



A Question of Inheritance

Curriculum Unit 90.06.05
by Sheila Martin-Corbin

INTRODUCTION

During adolescence, the question of inheritance is being expressed in many different ways by students. Their minds are constantly engaged with questions and comments concerning their image and development. For example, “Why am I so short?”, “I wish I was as tall as my dad” or “What is responsible for my uniqueness?”

This curriculum unit is developed for biology students, seventh graders, with the hope of clarifying many of these questions and to provide them with a clear understanding and knowledge of human genetics—the chemical nature and arrangement of the DNA that makes up the genes. This unit will examine human genetics from the perspective of variability and diversity.

In this unit students will be introduced to famous scientists, namely, Gregor Mendel, James Watson, Francis Crick, Maurice Wilkins, Barbara McClintock and Rosalind Franklin, emphasizing the importance of their discovery to modern genetics. This will be followed by a description of the structure, chemical nature and how DNA replicates itself during meiosis. A discussion of mutation and how it can affect the physical appearance of an organism.

Next, cellular structures, including genes and chromosomes will be discussed followed by a description of the process of mitosis and meiosis. Emphasis will be placed on multiple alleles and a discussion of how inherited diseases are caused by defective genes.

Students will be informed about methods of prevention and treatment for genetic disorders. The students will gain an understanding of applied genetics as genetic engineering is discussed.

Objectives for lessons, together with related activities will be included in this unit. The duration of this unit is about five weeks.

HISTORY AND DISCOVERY OF GENES

Objectives *Students will have opportunities to*

1. Collect and relate information concerning the work of Mendel, Watson, Crick, Wilkins, McClintock and Rosalind Franklin to the rest of the class.
2. Describe the structure and nature of DNA.

Approximate time *one week.*

One of the greatest scientific wonders is the human body and how it reproduces. What element is responsible for this rapid growth? The secret of how life is reproduced lies in the genes and their chemicals, DNA and RNA. DNA or deoxyribonucleic acid is the code of heredity. For example, it controls the plan of a person's appearance, intelligence or body structure. This hereditary information is passed on to the cells by chemical messengers called RNA or ribonucleic acid. DNA therefore directs their production and growth of every cell in the human body. Sometimes the message in the code tells some cells to switch off some genes and at another time to start some genes. In this way different cells are produced for varied purposes.

An English physicist, Francis Crick and an American biochemist, James Watson spent a great deal of time studying the DNA molecule, and in 1953, announced that they had worked out a model of how the Whole DNA molecule is constructed. They likened this DNA molecule to a spiral staircase, winding round and round— built like a double helix. The edges of the staircase are made up of bits of sugar deoxyribose, joined together by phosphate groups. The steps of the staircase are made up of pairs of the four organic bases. These bases are paired up in very definite ways. Adenine on one strand of the helix is always paired with thymine on the other, and guanine is always paired with cytosine.

One may ask, Why can't there be another combination, say for example an adenine pairing with cytosine or two cytosines join together? Would this combination permit proper functioning of the molecule? A little deviation from this structural sequence will result in malfunctioning of the molecule which will ultimately affect the structures as a whole. This lies in the fact that these bases are joined together by a hydrogen bond; one must have a hydrogen atom and the other must have a nitrogen or oxygen of a special kind. These atoms must be in the right places to form hydrogen bonds. Thus the wrong pair of bases could not hold the two chains of DNA together.

As mentioned earlier, DNA sends its orders to the cell by making RNA messengers. When a DNA molecule is ready to make RNA, part of it unzips. The hydrogen bonds that hold the two chains together are not as strong as other kinds of chemical bonds. Therefore these bonds can break and the chains can separate. Along one of the chains, an RNA base moves into place beside each DNA base that is uncovered. The RNA base guanine will line up next to a cytosine in the DNA, and a cytosine next to a guanine. An adenine will form a hydrogen bond with the thymine in DNA, and since RNA never contains thymine, a uracil will be joined into place next to an adenine in

DNA. (See diagram below).

After the RNA chain is made it breaks away, and the two DNA chains coil up together again into a double helix. This new RNA now has DNA's message to be translated in the cell.

Genes are composed of some of the most common elements such as carbon, hydrogen, oxygen, nitrogen and phosphorous. They are made of deoxyribonucleic acid (DNA). Genes are capable of exerting their influence through the proteins which they cause to be produced in the cells. These proteins are manufactured on the ribosomes in the cytoplasm of each cell. Genes in the nucleus produce messenger-RNA which passes into the cytoplasm and directs the information of polypeptide chains of amino-acids at the site of the ribosomes.

It is in this DNA molecule, the code of life that stores the secret of all our differences and similarities among all forms of life.

Suggested Activities

1. Have students visit the library and use the various resources, say books, magazines, journals, periodicals, microfIlms or the computer to gather information from Watson and Crick discovery to modern genetics. Students will organize themselves into small groups of four and gather related facts concerning the work of Mendel, Wilkins, McClintock and Rosalind Franklin. Each group will be given the opportunity to relate their work to the rest of the class.
2. Have students construct models of the double helix using colored construction paper and also utilize the DNA made-easy board to reinforce which bases pair up with other bases.
3. Teacher demonstration—use of colored paper clips, colored clothes pins, fruit loop cereal or gumdrops, could be used to show the linkage of DNA molecule.

MUTATION

Objectives Students will have the opportunities to:

(figure available in print form)

1. Define mutation and explain how mutations can affect the physical appearance of an organism and/or its genetic makeup.
2. List ways in which mutations can be harmful and beneficial.

Approximate time one-half week.

In 1886, Hugo de Vries, an American botanist, studied the growth of primroses and discovered that every so often a new variety of primrose would grow that could not be accounted for by genetic laws. He called these

changes in characteristics 'mutations'.

Errors are being made throughout our lives in one form or another whether intentionally or unintentionally. However, these mistakes are sometimes detected at an early stage and ways to correct these errors can be implemented instantaneously without causing great damage. An alteration, change, mistake in the transcription of one base in the DNA molecule of a gene can have severe consequences. This is sometimes the case with a gene mutation. A slight change in the DNA of a cell may not be detected in the early stages of life for correction, until it has manifested itself after a period of growth and development. This applies to other living things including plants.

If a mutation occurs in one of the early cells that start off the life of a new baby, the plans of development may be terribly upset. In some major ways babies are born deformed and it is believed that some of these deformities result from mutation in the DNA. Mutation is responsible for the diversity of the alleles necessary to produce genetic variation. Virtually any trait is the result of the combined action of genetic and environmental factors.

Most mutations either are so slight that they do not seem to have much effect on an organism's chance to survive or they harm it in some way. For example, a fruit fly that have orange eyes instead of the normal red eyes, would probably be able to get along just as well as if it had not had the mutation. But if a mutation caused it to be born without eyes may cause its life span to be curtailed. However, a mutation can actually help an organism to survive. Perhaps it can run or fly faster than the other of its kind. Or it may have skin or fur that matches the background of its environment as to escape or hide from its prey. Even today, farmers and animal breeders watch for and use them to breed stronger and better plants and animals. e.g. breeding strains of corn with more nourishing protein and perhaps rice that gives a much higher yield per acre.

Suggested Activities

1. Students will visit the Agriculture Garden Center and observe heredity traits of at least ten similar plants. Students will note common and uncommon traits among the plants, such as the shape of the leaves or the color of the petals.

Students will not only make observations, but will be applying concepts, comparing, identifying, relating and classifying the plants according to their observable traits.

2. Students will investigate topics including how some insects develop resistance to insecticides; the prolonged use of certain antibiotics and how radiation can cause mutations. A discussion of these topics will be held next lesson.

MITOSIS/MEIOSIS

Objectives *Students will have opportunities to*

1. Compare mitosis and meiosis briefly describing the activities of the chromosomes in each stage.

Approximate time *one week.*

Individuals have shown a marked difference in size and weight since the time of birth. A simple answer to this question is that cells reproduce by dividing. This cell division is controlled by the nucleus of the cell. During cell division, each chromosome splits down the middle to form a pair of twin chromosomes side by side. The pair of chromosomes lines up across the center of the cell and the nuclear membrane disappears. The twin chromosome of each pair separates and moves to opposite ends of the cell. The whole cell splits into two new cells. This division of the nucleus is called Mitosis. During this process the chromosome doubled before the cell is divided into two. Thus, each cell has a full set of chromosomes, DNA and genes.

Meiosis—refers to two successive nuclear divisions (with corresponding cell divisions) that produce gametes (in animals) or sexual spores (in plants) having half of the genetic material of the original cell.

In anaphase, the spindle pulls one chromosome from each homologous pair to one side of the cell and the other homologous chromosome to the opposite side. Eventually the two new cells that form contain one chromosome from each homologous pair.

During prophase, the replicate chromosomes of each homologous pair come close together and may twist around each other. In this position, parts of the chromatids of one chromosome may break off and exchange places with the identical parts of chromatids of the other homologous chromosomes—crossing over. After crossing over, the chromosomes are no longer identical to the original paternal and maternal chromosomes; they are a mixture of both.

In anaphase the homologous pairs separate as the spindle apparatus pulls the centromeres to opposite sides of the cell. The centromeres do not divide.

During metaphase, the homologous pairs move to the equator of the cell, and the centromeres attach to the spindle apparatus.

In telophase, the homologous chromosomes have separated and the reproductive cells are dividing.

The event of crossing over or genetic recombination is an event whereby genes recombine and are shuffled between the two homologous chromosomes, producing a new mixture of genes. Genetic recombination is a major contributor to variation among individuals of the same species. This is why one's brothers or sisters do not look exactly alike (unless identical twins).

During meiosis, the chromosome number is halved which prepares the cells for fertilization when the diploid number is restored.

Suggested Activities

1. Students will use the Gameto-discs to construct a diagram showing Mitosis and Meiosis.
2. Students will also make simple drawings in their notebooks illustrating both processes, reviewing the differences and similarities.

GENETIC DISORDERS

Objectives Students will have opportunities to

1. Define dominance, recessive, trait, sex-linked trait.
2. Give an example of how multiple alleles determine a human trait.
3. List the different types of genetic disorders. Give an explanation for each type of disorder.
4. Describe and give an example of each disorder.

Approximate time one-half week.

Any trait is the result of the combined action of genetic and environmental factors. Three main types of disorders are recognized.

Single-gene disorders

This is caused by mutant genes. The mutation may be present on only one chromosome of a pair or on both chromosomes of the pair. In either case, the cause of the defect is a single major error in the genetic information. Single-gene disorders usually exhibit obvious and characteristic pedigree patterns.

In regards to traits such as tasting certain chemicals, the pattern of inheritance are as follows: (T) those traits or genes for them that are fully or almost fully expressed, phenotypically that is, are known as *dominant* —taster (T). The dominant gene has the same expression in the heterozygous or homozygous state. Those genes carried on the autosomal chromosomes are classed with autosomal dominant inheritance.

A trait that is transmitted as autosomal *recessive* is expressed only in persons who have the gene in a homozygous state; that is, a non-taster (tt).

Turner Syndrome

Individuals with X-chromosome and no Y-chromosome, i.e. XO genotype . . . they are usually short,

underdeveloped sterile females. Females with an XXX genotype often have limited fertility and may have slight intellectual impairment. An XXY chromosome combination results in Klinefelter's disease or syndrome. These males often are tall, sexually underdeveloped and may have slight intellectual impairment.

Huntington Chorea

This disease is caused by an autosomal dominant gene. This disease is characterized spasmodic movements and incoordination and progressive mental deterioration.

Cystic Fibrosis

The most common genetic disorder among Caucasians is cystic fibrosis. Approximately, one in every twenty Americans of Northern European ancestry is heterozygous for this trait. This disorder is characterized by the excessive secretion of mucus, which accumulates and damages the lungs, digestive tract and other organs. With treatments such as the administration of pancreatic enzymes and the control of infections, the life span of people with such disease has been extended into early adulthood.

Most recessive disorders can be traced to an allele for a recessive trait that codes for an ineffective or nonfunctional protein product. An allele is a gene which codes for a protein, a mutant allele codes for an abnormal protein. If half of the normal protein is all right, the disease is recessive.

Hemophilia

This is an inherited disease that causes the blood to clot slowly or not at all. This is an example of a sex-linked recessive trait. Blood fails to clot normally because of abnormally low antihemophilic globulin factor VIII. The incidence of the trait is much higher in males than in females.

Chromosome disorders

Due not to a single mistake in the genetic blueprint but to an excess or deficiency of the whole chromosome or chromosome segments, which upsets the normal balance of the genome. For example, the presence of a specific extra chromosome, say chromosome #21 produces a characteristic disorder, Down syndrome, even though all the genes on the extra chromosome may be quite normal. People with this disease may have various physical problems and some degree of mental retardation.

During Meiosis, chromosomes pairs usually separate. But in rare cases, a pair may remain joined. This failure of chromosomes to separate is known as non-disjunction. When this happens, body cells inherit either extra or fewer chromosomes than normal. It is important to note that the extra chromosome on the twenty-first pair producing the condition, is a perfectly normal chromosome and can only come from either the mother or the father.

Multifactorial inheritance

This kind of inheritance is seen in a number of common disorders especially in developmental disorders resulting in congenital malformation. There is no major error in the genital

information but rather a combination of small variations that together can produce a serious defect. (Environmental factors may also be involved.) Multifactorial disorders tend to recur in families but do not show the characteristic pedigree patterns of single gene traits. These disorders arise from the action of at least

several genes and their interaction with their environment. Heart disease, which is the leading cause of death in the United States today, has been linked with smoking, diets high in cholesterol and saturated animal fats, stress and lack of exercise. These environmental factors can result in elevated blood cholesterol levels in individuals with and without the trait, that results in the accumulation of very high levels of cholesterol in the blood.

Spina Bifida

This is a birth defect of the backbone often called 'open spine'. Scientists believe that genetic factors and some environmental factors act together to cause spinal and related central nervous system defects.

Suggested Activities

1. Students will design a survey form and collect data by observing about six students in the class demonstrating dominant or recessive traits for example, hair color, tongue-roller, tasting.

In this experiment, the students will practice their skills in observing, comparing, relating, applying and recording by designing and drawing bar graphs of their data.

2. To predict the results of genetic crosses using probability by flipping a coin six times. Each flip represents one child; the six flips represent the six children in a family. This activity will reflect the chances of a girl rather than a boy being born into a family is 50:50.

Statistics will also come into play when students are allowed to manipulate the laboratory kit on Mendelian experiments—'Chances and Choices'.

3. Invite speaker or speakers on genetic conditions relative to the genetic disorders and other abnormalities covered in class.

4. Show to students the video on 'Anne' from the Yale Gene Department. Also students can listen to Tel-Med tapes of certain genetic disease from the hospital of St. Raphael.

Another video of interest for students to view is, 'The book of Life' from Tommy-K Video Store.

5. Call or write to your local March of Dimes for literature on hereditary diseases.

TREATMENT

Genetic counseling has grown as technology has enabled researchers to identify carriers of harmful alleles and test fetuses for chromosomal abnormalities and some genetic disorders. Genetic counseling can help families with questions about the chances of having additional affected children and can explain prenatal testing about genetic defects. Their role is to provide the family seeking help with a realistic view of the situation. If there are decisions to be made the parents can make more informed choices with the facts in hand. Some genetic facilities prefer to have patients and families referred by physicians or other health professionals, but many readily accept self-referred patients. Prenatal diagnosis of genetic disorders can be made by performing the following tests:

- a) amniocentesis
- b) chorionic villi sampling
- c) ultra sound

Precautionary measures concerning the intake of harmful drugs, alcohol intake and smoking would also be stressed.

Objectives Students will have the opportunities to

1. Be informed of the dangers and risks that expected mothers face during pregnancy.
2. To be aware of the prenatal testing techniques.
3. To learn about the different facilities available for providing genetic counseling.

Approximate time one week.

Suggested Activities

1. Discussions and/or debates of current issues of genetics from magazines, journals will be encouraged. The following issues can be used as a springboard for class debate:
 - i) have students debate the ethical and legal issues involved in surrogate motherhood.
 - ii) changing the genetic make-up of an individual. (See article title, "The Telltale Gene"—Consumer Report, July, 1990).

GENETIC ENGINEERING

Objective *Students will have the opportunities to*

1. Describe the process of genetic engineering.
2. Describe how recombinant DNA is made.
3. Describe how bacteria or yeast can produce human proteins.
4. List some goals of genetic engineering.

Approximate time *one week.*

Progress has been made along the line of genetic engineering in improving the quality of lives of different organisms. Scientists have the ability to make changes in the genes, to turn genes on and off and even to synthesize new genes.

Genetic engineering is the process that allows genes or parts of DNA to be transferred from one organism to another. This usually is carried out in single-celled organisms. The transferred genes become part of the receiving organism's DNA and the particular trait involved is inherited by succeeding generations. The new pieces of combined DNA are called recombinant DNA. The products of recombinant DNA are used to produce vaccines, insulin, interferon and human growth hormone.

Genetic engineering is aiding many areas of biological, agricultural and medical research. It is a field that people look at with both anticipation and fear. They see some of the benefits that could be gained from it, but they also see the dangers that can result. Through genetic engineering, it is becoming increasingly possible to breed plants and animals that would provide more and better food for the world's growing population.

Suggested Activities

1. Students will see a video on 'Genetic Engineering'. This video could be obtained via the audio-visual department in the New Haven Public School System—Dr. Theodore Astarita. The duration of this video is 15 minutes which helps students to understand the nature of change. Insights into how the quality of our lives could be improved.
2. Slide presentation on human karyotypes.
3. Growing plants in different environments.
4. Have students make a flow chart showing the correct sequence of events that occur during genetic engineering.

Additional Activities

5. Students will make charts showing how dominant, recessive and X-linked inheritance works.
6. Students will perform the activity on 'finger printing' to show that no two persons are alike.
7. Students will compare their heights and weights with other students of the class. Compare baby photos of themselves to see how people change as they grow older.

LESSON PLANS

History and Discovery of Genes

Activity Building the DNA molecule / DNA replication.

As a means of review and reinforcement have two or three students relate to the rest of the class about the work of Watson and Crick, in their discovery to modern genetics.

Point out that chromosomes are made of molecules of DNA. The DNA molecules are the genes that control all traits passed on from parents to offspring. DNA molecules are composed of the same elements but their arrangement varies. Emphasize to students that this variation in the arrangement of these elements (bases) determines individual heredity.

Explain to students that each unit of DNA has a phosphate, a sugar and a nitrogen base. There are four different types of nitrogen bases which combine in very specific ways. In the DNA, which takes on the shape of a twisted ladder, Adenine (A) always pairs with thymine (T) and Guanine (G) always pairs with Cytosine (C).

Materials (per class of 24, working in teams of four).

6 sets paper clips: 40 black 40 white
32 red 32 green

string or yarn

masking tape

magic marker

Directions Have students get into groups of four before distributing the different colors of paper clips and remaining materials to them.

Provide students with a key to designate the nucleotide bases. For example:

COLOR BASE
Black Adenine (A)

Green Guanine (G)
White Thymine (T)
Red Cytosine (C)

PART A

Ask students to construct one DNA strand by linking the colored paper clips together in the following way:

1. Link 3 black paper clips to each other followed by 2 green, 1 white, 1 red, 1 white, 2 red, 1 white, 1 red, 1 white, 2 black, 2 white, 2 green, 1 white, 1 red, 1 white, 2 red, 2 white, 1 black, 2 green, 1 white, 1 red, 1 white, 2 red, 2 white.

The students should realize that this strand of DNA begins with three Adenine bases and ends with two Thymine bases.

2. Use a small piece of masking tape labeled #1 and attach it to the AAA (three black paper clips) end of the strand to identify this strand.
3. Now construct the complementary strand of DNA that would pair with strand #1. You may want to monitor the groups to make sure that they are using the key properly and matching the base pairs correctly.

Remind students that Thymine(T) bonds with Adenine(A), and Guanine(G) bonds with Cytosine(C).

4. Attach another piece of masking tape labeled #2 to the TTT end of the complementary strand.
5. Ask students to place both strands alongside each other making certain that they have constructed the proper sequence of nucleotide bases in #2 strand.
6. Use the piece of yarn or string provided to tie or join the first paper clips in #1 strand (AAA) with the first paper clips in strand #2 (TTT).
7. Repeat step 6 for the paper clips on the other end of strands #1 and #2.

PART B

8. Place the completed double-stranded DNA on his/her desk or table so that both sides are in a straight line opposite each other. (Do not untie the string at the end.)

9. Count 22 paper clips beginning from the AAA end of the strand and tie this 22nd pair of paper clips together as done before on the ends of the molecule.
10. Untie the string holding the two ends of the molecule together at the AAA and TTT end of the strand. Strands will separate to form a “Y” or forked shape.

11. At this point, explain to students the process of DNA replication.

If time permits, ask students to construct new complementary DNA strands for strands #1 and #2 to show or to illustrate DNA replication.

Home-work Assignment *Describe how DNA replication makes it possible to produce two identical cells from one parent.*

Questions for Discussion

1. Which base pairs up with the adenine during replication?
2. Which base pairs up with cytosine during replication?
3. What would happen if the bases did not pair up this way?
4. Compare the two new double-stranded molecules that you have just completed. How are they similar to the original DNA molecule containing strands #1 and #2? How are they different?
5. Describe the differences in the way strand #1 and #2 are replicated.

CLASSROOM ACTIVITIES

Mutation

Review the definitions of the following terms with students: trait, chromosome, gene, mutation, dominant, recessive. Emphasize to students that mutations can occur in both body cells and sex cells. Consider the following question for group discussion:

If a mutation occurs in a body cell, what effect would it have on the organism? Its offspring?

Possible Response

A mutation in a body cell only affects the organism that carries it. It will not be passed on to its offspring. If a mutation occurs in a sex cell, it can be passed on to the next generation and cause a change in that generation. However, most individuals who have genetic disorders have the same mutation in *all cells*, body and sex cells.

FIELD TRIP

Students will be given the opportunity to visit the Agricultural Garden Center, New Haven, to observe the traits of flowering plants. This activity provides concrete opportunities for students to explore the concepts discussed prior to this activity. Also, students will be performing the following skills: observing, manipulating, comparing, relating and recording while completing this investigation.

Materials Pen/pencil Ruler Worksheet paper

Instructions Allow each student to select one type of flowering plant to be observed. Record the name of plant.

Students must observe at least two of these plans in order to observe hereditary traits.

Complete worksheet below:

(Students may make simple drawings to illustrate trait observe in plants. Students are encouraged to supplement the chart with other observable traits).

NAME OF PLANT	NUMBER FLOWER POSITION	LEAF SHAPE	NO. AND COLOR OF PETALS	STEM LENGTH	FRUITS
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B. Make a clear drawing of your plant in the space provided. Answer the following questions:

1. What *common* traits seem to be found on most of the plants?
2. What *uncommon* traits are found on one or more of the plants but not on the rest?
3. Which traits would you consider to be dominant? Why?

Home Work Assignment

4. List and explain the different agents that can cause mutations in plants. Students can also investigate how some insects develop resistance to insecticides.

CLASSROOM ACTIVITIES

Genetic Disorders

The primary purpose of this activity is to help students to become aware of the existence of inherited conditions and to understand that knowing about inherited conditions can be of use in making informed decisions about personal and social issues and values. It is important that students in this stage of their development develop a positive attitude toward acquiring genetic knowledge. A number of major inherited disorders occurs with some frequency only because there is a relatively large proportion of carriers of potentially harmful genetic traits in the general population. While having a recessive gene usually poses no health problem for a carrier, there is always the risk of serious genetic disease in any child of two carriers of the same harmful trait, or any son born to a mother carrying an X-linked defect.

Due to multiple-gene inheritance, interactions among several genes, and to an extent the activity of certain genes at a particular time in a person's life, human heredity is very complex. Many genetic disorders are the result of mutant alleles that follow Mendelian inheritance patterns. Most of these genetic disorders can be traced to an allele for a recessive trait that codes for an ineffective or nonfunctional protein product. When the protein is an enzyme, the result in a homozygous recessive individual may be a block in an essential metabolic pathway. The lack of the product of that pathway may account for the symptoms of the disease or an excess of the precursor in the pathway may be toxic.

1. Discuss the definitions of the following terms with the class: recessive, dominant, carrier, heterozygous, homozygous, inherited disorder, mutation, genes and alleles.

Have students observe other members of the class and develop a list of obvious differences. Point out to students that these differences are referred to as 'traits' e.g. hair color, which are controlled by genes.

2. Divide the class into two groups.

3. Distribute the worksheets on the vocabulary discussed earlier in the lesson to one group. These students will be given instructions to match the correct meaning with each word given. (See page below).

4. Divide the remainder of the class into four groups. Distribute to each group drawings showing how each disorder is inherited. Have students figure out the odds for each offspring. Each group will work together to analyze the drawing provided. Allow each group to choose a representative who will explain to the rest of the class the way in which genetic defects may be transmitted to an individual.

5. At the end of this presentation, a representative from section A will define the terms given earlier to the rest of the class.

6. Students will be given a copy of each activity performed in class to review for homework.

Note: For Reinforcement

7. Use Polaroid slides of chromosomes and genetic conditions to be shown during the next lesson.

Activity Sheet

TERMS : recessive, genome, heterozygous, trait, alleles, dominant, inherit, homozygous, gene, mutation,

Choose the correct term from the list *above* and match it with the correct definition given *below* . The first one is done for you.

1. gene basic unit of heredity.
2. _____ weaker trait in genetics.
3. _____ characteristic of an organism.
4. _____ change in genes or chromosomes that causes a new trait to be inherited.
5. _____ stronger trait in genetics.
6. _____ each member of a gene pair.
7. _____ to receive traits or qualities from parents.
8. _____ condition of an individual in which the genetic factor has been derived from only one of the two gametes.
9. _____ a full set of chromosomes with their associated genes.
10. _____ condition of an individual in which the genetic factor is doubly present due to like gametes.

To Show: Dominant Inheritance

(figure available in print form)

BIBLIOGRAPHY

TEACHERS

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This text discusses the principles of genetics and heredity in a very simple way.

Heath, D. C. *Biological Science: A Molecular Approach*, 6th edition, 1989. 1-413-562-2144.

Very enriched content. Detailed discussions of related topics in genetics. This text encourages students to think and analyze issues in research, technology and careers.

Mange, A. and Mange, E. *Genetics : Human Aspects* . Saunders College, Holt, Rinehart & Winston, Philadelphia, 1980.

This is an excellent reference text as applied to human genetics.

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This text simulates Mendel's experiments and his laws of genetics. Students will be able to review basic genetic terms and to discover the problems Mendel were faced with during his experiments.

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This text gives a complete review of gene mapping in clinical medicine. (Four parts). *Medicine* 65:1, 1986; 66:1, 237, 1987; 67:1, 1988.

Prentice Hall. *Life Science* , 1988.

This is a comprehensive, easy-to-use science text that emphasizes life science concepts and includes enrichment activities.

Thompson, J. and Thompson, M., *Genetics in Medicine*, W. B. Saunders Co., Philadelphia, 1980.

This is a basic, simplified text highlighting genetics as related to man.

Winchester, A. M. Barnes and Nobles, *Heredity*, N.Y., 1977.

READING LIST FOR STUDENTS

Consumer Reports, *The Telltale Gene* , July, 1990.

This article gives an account of genetic screening—advances in testing and treatment.

Engdahl Sylvia & Roberson Rick, *Tool for Tomorrow*, 1979.

This text presents basic science information. Very brief and easy reading to cope with, yet long enough to challenge the students

and create questions.

Morrison, Velma Ford, *There's Only One You* , Illustrated by William Jaber, 1978.

This illustrated text introduces fundamental concepts of genetics. The literature is very juvenile and contains a glossary of terms.

Parker, Gary; Reynolds, W.; and Reynolds, R., *Heredity*, Educational Methods, Chicago, 1977.

This is a programmed text on the basics of genetics.

Scientific American, Feb. 1988., Vol. 258, Number 2. *Chromosome Mapping with DNA Markers* .

Students will gain information on how individual markers serve for tracing defective genes.

Time Magazine, March 20, 1989. *The Gene Hunt* , pp. 62-67. This article explains how scientists go about mapping the human genome and solving the mysteries of heredity.

Watson, James, *The Double Helix*, The New American Library, Inc., 1968.

MATERIALS FOR CLASSROOM USE

Agricultural Center, New Haven, Connecticut

123 Huntington Avenue, New Haven, CT 06511

Lecture / Demonstration on how to breed pure seeds.

Gene Kit M89101/7 Phillip Harris, Biological Ltd. (Wards Catalog).

This kit contains pop-it beads and linkers.

Hawkhill Associates, Inc., 125 East Gilman Street, Madison, WI 53702. 1-800-422-4295.

Hawkhill provides Learning Power books and videos. Key scientific concepts are outlined as understood by today's scientists.

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Avenue, White Plains, N.Y. 10605. 1-914-428-7100.

CT Chapter for March of Dimes

31 Bernhard Road

North Haven, CT 06473

777-4030

National Clearinghouse for Human Genetic Diseases, P.O. Box 28612, Washington, D.C., 20005. (202)842-7617.

Excellent resources, including printed materials, educational packages, filmstrips and audiovisual presentations are made available.

National Teaching Aids, Inc., 1845 Highland Avenue, New Hyde Park, N.Y. 11040. (1-516-326-2555).

National Science Establishment, Inc., 5100 W. Henrietta Road, P.O. Box 92912, Rochester, N.Y. 146929012.

Supplies, lab. aids, including hands-on materials may be ordered.

Pamphlets, reading materials and films on varied defects may be obtained.

Tel-Med, Hospital of St. Raphael, New Haven, CT. 789-3333. Many tapes on genetic disorders are made available. Cystic Fibrosis—236, and Sickle cell anemia—566.

Trip to the Genetic department at Yale. Appointments could be made with Dr. Margretta Seashore.

Tasting papers to demonstrate population, variation and inheritance. Yale University School of Medicine, Department of Human Genetics, 333 Cedar Street, New Haven, CT 06520

Information relating to facilities and services may be obtained from:

Margretta Seashore, M.D., Associate Professor of Human Genetics and Pediatrics.

Cate Walsh Vockley, M.S. Genetic Associate.

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