19th Century modern biology:

To explain evolution and speciation, the theories of Darwin and Wallace was combined so that a uniform theory was proposed. To explain evolution and speciation, it is the population that must be observed instead of individuals (contrary to what was previously believed) because it is within populations that genetic variation occurs. There is a range of variation within a population and it was Mendel who proposed that these variations were results of genetic diversity (he didn't actually propose "genetic diversity" but he did realize there was a blue print) and were inheritable.

Darwin's five theories:

In order to observe natural selection, the variation within populations must be monitored and observed. This was contrary to what people believed because it was widely accepted that it was the essence within an individual that was changing and not the population.

Mendel:

The difficulty in transitioning from the old belief to the new belief was the lack of evidence for inheritability. Mendel, through his study of peas theorized that there must be a predetermined plan for organism and this plan was passed onto the next generation from both parents. He also formulated the Laws of Segregation and Independent Assortment.

20th Century:

The Synthetic theory of Evolution:

- It will be Huxley that formulates combines evolution with population genetics. He is going to formula calculations that can be used to determine the various variations within populations thus making variations predictable.
- If the theory of evolution was to be based on variation, then the variation must be determined to predict whether a change has occurred, and it must be measured and quantified.

Microevolution:

Microevolution is the change of alleles within a population. For example if the allele frequency of black hair vs blonde hair was 50/50 and the next generation changes to 40/60 due to external effects, then this is evolution. There will be different ways to measure this change in frequency such as change in chromosome structure, or mutations and recombination. Essentially if any of these occurred, then microevolution has taken place.

Some basic terms for microevolution:

Allele:

- Recall that it was Mendel who proposed that every genetic plan is carried on alleles and every individual carries two copies of each allele.

Phenotype:

- This is the visual expression of the allele in consideration. Mendel realized that the phenotype of an organism may not accurately portray the alleles the organism contains. For example, if a copy of an allele is recessive, the dominant allele will be expressed but the organism still carries the recessive copy.

Genotype:

- The allele types of an individual. The genotype give rise to the phenotype and it is the genotype that is calculated in determining variation within a population.

Homozygous:

- This is a term used to describe the genotype of an individual. When an individual carries two copies of a dominate allele or two copies of the recessive allele, they are homozygous. Hint: Homosexuals = same sex, so homo = same, so homozygous = same allele : D.

Heterozygous:

- This term refers to a genotype where both the dominant allele and the recessive alleles are carried by one individual. Hetero sexual = different sex, so hetero = different, so heterozygous = different allele.

Dominant and Recessive:

- These terms refer to the nature of the alleles carried. If an allele is dominant, it will always be expressed regardless of whether a recessive copy is carried. A recessive allele is one that will not be expressed unless in a homozygous recessive individual.

Incomplete Dominance – Snap Dragons:

A perfect example demonstrating dominance is the snap dragon (a flower). The allele for red pedal s is dominant over the allele for white pedal s. If the parents are homozygous red and homozygous white respectively, then the first generation will all be heterozygous red. The first generation will all carry a copy of the red allele as well as the white allele. The second generation that arise from the first will have 25% being homozygous red, 50% as heterozygous pink and 25% as homozygous white or a 1:2:1 ratio. This is Mendelian genetics.

Genotype and allele Frequency:

Huxley will give us a mathematical way of predicting allele frequencies within a population. For example, in a population of 1000 snap dragons, if 450 are red, 500 are pink and 50 are white, then the genotype frequency is 0.45 homozygous red, 0.50 heterozygous pink, and 0.05 homozygous white. The allele frequency would thus be 0.7 for red (total red alleles over total alleles) and 0.3 for white.

Using the Hardy-Weinberg Principle:

The HW principle employs the use of a punnet square and essentially takes the allele frequencies for the dominant trait and recessive trait and makes it mathematically possible to predict the combinations and the frequencies of each possibility that will result after mating. For example, in Snap Dragons, if the allele frequency of red pedal s was 0.7 and 0.3 for white for the parents, then the possibility of having an offspring that is homozygous Red would be 0.49 or 49%. The chances of having heterozygous pink would be 42% with a frequency of 0.42 and the chances of having homozygous white would be 9% or a frequency of 0.09.

Hardy-Weinberg Principle's Assumptions:

- No Natural Selection
  - No allele is favoured over another. If there is an allele that will increase survibility for the organism, then the fitness of the unfavoured allele will decrease thus resulting in more favour alleles.
- No Mutation
  - No allele is changed into something else.
- No genetic drift – population is large
  - There is sufficient population for sampling. If the population is too small, the random mixing will not exhibit actual chance.
- Gene flow
  - There has been no immigration or emigration.
- Random mating
  - Reproduction is random with no preference for characteristics.

If the allele frequencies used in the Hardy Weinberg principle have changed, then there has been micro evolution. If a change is found, the next step is determining which of the five caused the change. For example, in the peppered moth example, there was random mating, there was no gene flow, the population is large and there was no mutation. The change in allele frequency was a result of natural selection where one trait is favoured for survival.

Allele frequencies in populations:

If there was population drift and the population becomes too small, there will not be the same probability for the allele to appear in same frequency as did in the parent population. For example, if a sample of snap dragons had an allele frequency of 0.6 for red dominant allele and 0.4 for white recessive allele, if the population size was too small, the offspring may not exist in 0.36 for homozygous red, 0.48 for heterozygous pink and 0.16 for homozygous white. As a result, the end allele frequency would have changed.

If there is natural selection, then some individuals would have favoured characteristics and those unfavoured individuals will not be able to produce adequate gametes to put back into the population causing the allele frequency to change. Furthermore, if there was migration, then some alleles would be lost from the population. This loss of alleles would alter the frequency and thus the next generation would not reflect the parent in allele frequency. If there was mutation, then there was a change in the frequency within an individual or population. As a result, the allele frequency within the produced gametes would differ and thus the next generation would have a different allele frequency.

Effect of Selection:

In an arbitrary example, if a population have gametes with an allele frequency of 0.6 for A and 0.4 for a, then the next generation will have 36 individuals whom are homozygous A, 48 individuals who are Aa, and 16 individuals who are aa. If 25% of Aa and 50% of aa fail to pass on their gametes as a result of selection, then the second generation will have 36 individuals who are homozygous A, 36 Aa and 8 aa. The allele frequency of the resulting population would thus become 0.675 and 0.325 for A and a respectively.

Effects of Selection, Mice Example:

In one study, researchers bred caged mice based on the characteristics they exhibited. For example, in a population of caged mice, there were ones that enjoyed running on the wheel and there were others that did not. By breeding active mice with other active ones, the resulting off spring from several generations of breeding were much more fit and could run faster and longer. The reversal was observed in inactive mice. Several generations later, the offsprings were still inactive and lazy. Although this example does not clearly display how allele frequency and alleles are impacted, it does show how selective pressures will alter the outcomes of the offspring and ultimately allele frequency. From this, we can deduce that the alleles for fitness have increased in the population that resulted from active mice breeding and that the alleles for laziness have increased in frequency in the other population.

Effects of Selection – Fixation:

Although the provided example on mice does not exactly reflect allele frequency, it does provide evidence for a concept called fixation. Fixation occurs when one allele is found throughout the population and the other disappears. When selection is introduced into a population, the gene that is selected against slowly disappears. For example, if in a population, the amount of individuals that is AA survives 100 percent of the time, Aa survive 99.8 percent of the time, and aa survive 99.6 percent of the time, the frequency of A within the population will slowly increase. However, if AA survive 100 percent of the time, Aa survive 90 percent of the time and aa survive only 80 percent of the time, clearly a is detrimental to survival. After only about 100 generations, the allele a will have been eliminated from the population and every individual would carry only A alleles. A is said to be fixed. As one can see, the greater the selection against an allele, the faster that allele would disappear from a population.

This is important because when are selecting for a specific trait, as in the case of vegetation and artificial selection, the allele coding the trait we are not selecting for may disappear. This was exactly the case with bacterial and antibiotic resistance. When we applied antibiotics, we inadvertently selected for survival against the medicine by eliminating the alleles that did not in bacteria. The individuals carrying the allele that permit them to survive got to transfer that to the next generation and quickly the population became fixed with the allele that gave resistance. The same concept is present in agriculture. The seeds from species of plants that are produced and used for planting have been selected for and inbred to the point where there are only few varieties left in the world. In the attempt to get uniformity, we are also losing the other characteristics we are not selecting for which means if something was to occur to the climate or such, the agriculture plants will not survive because they have been bred to survive in ideal conditions. And as a result, hard selection tends to make the population more