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ABSTRACT

This booklet, one of a series developed by the Frederick County Board of Education, Frederick, Maryland, provides an instruction module for an individualized or flexible approach to secondary science teaching. Subjects and activities in this series of booklets are designed to supplement a basic curriculum or to form a total curriculum, and relate to practical process oriented science instruction rather than theory or module building. Included in each booklet is a student section with an introduction, performance objectives, and science activities which can be performed individually or as a class, and a teacher section containing notes on the science activities, resource lists, and references. This booklet presents a review of deoxyribonucleic acid (DNA) and its effect in controlling life codes and heredity. The estimated time for completing the activities in this module is 1-2 weeks. (SL)

Code of Life

AIDS TO INDIVIDUALIZE THE TEACHING OF SCIENCE

MINI-COURSE UNITS

BOARD OF EDUCATION OF FREDERICK COUNTY

1974

Marvin G. Spencer

CONTROLLING THE CODE OF LIFE

Prepared by

Paul Cook

Estimated Time for Completion

1-2 weeks

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1974

FOREWORD

The writing of these instructional units represents Phase II of our science curriculum mini-course development. In Phase I, modules were written that involved the junior high disciplines, life, earth and physical science. Phase II involves senior high physical science, biology, chemistry, physics and science survey.

The rationale used in the selection of topics was to identify instructional areas somewhat difficult to teach and where limited resources exist. Efforts were made by the writers of the mini-courses to relate their subject to the practical, real world rather than deal primarily in theory and model building.

It is anticipated that a teacher could use these modules as a supplement to a basic curriculum that has already been outlined, or they could almost be used to make up a total curriculum for the entire year in a couple of disciplines. It is expected that the approach used by teachers will vary from school to school. Some may wish to use them to individualize instruction, while others may prefer to use an even-front approach.

Primarily, I hope these courses will help facilitate more process (hands on) oriented science instruction. Science teachers have at their disposal many "props" in the form of equipment and materials to help them make their instructional program real and interesting. You would be remiss not to take advantage of these aids.

It probably should be noted that one of our courses formerly called senior high physical science, has been changed to science survey. The intent being to broaden the content base and use a multi-discipline approach that involves the life, earth and physical sciences. It is recommended that relevant topics be identified within this broad domain that will result in a meaningful, high interest course for the non-academic student.

ALFRED THACKSTON, JR.
Assistant Superintendent for Instruction

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CONTENTS

CONTROLLING THE CODE OF LIFE

A. The Future of D.N.A.

How would you feel if your parents had "ordered" you from a catalogue? They would have specified your sex, your intelligence, your athletic ability, your height, or the color of your eyes.

Do you have an idea of what you would look like? What do you believe your classmates would look like if they too were "made to order"? Probably your parents would have had similar characteristics in mind and you would all look almost alike. Instead of being someone special, you would be just another one of the clan.

The whole idea sounds far out, but most scientists think that we have moved from the Atomic Age to the Age of Genetics. Molecular biologists, starting with Watson and Crick, are continuing to unearth the secrets of D.N.A. and with each new discovery we come nearer the ability to "design" human beings.

Presently, man is indirectly controlling D.N.A. through several means. One is by using mutations that occur naturally or are artificially caused by radiation or chemicals. Another method is by being selective as to which animals or plants are to be involved in reproduction.

Is there any justification by man for controlling his genetic make-up, or the heredity of the plants and animals that surround him? What are the social implications involved if a government or parents have the say as to what people will look like, or act?

Professor Elof Carlson, a zoologist at the University of California at Los Angeles, believes that a process of reconstitution will occur when the code of life, D.N.A., is fully understood. He believes that the actual dead will not be brought back to life, but in their place will be grown physical copies of men and women who once lived. Theoretically, the process may take place by removing the preserved tissue from a body, copying the D.N.A. code and placing it in fertilized egg cells.

For example, once the genetic code of a great person is determined, such as of an Einstein or a Winston Churchill, hundreds of thousands of his duplicates could be created for the world's benefit. Certainly it will be possible to re-create King Tutankhamen from his Egyptian mummified remains, but it will be impossible to reconstitute Joan of Arc. Why?

Another possibility suggested by geneticist Dr. James Bonner of the California Institute of Technology, is the regrowth of new organs and limbs at will by controlling the genes which direct cell development.

Each of the body's cells has a full set of genes, and thus any cell could grow into an eye, a nose, a head or heart. Nature has a way, however, of telling each cell what to become. It does this with molecules called histones which sit on certain genes and keep them inactive. It has been found that chromosomal R.N.A. tells the histones what to do.

One last theoretical possibility that seems incredible is based upon the fact that there is a technique of transferring genes from one cell to another, causing a mixture of strains impossible in nature. With this genetic wizardry, some scientists like Dr. Robert Sinsheimer of the California Institute of Technology, predict that furry humans with powerful legs to explore the Antarctic are possible, as are gilled men who can live in the sea.

Such far-fetched ideas as have been stated above are going to give rise to some profound moral and social problems.

OBJECTIVES

The student will be able to:

1. weigh the value of scientists gaining complete knowledge of the D.N.A.'s code of life by discerning between the moral and social problems to society and the benefits that may be derived.

2. list several birth defects to the human body due to inheritance.

3. identify several advantages and disadvantages to man's research on controlling D.N.A.

4. describe cloning or test tube babies, and its possible uses in the future.

ACTIVITIES

a. Using any of the references following this set of activities, describe the cause, present medical treatment and/or cure, if known, of the birth defects identified on Worksheet #1.

b. Using the suggested references and the introduction to this unit, do Worksheet #2 on the advantages and disadvantages of controlling D.N.A.

c. On your own paper, make a report on cloning or test tube babies by using the references identified under the Story of Life, Volume 51 "Test-tube Babies," or Volume 52 "Cloning: Carbon-copy Children," or other sources from the library.

References:

Evolution (Life Science Library), "Man and His Genes", pages 173-183, 1964

Modern Biology, Otto, Towle, 1969, 1973
"Are diseases inherited?", "Is intelligence inherited?", "Inheritance of Mental Disorders"

Guide to Human Chromosome Defects, Redding and Hirschhorn, The National Foundation - March of Dimes

Fast Facts about Sickle Cell Anemia, The National Foundation - March of Dimes

Chromosome 21 and Its Association with Down's Syndrome, The National Foundation - March of Dimes

Genetic Counseling, The National Foundation - March of Dimes

Genetics: The Thread of Life, American Education Publications, Education Center, Columbus, Ohio 43216

Inherited Disorders (Poster Series), J. Weston Walch, Publisher, Portland, Maine 04104

Story of Life, Medical Dictionary
Volume 51 "Test-tube Babies"
Volume 52 "Cloning: Carbon-copy Children"
Marshall Cavendish, Ltd., 6 Commercial Street, Hicksville, New York

Why You Are You, The Science of Heredity, Sex, and Development, Chapter 8, page 34, "Genetic Disease", Xerox, 1973-74

Birth Defects: Original Article Series, "Conjoined Twins", The National Foundation, 1967

WORKSHEET #1

Name _____ Period _____ Date _____

BIRTH DEFECTS

For the following birth defects, describe the cause, present medical treatment and/or cure if known.

Birth Defect	Cause	Treatment or Cure
Hemophilia		
Tay-Sachs		
Cystic Fibrosis		
Sickle-cell anemia		
Albino		
Colorblindness		
P.K.U. (phenylketonuria)		
Marfan's Syndrome		
Down's Syndrome (Mongolism)		
Diabetes		
Dwarfism		

Birth Defect	Cause	Treatment or Cure
Giantism		
Epilepsy		
Muscular Dystrophy		
Galactosemia		
Siamese Twins		

WORKSHEET #2

Name _____ Period _____ Date _____

ADVANTAGES AND DISADVANTAGES OF MAN'S
CONTROL OVER D.N.A.

1. List four separate reasons for controlling the D.N.A. make-up in plants, animals, or man.

2. List three separate reasons for keeping hands off the make-up of an individual's (plant, animal, or man) D.N.A.

B. Present Standing of D.N.A.

Presently many of the before-mentioned areas of genetics are theoretical, and in the future. For all practical purposes the field of genetics involves the manipulation of D.N.A. as it is a part of the whole organism. The purpose of Part B of this unit is to explore some of the present work being done.

OBJECTIVES:

The student will:

1. explore some of the present work being done to use D.N.A. in the field of plant and animal domestication.

2. explain what is meant by a mutation, and describe several types.

3. give several examples of mutations which have been beneficial to man.

4. describe eugenics and the methods involved by breeders in improving plants and animals.

5. describe with examples, how chemicals are used in producing new varieties.

6. given information on the Santa Gertrudis beef cow, explain how it was developed.

7. list reasons why man desires to control genetically the plants and animals that we have domesticated.

ACTIVITIES:

Using the references identified at the end of this section, do the following activities that will help to accomplish the above objectives.

a. Do worksheet #3, "Mutations," identifying what a mutation is and describing four different types of mutations that occur in nature and their effect on the characteristics inherited by the organism. Also, on the same worksheet, list five examples of mutations that have occurred naturally and their benefit to man.

b. Complete worksheet #4 by defining eugenics and describing the methods used by breeders to improve plants and animals.

c. Complete worksheet #5 by studying the development of a new plant, and answering the related questions.

d. On your own paper, complete the following two activities;

(1) explain how the Santa Gertrudis beef cow was developed, and why it was done.

(2) list three reasons why man desires to control genetically the plants and animals that we have domesticated.

e. Complete worksheet #6 by describing the improvement done to each of the organisms listed.

References:

Biology and Human Progress by Eisman and Tanger, Prentice-Hall

Modern Biology by Otto, Towle, "Plant Varieties Resulting From Mutations" page 175, 1969 edition; or page 193, 1973 edition

Exploring Biology by Smith, Lisonbee

Evolution (Life Science Library), "Man-Made Evolution" pages 75-85, 1964

Biology, Smallwood-Green, Silver Burdett Co. 1971, Chapter 10, "Extra Chromosomes," page 219-220

Biology, An Inquiry into the Nature of Life, Allyn and Bacon, Inc. 1974

WORKSHEET #3

Name _____ Period _____ Date _____

MUTATIONS

1. What is a mutation?

2. Describe each of the following types of mutations, and explain what effect it has on the individual organisms:

Mutation	Description	Effect
crossing-over		
polyploidy		
polysomy (non-disjunction)		
translocation (random breakage)		

3. List five examples of mutations that have occurred in nature and how each has benefitted man.

WORKSHEET #4

Name _____ Period _____ Date _____

EUGENICS

1. What is eugenics?

2. Describe the following methods used by breeders in improving plants and animals:

   Selection:

   Cross-breeding:

   Wide crosses (i.e. Triticales; mules):

   Mutations:

3. Match the letter of the following practices of plant and animal breeders next to the method which it shows:

Practices	Methods
a. Seedless grape appearing in California	1. _____ Selection
b. Santa Gertrudis beef cow combining traits of resistance to heat and good beef quality	2. _____ Crossbreeding
c. The great strength and endurance of the mule resulting from mating of a horse and donkey	3. _____ Widecrosses
d. Selecting tomatoes for their resistance to blight	4. _____ Using a natural mutation
	5. _____ Making an artifical mutation
	6. _____ Improving the environment

(continued on next page)

Practices

e. exposing penicillium mold to ultraviolet radiation and mustard gas, thereby increasing the yield of penicillin 850 times

f. Increasing milk production by feeding dairy cattle high protein feed

4. Define euthenics, and identify the practice in activity 3 which shows this.

WORKSHEET #5

Name _____ Period _____ Date _____

I. DEVELOPMENT OF AN INTERSPECIES PLANT USING COCHICINE

The following procedure was followed by geneticist to develop a new cabbage, never before found in nature. It was done by crossing an ordinary cabbage with a Chinese cabbage which yielded a hybrid incapable of reproducing. Then, this hybrid was treated with cochicine which doubled the chromosome number, but, this hybrid was also sterile. The scientists then took this hybrid with double the number of chromosomes and cross pollinated it with a rutabaga plant (a "cousin" of the cabbage) which had the same number of chromosomes. The result of this cross produced a new cabbage plant capable of breeding true; thus, introducing a new plant in nature.

A
Ordinary cabbage
(20 diploid
10 haploid)

x

B
Chinese cabbage
(18 diploid
9 haploid)

→

C
Hybrid cabbage
(19 diploid
sterile)

D
Hybrid cabbage (treated with
(19 diploid) cochicine)

Yielded →

E
Hybrid Cabbage
(38 diploid
sterile)

F
Hybrid cabbage
(38 diploid
19 haploid)

x

G
Rutabaga
(38 haploid
19 haploid)

→

H
New cabbage
(38 diploid)
fertile and
capable of
breeding true

Note: Diploid is referring to the full number of chromosomes, and haploid refers to half the number of chromosomes resulting from meiosis.

1. In relation to the rutabaga plant, what did the cochicine do to the hybrid cabbage which enabled the development of a new, fertile plant?

2. Review meiosis and fertilization which follows meiosis and explain why the hybrid cabbage at "C" is sterile.

II. Identify three different plants that have resulted from doubling the number of chromosomes.

WORKSHEET #6

Name _____ Period _____ Date _____

9. Next to each of the following plants or animals, state one or more improvements which breeders have made, or are trying to make.

Organism	Improvement
Potato	
Cow	
Chickens	
Corn	
Grapefruit	
Wheat	
Apple	
Mink	
Dogs	
Flowers	

Teaching Units:

This unit is recommended as a follow-up of the study of the basic laws of genetics and the D.N.A. molecule.

The references from Story of Life Medical Dictionary are part of a 10? volume series on the human body. Many of the subjects discussed are current, like volumes 51 and 52 which deal with test tube babies and cloning, respectively. It would be well worth your time to attempt getting the complete set for your school; the cost will be approximately $80.00 plus. Another reference especially recommended for the teacher is The Second Genesis - The Coming Control of Life, by Albert Rosenfeld. This paperbound book is available from Walden's Book Store, Fredericktowne Mall.

Objectives:

A. The student will:

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5. describe, with examples, how chemicals are used in producing new varieties;

6. given information on the Santa Gertrudis beef cow, explain how it was developed;

7. list reasons why man desires to control genetically the plants and animals that we have domesticated.

Film:

Genetics : Improving Plants and Animals, I.M.C.

References:

Modern Biology, Otto, Towle, Holt, Rinehart and Winston, 1969, 1973

Inherited Disorders, J. Weston Walch, Portland, Maine, 04104

Story of Life, Medical Dictionary, Marshall Cavendish Ltd, 6 Commercial Street, Hicksville, N.Y.

Why You Are You, The Science of Heredity, Sex, and Development, Xerox, 1973

Genetics: The Thread of Life, American Education Publications, Education Center, Columbus, Ohio, 43216

Evolution (Life Science Library), Time, Inc., New York, 1964

Biology and Human Progress, Eisman and Tanzer, Prentice - Hall

Exploring Biology, Smith - Lawrence, Harcourt, Brace and World

Biology, Smallwood and Green, Silver Burdett Co., 1971

Biology, An Inquiry into the Nature of Life, Weinberg, Allyn and Bacon, Inc., 1974

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Fast Facts about Sickle Cell Anemia

Chromosome 21 and Its Association with Down's Syndrome

Genetic Counseling

Birth Defects: Original Article Series, "Conjoined Twins"

Evaluation Form for Teachers

Name of unit: _____

Evaluation Questions	Yes	No	Comments
1. Did this unit accomplish its objectives with your students?			
2. Did you add any of your own activities? If so, please include with the return of this form.			
3. Did you add any ideas that other teachers would find useful? Please mention below.			
4. Were the student instructions clear?			
5. Was there enough information in the teacher's section?			
6. Do you plan to use this unit again?			

7. Which level of student used this unit? _____

8. How did you use this unit - class, small group, individual? _____

_____

PLEASE RETURN TO THE TECHNOLOGY ADVISOR'S OFFICE AS SOON AS YOU COMPLETE THE COURSE

SCIENCE MINI-COURSES

PHYSICAL SCIENCE	Prepared by
ELECTRICITY: Part 1 (Types of Generation of Electricity)	Marvin Blickenstaff
ELECTRICITY: Part 2 (The Control and Measurement of Electricity	Marvin Blickenstaff
ELECTRICITY: Part 3 (Applications for Electricity)	Marvin Blickenstaff
CAN YOU HEAR MY VIBES? (A Mini-course on Sound)	Charles Buffington
LENSES AND THEIR USES	Beverly Stonestreet
WHAT IS IT? Identification of an Unknown Chemical Substance	Jane Tritt
BIOLOGY	
A VERY COMPLEX MOLECULE: D.N.A. The Substance that Carries Heredity	Paul Cook
Controlling the CODE OF LIFE	Paul Cook
Paleo Biology – BONES: Clues to Mankind's Past	Janet Owens
A Field Study in HUMAN ECOLOGY	Janet Owens
Basic Principles of GENETICS	Sharon Sheffield
HUMAN GENETICS – Mendel's Laws Applied to You	Sharon Sheffield
SCIENCE SURVEY	
WEATHER Instruments	John Fradiska
TOPOGRAPHIC Maps	John Geist and John Fradiska
CHEMISTRY	
WATER	Ross Foltz
PHYSICS	
PHYSICAL OPTICS	Walt Brilhart