**Population Genetics Notes 2019**

**Concept: Genetic variation makes evolution possible**

Genetic Variation:

-Genetic variation is the substrate on which natural selection works

Quantitative characters:

Vary along a continuum within a population

Human height

-Discrete characters:

“Either-or”

Usually determined by a single gene locus

Dimples/no dimples; ABO blood groups

-Polymorphism

When a population has \_\_\_\_\_\_\_\_\_\_ or more different “morphs” for a given trait

-Freckles/no freckles

Preserving Genetic Variation:

-What prevents natural selection from reducing a population’s variation by eliminating unfavorable genotypes?

Diploidy

-Recessive alleles can “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” in heterozygotes

Balanced polymorphism

-Heterozygote advantage (sickle cell)-carriers are less likely to get malaria than homozygous normal individuals.

Frequency-dependent selection

-Survival and reproduction of any one morph declines if it becomes too common

Mutation:

A mutation is a change in an organism’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mutation at a given gene locus is very rare, but mutations at all gene loci can have a big impact

Chromosomal Mutations=Additions; Deletions; Inversions, Translocations

Point Mutations- Substitutions & Frame Shift Mutations

Sexual Reproduction Variation:

Sexual reproduction shuffles alleles and deals them at random to produce individual genotypes. Recall there are three mechanisms for this shuffling of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Crossing over during prophase I of meiosis

Independent assortment of chromosomes during meiosis (2^23 different combinations possible in the formation of human gametes!

Fertilization (2^23 x 2^23 different possible combinations for human sperm and egg)

Population Genetics:

-Population genetics is the study of how populations change genetically over time.

-Population: A group of individuals of the same species that live in the same area and interbreed, producing fertile offspring.

-Gene pool: All of alleles at all \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in all the members of a population.

In diploid species, each individual has two alleles for a particular gene, and the individual may be either homozygous or heterozygous.

If all the members of a population are homozygous for the same allele, the allele is said to be fixed. Only one allele exists at that particular locus in the population. For example, the fruit fly is heterozygous for 1,920 of its 13,700 genes-the remaining 11,780 are fixed. It follows that the greater the number of fixed alleles, the lower the species genetic diversity.

Hardy-Weinberg equilibrium:

-Hypothetical situation

-serves as null hypothesis

-non-evolving population

REMOVE all agents of evolutionary change

no genetic drift (very large population size )

no gene flow (no migration in or out)

no mutation (no chemical change to DNA)

random mating (no sexual selection)

no natural selection (equal survival)

The Hardy-Weinberg principle is used to describe a population that is NOT evolving. It states that the frequencies of alleles and genes in a population’s gene pool will remain constant over the course of generations unless they are acted upon by forces other than Mendelian segregation and the recombination of alleles. The population is at Hardy-Weinberg equilibrium.

Example of strong selection pressure:

Tay Sachs

primarily in Ashkenazi Jews & Cajuns

recessive disease = aa

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ storage disease

lack of one functional digestive enzyme in lysosome

build up undigested fat in brain cells

children die before they are 5 years old

Example of heterozygote advantage:

Sickle cell anemia

inherit a mutation in gene coding for one of the subunits in hemoglobin

oxygen-carrying blood protein

normal allele = Hb

mutant allele = Hs

recessive trait = HsHs

low oxygen levels causes RBC to sickle

clogging small blood vessels

damage to organs

often lethal

High frequency of heterozygotes

1 in 5 in Central Africans = HbHs

unusual for allele with severe detrimental effects in homozygotes

1 in 100 = HsHs

usually die before reproductive age

In tropical Africa, where malaria is common:

homozygous dominant (normal)

-reduced survival or reproduction from malaria: HbHb

homozygous recessive

-reduced survival & reproduction from sickle cell anemia: HsHs

heterozygote carriers

-survival & reproductive advantage: HbHs

**Concept: Natural Selection, genetic drift, and gene flow can alter allele frequencies in a population.**

Microevolution:

At the population level, evolution is a generation-to-generation change in a population’s frequency of alleles

Even if the allele frequencies of only \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gene (ie. flower color) are changing, the change in the gene pool is known as microevolution

There are 5 factors that cause microevolution:

1. Genetic drift

2. Natural selection

3. Gene flow

4. Mutation

5. Non-random mating (Sexual Selection= picking mates with selected traits that might aid survival/reproduction. Example: showy feathers on birds; Deer with large rack

Sexual Dimorphism- males & females showing 2 forms are common in animal kingdom.

Genetic Drift:

Genetic drift is the chance fluctuation of a small population due to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

700 heads, 300 tails vs. 7 heads, 3 tails

Sampling error

2 major types of genetic drift

Bottleneck effect

Founder effect

Bottleneck Effect:

Disasters reduce the size of a population dramatically, killing victims unselectively

Result:

The small surviving population is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to be representative of the original population in its genetic makeup

Some alleles may be lost

Founder Effect:

The founder effect results when a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ individuals from a larger population colonize a new, isolated habitat

The new population is unlikely to be representative of the original population

Natural Selection:

Populations consist of varied individuals, with some variations of individuals leaving more offspring than others

Darwinian fitness: the relative contribution an individual makes to the gene pool of the next generation

“survival of the fittest”

-There are 3 major types of natural selection:

Directional selection

Diversifying/disruptive selection

Stabilizing selection

Directional Selection:

Shifts the frequency curve for variations in some phenotypic character in \_\_\_\_\_\_\_\_\_\_\_ direction or another

From rare to average

-Example: Average size of black bears in Europe increases in ice ages, decreases in warmer periods

Diversifying/Disruptive Selection:

Favors variants of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ extremes over intermediate individuals

Stabilizing Selection:

Acts against \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ phenotypes

Favors the more common intermediate variants

Maintains the “status quo”

-Example: 3 – 4 kg. average for human births

Gene Flow:

A population may gain or lose \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ by gene flow

Gene flow is genetic exchange due to the migration of fertile individuals or gametes between populations

Sexual selection is a form of natural selection in which individuals with certain traits inherited characteristics are more likely than other individuals to obtain mates. It can result in sexual dimorphism, a difference between the ornamentation, and behavior. Example: Peacocks.