



## Basic Concepts in Genetics

Undoubtedly, you learned some genetic principles in other biology classes. Let's take a few moments to review some of these fundamental genetic concepts.

**Cells are of two basic types: eukaryotic and prokaryotic-** Structurally, cells consist of two basic types, although, evolutionarily, the story is more complex. Prokaryotic cells lack a nuclear membrane and possess no membrane bounded cell organelles, whereas eukaryotic cells are more complex, possessing a nucleus and membrane bounded organelles such as chloroplasts and mitochondria.

**A gene is the fundamental unit of heredity-** The precise way in which a gene is defined often varies. At the simplest level, we can think of a gene as a unit of information that encodes a genetic characteristic. We will enlarge this definition as we learn more about what genes are and how they function.

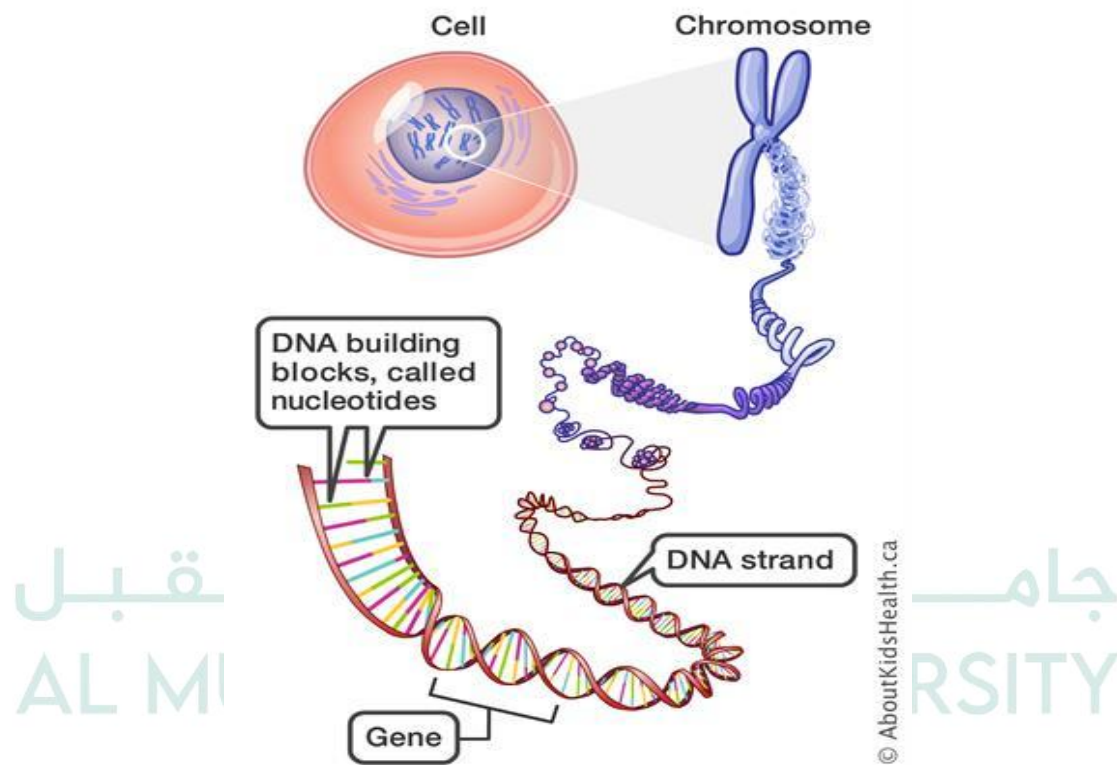
**Genes come in multiple forms called alleles-** A gene that specifies a characteristic may exist in several forms, called alleles. For example, a gene for coat color in cats may exist in alleles that encode either black or orange hair.

**Genes encode phenotypes-** One of the most important concepts in genetics is the distinction between traits and genes. Traits are not inherited directly. Rather, genes are inherited and, along with environmental factors, determine the expression of traits. The genetic information that an individual organism possesses is its genotype; the trait is its phenotype. For example, the A blood type is a phenotype; the genetic information that encodes the blood type A antigen is the genotype.

**Genetic information is carried in DNA and RNA** Genetic information is encoded in the molecular structure of nucleic acids, which come in two types: deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Nucleic acids are polymers consisting of repeating units called nucleotides; each nucleotide consists of a sugar, a phosphate, and a nitrogenous base. The

nitrogenous bases in DNA are of four types (abbreviated A, C, G, and T), and the sequence of these bases encodes genetic information. Most organisms carry their genetic information in DNA, but a few viruses carry it in RNA. The four nitrogenous bases of RNA are abbreviated A, C, G, and U.

**Genes are located on chromosomes-** The vehicles of genetic information within the cell are chromosomes, which consist of DNA and associated proteins. The cells of each species have a characteristic number of chromosomes; for example, bacterial cells normally possess a single chromosome; human cells possess 46; pigeon cells possess 80. Each chromosome carries a large number of genes.



**Chromosomes separate through the processes of mitosis and meiosis-** The processes of mitosis and meiosis ensure that each daughter cell receives a complete set of an organism's chromosomes. Mitosis is the separation of replicated chromosomes during the division of

somatic (nonsex) cells. Meiosis is the pairing and separation of replicated chromosomes during the division of sex cells to produce gametes (reproductive cells).

**Genetic information is transferred from DNA to RNA to protein-** Many genes encode traits by specifying the structure of proteins. Genetic information is first transcribed from DNA into RNA, and then RNA is translated into the amino acid sequence of a protein.

**Mutations are permanent, heritable changes in genetic information**

Gene mutations affect only the genetic information of a single gene; chromosome mutations alter the number or the structure of chromosomes and therefore usually affect many genes.

**Some traits are affected by multiple factors**

Some traits are influenced by multiple genes that interact in complex ways with environmental factors. Human height, for example, is affected by hundreds of genes as well as environmental factors such as nutrition.

**Evolution is genetic change-** Evolution can be viewed as a two-step process: first, genetic variation arises and, second, some genetic variants increase in frequency, whereas other variants decrease in frequency.

**Genetic engineering**, the artificial manipulation, modification, and recombination of DNA or other nucleic acid molecules in order to modify an organism or population of organisms. The term *genetic engineering* is generally used to refer to methods of recombinant DNA technology, which emerged from basic research in microbial genetics. The techniques employed in genetic engineering have led to the production of medically important products, including human insulin, human growth hormone, and hepatitis B vaccine, as well as to the development of genetically modified organisms such as disease-resistant plants.



### **Recombinant DNA technology**

is a set of molecular techniques for locating, isolating, altering, and studying DNA segments. The term *recombinant* is used because frequently the goal is to combine DNA from two distinct sources. Genes from two different bacteria might be joined, for example, or a human gene might be inserted into a viral chromosome. Commonly called **genetic engineering**, recombinant DNA technology now encompasses an array of molecular techniques that can be used to analyze, alter, and recombine virtually any DNA sequences.

