GENETICS

Genetics is a branch of biology that deals with the heredity and variation of organisms.

In other words, it is the science of heredity, dealing with resemblances and differences of related organisms resulting from the inte raction of their genes and the environment.

Though started to develop at the beginning of 20th century, when we look at the history of genetics, we can divide it into 3 parts as **Pre-Mendelian period**, **Mendelian period** and **Post-Mendelian period**.

1) Pre-Mendelian period

False beliefs like living beings arise suddenly and by themselves; the genetic contribution of the father is more than the mother in the offspring were solved with the discovery of microscope and examination of the cells with it. Some genetic studies similar to Mendel's have been performed, however the results were not interpreted well, and therefore convincing explanations could not be made.

2) Mendelian period

Gregor Mendel was an Austrian monk who discovered the basic principles of heredity through experiments in his garden. Mendel's observations became the foundation of modern genetics and the study of heredity, and he is widely considered a pioneer in the field of genetics. Around 1854, Mendel began to research the transmission of hereditary traits in plant hybrids. Mendel chose to use peas for his experiments due to their many distinct varieties, and because offspring could be quickly and easily produced. He cross-fertilized pea plants that had clearly opposite characteristics—tall with short, smooth with wrinkled, those containing green seeds with those containing yellow seeds, etc.—and, after analyzing his results, reached two of his most important conclusions.

What did Mendel achieve?

1- The **Law of Segregation**, which established that there are dominant and recessive traits passed on randomly from parents to offspring (and provided an alternative to blending inheritance, the dominant theory of the time).

2- The **Law of Independent Assortment**, which established that traits were passed on independently of other traits from parent to offspring. He also proposed that this heredity followed basic statistical laws. Though Mendel's experiments had been conducted with pea plants, he put forth the theory that all living things had such traits

3- The **Law of Dominance** states that one factor in a pair of traits dominates the other in inheritance unless both factors in the pair are recessive.

3) Post-Mendelian period

Studies related to genetics continued and important achievements like chromosome mapping, elucidation of the structure of DNA etc. have been made.

Today genetics is being used in agriculture and husbandry, especially in breeding. In addition, genetic was found to be the foundation of many diseases and therefore started to be taken into consideration in medicine. E.g., diabetes, hemophilia, sickle cell anemia, color blindness etc. All have genetic basis. As a result, another field of science called **Medical Genetics** have arisen and **Genetic Counseling** was established to understand and correct genetic defects beforehand.

A genetic consultation is a health service that provides information and support to people who have, or may be at risk for, genetic disorders. During a consultation, a genetics professional meets with an individual or family to discuss genetic risks or to diagnose, confirm, or rule out a genetic condition.

Terminology:

Allele - Alternate forms of a gene.
Chromosomes - Threadlike strand found in the nucleus made up of a series of genes; carries genetic information, DNA.
Dominant - Gene/trait that appears or expresses itself; shown with a capital letter (e.g. Tall = T, Brown = B, etc.).
Recessive - Gene/trait that is hidden in the presence of a dominant; shown with a small, or lower-case, letter (e.g. short = t, blue = b, etc.).
Genotype - Genetic makeup of an organism (e.g. TT, Tt, tt).
Phenotype- Physical appearance of an organism (e.g. tall, short). Usually the appearance of the dominant gene, or the recessive if it is a purebred trait.

Hybrid - Organism with different alleles/genes for a trait (see heterozygous) .

Purebred - Organism with identical alleles/genes for a trait (see homozygous).

Sex chromosomes - The chromosomes that determine the sex or gender of an organism. An organism with two X chromosomes (XX) is a female. An organism with one X chromosome and one Y chromosome (XY) is a male.

Gamete

A reproductive sex cell (i.e. ovum or sperm)

Crossing over

The exchange of genetic material between a pair of homologous chromosomes

Gene

Units of inheritance typically occurring at specific locations (a chromosome)

Heterozygous: Having two different alleles for a particular gene, not true breeding

Homozygous: Having two identical alleles for a particular characteristic, true breeding

Mutation: Change that occurs in DNA sequence

Cloning: A process that produces identical genetic individuals

Genetic code: The genetic information held in the DNA

Trait: A feature whose appearance is determined by genes

Heredity and Genetics

Genetics, simply is the branch of biology, that deals with heredity and variations. It has 3 main disciplines:

- Hereditary genetics
- Molecular genetics
- Population genetics

- Hereditary genetics: Explians the basic principles of heredity (how traits are passed to the offsprings and the relationship between chromosomes and heredity.

Molecular genetics: This is the study of the processes whereby biological information is stored, copied, repaired and decoded to create protein and other molecules within cells and tissues.

This influential area of bioscience contributes significantly to expanding our understanding of biology and allows us to develop customized diagnosis, treatment and disease prevention for each patient based on their own genetic make-up.

Population genetics: This is the study of genetic variation within populations, and involves the examination and modelling of changes in the frequencies of genes and alleles in populations over space and time.

Many of the genes found within a population will be **polymorphic** - that is, they will occur in a number of different forms (or **alleles**). Mathematical models are used to investigate and predict the occurrence of specific alleles or combinations of alleles in populations, based on developments in the molecular understanding of genetics, Mendel's laws of inheritance and modern evolutionary theory. The focus is the population or the species - not the individual

The collection of all the alleles of all of the genes found within a freely interbreeding population is known as the **gene pool** of the population. Each member of the population receives its alleles from other members of the gene pool (its parents) and passes them on to other members of the gene pool (its offspring). Population genetics is the study of the **variation** in alleles and genotypes within the gene pool, and how this variation changes from one generation to the next.

GMO (Genetically Modified Organisms)

A GMO, or genetically modified organism, is a plant, animal, microorganism or other organism whose genetic makeup has been modified in a laboratory using genetic engineering or transgenic technology. This creates combinations of plant, animal, bacterial and virus genes that do not occur in nature or through traditional crossbreeding methods.

In most cases, GMOs have been altered with DNA from another organism, be it a bacterium, plant, virus or animal; these organisms are sometimes referred to as "transgenic" organisms. A gene from a spider that helps the arachnid produce silk, for example, could be inserted into the DNA of an ordinary goat.

That may sound far-fetched, but that exact process was used to breed goats that produce silk proteins in their goat milk. The milk is then harvested and the silk protein is isolated to make a lightweight, ultra-strong silk with a wide range of industrial and medical uses.

The range of GMOs can boggle the mind. Geneticists have bred GMO pigs that glow in the dark by inserting into their DNA a gene for bioluminescence from a jellyfish. Tomatoes have been developed that resist frost and freezing temperatures with antifreeze genes from a cold-water fish, the winter flounder (*Pseudopleuronectes americanus*). The Food and Drug Administration also recently approved potatoes that don't bruise and apples that don't brown. The apples have been genetically engineered to reducing levels of enzymes that can cause browning or bruising.

Why We Will Need Genetically Modified Foods?

Climate change will make it increasingly difficult to feed the world. Biotech crops will have an essential role in ensuring that there's enough to eat.

So the choice is dying of hunger now, or having yet unknown negative efects in the future (and probably dying due to them).

In respect to technology:

Scientists are developing ways of making trees glow so they can be used as natural streetlights without the need for electricity.

A team of researchers are experimenting with genes to allow the trait that causes fireflies to glow - bioluminescence - to be implanted into a variety of different organisms.