There are five different forces that cause populations to evolve: mutation, genetic drift, natural selection, recombination, and gene flow.

Mutations are the source of all genetic variance. Mutations are changes within the genetic sequence. Types of mutations include: duplications, deletions, and insertions. Mutations can lead to functional genes as well as the creation of pseudogenes- genes that no longer have a function. The effects of mutations can be deleterious, neutral, or beneficial to an organism. Deleterious mutations will cause organisms within the population to be less reproductively fit. Neutral mutations will have no effect on reproductive fitness. Beneficial mutations will cause the organisms within the population to be more reproductively fit.

Mutation rate is the rate at which genetic variation is created within a population. This genetic variation is induced by some outside force that causes the DNA within an organism's genome to alterate. This alteration can be beneficial, neutral, or deleterious to the organism. Certain mutations are more common than others. For example, point mutations will occur more often than chromosomal deletions. Substitution rate is the rate at which said mutation goes from being at a low frequency (within a single or few individuals in a population) to being fixed within the population. The average rate of substitution differs due to regulatory elements within genes and at the aforementioned sites within the DNA sequence. Selection will select against mutations in genes that are necessary for survival (such as histone genes) to a greater extent, which will result in a lowering of the substitution rate of that gene, then in genes that are not absolutely necessary for viability.

The effective population size (Ne) can be defined as the number of individuals in a population that contribute offspring, and hence genetic material, to the next generation. Larger populations will have a high Ne when compared to smaller populations simply because there is more genetic variation available to give rise to new mutations within the population. Mutations that arise within a population can be acted upon by two forces: natural selection and genetic drift. In a small population, mutations are affected more by genetic drift in determining whether it will be fixed within the population and passed on to subsequent generations. In contrast, mutations are affected more by natural selection within large populations. In a large population, mutations that are deleterious are more quickly acted upon by natural selection when compared to small populations.

Genetic drift is variation in genetic material due to random chance- certain alleles are either fixed or deleted within a population with no regard to whether the allele is beneficial, neutral, or deleterious. An example would be a population of flowers that have alleles for both a pink and red phenotype regarding petal color. Say all of the flowers with the allele for the red phenotype were killed by a freak hailstorm resulting in only the flowers with the allele for the pink phenotype being left to reproduce. The next generation would only have the allele for the pink phenotype and this allele would become fixed within the population. This allele is not prevalent due to selection but merely due to random chance. Genetic drift has a stronger effect on smaller populations since it is due to randomness rather than a selective force.

Natural selection is the process by which allelic survival is either selected for or against depending on the allele's effect on the reproductive fitness of the organism. Genetic variants that offer a reproductive fitness advantage to an organism are selected for and maintained within the population. Genetic variants that cause a decrease in reproductive fitness will be selected against and lost from the population. This evolutionary force has a greater influence on large populations due to there being more genetic variation to be acted upon. Fitness in a biological sense is an organism's ability to reproduce successfully. The possible fitness effects of a mutation can be: beneficial, neutral, or deleterious. A beneficial mutation will result in an organism being able to reproduce more efficiently and effectively. An example of a mutation with a beneficial fitness effect would be fur color in mice- those with fur color that allows them to blend in with their environment and avoid predation would be able to reproduce longer. A neutral mutation has no effect whatsoever on the reproductive fitness of the organism. An example of a mutation with a neutral fitness effect would be Autosomal-dominant Compelling Helio-Ophthalmic Outburst) syndrome. This mutation does not offer an edge to reproduction capabilities nor does it hinder them. A deleterious mutation inhibits the reproductive efficacy of an organism by either causing infertility, not allowing the organism to reach reproductive maturity, or shortening the organism's window of reproducibility. An example of a deleterious mutation would be muscular dystrophy (caused by a mutation in the gene that codes for the protein dystrophin).

Recombination is merely the rearrangement of the available genetic material during the process of mitosis. This rearrangement of genetic material can introduce new sequences that can then be acted upon by natural selection. This evolutionary process can also have an effect on genetic draft by separating genes that are linked.

Gene flow is an introduction of genetic variation from one population to another. It occurs when there is migration between two populations. The addition or loss of individuals within a population can easily change the frequencies of alleles within a gene pool of a population even if there are no other evolutionary forces at work. When gene flow is restricted, speciation can occur as populations genetically diverge from one another.

Motoo Kimura's Neutral Theory of Molecular Evolution does not contradict Darwin's theory of evolution. In order for complex adaptations to arise, natural selection must have genetic variation available for it to act upon. Neutral theory accounts for how this genetic variation that is needed by natural selection arises. The random processes of mutation and genetic drift have the ability to create genetic variation that natural selection can then act upon and use to form complex adaptations. Both the Neutral Theory of Molecular Evolution and Darwin's theory of evolution are needed to understand the complexities of the evolutionary process.