Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
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"A Look Into the Past"

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INTRODUCTION

When some boys look at their parents who are well over six feet tall, they feel quite comfortable in the assumption that they too will grow to be at least six feet tall and hence be able to control the basketball "hoop". Occasionally they don't quite measure up and look to their parents and teachers for some answers. Girls too, fantasize on being that perfect "10". Lot's of money is spent on special diets and surgery every year. Finally, when they face the reality that things are not working out as dreamed they too turn to their parents, teachers, and doctors for some answers.

There is a growing concern among the students as to why their physiological make-up is what it is. They are also asking such questions as. why did this illness have to happen to me? The answer to many of their questions lie in the genes. dominant and recessive traits. Therefore we must take a look into the past in order to find the answers.

Human beings are what they are because of the genes that they inherited from their parents. The basic heredity principal discovered by Mendel, applies to humans as well as to plants.

This unit will be used in a seventh grade Life Science class and can be used in grades six through eight.

By looking into the past, students can learn from this unit:

1. Genetics has to do primarily with the passing of traits from generation to generation. This is done through the passing of genes which are located on the chromosomes. Each individual inherits 23 pairs of chromosomes from each parent.

2. Some genes are dominant and others are recessive. The dominant genes mask the recessive genes, therefore the dominant characters are more noticeable.
3. Meiosis has to do with the duplication of the chromosomes and the division of the nucleus.
4. DNA, deals with the production of sex cells and the effect of mutation; a change in a gene that causes a change in inherited traits, whether it is good, bad, or indifferent. It is also referred to as the code of life because it contains all of the information to make and control every cell of an

organism.
5. Mitosis, which has to do with duplication of the chromosomes and the division of the nucleus and the cytoplasm. It is through mitotic cell division that organisms grow and develop.

6. Inherited diseases can and will occur because of errors in the genes. This unit also includes a vocabulary list, lesson plans, teacher and student reading list, hands on activities, resources, and a bibliography.

HEREDITY

A lot of students look to athletes as a role model and in so doing, they want to become another generation of Michael Jordans. In their searching they have added new words and meanings to their vocabularies. These words and meanings are helping them to come to understand the probabilities of being tall or short. Heredity is the transferring of developmental potentialities from one generation of living organisms to the following generations. These potentialities reside in the chromosomes of body cells.

It was Gregor Mendel, in the 1860's, who began analyzing hybrid pea plants to see if he could find a pattern in the characters handed down from one generation to the next. Mendel and his successors reasoned that, characters genes were the vehicle and repository of the heredity mechanism and each inherited trait or function of an organism had a gene directing its development and appearance. However,

Mendel did not know the location of the genes. It was not until the late 19th century that new microscopes and dyes were improved which aided in locating the genes. In the early 20th century Mendel's work was rediscovered and fully appreciated.

Genetics is a branch of biology which has to do with heredity and the variations between parents and offspring.

The following are the basic principals of genetics:

1. Traits or characteristics are handed down from one generation of organisms to the next generation.

2. The traits of an organism are controlled by the genes.
3. Organisms inherit genes in pairs—one from each parent.
4. Some genes are dominant shile others are recessive.

5. Dominant genes mask recessive genes when both are inherited by an organism. Traits or genes are located on the chromosomes. The chromosomes are rod-like structures located in the nucleus of cells of all plant and

animals. The main function of chromosomes is to control the production of proteins which consequently control the traits of plants and animals.

MITOSIS

All animals and plants are made up of cells. As the human embryo forms like cells organize the body according to the genetic blueprint each cell carries within itself. All cells contain a nucleus that is the center for reproduction and carries the genetic code. The division of one living cell and making two complete living cells is an important biological phenomenon. By this process, continuity of a species is ensured and mutation of a species is made possible.

Before the cell divides the material in the nucleus is duplicated. Cell division involves the cleavage of the cytoplasm and the nucleus.

To form two new cells the nucleus of the dividing cell goes through four stages:

Prophase—This is the first phase of mitosis. The nuclear membrane begins to disappear. The chromatin shortens and thickens to form the rod-like chromosomes. Two centrioles double then seperate. Spindle fivers form between centrioles. Chromosomes pairs become attached.

Metaphase—In the second phase the chromosomes pair up along the equator.
Anaphase—In the third phase, there is a separation of sister chromosomes and the beginning of movement of sister chromosomes toward the opposite poles.

Telophase—In the final phase of the cell division process, the cell body divides into two. Each daughter cell completes the process which restores it to an interphase cell. Interphase is the period between mitosis. During this stage, the cell is performing all of its life function but no division is taking place.

Mitosis Cell Division

(figure available in print form)

MEIOSIS

When a child is born he usually possesses a gene pair for each trait. For any particular trait, one gene contributed by a parent is on one of the paired chromosomes. The other gene for that trait from the other parent is on the opposite chromosomes. An offspring normally has 46 chromosomes or 23 pairs. Each parent contributes one of each chromosomes to make up the 46 chromosomes.

In the process of meiosis, sex cells are produced. These cells can be either sperm or egg cells. In this same process, the number of the chromosomes carried by each sex cell is exactly half the normal number of chromosomes found in the parent. In the formation of the offspring the sex cells combine and each contributes half the number of chromosomes. At the termination of the process the offspring gets the normal

number of chromosomes and half are from each parent.

In 1907, Thomas Hunt, a zoologist, began his study of chromosomes and genetics by using the fruitfly. His study indicated a peculiarity about the chromosome shape. He labeled the pair with the rod-shape the X chromosome and the pair with the hook shape the Y chromosome. More studies and testing led to the outcome that the X and Y chromosome determine the sex of an organism. Any organism that has two (XX) chromosomes is a female and any organism that has one X and one Y chromosome is a male. This may be true in humans but in the case of the fruit fly, Drosophilia Melanogaster, the inheritance of sex depends on a simple chromosomal mechanism. The male species has one X chromosome and the female species has two (XX) chromosomes.

Meiosis Cell Division
(figure available in print form)

DOMINANT/RECESSIVE

Occasionally when children question why they are not measuring up to what they want to become, they then go to their parents for some answers. Some parents may not be knowledgeable in the fact that some of the answers reside in the dominant and recessive genes. Mendel, during his study of plants realized that each plant contained two factors for a particular trait. In some plants the two factors (genes) were both for the tallness trait. These plants were true breeders and only produced tall plants. In a like-wise manner short plants contained two shortness factors were true breeding short plants. In instances when a plant contained both tallness and shortness factors, the plant would grow tall. This particular plant might still pass on on its shortness factor to the next generation of plants.

Today scientists use symbols to represent different forms of traits. The capital letter represents dominant genes and the small letter represents recessive genes.

(figure available in print form)
Shortness in the parent generation (P1) generation, disappears in the first generation (F1) generation, and reappears in the second generation. (F2 generation). What is true for the plant is also true of the animal for many traits.

Organisms that have genes that are alike for a particular trait (TT) are purebreds and organisms that have genes that are different for a trait (Tt) are hybrids.

In the case of incomplete dominance the genes are neither dominant nor recessive. The genes appear to blend together when they are inherited and become combinational. An example in animals for incomplete dominance is the Andalusian fowl. Neither black nor white feathers are dominant. When a gene for a black feathered fowl and a white feathered fowl is present, the fowl appears to have black feathers with tiny white dots.

MUTATION

Mutation can occur in plants creating a new variety. Mutation is a change in genes or chromosomes which cause a new trait to be inherited. When mutation occurs in a body cell, only that organism that carries the mutant gene is affected. An example is sickle cell anemia. If mutation occurs in a sex cell, that mutation can be expressed in the next generation. It is a possibility that the characters of the next generation may be changed.

Some mutations are harmful and can reduce an organism's chance of survival or reproduction.

There are also some helpful mutations. An example is the Katahdin potato. This new potato variety resists diseases that attack other potatoes.

Most mutations are neutral and do not produce any obvious changes.

In 1946, professor Muller, earned the Nobel Peace Prize in physiology, his work concluded that mutation could be produced by an environmental agent, such as X-rays. However, since that time scientists have evidence that ionizing irradiations, various chemicals, and heat shocks are mutgenic agents.

(figure available in print form)
NITROGENBASES
The structure of DNA resembles a spiral staircase. The rungs in the staircase are formed by pairs of nitrogen bases. The order of the nitrogen bases determine the particular genes of the DNA molecule. The code is the order of nitrogen bases on the DNA molecule. It is the variation in the arrangement of the bases that determines the individual's heredity.

In RNA, the nucleotide bases are U, C, A, and G. In the RNA the U takes the place of the T. There are 20 amino acids and each have more than one codon. The code for amino acids is based on triplets. The codons for the amino acid phenylalanine are UUU and UUC.

DNA (Deoxyribonucleic Acid)

The key to all of the "why" questions is locked up in the DNA. DNA is the basic substance of heredity and is found in every cell in the body. It contains all of the information needed to make and control every cell of an organism and is there-by called the code of life. DNA is the major component of chromosomes. There is also a basic protein component in the chromosomes. In some viruses the genetic determinants are RNA rather than DNA. DNA appears to be the heredity material of the majority of life forms.

The DNA molecules have two functions: replicating themselves and directing the synthesis of RNA. Each complementary strand of the double helical structure directs the synthesis of its complementary strand. In the rebuilding process each half of the two complete molecules will specify that its new complement be an exact copy of the original.

"DNA is to serve as a template of RNA synthesis. The biosynthesized RNA molecule copies the base sequence of the DNA, so that it transcribes the information carried in the original genetic code. The function of RNA is to carry the genetic message from DNA to the cytoplasm to conduct protein biosynthesis." Chromosomes synthesize RNA only in the interphase stage.

DNA is a chemical structure in the body put together like a string of beads. This unit is made up of four bases: T-thymine, A-adenine, C-cytosine, G-guanine. The angular ring shapes represent rings of linked carbon and nitrogen atoms. Each base is attached to a sugar and phosphate molecule. The sugars are rings of carbon and ten or eleven rings of oxygen, and the base is attached directly to the sugar. The base-sugar phosphate units of DNA chain are called nucleotides.

Human DNA is broken up into 46 chromosomes in each of or 60 trillion body cells. If all of our cells's DNA were laid end to end it would reach the sun and back many times.

DNA STRUCTURE
(figure available in print form)

SICKLE-CELL ANEMIA

When the structure of an inherited gene contains an error and the genes control the production of an important protein such as hemoglobin, the red oxygen carrying pigment in the blood, the outcome is that the hemoglobin may not be able to do its job well. An example of this is Sickle-cell Anemia. In this inherited condition the red blood cells are easily destroyed in the body. This condition is transferred by a single gene structure of the hemoglobin. The person inherits one gene for sickle-cell anemia from each parent. Should the individual inherit only one abnormal gene from only one parent he will have the Sickle-cell trait. The carrier of sickle-cell trait leads a completely healthy life except for extreme conditions of low oxygen. The carrier has no anemia nor symptoms. About 7% of black Americans have Sicklecell trait, and one out of 625 have the disease.

These abnormal red blood cells take on an abnormal chemical composition which leads to the decreased ability of the red blood cells to carry oxygen. This sickling shape causes clumps and clots and will block blood vessels.

The symptoms of Sickle-cell anemia are: general weakness, headaches, nausea, vomiting, fever, jaundice, and pain in muscles and joints. The blockage of the blood vessels can cause crisis which leads to the lost of function and causes pain. The crisis may involve the chest, brain, back, abdomen, and extremities.

There is no cure for Sickle-cell Anemia or the painful crisis. The treatment includes administration of fluids and pain relieving medication including narcotics.

In order to cure an inherited disease means correcting the error in a gene or replacing the abnormal protein completely.

SICKLE-CELL ANEMIA PEDIGREE
(figure available in print form)

THALASSEMIA

In the United States, thalassemia is mostly diagnosed in people of Mediterranean decent: Italian, Greek and Southeastern Asiatics, Cambodians and Laotians. Thalassemia is an inherited anemia which results in decreased production of hemoglobin. This disease occurs in two forms. The Thalassemia trait is mild anemia resulting from a person inheriting one thalassemia gene. The individuals with the trait has no symptoms and does not become ill. Five percent of Americans with Greek and Italian ancestors have the trait.

Thalassemia Major or Cooley's Anemia occurs when an individual inherits two thalassemia genes, one from each parent. The anemia is so severe that regular blood transfusions are necessary every four to five weeks. These transfusions make it possible for the child to be generally well through childhood. The side affects of the blood transfusions is a build up of iron. Excess iron damages the pancreas, resulting in diabetes. It can also damage the heart causing heart failure and death.

The treatment for the iron overload is the drug desferal. This drug must be injected over an eight to ten hour span using a battery driven pump. The injections are administered five to six nights weekly.

THALASSEMIA
(figure available in print form)

HEMOPHILIA

Hemophiliacs do not bleed any faster that any one else, they just bleed longer. The problem lies in the prolonged oozing primarily into muscles and joints. Approximately one in every 10,000 boys is born with hemophilia. This disease knows no race, creed nor color. Hemophilia is a recessive sex-linked disorder. The female may be a carrier but seldom has bleeding problems herself.

The disorder is caused by the absence of one of the 10 clotting factors, which are proteins necessary for blood clotting.

There are two types of hemophilia, Hemophilia A (classic hemophilia) also known as factor VIII deficiency and Hemophilia B (Christmas disease) also known as factor IX deficiency.

Hemophilia has three levels of severity: mild, moderate, and severe.

Mild hemophiliacs have prolonged bleedings only with surgery, tooth extractions, or major injuries. In case of the moderate hemophilia, bleeding can occur into joints or muscles following a mild trauma such as sprains or bumps. The severe hemophiliac will have more frequent and severe bleeding. This bleeding may take place into joints, muscles, or body organs with no apparent injury, cause, or after surgery.

When a hemophiliac sustains an injury the first aid treatment is the same as for anyone else. In some instances an intravenous transfusion may be necessary to replace the missing clotting factor. This procedure takes approximately 10-20 minutes.

The majority of students with hemophilia can engage in many normal physical activities. Moderate exercise is an essential for the hemophiliac because it helps to strengthen muscles and help prevent joint damage.

Modern treatment with biosynthetic factor VIII also helps them to lead a more normal life.

HEMOPHILIA
(figure available in print form)

MARFAN SYNDROME

Marfan syndrome is an inherited disease that affects the connective tissue of the bones and ligaments and of the eye, heart, blood vessels and lungs. This disorder can affect more than one person in a family. An individual when affected by Marfan syndrome is often tall, slender and very flexible. The spinal curve can become severe without treatment. The breast bone protrudes due to an over growth of ribs. The face is long and slender. The teeth are crowded. Infants tend to look older than they are. The individual will also suffer nearsightedness and the lens will be off center. In the heart, the blood vessels are affected in nearly all persons. These affected vessels cause an abnormal motion when the left ventricle contracts sometimes leading to heart murmurs. The aorta can become enlarged therefore requiring more frequent doctor visits. In the lungs there is less elasticity than normal.

Marfan syndrome is caused by a mutant gene. The Marfan gene may be inherited from a parent affected by the disorder or from an unaffected parent who had a mutation in the sperm or egg cell.

Some researchers tend to believe that the cause for Marfan syndrome is due to a change in one of the proteins that provide strength to connective tissue.

It is estimated that one out of 10,000 persons in the United States is affected. Marfan syndrome is no respector of race, sex, or ethnic group.

Presently, there is no cure for Marfan syndrome. A true cure includes altering the gene structure of that gene responsible for causing the condition.

This condition does not prevent the affected person from holding down a compatible job, however, vigorous physically exerting activities should be avoided.

Pedigree of family with Marfan Syndrome
(figure available in print form)

CYSTIC FIBROSIS

Cystic Fibrosis is a hereditary disorder that affects the mucus producing glands in the pancreas, lungs, and intestines; causing a thick, sticky mucus to form. It is one of the most common life threatening genetic disorders in caucasians, affecting one in 1,500 to 2,500 infants. Cystic Fibrosis is very rare in blacks and orientals. The pancreas is responsible for producing insulin and enzymes essential for proper food digestion. In cystic fibrosis the pancreatic ducts are obstructed and this causes a deficiency or total absence of its secretion. This problem leads to an inability to digest fats and consequently leads to malnutrition. In most cases insulin is still produced and diabetes is not a side affect.

In cystic fibrosis a chronic infection can occur when the mucus producing glands of the respiratory system are affected. This is characterized by the lungs becoming filled with little cysts containing pus and the delicate tissue in the air sacs is replaced by fibrin which is rigid. This can bring on hacking coughs, wheezing, and shortness of breath. Severe lung infection leading to respiratory arrest is a primary cause of death in a person with cystic fibrosis.

A diagnostic test for cystic fibrosis is the sweat test. This test measures the amount of salt in perspiration especially chloride. An affected person will have higher than normal amounts of chloride.

There is no cure for cystic fibrosis, only treatment of symptoms; antibiotics for infection, medication to thin mucus in the lungs, high calorie low fat diets to help with digestion, vitamin supplements, and supplementation with pancreatic enzymes.

Cystic Fibrosis is inherited only if both parents are carriers of the gene. It cannot be passed on if only one parent is a carrier.

Cystic Fibrosis family pedigree
(figure available in print form)

Vocabulary
HEREDITY

TRAIT

CHARACTER

GENETICS

GENE

DOMINANT

RECESSIVE

CHROMOSOME

Y CHROMOSOME

X CHROMOSOME

MEIOSIS

MITOSIS

PUREBRED

HYBRIDS

MUTATION

DNA

INHERIT

HEMOGLOBIN

SICKLE-CELL ANEMIA

THALASSEMIA

HEMOPHILIA

CYTOPLASM

NUCLEUS

GERM CELL

EMBRYO

RNA

SPINDLE

CHROMATIN

GENETIC CODE

LESSON PL *ANS*

I. MEIOSIS AND MITOSIS

Performance Objectives

1. After completing this unit the students will be able to distinguish the difference between meiosis and mitosis cell division.
2. They will be able to discuss each stage of mitosis.
3. The students will be able to discuss the difference in the germ cells of the Drosophilia melanogaster and the human being.

Vocabulary	Discussion
1. meiosis (see topic)	1. Meiosis cell division
2. mitosis (see topic)	2. Mitosis cell division
3. chromosomes	3. The 23 pairs of chromosomes

4. genetics (where they come from)

Mitosis cell division	*Meiosis cell division*	
(see drawing)	(Sex cells produced)	
Interphase		
1. Prophase Stage	XX—female	XX—female
2. Metaphase Stage	XY—male	X—male
3. Anaphase Stage	human beings	Drosophilia
4. Telophase Stage		melanogaster

II. HEREDITY

1. The students will do a library investigation on Gregor Mendel to be presented in class.
2. The students will do a classroom investigation on hereditary characteristics.
3. The students will do a field investigation at the Connecticut Agriculture Center to observe the growth of various plants.

Vocabulary

1. heredity

2. chromosomes

3. hybrid

4. genetics

5. traits

6. characters

7. gene

Materials

1. graph paper (3 sheets)

2. meter stick

3. pencil

Procedures On a graph the students will plot their height according to age and sex. The students will be put into groups of 4. The students will then use a meter stick to measure each others height, and record it on the graph paper according to sex and age. The students will then share the groups measurements with the class, the class will record the measurements according to age and sex. The teacher will record the same measurements on the board.

The students will try to justify the variances in the sex, ages, and heights genetically.

III. DISEASES

1. The students will use the library to write a report on one of the genetic diseases.
2. A resource person will discuss with the class three other genetic diseases of their choice.
3. The class will review the pedigree of all of the diseases.(see various diseases)

Genetic Diseases

1. Marfan Syndrome

2. Sickle-Cell Anemia

3. Brachydactyly

4. Hemophilia

5. Cystic Fibrosis

6. Thalassemia

Vocabulary

1. Hemophilia

2. Sickle-Cell Anemia

3. hemoglobin

4. trait

5. chromosome

6. gene

Notes

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*—students **—teachers