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Cell Structure and DNA

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My curriculum unit contains an elementary approach to genetics. It is directed for a sixth grade class for a six week unit, Essentially it will explain the different parts of the cell and the function of DNA. The most important purpose of the unit is to give an introduction to the function of DNA and how it effects our heredity. Many activities are included to give the students a chance to get involved other than the usual textbook readings or lectures.

The following is a list of the most important parts of the cell and the function of each. Each structure on the list is also pictured on the illustration of “Cell Structures”.

A. *Nucleus* —located in the middle of the cell, center for cell reproduction, contains the hereditary material of the cell
B. *Chromatin* —tangled, threadlike material in the cell nucleus that forms the chromosomes, the chromosomes are the basis of the hereditary functions of the cell, there are 46 chromosomes in human cells (except mature sex cells in which there are 23)
C. *Nuclear Membrane* —thin wall enclosing the nucleus, double membrane, controls what goes in and out of nucleus
D. *Vacuole* —a bubblelike structure that stores food or waste products
E. *Ribosome* —found along the endoplasmic reticulum, makes proteins for the cell
F. *Endoplasmic Reticulum* —channels in cytoplasm that store and carry materials throughout the cell
G. *Cytoplasm* —fluid part of cell outside the nucleus and inside the cell membrane
H, *Cell Membrane* —thin wall enclosing cell that controls what goes in and out of cell
I. *Mitochondrion* —provide energy for cell, “powerhouse” of cell, food is broken down and used for energy

The nucleus is the most important structure in cell reproduction because it contains the blueprints which determine the size, shape, job, number of new cells, and repairs for each cell. Inside the nucleus are small units called chromosomes where the blueprint directions are stored. Every human cell contains 46 chromosomes or 23 pairs. The chromosomes contain important proteins and the hereditary chemical material called DNA (deoxyribonucleic acid).

There are two kinds of cell reproduction: mitosis and meiosis. Mitosis reproduces cells exactly like the original through replication of the chromosomes. Mitosis is a continuous process which has been broken down into five stages. Meiosis is the process where reproductive cells are produced. Meiosis happens in the reproductive parts of the body.

The five stages of mitosis are: interphase, prophase, metaphase, anaphase, and telophase. (See “Mitosis” illustration)

A. *Interphase* —an exact copy of each chromosome is made in the nucleus, the pairs stay physically stuck together; outside the nucleus a small part of the cell called a centriole divides; the 46 chromosomes are strung out like single threads and begin to condense as the next phase starts.
B. *Prophase* —the nuclear membrane disappears, the centrioles replicate and separate to opposite ends of the cell, tiny threads appear between the centrioles to form a spindle, the chromosomes coil and condense
C. *Metaphase* —the centrioles finish separating, the chromosomes randomly line up in the middle of the spindle
D. *Anaphase* —each pair of chromosomes separate
E. *Telophase* —a furrow forms in the center of the cell and separates the cell into two parts, the chromosomes uncoil and a nuclear membrane separates each new nucleus

Inside the nucleus during mitosis, or cell division, the chromosomes duplicate themselves because they contain DNA. DNA contains a sugar (deoxyribose), phosphate, and four bases. The bases and their abbreviations are adenine—A, thymine—T, guanine—G, and cytosine—C.

DNA is built like a double helix winding around. It is usually found in two long strands which are connected by hydrogen bonds. (See “DNA Structure” illustration) They are connected so that the same bases are always opposite each other forming a base pair. Adenine and thymine are bonded together by two hydrogen bonds and cytosine and guanine with three bonds. These are the only possible combinations because the atoms in the other bases are not in the right place to form a hydrogen bond. A chain would look like this. The DNA code is written out with the 4-letter alphabet in a specific order. The order is recognized or decoded in triplets with 64 (4^3) different combinations. DNA sends this genetic code through the chemical called messenger RNA (ribonucleic acid). DNA sends information into RNA and RNA sends information into polypeptide chains and in turn proteins.

(figure available in print form)

RNA contains a sugar (ribose), phosphate, and four bases. The bases are adenine—A, cytosine—C, guanine—G, and uracil—U. Uracil replaces thymine that was in the DNA strand. RNA is different from DNA because it is just one chain and the bases usually don't pair up with each other although they can. There are three kinds of RNA each with individual functions. Ribosomal RNA makes up 85%-90% of the total RNA and is located in the ribosome in the cytoplasm. Messenger RNA makes up 5%-10% and is the genetic code carrier from DNA. It carries the message from the nucleus of the cell to the ribosome. It carries the information on how to make proteins.

DNA makes mRNA by separating the bonds that hold the DNA bases together. The DNA codons, or triplets, are translated into RNA codons. A mRNA base which was in the nucleus attaches to each DNA base that is uncovered by the hydrogen bond splitting. (See "Base Pairing" illustration) After the mRNA has copied the DNA it separates and must then be processed within the nucleus before going into the cytoplasm. During processing, lengths of RNA that do not carry information for protein synthesis are spliced out yielding a mature mRNA molecule. The DNA coils back up into the original helix state.

mRNA finds a ribosome and stretches out on the surface of it and waits for a specific code on a transfer RNA molecule to join it. (See "Transfer RNA—Messenger RNA" illustration) Transfer RNA is about 5% and its job is to transfer amino acids to mRNA with the correct codon to make a protein. tRNA is single stranded and falls back on itself. There is a different tRNA molecule for each of the 61 amino acid codons.

Each tRNA is three dimensional with an anticodon at one end and an amino acid attachment at the other. The anticodon is the part that pairs with the mRNA codon. Protein synthesis at the ribosome begins with the starting codon GUG or AUG and ends with UAG, UGA, or UAA on the mRNA strand. The tRNAs carry each amino acid to a triplet of mRNA bases and join using the usual complementary base pair rules. When an ending codon joins the end of a polypeptide chain no amino acids will join on and the polypeptide chain is released from the ribosome. The polypeptide coils and acts as a protein molecule. The protein that is made is determined by the sequence of specific amino acids.

Objectives

1. Name the different parts of the cell
2. Name the five steps in Mitosis
3. Label the six parts of the basic structure of DNA
4. Understand how DNA separates
5. Understand the code that is used to make mRNA
6. Understand how mRNA and tRNA meet
7. Translate the code in triplets to amino acids
8. Understand the process of amino acids into proteins

Illustrations

1. The different parts of the cell
2. The five stages of mitosis
3. The six basic parts of DNA
4. mRNA making and coding
5. tRNA molecules looking for mRNA
6. Chart of amino acid codes-triplets

Activities

1. Crossword puzzles using vocabulary
2. word search puzzles using vocabulary
3. Coloring illustrations of UNA to distinguish sugar, phosphates, and base pairing
4. Activities in pairing correct bases
5. Looking at real cells
6. Label parts of a cell
7. Chromosomes and play acting
8. Make RNA chain with snap-together beads

Lesson Plans

Lesson I

A ditto should be made of the “Cell Structure” illustration and given to each student. Each part of the cell and the individual function should be explained in detail to the students.

Lesson II

A copy of “The Stages of Mitosis” should be distributed to the students. The five different stages of mitosis and the different activities of each should be explained.

Lesson III

A ditto of “DNA Structure” should be given to the students. The six basic parts that make up DNA should be discussed. The students could color the four bases to make an illustration of how the base pairing system works.

Lesson IV

Give each student a copy of “Base Pairing”. Explain to students the difference between DNA and RNA base pairing with uracil instead of thymine. Make a hypothetical example of mRNA copying DNA to check for student understanding.

Lesson V

Distribute a copy of “Transfer RNA-Messenger RNA” to each student. Discuss how proteins are made and the function of tRNA with the attached amino acids. Review the base pairing with students so they will understand why the triplets of tRNA pair with mRNA.

Outline

I. Parts of the cell
    A. Nucleus
    B. Chromatin
    C. Nuclear Membrane
    D. Vacuole
    E. Ribosome
    F. Endoplasmic Reticulum
    G. Cytoplasm
    H. Cell Membrane
I. Mitochondrion
II. Function of the nucleus
III. Mitosis
    A. Interphase
    B. Prophase
    C. Metaphase
    D. Anaphase
    E. Telophase
IV. DNA basic structure
    A. Six parts
    B. Separation
V. Duplication of DNA to mRNA
    A. mRNA and tRNA meeting
    B. Triplet code

VI. Making of proteins with amino acids

Annotated Bibliography for Teachers and Students

Bernstein, Leonard., et al. *Concepts and Challenges in Life Science* . New Jersey: Cebco Standard Pub., 1979. (Very readable for students, excellent illustrations and questions for students)

Cobb, Vicki. *Cells* . New York: Franklin Watts, 1910. (This book gives the student a chance to look at many different types of cells)

Dunbar, Robert E. *Heredity* . New York: Franklin Watts, 1978. (Basic book on inheritance and DNA)

Facklam, Margery and Howard. *From Cell to Clone* . New York: Harcourt Brace Jovanovich, 1979. (Explains why the discovery of DNA is important to modern day science)

Lesser, Milton S. *The Meaning of Life* . New York: Amsco School Pub., 1975. (Elementary descriptions of cell structures)

Morrison, Velma Ford. *There's Only One You* ; *The Story of Heredity* . New York: Julian Messner, 1978. (Good book which describes

family trees)

Nagle, James J. *Heredity and Human Affairs* . St. Louis: The C. V. Mosby Co., 1979. (Excellent book for teachers to gain background information on genetics in general)

Pfeiffer, John. *The Cell* . New York: Time-Life Books, 1964. (Excellent color illustrations of many different types of cells)

Silverstein, Alvin and Virginia. *The Code of Life* . New York: Atheneum, 1972. (Excellent book, extremely useful, very readable for all ages and interests, detailed information about DNA and RNA)

Smith, Herbert A., et al. *Exploring Living Things* . Illinois: Laidlaw Brothers Pub., 1980. (Excellent student text with many illustrations on cell reproduction)

Webster, Vera., et al. *Life Science* . New Jersey: Prentice-Hall, 1980. (Excellent student text with detailed DNA structure diagrams, very readable)

List as many genetic terms as you can find.

THE CELL

mitochondrion	interphase
chromatin	nucleus
nuclear membrane	Telophase
vacuole	Guanine
ribosome	Adenine
cytoplasm	Thymine
cell membrane	Uracil
mitosis	DNA
prophase	RNA

(figure available in print form)

CELL STRUCTURES

(figure available in print form)

ACROSS DOWN

4. “powerhouse” of cell	1. form the chromosomes
6. thin wall enclosing cell	2. make proteins
7. center for cell reproduction	3. channels in cytoplasm
9. fluid part of cell	5. thin wall enclosing nucleus
	8. stores food or waste products

Cell Structures

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DNA STRUCTURE
(figure available in print form)
The formation of messenger RNA
Base Pairing
(figure available in print form)
Transfer RNA—Messenger RNA
(figure available in print form)
(figure available in print form)