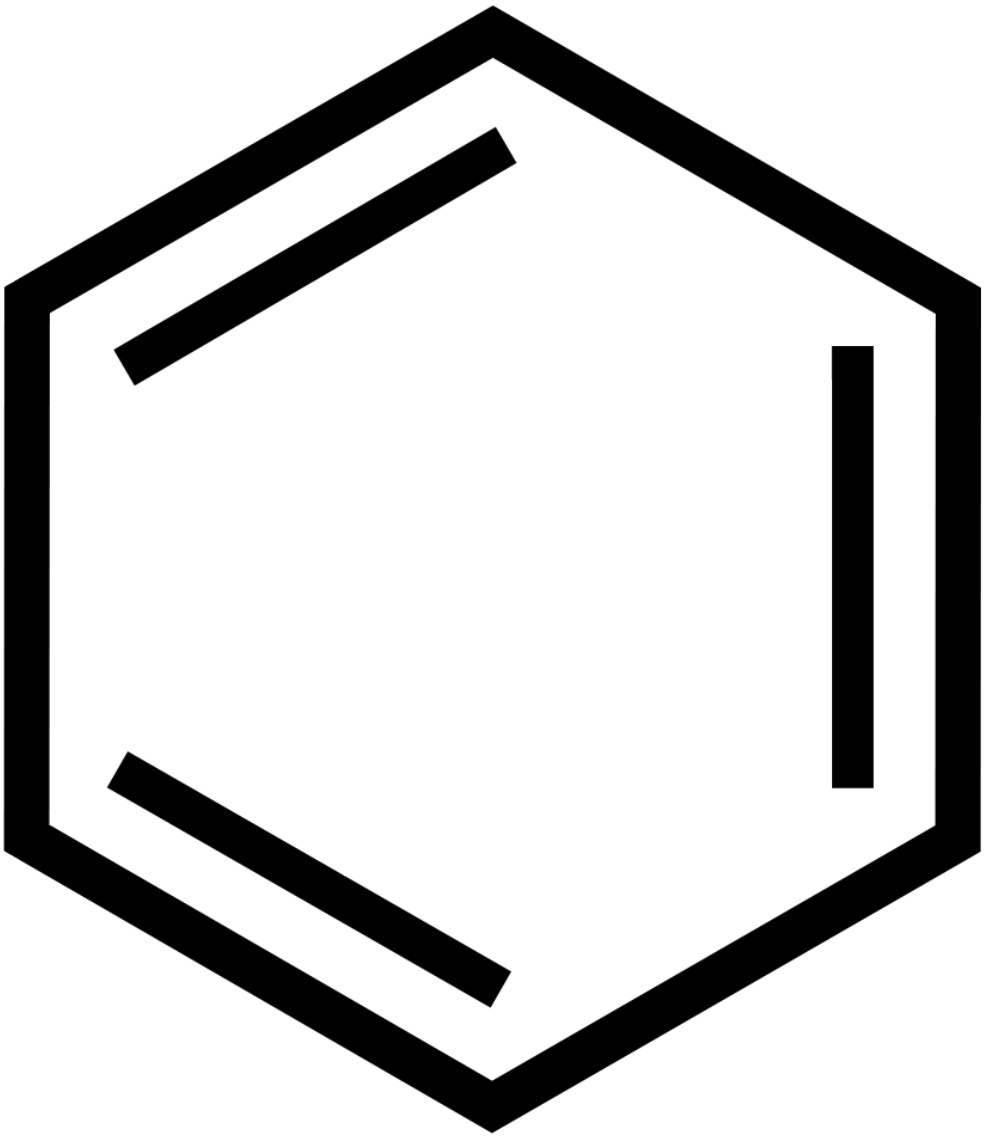

CLUTCH

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CONCEPT: HARDY-WEINBERG

● **Hardy-Weinberg** is a formula used to measure the frequencies of _____ and genotypes in a population

□ **Allelic frequencies** are the frequency of alleles in a population

- $p + q = 1$, where p = dominant alleles and q = recessive alleles

- **Gene pool** is the sum of all alleles in the breeding member of a population at a specific time

□ **Genotypic frequencies** are the frequency of genotypes (homozygotes or heterozygotes) in a population

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

- p^2 are dominant homozygotes, 2pq are heterozygotes, and q^2 are recessive homozygotes

□ Genes or genotype frequencies do not change from one generation to the next

- Why? *SAMIR*

EXAMPLE:

1. A recessive disease has a frequency of 1:1100 in the population. Assuming Hardy-Weinberg principles, calculate q^2, p^2, 2pq, q, and p.

● To use the Hardy-Weinberg formula, five _____ have to be met (**SAMIR)**

□ **S:** No **S**election

- All genotypes have equal viability and equal ability to mate and be passed onto the next generation

□ **A:** No new **A**lleles

- No new alleles are created or converted from one allele to another (no mutations)

□ **M:** No **M**igration (gene flow)

- Individuals do not migrate out of or into the population

- There are no subpopulations that are genetically isolated

□ **I:** The population is **I**nfinitely large

- No *genetic drift* occurs

□ **R: R**andom mating occurs

- Mates are chosen completely at random, and are not influenced by the gene in question

PRACTICE:

1. Which of the following is NOT an assumption made when using the Hardy-Weinberg formula?
    a. No Selection
    b. New Alleles
    c. No Migration
    d. Infinitely large population
    e. Random Mating occurs

2. Which of the following formulas can be used to calculate heterozygote frequency in a population?
    a. p^2
    b. q^2
    c. 2pq
    d. p-q

3. In a random mating population of *Drosophila,* 5% of the flies have black bodies (encoded by recessive b) and 95% have brown bodies (encoded by B). Assuming Hardy-Weinberg equilibrium what is the allele frequency of B in the population?
    a. 0.77
    b. 0.60
    c. 0.50
    d. 0.95

4. In a random mating population of *Drosophila,* 5% of the flies have black bodies (encoded by recessive b) and 95% have brown bodies (encoded by B). Assuming Hardy-Weinberg equilibrium what is the genotypic frequency of BB in the population?
    a. 0.77
    b. 0.60
    c. 0.50
    d. 0.95

CONCEPT: ALLELIC FREQUENCY CHANGES

● In real-life genetics, the SAMIR assumptions of Hardy-Weinberg are too _____

Selection

1. **Natural selection** is when organisms with genes that better allow them to survive produce more offspring

□The struggle for survival means that not everyone _____

- Individuals with particular phenotypes will be more apt to survive and pass on their genes

□ There are multiple types of selection

- **Directional selection** moves alleles in one direction until they're fixed in the population or lost

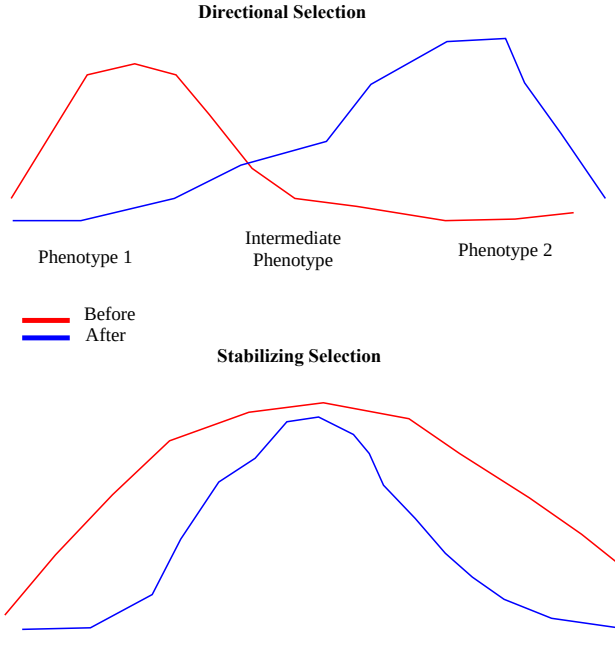
- **Fixed** alleles are found in every organism in the population

- **Positive selection** brigs favorable mutations to a higher frequency

- **Purifying selection** removes harmful mutations

- **Balancing selection** moves population to an equilibrium where both alleles are maintained in population

EXAMPLE:



□ **Fitness** is a measurement of how well an individual's genetic makeup contributed to _____ generations

- **Absolute fitness** is the number of offspring an individual has

- **Relative fitness** is the fitness of an individual relative to another individual

New Alleles and Migration

2. Allelic frequencies are changed by the creation or introduction of _____ alleles

□ Mutation is one major way new alleles are created in a population

- **Mutation rate (μ)** is the rate at which mutations occur in a population

- Can be used to calculate how frequently new alleles will arise

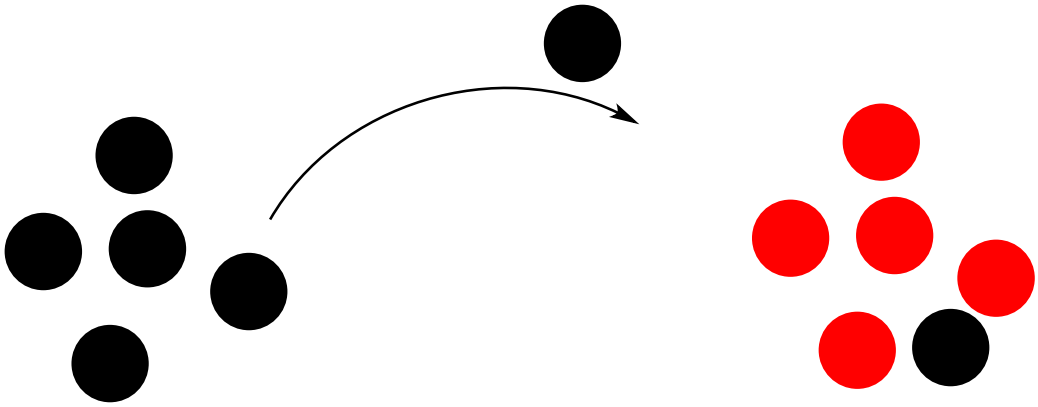
- Formula: $\Delta q = \mu p$ calculates how the mutation rate on allele p causes a change in q freq.

3. **Migration (gene flow)** is the movement of individuals between _____

□ Creates a **genetic admixture** which is a mix of genes in individuals that arose from 1+ subpopulations

- Migration adds genetic variation to the population

EXAMPLE:



Genetic Drift and Non-Infinite Populations

4. Populations are not infinite, which means gametes only contain a sample of alleles present in the parental gene pool

□ Purely by chance, not all alleles will be passed onto the next _____

- But, the more offspring that are produced, the more alleles will be passed on

□ If the gametic sample is small (so small number of gametes are used to produce offspring),

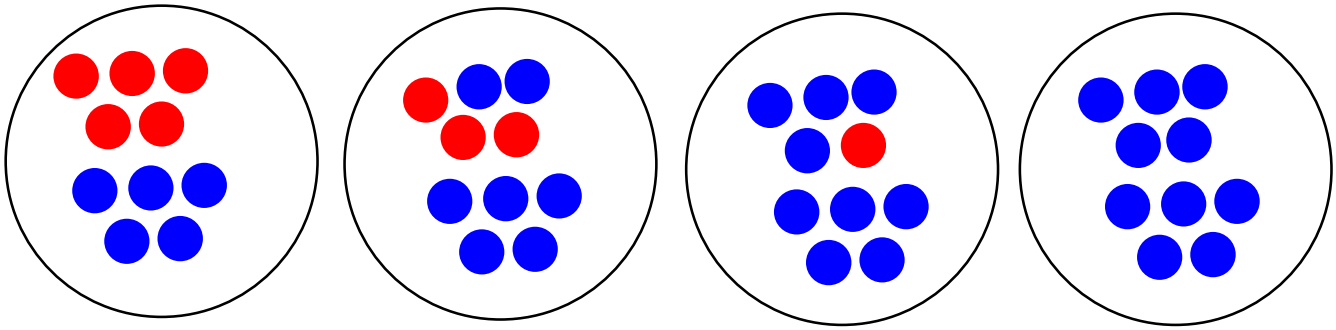
- Then, the greater the change that the gametes composition will deviate from the entire gene pool

- **Sampling error** is a deviation from expected ratio due to limited sample size

□ **Genetic drift** is a change in allelic frequency due to a random disappearance of genes in small populations

- Higher in small populations, and when allelic frequencies are equal

EXAMPLE: Genetic drift over four generations



□ Genetic drift can lead to fixation or loss of an _____

- **Fixation** occurs when all individuals in a population are homozygous for one allele

- Loss is when no individual in a population carries the allele

□ Genetic drift can also be caused by two major occurrences in a population

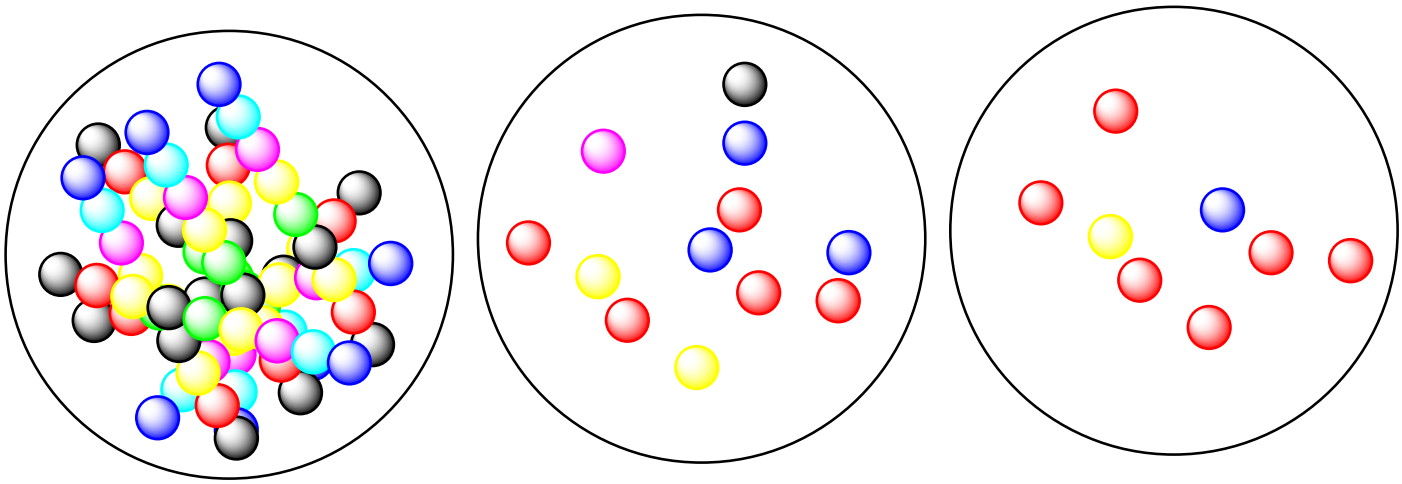
- **Founder effect** occurs when a new population of a much smaller size is formed by a founder

  - The founder doesn't carry every allele at the same frequency as the original population

- **Bottleneck** occurs when there is a contraction in population size which reduces the variation of alleles

  - Can occur in one or over several generations

EXAMPLE: Example of bottleneck effect



PRACTICE:

1. Which of the following terms describes a change in allelic frequency due to random disappearance of genes in a small population?
    a. Natural Selection
    b. Allele creation through mutation
    c. Gene Flow
    d. Genetic Drift
    e. Non-random mating

2. A group of finches live on a small, isolate island. One day, a few finches travel to a distant island and start a new population of finches. This type of change in a population is called what?
    a. Speciation
    b. Founder effect
    c. Bottleneck effect
    d. Genetic drift

3. Which of the following is an example of natural selection?
    a. A neutral mutation is carried from generation to generation
    b. A rabbit migrated to a new location and brought new alleles to the endogenous rabbit population
    c. A mutation causes a finch to develop a stronger beak, which makes it more likely to grow, survive, and reproduce.
    d. One allele becomes fixed in a population due to random genetic drift over time.

Non-random Mating

5. Non-random mating due to _____ occurs in every organism on Earth

□ **Assortative mating** occurs when individuals choose mates based phenotypes

- **Positive assortative mating** occurs when mates are chosen based on similar phenotypes

- **Negative assortative mating** occurs when mates are chosen based on dissimilar phenotypes

EXAMPLE: Female humans prefer the odor of males with different MHC alleles than their own

□ Isolation by distance can also cause non-random _____

- Two populations of the same species separated by large distances likely wont mate

  - Therefore genetic variations begin to develop between the populations

- **Speciation**, which is the creation of a new species, can occur

  - Usually occurs upon reproductive isolation

    - **Prezygotic** isolation are biological barriers that reduce breeding between populations

    - **Postzygotic** isolation is due to infertility or inviability of hybrids created via interbreeding

EXAMPLE:

Barrier Formation

Isolation

□ **Inbreeding**, which is the mating between relatives**,** also is a result of non-random mating

- Inbred individuals are much more likely to be homozygous for _____ recessive alleles

- **Inbreeding depression** can lead to reduction in vigor and reproduction success

- In plants, inbreeding through self-fertilization can often be positive

- **Inbreeding coefficient (F)** is the probability that 2 alleles in an individual trace back to the same ancestor

- Inbreeding is more common among small populations

EXAMPLE:

Relationship	**Inbreeding Coefficient (F)**
Father/Daughter	25%
Grandfather/Granddaughter	12.5%
Uncle/Niece	12.5
First Cousins	6.25%
Second Cousins	1.56