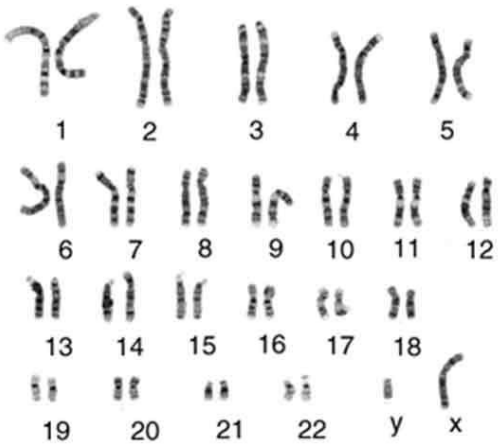
STATION 6H- GENETIC MODIFICATION & ANALYSIS

Background Information

A genome is all of an organism's genetic material. Other than identical twins, no two individuals have the same genetic material. Studying genomes enables scientists to learn about the function of genes and to identify genetic mutations, as well as analyze evolutionary relationships among organisms. Scientists use a variety of techniques to study organisms' genomes. Some of these techniques involve cutting long DNA molecules into smaller pieces with restriction enzymes, and then separating and reading the fragments using gel electrophoresis.

In 2003 the U.S., along with several other countries, completed the Human Genome Project. The goal of this project was to identify and sequence all human genes. The project relied on a technique called DNA, or gene, sequencing. Gene sequencing allows scientists to determine the order of DNA nucleotides in genes or in entire genomes. To do this, scientists mix an unknown strand of DNA with the enzyme DNA polymerase, and add samples of the four nucleotide bases: adenine, thymine, cytosine, and guanine. The nucleotide bases are tagged with trace amounts of dye. The unknown strand of DNA is used as a template to make multiple new strands of DNA. When a tagged nucleotide base is incorporated into a new DNA strand, DNA synthesis stops, producing strands of different lengths. The fragments then are separated using gel electrophoresis, and analyzed in DNA sequencing computers. Each individual (other than identical twins) has a unique pattern of banding, or DNA fingerprint. The banding patterns from two individuals can be compared to establish whether they are related, such as in a paternity case. DNA fingerprinting also is valuable for identifying the genes that cause genetic disorders, such as Huntington's disease and sickle cell anemia.

Another technique used to study genomes is genetic modification. Genetic modification involves scientists identifying and isolating genes that code for specific traits, and then manipulating those factors that affect the genes' expression. In 1973, Stanley Cohen and Herbert Boyer conducted an experiment that revolutionized genetic studies in biology. They isolated the gene that codes for ribosomal RNA (rRNA) from the DNA of an African clawed frog and then inserted it into the DNA of *Escherichia coli* bacteria. During transcription, the bacteria produced frog rRNA, thereby becoming the first genetically altered organisms.



In some cases, scientists study an organism's chromosomes directly to learn about their genomes. A karyotype (pictured above) is a picture of all the chromosomes in a cell, grouped together
in pairs and organized in order of decreasing size. The chromosomes are stained during metaphase, which produces a distinct pattern of banding on each chromosome. Karyotypes can be used to identify the possible location of a gene or a genetic abnormality on a chromosome. Karyotypes also can show how chromosomes change over time.