DNA—From Genes to Proteins

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About **DNA—From Genes to Proteins**

DeltaScienceModules, THIRD EDITION

Students explore the elements shaping the characteristics of our features and the genetics of our makeup. Modeling activities combine with microslide images to help students decipher the codes of life. Students trace the characteristics of their own features to proteins and then even further to the genetic material inside the nucleus in every cell in their bodies. Students identify cell structures and functions and the chromosomes and genes that determine unique traits. Using base-pair models of double-helix DNA molecules, they study DNA replication and DNA transcription to messenger RNA. They investigate how and where mutations can occur, and they compare animal cells to bacterial and virus cells. Then, as the perspective changes, students consider some cutting-edge applications of biotechnology as they explore genetic engineering, DNA fingerprinting, and the Human Genome Project.

In the Delta Science Reader *DNA—From Genes to Proteins,* students find out about cell theory and the role of cells as the building blocks of life in all organisms. They read about the compounds that make up cells and how specialized cells differ in structure and function. Next, students discover how cells work to gather, release, store, and use energy to carry out life processes. Students learn about a key life process, growth, as they explore the cell cycle. They find out about genes, chromosomes, and DNA. They learn how traits are passed from generation to generation through heredity and how natural selection operates. Finally, students are introduced to the researchers who constructed the double-helix model of the DNA molecule and to the Human Genome Project.

Overview Chart for Hands-on Activities

Hands-on Activity	Student Objectives
1 **How Do I Look?** *page 13*	• observe and record the characteristics of their own features • compare the characteristics of their own features with those of their classmates • discuss the idea that people share the same features but that the characteristics of those features vary from person to person
2 **Proteins and Appearances** *page 19*	• note variations in skin color among people • relate differences in features to cell proteins • describe amino acids as the building blocks of proteins
3 **What's in a Cell?** *page 25*	• observe that most cells share similar structures • observe that most cells contain organelles that perform different functions within the cell • learn that the nucleus contains the information that directs the formation of proteins
4 **Modeling a Cell** *page 31*	• review the parts of a cell and compare a cell membrane and a nuclear membrane • discuss the function of nuclear pores • make a model to help them visualize the parts of a cell • compare the structures of plant and animal cells and summarize the functions of plant and animal cell parts, using a poster • explain how cellular processes are essential to the survival of the organism as a whole
5 **What's in the Nucleus?** *page 41*	• model the genetic material of the nucleus • relate genetic material to the formation of cell proteins • use the term *DNA* to describe the genetic material • observe and explore the stages of the cell cycle and the steps of mitosis, using a poster • explain how mitosis is essential to the survival of an organism as a whole
6 **Modeling DNA** *page 51*	• use a model to explore the structure of the DNA molecule • identify the components of the DNA molecule • observe the double-stranded nature of DNA • learn that the order of the bases creates a code that determines which protein is made • learn that three consecutive bases constitute one unit of the code
7 **Replicating DNA** *page 59*	• see how each single strand of the DNA molecule acts as a template for making an exact copy of its opposite single strand • use the term *replication* to describe the process by which DNA molecules are copied
8 **Modeling a Message** *page 67*	• use the open-ladder model of DNA to form a messenger RNA strand • use the term *transcription* to describe the process they are modeling • define the term *codon* as the fundamental unit of the genetic code
9 **The Code Makes a Product** *page 77*	• use models to simulate how mRNA directs the synthesis of a protein • use the term *protein synthesis* to describe the steps involved in making a protein • distinguish between translation and transcription
10 **Genes and Mutations** *page 87*	• identify a gene as a sequence of base pairs in DNA that codes for one characteristic • identify a chromosome as a set of genes connected together • use their DNA models to illustrate how a single-base mutation can alter the type of protein made
11 **Simpler Cells** *page 95*	• observe the body shapes of bacteria—spheres, rods, and spirals • compare the structure of a bacterial cell and a virus particle with that of an animal cell • learn about some uses of bacteria and viruses in genetic research
12 **How We Use DNA in Cells** *page 101*	• diagram the transplanting of genes from a eukaryotic cell into a bacterial cell • infer the effect of DNA recombination on protein synthesis • discuss possible uses of bacterial DNA in plant and animal cells
13 **DNA Fingerprinting** *page 109*	• discover how enzymes can cut up pieces of DNA and how those pieces can be separated • explore the technique and applications of DNA fingerprinting • learn about the Human Genome Project and discuss its implications
Assessment *page 117*	• See page 117.

Process Skills	Vocabulary	Delta Science Reader
observe, compare, classify, communicate	**characteristic, feature, variation**	pages 6–7, 16, 19–20
observe, communicate, conclude	**amino acid, cell, pigment, protein**	pages 2, 4, 6, 13, 19
observe, infer, communicate	**cell membrane, cytoplasm, nuclear membrane, nucleus, organelle, ribosome**	pages 4–7
compare, make and use models, communicate, conclude	**cell wall, chloroplast, mitochondria, model, nuclear pores, respiration, vacuole**	pages 4–11
observe, predict, make and use models, conclude, infer	**cell cycle, coil, DNA, double helix, genetic material, helix, mitosis**	pages 4–5, 12, 14, 16, 21
predict, interpret data, communicate, make and use models	**base, code, phosphate, sugar**	pages 12–13, 21
make and use models, predict, investigate, define based on observations	**nucleotide, replication**	pages 12–13
predict, infer, compare, make and use models, define based on observations, interpret data	**codon, messenger RNA (mRNA), template, transcription**	page 13
observe, make and use models, conclude, communicate	**anticodon, protein synthesis, transfer RNA (tRNA), translation**	page 13
make and use models, predict, communicate, infer	**chromosome, gene, genome, mutation**	pages 5, 16–17, 22
observe, compare, communicate	**bacteria, eukaryotic, prokaryotic, virus**	pages 3, 5–7
predict, compare, infer, communicate	**biotechnology, clone, genetic engineering, plasmid, recombinant DNA**	pages 5–6, 22
predict, interpret data, communicate	**DNA fingerprinting, enzyme, Humane Genome Project**	pages 4, 22

See the following page for the Delta Science Reader Overview Chart.

Overview Chart for Delta Science Reader
DNA—From Genes to Proteins

Selections	Vocabulary	Related Activity
Think About...		
What Are Cells? *pages 2–3* • Discovery of Cells • Levels of Organization in Living Things	**cell, cell theory, compound microscope, convex lens, magnification, microscope, organ, organ system, tissue**	Activities 2, 11
What Is Inside a Cell? *pages 4–7* • Chemical Compounds in Cells • Cell Types and Structures • Plant and Animal Cells	**carbohydrate, cell membrane, cell wall, chloroplast, chromosome, cytoplasm, DNA, endoplasmic reticulum, enzyme, eukaryotic cell, gene, Golgi body, lipid, lysosome, mitochondrion, nuclear membrane, nucleic acid, nucleus, organelle, organic compound, pigment, prokaryotic cell, protein, ribosome, specialized, stomata, trait, vacuole**	Activities 3, 4, 5, 10, 11, 12
How Do Cells Carry Out Life Processes? *pages 8–11* • Transporting Materials • Getting and Storing Energy • Releasing and Using Energy	**active transport, autotroph, diffusion, endocytosis, equilibrium, exocytosis, fermentation, heterotroph, metabolism, osmosis, passive transport, photosynthesis, respiration, selectively permeable**	Activities 3, 4
How Do Cells Grow and Reproduce? *pages 12–14* • Interphase • Mitosis and Cytokinesis	**amino acid, anaphase, asexual reproduction, cell cycle, chromatid, chromatin, cytokinesis, interphase, messenger RNA (mRNA), metaphase, mitosis, nitrogen base, prophase, protein synthesis, replication, telophase, transcription, transfer RNA (tRNA)**	Activities 5, 6, 7, 8, 9
Heredity and Genetics *pages 15–20* • Mendel's Experiments • How Are Traits Inherited? • Variations Within Species • The Effect of Environment	**allele, autosome, cross, diploid, dominant, egg, fertilization, genetics, genotype, haploid, heredity, heterozygous, homozygous, incomplete dominance, meiosis, multiple alleles, natural selection, phenotype, pollination, polygenic inheritance, probability, Punnett square, recessive, selective breeding, sex chromosome, sex-linked inheritance, sexual reproduction, sperm, variation, zygote**	Activities 1, 2, 5, 10
People in Science		
• **Pioneers in DNA Research** *page 21*		Activity 6
Did You Know?		
• **About Advances in Genetics** *page 22*	**genome**	Activity 13

Teaching suggestions for the Delta Science Reader are in a 32-page booklet included with this guide.

MATERIALS LIST

DNA—From Genes to Proteins

Quantity	Description
9	bags, reclosable, plastic
40	beads
1	book, *About Me* (cover photographs)
1	buttons, assorted, p/50
1	cellophane, yellow, roll
1	Delta Science Dictionary
1	Delta Science Dictionary Copymaster Booklet
1	macaroni, 1 lb
4	microslide strips
4	microslide viewers
16	mirrors
8	models, DNA
1	overhead model, DNA
8	photographs, Animal Cell
1	poster, Building Science Vocabulary
1	poster, Measurement
1	poster, Science Safety
1	poster, Visualizing Cells
1	poster, Visualizing Mitosis
8	spheres, plastic, large
8	spheres, plastic, small
1	tape, masking*
1	yarn, 2-ply, blue*
1	yarn, 2-ply, green*
1	**Teacher's Guide**
8	**Delta Science Readers**

TEACHER-PROVIDED ITEMS

Quantity	Description
1	overhead projector
8	paper, 11 × 17 in.*
32	pencils, blue
32	pencils, red
2	rulers
1	scissors
1	string, roll*

* = consumable item

† = in separate box

ACTIVITY SUMMARY

In this Delta Science Module, students are introduced to the structure and function of DNA.

ACTIVITY 1 Students identify various human features, such as ears, hair, and so on. They then observe the characteristics of their own features, such as the shape of their earlobes and the color of their hair. They observe that all humans share the same features, but the characteristics of those features vary from individual to individual.

ACTIVITY 2 Students focus on the characteristic of skin color. They learn that pigment is a type of protein and that visible body features such as skin color depend on the types and amounts of proteins in cells.

ACTIVITY 3 Students are introduced to the major parts of a cell. They observe that most cells share similar structures, including a nucleus, which contains the information that directs the formation of proteins. Students view a microslide image and a photograph of actual cells.

ACTIVITY 4 Students construct a model to help them visualize the three-dimensional structure of a eukaryotic (nucleus-bearing) cell. They also use a poster to compare plant and animal cells.

ACTIVITY 5 Students focus on the contents of the cell nucleus. After viewing a microslide image of human chromosomes, they use strands of yarn to model the genetic material found in the nucleus of a cell. Students are introduced to the relationship between the genetic material—the DNA—and the formation of cell proteins. They also use a poster to learn about cell division, or mitosis.

ACTIVITY 6 Students use a two-dimensional model to observe that DNA is made up of paired building blocks with a backbone of sugar and phosphate. They also observe the double-stranded "ladder" structure of DNA.

ACTIVITY 7 Students continue using the DNA model pieces by demonstrating DNA replication—the process by which DNA molecules are copied. They discover how the double helix can "unzip" so that each single strand of the DNA molecule becomes the basis for making an exact copy of its opposite strand.

ACTIVITY 8 Students use the DNA model pieces to model transcription, the formation of single-stranded messenger RNA (mRNA) from double-stranded DNA.

ACTIVITY 9 Students are introduced to translation, the reading of mRNA to produce a specific protein. First, students view a microslide image of ribosomes, the site of protein synthesis. Then they add transfer RNA (tRNA) and amino acid pieces to their DNA models to illustrate how mRNA directs the synthesis of protein.

ACTIVITY 10 Students are introduced to the related concepts of genes, chromosomes, and genomes. They use their DNA models to illustrate how a mutation that changes a single base pair can alter the type of protein made.

ACTIVITY 11 Students observe microslide images of bacterial cells and virus particles and use a poster to visualize the shapes of bacterial cells. They compare the structure of bacterial cells and virus particles to that of animal cells and see that their simpler structure allows them to be more easily manipulated for purposes related to genetic engineering.

ACTIVITY 12 Students learn about recombinant DNA and the biotechnology that exists to artificially recombine DNA in living cells. They use the DNA models to illustrate DNA recombination and infer the effect of this practice on protein synthesis.

ACTIVITY 13 Students learn about DNA fingerprinting and the Human Genome Project and discuss the social implications of each.