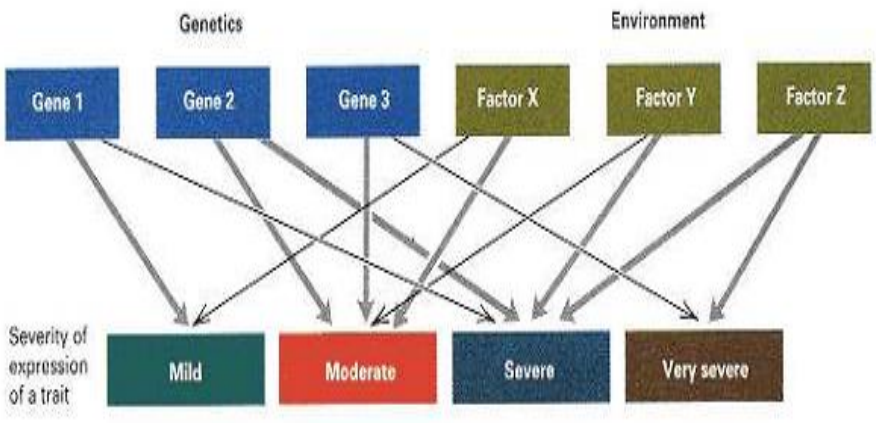
INTERACTION WITH ENVIROMENT AND EVOLUTION

Effects of the Environment

Genes and environment also interact. To appreciate the interaction between genes and environment, consider the trait "anemia," which refers to a generalized weakness resulting from an insufficient number of red blood cells or from an inadequate volume of blood. There are many different types of anemia. Some forms of anemia are genetically determined, such as sickle-cell anemia. Other forms of anemia are caused by the environment; an example is anemia resulting from chronic deficiency of dietary iron or from infection with malaria. Still other forms of anemia are caused by genetic and environmental factors acting together.

A familiar example is heart disease. It is well known that inherited risk factors in heart disease are related to the metabolism of saturated fats and cholesterol. Some rare forms of the disease with a strong genetic component have already been identified. There are also environmental risk factors in heart disease—cigarette smoking, being overweight, lack of exercise, high dietary intake of saturated fats and cholesterol, and so forth.

With these examples as background, consider this question: Is anemia and heart disease caused by heredity or environment?



Type of disease	Causes
Mild	determined by one major genetic factor and one minor environmental factor
Moderate	determined by two major genes together with one major and one minor environmental factor
Severe	determined by two major environmental factors together with one major and one minor genetic factor
Very severe	determined by one minor genetic factor and one major environmental factor

Evolution

The evolution refers to changes in the gene pool resulting in the progressive adaptation of populations to their environment. Evolution occurs because genetic variation exists in populations and because there is a natural selection favoring organisms that are best adapted to the environment.

There are four processes account for most of the changes in allele frequency in populations. These process are:

1. **Mutation,** the origin of new genetic capabilities in populations by means of spontaneous heritable changes in genes.
2. **Migration,** the movement of individuals among subpopulations within a larger population.
3. **Natural selection,** which results from the differing abilities of individuals to survive and reproduce in their environment.

Mutation

Mutation is the ultimate source of genetic variation. It is an essential process in evolution, but it is a relatively weak force for changing allele frequencies, primarily because typical mutation rates are too low. Moreover, most newly arising mutations are harmful to the organism. Although some mutations may be **selectively neutral,** which

means they do not affect the ability of the organism to survive and reproduce, only a very few mutations are favorable for the organism and contribute to evolution.

Migration

Migration is similar to mutation in that new alleles can be introduced into a local population, although the alleles derive from another subpopulation rather than from new mutations. In the absence of migration, the allele frequencies in each local population can change independently, so local populations can undergo considerable genetic differentiation. Genetic differentiation among subpopulations means that there are differing frequencies of common alleles among the local populations or that some local populations possess certain rare alleles not found in others.

Natural Selection

The driving force of adaptive evolution is natural selection, which is a consequence of hereditary differences among organisms in their ability to survive and reproduce in the prevailing environment.

The occurrence of natural selection rests on three premises.

1. In all organisms, more offspring are produced than can possibly survive and reproduce.

2. Organisms differ in their ability to survive and reproduce, and some of these differences are due to genotype.

3. In every generation, the genotypes that promote survival in the prevailing environment (favored genotypes) are present in excess among individuals of reproductive age, and hence the favored genotypes contribute disproportionately to the offspring of the next generation.