Name____ Date____________

TEKS 1.B.4.A **Biology**

CELL STRUCTURE AND FUNCTION

The student will demonstrate an understanding of biomolecules as building blocks of cells, and that cells are the basic unit of structure and function of living things.

(B.4) **Science concepts.** The student knows that cells are the basic structures of all living things with specialized parts that perform specific functions and that viruses are different from cells. The student is expected to (A) compare and contrast prokaryotic and eukaryotic cells;

STANDARD REVIEW

As scientists have learned more about living things, they have created a classification system to organize what they know. Today, there are three domains in the classification system: Archaea, Bacteria, and Eukarya. Domains represent the largest differences between organisms.

Cell structure plays a key role in determining how organisms are classified. For example, two of the domains within the modern classification system are composed entirely of prokaryotes, or organisms made up of prokaryotic cells. These single-celled microscopic organisms lack a nucleus and other organelles bound within membranes. Because prokaryotic cells lack a nucleus, the DNA of the cell is suspended within the cell's cytoplasm. The cytoplasm of a prokaryotic cell is contained by a cell membrane that is surrounded by a cell wall.

The two domains of prokaryotes are the domain Archaea and the domain Bacteria. The domain Archaea is made up entirely of archaea. Many archaea live in extreme environments where other organisms cannot survive. Others live in more moderate environments, such as the open ocean. All bacteria belong to the domain Bacteria.

Eukaryotes, or organisms made up of eukaryotic cells, are composed of one or more cells that have a nucleus and membrane-bound organelles. Although eukaryotic cells are most often microscopic, these cells tend to be larger in size than prokaryotic cells. In eukaryotic cells, the nucleus directs cell activities. The cell's genetic information, which is organized into structures called chromosomes, is contained within the cell's nucleus. Other membrane-bound organelles common to most eukaryotic cells include: mitochondria, ribosomes, Golgi apparatus, and endoplasmic reticulum.

Like prokaryotic cells, eukaryotic cells are enclosed by a cell membrane. Some eukaryotic cells, such as those that make up plants, fungi, and some protists, also are surrounded by a cell wall that differs in structure and chemical composition from the cell wall that surrounds prokaryotic cells. Other membrane-bound organelles present in some eukaryotic cells include chloroplasts, which are used by plants and some protists to carry out photosynthesis, and vacuoles that may be used as storage sites for water or wastes.

Eukaryotes belong to the domain Eukarya. Four kingdoms currently make up the domain Eukarya: Protista, Fungi, Plantae, and Animalia.

Name____ Date____________

TEKS **1.B.4.B** **Biology**

CELL STRUCTURE AND FUNCTION

The student will demonstrate an understanding of biomolecules as building blocks of cells, and that cells are the basic unit of structure and function of living things.

(B.4) **Science concepts.** The student knows that cells are the basic structures of all living things with specialized parts that perform specific functions and that viruses are different from cells. The student is expected to (B) investigate and explain cellular processes, including homeostasis, energy conversions, transport of molecules, and synthesis of new molecules;

STANDARD REVIEW

Individual cells must maintain homeostasis in order to live. One way that a cell maintains homeostasis is by controlling the movement of substances across the cell membrane. For example, osmosis allows red blood cells to maintain water balance as their environment changes.

Movement across the cell membrane that does not require energy from the cell is called passive transport. One kind of passive transport, diffusion, is the movement of a substance from an area of high concentration to an area of lower concentration caused by the random motion of particles of the substance. The diffusion of water through a selectively permeable membrane is called osmosis. In facilitated diffusion, a carrier protein transports a substance across the cell membrane down the concentration gradient of the substance. Active transport is the movement of a substance against the concentration gradient of the substance. Active transport requires energy from the cell. In animal cells, the sodium-potassium pump uses energy supplied by ATP to transport sodium ions out of the cell and potassium ions into the cell. During endocytosis, substances are moved into a cell by a vesicle that pinches off from the cell membrane. During exocytosis, substances inside a vesicle are released from a cell as the vesicle fuses with the cell membrane.

Cells also need energy in order to live and function. Two of the most important chemical reactions for living things are photosynthesis and cellular respiration. During photosynthesis, plants convert carbon dioxide and water into glucose and oxygen. The energy from light is used to form the high-energy bonds that make sugars, from which the plant gets the energy that its cells need. You also get this energy, which originally came from the sun, when you eat fruits or vegetables. During cellular respiration, energy is released in the chemical reaction of glucose and oxygen to form carbon dioxide and water. This energy can be used by living cells.

Photosynthesis: $6CO_2 + 6H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2$
Cellular respiration: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$

Name____ Date_____________

TEKS **1.B.4.C** **Biology**

CELL STRUCTURE AND FUNCTION

The student will demonstrate an understanding of biomolecules as building blocks of cells, and that cells are the basic unit of structure and function of living things.

(B.4) **Science concepts.** The student knows that cells are the basic structures of all living things with specialized parts that perform specific functions and that viruses are different from cells. The student is expected to (C) compare the structures of viruses to cells, describe viral reproduction, and describe the role of viruses in causing diseases such as human immunodeficiency virus (HIV) and influenza.

STANDARD REVIEW

Viruses are segments of nucleic acids contained in a protein coat. They are agents that can cause disease. Viruses replicate by infecting cells and using those cells to make more viruses. Because viruses do not have all the properties of life, biologists do not consider them to be living. Viruses do not grow, do not maintain homeostasis, and do not metabolize.

The virus protein coat, or capsid, may enclose either RNA or DNA, but not both. RNA viruses include the human immunodeficiency virus (HIV), which causes AIDS; influenza viruses; and the rabies virus. DNA viruses include those viruses that cause warts, chicken pox, and mononucleosis. Many viruses, such as the influenza virus, have a membrane, or envelope, surrounding the capsid. The envelope helps the virus enter cells. It consists of proteins, lipids, and glycoproteins, which are proteins with attached carbohydrate molecules. Some viruses also contain specific enzymes.

Viruses lack the enzymes necessary for metabolism and have no structures to make protein. Therefore, viruses must rely on living cells (host cells) for replication. Before a virus can replicate, it must first infect a living cell. A plant virus, like tobacco mosaic virus, enters a plant cell through tiny tears in the cell wall at points of injury. An animal virus enters its host cell by endocytosis. A bacterial virus, or bacteriophage, punches a hole in the bacterial cell wall and injects its DNA into the cell.

Once inside a cell, viruses set out on one of two different paths: the lytic cycle or the lysogenic cycle. In bacterial viruses, the cycle of viral infection, replication, and cell destruction is called the lytic cycle. After the viral genes have entered the cell, they use the host cell to replicate viral genes and to make viral proteins, such as capsid proteins. The proteins are then assembled with the replicated viral genomes to form complete viruses. The host cell is broken open and releases newly made viruses.

During an infection, some viruses stay inside the cells but do not make new viruses. Instead of producing virus particles, the viral DNA integrates itself into the host cell's DNA and becomes a provirus. Whenever the cell divides, the provirus also divides, resulting in two infected host cells. In this cycle, called the lysogenic cycle, the viral genome replicates without destroying the host cell. In some lysogenic viruses, a change in the environment can cause the provirus to begin the lytic cycle. This results in the destruction of the host cell. For example, the virus that causes cold sores in humans hides in facial nerve cells. When conditions become favorable for the virus, such as when a person is under stress, the virus emerges, causing a cold sore or fever blister to form.

Name____ Date_____________

TEKS 1.B.5.A Biology

CELL STRUCTURE AND FUNCTION

The student will demonstrate an understanding of biomolecules as building blocks of cells, and that cells are the basic unit of structure and function of living things.

(B.5) **Science concepts.** The student knows how an organism grows and the importance of cell differentiation. The student is expected to (A) describe the stages of the cell cycle, including deoxyribonucleic acid (DNA) replication and mitosis, and the importance of the cell cycle to the growth of organisms;

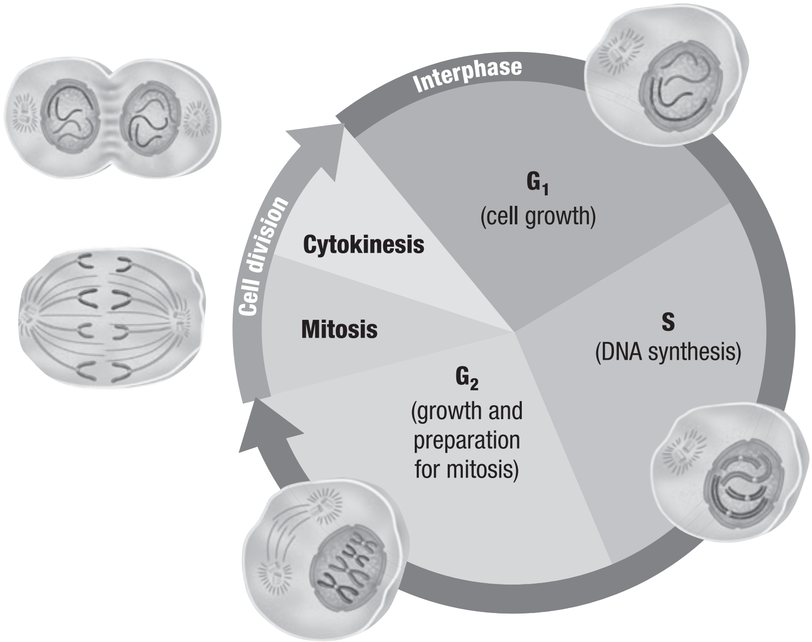
STANDARD REVIEW

The life of a eukaryotic cell is traditionally shown as a cycle, as illustrated in the figure on the next page. The cell cycle is a repeating sequence of cellular growth and division during the life of an organism. A cell spends 90 percent of its time in the first three phases of the cycle, which are collectively called interphase. A cell will enter the last two phases of the cell cycle only if it is about to divide. The five phases of the cell cycle are summarized below:

1. **First growth (G_1) phase:** During the G_1 phase, a cell grows rapidly and carries out its routine functions. For most organisms, this phase occupies the major portion of the cell's life. Cells that are not dividing remain in the G_1 phase.
2. **Synthesis (S) phase:** A cell's DNA is copied during this phase. At the end of this phase, each chromosome consists of two chromatids attached at the centromere.
3. **Second growth (G_2) phase:** In the G_2 phase, preparations are made for the nucleus to divide. Hollow protein fibers called microtubules are rearranged during G_2 in preparation for mitosis.
4. **Mitosis:** The process during cell division in which the nucleus of a cell is divided into two nuclei is called mitosis. Each nucleus ends up with the same number and kinds of chromosomes as the original cell.
5. **Cytokinesis:** The process during cell division in which the cytoplasm divides is called cytokinesis.

Name____ Date_____________

TEKS **1.B.5.A** **Biology**



Steps of Mitosis

Step 1: Prophase Chromosomes coil up and become visible during prophase. The nuclear envelope dissolves, and a spindle forms.

Step 2: Metaphase During metaphase, the chromosomes move to the center of the cell and line up along the equator. Spindle fibers link the chromatids of each chromosome to opposite poles.

Step 3: Anaphase Centromeres divide during anaphase. The two chromatids (now called chromosomes) move toward opposite poles as the spindle fibers attached to them shorten.

Step 4: Telophase A nuclear envelope forms around the chromosomes at each pole. Chromosomes, now at opposite poles, uncoil and the spindle dissolves. The spindle fibers break down and disappear. Mitosis is complete.

Mitosis and cytokinesis produce new cells that are identical to the original cells and allow organisms to grow, replace damaged tissues, and, in some organisms, reproduce asexually.

Name____ Date_____________

TEKS **1.B.5.B** **Biology**

CELL STRUCTURE AND FUNCTION

The student will demonstrate an understanding of biomolecules as building blocks of cells, and that cells are the basic unit of structure and function of living things.

(B.5) **Science concepts.** The student knows how an organism grows and the importance of cell differentiation. The student is expected to (B) examine specialized cells, including roots, stems, and leaves of plants; and animal cells such as blood, muscle, and epithelium;

STANDARD REVIEW

The cell types of the body are grouped by function into four basic kinds of tissues: epithelial, nervous, connective, and muscle tissues. These tissues are the building blocks of the human body.

- Epithelial tissues line most body surfaces and protect other tissues from dehydration and physical damage. An epithelial layer is usually no more than a few cells thick. These cells are typically flat and thin, and they contain only a small amount of cytoplasm.
- Nervous tissue consists of nerve cells, or neurons, and their supporting cells. A neuron's unique structure enables it to conduct electrical signals called nerve impulses. Dendrites extend from the cell body of the neuron and are the "antennae" of the neuron. An axon is a long membrane-covered extension of the cytoplasm that conducts nerve impulses.
- Various types of connective tissue support, protect, and insulate the body. Connective tissue includes fat, cartilage, bone, tendons, and blood. Some connective tissue cells, such as those in bone, are densely packed. Others, such as those found in blood, are farther apart from each other.
- Muscle tissue enables the movement of body structures by muscle contraction. Muscle tissues are made up of many parallel elongated cells.

TEKS 1.B.5.B Biology

Like the human body, a plant's body is made up of tissues that form organs. In vascular plants, there are three types of tissue systems—the dermal tissue system, ground tissue system, and vascular tissue system. Each type of tissue contains one or more kinds of cells that are specialized to perform particular functions.

- Dermal tissue covers the outside of a plant's body. In the nonwoody parts of a plant, dermal tissue forms a "skin" called the epidermis. The epidermis of most plants is made up of a single layer of flat cells. A waxy cuticle, which prevents water loss, coats the epidermis of the stems and leaves. Often, the cells of the epidermis have hairlike extensions or other structures. Extensions of the epidermal cells on leaves and stems often help to slow water loss. Extensions of the epidermal cells on root tips help increase water absorption. The dermal tissue on woody stems and roots consists of several layers of dead cells that are referred to as cork. Cork cells contain a waterproof chemical and are not covered by a waxy cuticle. In addition to protection, dermal tissue also functions in gas exchange and in the absorption of mineral nutrients.
- Ground tissue makes up much of the inside of most plants. Most ground tissue consists of thin-walled cells that remain alive and keep their nucleus after they mature. In addition, ground tissue contains some thick-walled cells. Ground tissue has different functions, depending on where it is located in a plant. The ground tissue in leaves, which is packed with chloroplasts, is specialized for photosynthesis. The ground tissue in stems and roots functions mainly in the storage of water, sugar, and starch.
- Plants have two kinds of vascular tissue—xylem and phloem. Both xylem and phloem contain strands of cells that are stacked end to end and act like tiny pipes. These strands of cells act as a plumbing system, carrying fluids and dissolved substances throughout a plant's body.

TEKS 1.B.5.C Biology

CELL STRUCTURE AND FUNCTION

The student will demonstrate an understanding of biomolecules as building blocks of cells, and that cells are the basic unit of structure and function of living things.

(B.5) **Science concepts.** The student knows how an organism grows and the importance of cell differentiation. The student is expected to (C) describe the roles of DNA, ribonucleic acid (RNA), and environmental factors in cell differentiation;

STANDARD REVIEW

Multicellularity enables cells to specialize in different functions. With this division of labor, a multicellular organism can have cells that protect it. Other cells help the organism move about, and still others play roles in reproduction and feeding. Cell specialization begins as a new organism develops. For example, as a chicken develops from an egg, new cells form by cell division. These cells grow and undergo differentiation, the process by which cells develop a specialized form and function.

In all animals except sponges, the zygote (fertilized egg cell) undergoes cell divisions that form a hollow ball of cells called a blastula. In this early stage in humans, a mass of embryonic stem cells forms. These early, undifferentiated cells will give rise to all of the types of cells of the developing body. Embryonic stem cells are immortal—that is, they divide indefinitely. Embryonic stem cells have not yet undergone cell differentiation and thus are not yet specialized. Indeed, any embryonic stem cell is capable of becoming any type of tissue found in the adult body.

Cells begin to specialize very early in development, shortly after fertilization. All cells in the body contain the same DNA, and so have the same genes. However, a typical human cell only expresses 20 percent of its genes at any given time. As cells develop in different parts of the body, various chemicals are produced that cause the cells to turn genes "on" or "off." The type of cell that a stem cell becomes depends on what genes are expressed. Gene expression is controlled by proteins produced within the body.

Most gene regulation in eukaryotes controls the onset of transcription—when RNA polymerase binds to a gene. Prokaryotic cells and eukaryotic cells both use regulatory proteins, but many more proteins are involved in eukaryotes, and the interactions are more complex. These regulatory proteins in eukaryotes are called transcription factors.

Name____ Date____________

TEKS 1.B.5.D **Biology**

CELL STRUCTURE AND FUNCTION

The student will demonstrate an understanding of biomolecules as building blocks of cells, and that cells are the basic unit of structure and function of living things.

(B.5) **Science concepts.** The student knows how an organism grows and the importance of cell differentiation. The student is expected to (D) recognize that disruptions of the cell cycle lead to diseases such as cancer.

STANDARD REVIEW

Just as traffic lights control the flow of traffic, cells have a system that controls the phases of the cell cycle. Cells have a set of "red light–green light" switches that are regulated by feedback information from the cell. The cell cycle has key checkpoints (inspection points) at which feedback signals from the cell can trigger the next phase of the cell cycle (green light). Other feedback signals can delay the next phase to allow for completion of the current phase (yellow or red light). The cell cycle in eukaryotes is controlled by many proteins.

Certain genes contain the information necessary to make the proteins that regulate cell growth and division. If one of these genes is mutated, the protein may not function, and regulation of cell growth and division can be disrupted. Cancer, the uncontrolled growth of cells, may result. Cancer is essentially a disorder of cell division. Cancer cells do not respond normally to the body's control mechanisms.

Some mutations cause cancer by overproducing growth-promoting molecules, thus speeding up the cell cycle. Others cause cancer by inactivating the control proteins that normally act to slow or stop the cell cycle.

Name____ Date______________

TEKS 1.B.9.A Biology

CELL STRUCTURE AND FUNCTION

The student will demonstrate an understanding of biomolecules as building blocks of cells, and that cells are the basic unit of structure and function of living things.

(B.9) **Science concepts.** The student knows the significance of various molecules involved in metabolic processes and energy conversions that occur in living organisms. The student is expected to (A) compare the structures and functions of different types of biomolecules, including carbohydrates, lipids, proteins, and nucleic acids;

STANDARD REVIEW

Four principal classes of organic compounds are found in living things: carbohydrates, lipids, proteins, and nucleic acids.

Carbohydrates are organic compounds made up of carbon, hydrogen, and oxygen atoms in the proportion of 1:2:1. Carbohydrates are a key source of energy, and they are found in most foods. The building blocks of carbohydrates are single sugars, called monosaccharides, such as glucose, $C_6H_{12}O_6$, and fructose.

Disaccharides are double sugars formed when two monosaccharides are joined. For example, sucrose, or common table sugar, consists of both glucose and fructose. Polysaccharides, such as starch, are chains of three or more monosaccharides. Starch and cellulose, which are found in plants, and are examples of polysaccharides.

Lipids are nonpolar molecules that are not soluble or mostly insoluble in water. They include fats, phospholipids, steroids, and waxes. Phospholipids make up the lipid bilayer of cell membranes. Steroids include cholesterol, which is found in animal cell membranes. Other lipids include some light-absorbing compounds, such as the plant pigment chlorophyll. Fats are lipids that store energy.

Proteins are usually large molecules formed by linked smaller molecules called amino acids. Amino acids are the building blocks of proteins. Twenty different amino acids are found in proteins. Some amino acids are polar, and others are nonpolar. Some amino acids are electrically charged, and others are not charged. Proteins fold into compact shapes, determined in part by how the protein's amino acids interact with water and one another.

Some proteins are enzymes and promote chemical reactions. Others have important structural functions. Yet other proteins called antibodies help your body defend against infection. Specialized proteins in muscles enable your muscles to contract. In your blood, a protein called hemoglobin carries oxygen from your lungs to body tissues.

TEKS 1.B.9.A Biology

Nucleic acids are long chains of smaller molecules called nucleotides. A nucleotide has three parts: a sugar, a base, and a phosphate group, which contains phosphorus and oxygen atoms. There are two types of nucleic acids—DNA and RNA—and each type contains four kinds of nucleotides. DNA, or deoxyribonucleic acid, consists of two strands of nucleotides that spiral around each other. Chromosomes contain long strands of DNA, which stores hereditary information. RNA, or ribonucleic acid, may consist of a single strand of nucleotides or of based-paired nucleotides. RNA plays many key roles in the manufacture of proteins.

Name____ Date____________

TEKS **1.B.9.D** **Biology**

CELL STRUCTURE AND FUNCTION

The student will demonstrate an understanding of biomolecules as building blocks of cells, and that cells are the basic unit of structure and function of living things.

(B.9) **Science concepts.** The student knows the significance of various molecules involved in metabolic processes and energy conversions that occur in living organisms. The student is expected to (D) analyze and evaluate the evidence regarding formation of simple organic molecules and their organization into long complex molecules having information such as the DNA molecule for self-replicating life.

STANDARD REVIEW

Scientists who study the origins of life think that the path to the development of living things began when molecules of nonliving matter reacted chemically during the first billion years of Earth's history. These chemical reactions produced many different simple, organic molecules. Energized by the sun and volcanic heat, these simple, organic molecules formed more complex molecules that eventually became the building blocks of the first cells.

In the 1920s, the Russian scientist A. I. Oparin and the British scientist J.B.S. Haldane both suggested that the early Earth's oceans contained large amounts of organic molecules. This hypothesis became known as the primordial soup model. Oparin and Haldane hypothesized that these molecules formed spontaneously in chemical reactions activated by energy from solar radiation, volcanic eruptions, and lightning.

In 1953, the primordial soup model was tested by Stanley Miller and Harold Urey. Miller and Urey placed gases they thought made up Earth's early atmosphere (methane, ammonia, hydrogen, and water vapor) into a device made up of glass tubes and vessels. To simulate lightning, he provided electrical sparks. After a few days, they found a collection of organic molecules, including some of life's basic building blocks: amino acids, fatty acids, and other hydrocarbons. These results provided evidence that simple organic molecules could be made from inorganic molecules, as Oparin and Haldane had hypothesized.

Scientists have reevaluated the Miller-Urey experiment in light of the fact that scientists now think that four billion years ago, Earth's atmosphere did not contain ammonia and methane. Based on this new evidence, scientists have performed similar experiments that still produce simple organic molecules, such as amino acids, sugars, and nucleotides. This includes Miller's 1995 experiment in which he produced two nitrogen bases found in RNA.

In 1969, scientists analyzed a meteorite found in Australia and noted that it contained a number of amino acids found on Earth. This evidence led to the theory that simple organic molecules were present when Earth formed or were brought to Earth through meteorite or asteroid impacts. Still other scientists speculate that simple organic molecules originated in hydrothermal volcanic vents found in the deep sea.

Name____ Date______________

TEKS 1.B.9.D Biology

Through a series of chemical events on early Earth, scientists hypothesize that simple organic molecules, or monomers, evolved into more complex organic molecules, or polymers. One hypothesis is that water in the form of rain or waves may have left monomers on hot lava or rock. As the water vaporized, the monomers were concentrated, organized, and then linked together to form polymers. Scientists have been successful in simulating this process in the lab. Some scientists think that just as monomers originated in hydrothermal volcanic vents, the conditions may have given rise to the formation of polymers. Still, another hypothesis states that amino acids may have assembled into proteins by binding to clay particles, which were found in early oceans.

The origin of long, self-replicating, complex molecules, such as DNA, is important to understanding the evolution of life. Some scientists speculate that primitive genetic information was found in short strands of RNA, which preceded the existence of DNA. The presence of ribozymes in today's cells, which are RNA molecules that act as enzymes, suggest to some scientists that RNA molecules could have catalyzed their own self-replication.

As is the case in any field of science, these scientific explanations are subject to change as new evidence becomes available.