Biology Keystone Review Packet Part I

Assessment Anchors

Glossary

Module A Review Materials

Keystone Exams: Biology
Assessment Anchors and Eligible Content

Pennsylvania Department of Education

www.education.state.pa.us

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PENNSYLVANIA DEPARTMENT OF EDUCATION

General Introduction to the Keystone Exam Assessment Anchors

Introduction

Since the introduction of the Keystone Exams, the Pennsylvania Department of Education (PDE) has been working to create a set of tools designed to help educators improve instructional practices and better understand the Keystone Exams. The Assessment Anchors, as defined by the Eligible Content, are one of the many tools the Department believes will better align curriculum, instruction, and assessment practices throughout the commonwealth. Without this alignment, it will not be possible to significantly improve student achievement across the Commonwealth.

How were Keystone Exam Assessment Anchors developed?

Prior to the development of the Assessment Anchors, multiple groups of PA educators convened to create a set of standards for each of the Keystone Exams. Enhanced standards, derived from a review of existing standards, focused on what students need to know and be able to do in order to be college and career ready.

Additionally, the Assessment Anchors and Eligible Content statements were created by other groups of educators charged with the task of clarifying the standards assessed on the Keystone Exams. The Assessment Anchors, as defined by the Eligible Content, have been designed to hold together or *anchor* the state assessment system and curriculum/instructional practices in schools.

Assessment Anchors, as defined by the Eligible Content, were created with the following design parameters:

- **Clear:** The Assessment Anchors are easy to read and are user friendly; they clearly detail which standards are assessed on the Keystone Exams.
- **Focused:** The Assessment Anchors identify a core set of standards that could be reasonably assessed on a large-scale assessment, which will keep educators from having to guess which standards are critical.
- **Rigorous:** The Assessment Anchors support the rigor of the state standards by assessing higher-order and reasoning skills.
- **Manageable:** The Assessment Anchors define the standards in a way that can be easily incorporated into a course to prepare students for success.

How can teachers, administrators, schools, and districts use these Assessment Anchors?

The Assessment Anchors, as defined by the Eligible Content, can help focus teaching and learning because they are clear, manageable, and closely aligned with the Keystone Exams. Teachers and administrators will be better informed about which standards will be assessed. The Assessment Anchors and Eligible Content should be used along with the Standards and the Curriculum Framework of the Standards Aligned System (SAS) to build curriculum, design lessons, and support student achievement.

The Assessment Anchors and Eligible Content are designed to enable educators to determine when they feel students are prepared to be successful in the Keystone Exams. An evaluation of current course offerings, through the lens of what is assessed on those particular Keystone Exams may provide an opportunity for an alignment to ensure student preparedness.

How are the Assessment Anchors organized?

The Assessment Anchors, as defined by the Eligible Content, are organized into cohesive blueprints, each structured with a common labeling system that can be read like an outline. This framework is organized first by module, then by Assessment Anchor, followed by Anchor Descriptor, and then finally, at the greatest level of detail, by an Eligible Content statement. The common format of this outline is followed across the Keystone Exams.

Here is a description of each level in the labeling system for the Keystone Exams:

- **Module:** The Assessment Anchors are organized into two thematic modules for each of the Keystone Exams. The module title appears at the top of each page. The module level is important because the Keystone Exams are built using a module format, with each of the Keystone Exams divided into two equally-sized test modules. Each module is made up of two or more Assessment Anchors.
- **Assessment Anchor:** The Assessment Anchor appears in the shaded bar across the top of each Assessment Anchor table. The Assessment Anchors represent categories of subject matter that anchor the content of the Keystone Exams. Each Assessment Anchor is part of a module and has one or more Anchor Descriptors unified under it.
- **Anchor Descriptor:** Below each Assessment Anchor is a specific Anchor Descriptor. The Anchor Descriptor level provides further details that delineate the scope of content covered by the Assessment Anchor. Each Anchor Descriptor is part of an Assessment Anchor and has one or more Eligible Content unified under it.
- **Eligible Content:** The column to the right of the Anchor Descriptor contains the Eligible Content statements. The Eligible Content is the most specific description of the content that is assessed on the Keystone Exams. This level is considered the assessment limit and helps educators identify the range of the content covered on the Keystone Exams.
- **Enhanced Standard:** In the column to the right of each Eligible Content statement is a code representing one or more Enhanced Standards that correlate to the Eligible Content statement. Some Eligible Content statements include annotations that indicate certain clarifications about the scope of an eligible content.
    - "e.g." ("for example") —sample approach, but not a limit to the eligible content.
    - "i.e." ("that is") —specific limit to the eligible content.

Standards Aligned System — http://www.pdesas.org/ **Pennsylvania Department of Education** — www.education.state.pa.us

ASSESSMENT ANCHOR BIO.A.1 Basic Biological Principles		
Anchor Descriptor	**Eligible Content**	**Enhanced Standard**
BIO.A.1.1 Explain the characteristics common to all organisms.	**BIO.A.1.1.1** Describe the characteristics of life shared by all prokaryotic and eukaryotic organisms.	3.1.B.A1 3.1.B.C2 4.1.3.A 4.1.4.A
Anchor Descriptor	**Eligible Content**	**Enhanced Standard**
BIO.A.1.2 Describe relationships between structure and function at biological levels of organization.	**BIO.A.1.2.1** Compare cellular structures and their functions in prokaryotic and eukaryotic cells.	3.1.B.A1 3.1.B.A5 3.1.B.C2 4.1.4.A
	BIO.A.1.2.2 Describe and interpret relationships between structure and function at various levels of biological organization (i.e., organelles, cells, tissues, organs, organ systems, and multicellular organisms).	3.1.B.A5 3.1.B.A6 3.1.B.A1

Eligible Content may be assessed using knowledge and/or skills associated with the Nature of Science.

ASSESSMENT ANCHOR
BIO.A.2 The Chemical Basis for Life

Anchor Descriptor	Eligible Content	Enhanced Standard
BIO.A.2.1 Describe how the unique properties of water support life on Earth.	**BIO.A.2.1.1** Describe the unique properties of water and how these properties support life on Earth (e.g., freezing point, high specific heat, cohesion).	3.1.B.A8 3.1.B.A5 4.2.5.C

Anchor Descriptor	Eligible Content	Enhanced Standard
BIO.A.2.2 Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules, and macromolecules).	**BIO.A.2.2.1** Explain how carbon is uniquely suited to form biological macromolecules.	3.1.B.A7 3.2.C.A2
	BIO.A.2.2.2 Describe how biological macromolecules form from monomers.	3.1.B.A7 3.1.B.A8 3.1.B.A2 3.1.C.A2 3.1.C.A7
	BIO.A.2.2.3 Compare the structure and function of carbohydrates, lipids, proteins, and nucleic acids in organisms.	3.1.B.A7 3.1.B.A2 3.1.C.A2 3.1.C.A7

Anchor Descriptor	Eligible Content	Enhanced Standard
BIO.A.2.3 Explain how enzymes regulate biochemical reactions within a cell.	**BIO.A.2.3.1** Describe the role of an enzyme as a catalyst in regulating a specific biochemical reaction.	3.1.B.A2 3.1.B.A7
	BIO.A.2.3.2 Explain how factors such as pH, temperature, and concentration levels can affect enzyme function.	3.1.B.A2 3.1.B.A7

Eligible Content may be assessed using knowledge and/or skills associated with the Nature of Science.

ASSESSMENT ANCHOR BIO.A.3 Bioenergetics		
Anchor Descriptor	**Eligible Content**	**Enhanced Standard**
BIO.A.3.1 Identify and describe the cell structures involved in processing energy.	**BIO.A.3.1.1** Describe the fundamental roles of plastids (e.g., chloroplasts) and mitochondria in energy transformations.	3.1.B.A2 3.1.B.A5 3.1.C.A1
Anchor Descriptor	**Eligible Content**	**Enhanced Standard**
BIO.A.3.2 Identify and describe how organisms obtain and transform energy for their life processes.	**BIO.A.3.2.1** Compare the basic transformation of energy during photosynthesis and cellular respiration.	3.1.B.A2 3.1.B.A5 3.1.C.A1 4.1.10.C
	BIO.A.3.2.2 Describe the role of ATP in biochemical reactions.	3.1.B.A2 3.1.C.A1 3.1.C.A2

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ASSESSMENT ANCHOR BIO.A.4 Homeostasis and Transport				
Anchor Descriptor		**Eligible Content**		**Enhanced Standard**
BIO.A.4.1	Identify and describe the cell structures involved in transport of materials into, out of, and throughout a cell.	**BIO.A.4.1.1**	Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for a cell.	3.1.B.A5 3.1.B.A2 3.1.B.A4 3.1.B.A7 3.2.C.A1 3.2.P.B6
		BIO.A.4.1.2	Compare the mechanisms that transport materials across the plasma membrane (i.e., passive transport—diffusion, osmosis, facilitated diffusion; and active transport—pumps, endocytosis, exocytosis).	3.1.B.A5 3.1.B.A2 3.1.B.A7 3.2.C.A1 3.2.P.B6
		BIO.A.4.1.3	Describe how membrane-bound cellular organelles (e.g., endoplasmic reticulum, Golgi apparatus) facilitate the transport of materials within a cell.	3.1.B.A5 3.1.B.A2
Anchor Descriptor		**Eligible Content**		**Enhanced Standard**
BIO.A.4.2	Explain mechanisms that permit organisms to maintain biological balance between their internal and external environments.	**BIO.A.4.2.1**	Explain how organisms maintain homeostasis (e.g., thermoregulation, water regulation, oxygen regulation).	3.1.B.A8 3.1.B.A5 4.5.4.D 4.2.4.C

Eligible Content may be assessed using knowledge and/or skills associated with the Nature of Science.

ASSESSMENT ANCHOR
BIO.B.1 Cell Growth and Reproduction

Anchor Descriptor	Eligible Content	Enhanced Standard
BIO.B.1.1 Describe the three stages of the cell cycle: interphase, nuclear division, cytokinesis.	**BIO.B.1.1.1** Describe the events that occur during the cell cycle: interphase, nuclear division (i.e., mitosis or meiosis), cytokinesis.	3.1.B.A4 3.1.B.A5 3.1.B.B2 3.1.B.B3 3.1.B.B5 3.1.B.C2 3.1.C.C2
	BIO.B.1.1.2 Compare the processes and outcomes of mitotic and meiotic nuclear divisions.	3.1.B.A4 3.1.B.A5 3.1.B.B2 3.1.B.B3 3.1.B.B5 3.1.B.C2 3.1.C.C2

Anchor Descriptor	Eligible Content	Enhanced Standard
BIO.B.1.2 Explain how genetic information is inherited.	**BIO.B.1.2.1** Describe how the process of DNA replication results in the transmission and/or conservation of genetic information.	3.1.B.B1 3.1.B.B3 3.1.B.B5 3.1.B.C2 3.1.C.C2
	BIO.B.1.2.2 Explain the functional relationships between DNA, genes, alleles, and chromosomes and their roles in inheritance.	3.1.B.B1 3.1.B.B5 3.1.B.B2 3.1.B.B3 3.1.C.C2

Eligible Content may be assessed using knowledge and/or skills associated with the Nature of Science.

ASSESSMENT ANCHOR
BIO.B.2 Genetics

Anchor Descriptor		Eligible Content		Enhanced Standard
BIO.B.2.1	Compare Mendelian and non-Mendelian patterns of inheritance.	BIO.B.2.1.1	Describe and/or predict observed patterns of inheritance (i.e., dominant, recessive, co-dominance, incomplete dominance, sex-linked, polygenic, and multiple alleles).	3.1.B.B5
		BIO.B.2.1.2	Describe processes that can alter composition or number of chromosomes (i.e., crossing-over, nondisjunction, duplication, translocation, deletion, insertion, and inversion).	3.1.B.B1 3.1.B.B2 3.1.B.B3 3.1.C.C2
Anchor Descriptor		**Eligible Content**		**Enhanced Standard**
BIO.B.2.2	Explain the process of protein synthesis (i.e., transcription, translation, and protein modification).	BIO.B.2.2.1	Describe how the processes of transcription and translation are similar in all organisms.	3.1.B.B1 3.1.B.B3 3.1.B.B5 3.1.C.B3 3.1.C.C2
		BIO.B.2.2.2	Describe the role of ribosomes, endoplasmic reticulum, Golgi apparatus, and the nucleus in the production of specific types of proteins.	3.1.B.A5 3.1.B.B3 3.1.B.B5 3.1.C.B3
Anchor Descriptor		**Eligible Content**		**Enhanced Standard**
BIO.B.2.3	Explain how genetic information is expressed.	BIO.B.2.3.1	Describe how genetic mutations alter the DNA sequence and may or may not affect phenotype (e.g., silent, nonsense, frame-shift).	3.1.B.B1 3.1.B.B3 3.1.B.C2 3.1.C.B3 3.1.C.C2

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Anchor Descriptor		Eligible Content		Enhanced Standard
BIO.B.2.4	Apply scientific thinking, processes, tools, and technologies in the study of genetics.	BIO.B.2.4.1	Explain how genetic engineering has impacted the fields of medicine, forensics, and agriculture (e.g., selective breeding, gene splicing, cloning, genetically modified organisms, gene therapy).	3.1.B.B4 4.4.7.A 4.4.10.A 4.4.12.A 4.4.7.B 4.4.10.B 4.4.12.B

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ASSESSMENT ANCHOR BIO.B.3 Theory of Evolution			
Anchor Descriptor		**Eligible Content**	**Enhanced Standard**
BIO.B.3.1 Explain the mechanisms of evolution.	BIO.B.3.1.1	Explain how natural selection can impact allele frequencies of a population.	3.1.B.C1
	BIO.B.3.1.2	Describe the factors that can contribute to the development of new species (e.g., isolating mechanisms, genetic drift, founder effect, migration).	3.1.B.C1 3.1.B.C2
	BIO.B.3.1.3	Explain how genetic mutations may result in genotypic and phenotypic variations within a population.	3.1.B.C2 3.1.B.B1
Anchor Descriptor		**Eligible Content**	**Enhanced Standard**
BIO.B.3.2 Analyze the sources of evidence for biological evolution.	BIO.B.3.2.1	Interpret evidence supporting the theory of evolution (i.e., fossil, anatomical, physiological, embryological, biochemical, and universal genetic code).	3.1.B.C3 3.1.B.C1 3.1.B.B3
Anchor Descriptor		**Eligible Content**	**Enhanced Standard**
BIO.B.3.3 Apply scientific thinking, processes, tools, and technologies in the study of the theory of evolution.	BIO.B.3.3.1	Distinguish between the scientific terms: hypothesis, inference, law, theory, principle, fact, and observation.	3.1.B.A9

Eligible Content may be assessed using knowledge and/or skills associated with the Nature of Science.

ASSESSMENT ANCHOR
BIO.B.4 Ecology

Anchor Descriptor	Eligible Content	Enhanced Standard
BIO.B.4.1 Describe ecological levels of organization in the biosphere.	**BIO.B.4.1.1** Describe the levels of ecological organization (i.e., organism, population, community, ecosystem, biome, and biosphere).	4.1.4.A 4.1.10.A 4.4.6.A 4.5.3.D 4.1.7.A 4.1.7.C
	BIO.B.4.1.2 Describe characteristic biotic and abiotic components of aquatic and terrestrial ecosystems.	4.1.7.A 4.1.4.B 4.1.4.C 4.4.3.C 4.1.3.A 4.2.10.A 4.4.5.C

Anchor Descriptor	Eligible Content	Enhanced Standard
BIO.B.4.2 Describe interactions and relationships in an ecosystem.	**BIO.B.4.2.1** Describe how energy flows through an ecosystem (e.g., food chains, food webs, energy pyramids).	4.1.4.C 4.1.10.C 4.1.3.C 4.1.5.A 4.1.7.C 4.1.12.C 4.1.5.C
	BIO.B.4.2.2 Describe biotic interactions in an ecosystem (e.g., competition, predation, symbiosis).	4.1.7.A 4.1.10.A 4.5.3.D 4.5.6.D
	BIO.B.4.2.3 Describe how matter recycles through an ecosystem (i.e., water cycle, carbon cycle, oxygen cycle, and nitrogen cycle).	4.1.4.B 4.2.7.A 4.5.4.C 4.3.4.D 4.1.7.B 4.3.12.A 4.5.8.C 3.1.B.A2 4.2.5.A 4.4.3.C
	BIO.B.4.2.4 Describe how ecosystems change in response to natural and human disturbances (e.g., climate changes, introduction of nonnative species, pollution, fires).	4.1.10.A 4.1.7.E 4.2.10.B 4.3.10.B 4.1.10.B 4.1.10.E 4.2.12.B 4.5.10.B 4.1.12.A 4.5.10.D 4.2.10.C 4.5.12.B 4.1.4.A 4.2.8.A 4.2.12.C 4.5.4.C 4.1.12.C 4.2.10.A 4.3.12.A 4.5.7.C 4.1.4.E 4.2.12.A
	BIO.B.4.2.5 Describe the effects of limiting factors on population dynamics and potential species extinction.	4.1.4.A 4.2.10.C 4.2.10.A 4.4.6.B 4.1.10.A 4.5.3.D 4.2.7.A 4.4.3.C 4.1.12.A 4.5.5.D 4.2.8.A 4.4.5.C 4.1.7.E 4.5.6.D 4.2.10.B 4.5.7.B 4.1.10.E 4.5.10.D 4.4.6.A 4.5.7.C 4.1.4.E

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Keystone Exams: Biology

Glossary to the Assessment Anchor & Eligible Content

The Keystone Glossary includes terms and definitions associated with the Keystone Assessment Anchors and Eligible Content. The terms and definitions included in the glossary are intended to assist Pennsylvania educators in better understanding the Keystone Assessment Anchors and Eligible Content. The glossary does not define all possible terms included on an actual Keystone Exam, and it is not intended to define terms for use in classroom instruction for a particular grade level or course.

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Abiotic	A term that describes a nonliving factor in an ecosystem.
Activation Energy (E_a)	The minimum energy required to initiate a specific chemical reaction.
Active Transport	The movement of particles from an area of low concentration to an area of high concentration that uses energy provided by ATP or a difference in electrical charges across a cell membrane.
Adenosine Triphosphate (ATP)	A molecule that provides energy for cellular reactions and processes. ATP releases energy when one of its high-energy bonds is broken to release a phosphate group.
Adhesion	The intermolecular attraction between unlike molecules. Capillary action results from the adhesive properties of water and the molecules that make up plant cells.
Agriculture	The artificial cultivation of food, fiber, and other goods by the systematic growing and harvesting of various organisms.
Allele	A variation of a gene's nucleotide sequence (an alternative form of a gene).
Allele Frequency	The measure of the relative frequency of an allele at a genetic locus in a population; expressed as a proportion or percentage.
Analogous Structure	A physical structure, present in multiple species, that is similar in function but different in form and inheritance.
Aquatic	A term that describes an organism associated with a water environment.
Atom	The smallest unit of an element that retains the chemical and physical properties of that element.
Biochemical Conversion	The changing of organic matter into other chemical forms such as fuels.

Bioenergetics	The study of energy flow (energy transformations) into and within living systems.
Biogeochemical Cycles	The movement of abiotic factors between the living and nonliving components within ecosystems; also known as nutrient cycles (i.e., water cycle, carbon cycle, oxygen cycle, and nitrogen cycle).
Biological Macromolecules	A group of biomacromolecules that interact with biological systems and their environments.
Biology	The scientific study of life.
Biome	A large area or geographical region with distinct plant and animal groups adapted to that environment.
Biosphere	The zone of life on Earth; sum total of all ecosystems on Earth.
Biotechnology	Any procedure or methodology that uses biological systems or living organisms to develop or modify either products or processes for specific use. This term is commonly associated with genetic engineering, which is one of many applications.
Biotic	A term that describes a living or once-living organism in an ecosystem.
Carbohydrate	A macromolecule that contains atoms of carbon, hydrogen, and oxygen in a 1:2:1 ratio and serves as a major source of energy for living organisms (e.g., sugars, starches, and cellulose).
Carrier (Transport) Proteins	Proteins embedded in the plasma membrane involved in the movement of ions, small molecules, and macromolecules into and out of cells; also known as transport proteins.
Carrying Capacity	The number of individuals in a population that can be supported in an ecosystem given the resources available and other environmental pressures.

Catalyst	A substance that enables a chemical reaction to proceed at a usually faster rate or under different conditions (e.g., lower temperature) than otherwise possible without being changed by the reaction.
Cell	The basic unit of structure and function for all living organisms. Cells have three common components: genetic material, cytoplasm, and a cell membrane. Eukaryotic cells also contain specialized organelles.
Cell Cycle	The series of events that take place in a cell leading to its division and duplication. The main phases of the cell cycle are interphase, nuclear division, and cytokinesis.
Cellular Respiration	A complex set of chemical reactions involving an energy transformation where potential chemical energy in the bonds of "food" molecules is released and partially captured in the bonds of adenosine triphosphate (ATP) molecules.
Chloroplast	An organelle found in plant cells and the cells of other eukaryotic photosynthetic organisms where photosynthesis occurs.
Chromosomal Mutation	A change in the structure of a chromosome (e.g., deletion, the loss of a segment of a chromosome and thus the loss of segment containing genes; duplication, when a segment of a chromosome is duplicated and thus displayed more than once on the chromosome; inversion, when a segment of a chromosome breaks off and reattaches in reverse order; and translocation, when a segment of one chromosome breaks off and attaches to a nonhomologous chromosome).
Chromosomes	A single piece of coiled DNA and associated proteins found in linear forms in the nucleus of eukaryotic cells and circular forms in the cytoplasm of prokaryotic cells; contains genes that encode traits. Each species has a characteristic number of chromosomes.
Cloning	A process in which a cell, cell product, or organism is copied from an original source (e.g., DNA cloning, the transfer of a DNA fragment from one organism to a self-replicating genetic element such as a bacterial plasmid; reproductive cloning, the transfer of genetic material from the nucleus of a donor adult cell to an egg cell that has had its nucleus removed for the purpose of creating an embryo that can produce an exact genetic copy of the donor organism; or therapeutic cloning, the process of taking undifferentiated embryonic cells [STEM cells] for use in medical research).

Co-dominance	A pattern of inheritance in which the phenotypic effect of two alleles in a heterozygous genotype express each phenotype of each allele fully and equally; a phenotype which would not be expressed in any other genotypic combination.
Cohesion	The intermolecular attraction between like molecules. Surface tension results from the cohesive properties of water.
Community (Ecological)	Different populations of organisms interacting in a shared environment.
Competition	When individuals or groups of organisms compete for similar resources such as territory, mates, water, and food in the same environment.
Concentration	The measure of the amount or proportion of a given substance when combined with another substance.
Concentration Gradient	The graduated difference in concentration of a solute per unit distance through a solution.
Consumer (Ecological)	An organism that obtains energy by feeding on other organisms or their remains.
Crossing-over	An exchange of genetic material between homologous chromosomes during prophase I of meiosis; contributes to the genetic variability in gametes and ultimately in offspring.
Cytokinesis	The final phase of a cell cycle resulting in the division of the cytoplasm.
Decomposer	An organism that obtains nutrients by consuming dead and decaying organic matter which allows nutrients to be accessible to other organisms.
Dehydration Synthesis	A chemical reaction in which monomers are linked together by removing one water molecule from each linked pair of monomers to form polymers.

Deletion Mutation	A genetic mutation in which one or more nucleotides are removed from a section of DNA.
Deoxyribonucleic Acid (DNA)	A biological macromolecule that encodes the genetic information for living organisms and is capable of self-replication and the synthesis of ribonucleic acid (RNA).
Diffusion	The movement of particles from an area of high concentration to an area of low concentration; a natural result of kinetic molecular energy.
Diploid Cell	A cell containing two homologous pairs of chromosomes (2n).
DNA Replication	The process in which DNA makes a duplicate copy of itself.
Dominant Inheritance	A pattern of inheritance in which the phenotypic effect of one allele is completely expressed within a homozygous and heterozygous genotype.
Duplication Mutation	A genetic mutation in which a region that contains a gene or an entire chromosome is duplicated, which results in multiple copies of that region or nucleotide.
Ecology	The study of the relationships between organisms and their interactions with the environment.
Ecosystem	A system composed of organisms and nonliving components of an environment.
Embryology	The branch of zoology studying the early development of living things.
Endemic Species	A species that is found in its originating location and is generally restricted to that geographic area.
Endocytosis	A process in which a cell engulfs extracellular material through an inward folding of its plasma membrane.

Endoplasmic Reticulum (ER)	An organelle, containing folded membranes and sacs, responsible for the production, processing, and transportation of materials for use inside and outside a eukaryotic cell. There are two forms of this organelle: rough ER that has surface ribosomes and participates in the synthesis of proteins mostly destined for export by the cell and smooth ER that has no ribosomes and participates in the synthesis of lipids and steroids as well as the transport of synthesized macromolecules.
Endosymbiosis	A theorized process in which early eukaryotic cells were formed from simpler prokaryotes.
Energy Pyramid	A model that illustrates the biomass productivity at multiple trophic levels in a given ecosystem.
Energy Transformation	A process in which energy changes from one form to another form while some of the energy is lost to the environment.
Environment	The total surroundings of an organism or a group of organisms.
Enzyme	A protein that increases the rate of a chemical reaction without being changed by the reaction; an organic catalyst.
Eukaryote	A type of organism composed of one or more cells containing a membrane-bound nucleus, specialized organelles in the cytoplasm, and a mitotic nuclear division cycle.
Evolution	A process in which new species develop from preexisting species (biological evolution or macroevolution); a change in the allele frequencies of a population of organisms from generation to generation (genetic evolution or microevolution).
Exocytosis	A process in which a cell releases substances to the extracellular environment by fusing a vesicular membrane with the plasma membrane, separating the membrane at the point of fusion and allowing the substance to be released.
Extinction	A term that typically describes a species that no longer has any known living individuals.
Extracellular	Located outside a cell.

Facilitated Diffusion	A process in which substances are transported across a plasma membrane with the concentration gradient with the aid of carrier (transport) proteins; does not require the use of energy.
Food Chain	A simplified path illustrating the passing of potential chemical energy (food) from one organism to another organism.
Food Web	A complex arrangement of interrelated food chains illustrating the flow of energy between interdependent organisms.
Forensics	The science of tests and techniques used during the investigation of crimes.
Fossils	The preserved remains or traces of organisms that once lived on Earth.
Founder Effect	A decrease in genetic variation caused by the formation of a new population by a small number of individuals from a larger population.
Frame-shift Mutation	The addition (insertion mutation) or removal (deletion mutation) of one or more nucleotides that is not divisible by three, therefore resulting in a completely different amino acid sequence than would be normal. The earlier in the sequence that nucleotides are added or removed, the more altered the resulting protein will be.
Freezing Point	The temperature at which a liquid changes state to a solid.
Gamete	A specialized cell (egg or sperm) used in sexual reproduction containing half the normal number of chromosomes of a somatic cell.
Gene	A sequence of nucleotides composing a segment of DNA that provides a blueprint for a specific hereditary trait.
Gene Expression	The process in which a nucleotide sequence of a gene is used to make a functional product such as protein or RNA.

Gene Mutation	A permanent alteration that changes a segment of DNA within a gene.
Gene Recombination	A natural process in which a nucleic acid molecule (usually DNA but can be RNA) is broken and then joined to a different molecule; a result of crossing-over.
Gene Splicing	A type of gene recombination in which the DNA is intentionally broken and recombined using laboratory techniques.
Gene Therapy	The intentional insertion, alteration, or deletion of genes within an individual's cells and tissues for the purpose of treating a disease.
Genetic Drift	A change in the allele frequency of a population as a result of chance events rather than natural selection.
Genetic Engineering	A technology that includes the process of manipulating or altering the genetic material of a cell resulting in desirable functions or outcomes that would not occur naturally.
Genetically Modified Organism	An organism whose genetic material has been altered through some genetic engineering technology or technique.
Genetics	The scientific study of inheritance.
Genotype	The genetic composition of an organism with reference to a single trait, a set of traits, or the entire complement of traits of an organism.
Golgi Apparatus	An organelle found in eukaryotic cells responsible for the final stages of processing proteins for release by the cell.
Gradualism	A proposed explanation in evolutionary biology stating that new species arise from the result of slight modifications (mutations and resulting phenotypic changes) over many generations.

Habitat	An area that provides an organism with its basic needs for survival.
Haploid Cell	A cell containing one chromosome (n) from each homologous pair, typically observed in somatic cells.
Homeostasis	The regulatory process in which an organism regulates its internal environment.
Homeostatic Mechanism	A regulatory mechanism that contributes to maintaining a state of equilibrium (e.g., thermoregulation, water regulation, and oxygen regulation).
Homologous Structure	A physical characteristic in different organisms that is similar because it was inherited from a common ancestor.
Hydrolysis	A chemical reaction in which chemical bonds in polymers are broken through the addition of water, decomposing the polymers into simpler units.
Hypothesis	A proposed, scientifically testable explanation for an observed phenomenon.
Impermeable	Not permitting passage of a substance or substances.
Incomplete Dominance	A pattern of inheritance in which two alleles, inherited from the parents, are neither dominant nor recessive. The resulting offspring have a phenotype that is a blending of the parental traits.
Inference	An idea based on evidence, observation, and/or known information applied to a situation or phenomena.
Inheritance	The process in which genetic material is passed from parents to their offspring.
Insertion Mutation	A genetic mutation in which one or more nucleotides are inserted into a genetic sequence.

Interphase	The longest-lasting phase of the cell cycle in which a cell performs the majority of its functions, such as preparing for nuclear division and cytokinesis.
Intracellular	Located inside a cell.
Inversion Mutation	A genetic mutation in which the order of a segment of genetic material is reversed. This type of mutation can involve a small number of nucleotides as well as larger sections of a chromosome containing more than one gene.
Isolating Mechanisms	Features of behaviors, morphology, or genetics that prevent mating or breeding between two different species (e.g., temporal isolation, in which individuals are active at different times of the day, seasons, or mating periods; geographical isolation, in which individuals only mate in their specific habitat; behavioral isolation, when there are no sexual cues between representatives of the species; mechanical isolation, when there is no gamete transfer during an attempted mating; and gametic incompatibility, when there is sperm transfer without fertilization occurring).
Law (Scientific)	A law that generalizes a body of observations. At the time it is made, no exceptions have been found to a law. It explains things but does not describe them; serves as the basis of scientific principles.
Limiting Factor	Chemical, physical, or biological factor that limits the existence, growth, abundance, or distribution of an individual organism or a population.
Lipids	A group of organic compounds composed mostly of carbon and hydrogen including a proportionately smaller amount of oxygen; are insoluble in water, serve as a source of stored energy, and are a component of cell membranes.
Locus (gene locus)	The specific location of a gene or DNA sequence on a chromosome or linkage map.
Macromolecule	A polymer with a high molecular mass. Within organisms there are four main groups: carbohydrates, lipids, proteins, and nucleic acids.

Mechanism (Scientific)	The combination of components and processes that serve a common function.
Meiosis	A two-phase nuclear division that results in the eventual production of gametes with half the normal number of chromosomes.
Migration (Genetics)	The permanent movement of genes into or out of a population resulting in a change in allele frequencies.
Missense Mutation	A genetic mutation in which a point mutation of a single nucleotide changes the existing code to a sequence that codes for a different amino acid, which results in a nonfunctional protein. (If the amino acid remains the same after the point mutation, this mutation is considered to be a silent mutation. If the resulting amino acid is a premature stop codon, this mutation is considered to be a nonsense mutation.)
Mitochondrion	A membrane-bound organelle found in most eukaryotic cells; site of cellular respiration.
Mitosis	A nuclear division resulting in the production of two somatic cells having the same genetic complement as the original cell.
Molecule	The smallest particle of a substance that retains the chemical and physical properties of the substance and is composed of two or more atoms held together by chemical forces.
Monomer	A molecule of any compound that can react with other molecules of the same or different compound to form a polymer. Each biological macromolecule has characteristic monomers.
Multicellular	Made up of more than one cell.
Multiple Alleles	More than two forms of a gene controlling the expression of a trait.
Mutation	A permanent transmissible change of genetic material (e.g., chromosomal mutations and gene mutations).

Natural Selection	A process in nature in which organisms possessing certain inherited traits are better able to survive and reproduce compared to others of their species.
Nondisjunction	The process in which homologous chromosomes or sister chromatids fail to separate during meiosis.
Nonnative Species	A species typically living outside a distribution range that has been introduced through either deliberate or accidental human activity; also known as introduced, alien, nonindigenous, or exotic species.
Nonsense Mutation	A genetic mutation, which is typically the result of a point mutation, that causes the sequence of nucleotides to code for a premature stop codon. This type of mutation usually results in a protein product that is shortened, incomplete, and often nonfunctional.
Nucleic Acid	A biological macromolecule (DNA or RNA) composed of the elements C, H, N, O, and P that carries genetic information.
Nucleus	A membrane-bound organelle in eukaryotic cells functioning to maintain the integrity of the genetic material and, through the expression of that material, controlling and regulating cellular activities.
Organ	An anatomical unit composed of tissues serving a common function.
Organ System	An anatomical system composed of a group of organs that work together to perform a specific function or task.
Organelle	A subunit within a cell that has a specialized function.
Organic Molecule	A molecule containing carbon that is a part of or produced by living systems.
Organism	A form of life; an animal, plant, fungus, protist or bacterium.

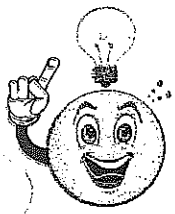
Osmosis	The movement of water or another solvent through permeable membranes from an area of higher water concentration (dilute) to an area of lower water concentration (concentrated).
Passive Transport	The transportation of materials across a plasma membrane without using energy.
pH	The measure of acidity or alkalinity (basicity) of an aqueous solution scaling from 1 (highly acidic) to 14 (highly alkaline) with a midpoint of 7 (neutral).
Phenotype	The observable expression of a genotype.
Photosynthesis	A process in which solar radiation is chemically captured by chlorophyll molecules through a set of controlled chemical reactions resulting in the potential chemical energy in the bonds of carbohydrate molecules.
Plasma Membrane	A thin, phospholipid and protein molecule bilayer that encapsulates a cell and controls the movement of materials in and out of the cell through active or passive transport.
Plasmid	Circular DNA molecules that are separate from chromosomal DNA and can replicate independently.
Plastids	A group of membrane-bound organelles commonly found in photosynthetic organisms and mainly responsible for the synthesis and storage of food.
Point Mutation	A single-base substitution causing the replacement of a single-base nucleotide with another nucleotide (e.g., silent mutation, in which there is no change in an amino acid; missense mutation, in which there is a different amino acid; and nonsense mutation, in which there is an insertion of a stop codon in the amino acid which stops protein synthesis).
Polygenic Trait	A trait in which the phenotype is controlled by two or more genes at different loci on different chromosomes.

Population	A group of individuals of the same species living in a specific geographical area and reproducing.
Population Dynamics	The study of short- and long-term changes in the number of individuals for a given population, as affected by birth, death, immigration, and emigration.
Principle (Scientific)	A concept based on scientific laws and axioms (rules assumed to be present, true, and valid) where general agreement is present.
Producer (Ecological)	An organism that uses a primary energy source to conduct photosynthesis or chemosynthesis.
Prokaryote	A single-celled organism that lacks a membrane-bound nucleus and specialized organelles.
Protein	A macromolecule that contains the principal components of organisms: carbon, hydrogen, oxygen, and nitrogen; performs a variety of structural and regulatory functions for cells.
Protein Synthesis	The process in which amino acids are arranged in a linear sequence through the processes of transcription of DNA to RNA and the translation of RNA to a polypeptide chain.
Pumps (Ion or Molecular)	Any of several molecular mechanisms in which ions or molecules are transported across a cellular membrane requiring the use of an energy source (e.g., glucose, sodium [Na+], calcium [Ca+], and potassium [K+]).
Punctuated Equilibrium	A proposed explanation in evolutionary biology stating that species are generally stable over long periods of time. Occasionally there are rapid changes that affect some species which can quickly result in a new species.
Recessive Inheritance	A pattern of inheritance in which the phenotypic effect of one allele is only expressed within a homozygous genotype. In a heterozygous condition with a dominant allele, it is not expressed in the phenotype.
Ribosome	A cellular structure composed of RNA and proteins that is the site of protein synthesis in eukaryotic and prokaryotic cells.

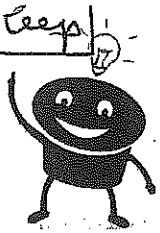
Science	A body of evidence-based knowledge gained through observation and experimentation related to the natural world and technology.
Selective Breeding	The process of breeding organisms that results in offspring with desired genetic traits.
Semiconservative Replication	The process in which the DNA molecule uncoils and separates into two strands. Each original strand becomes a template on which a new strand is constructed, resulting in two DNA molecules identical to the original DNA molecule.
Sex-linked Trait	A trait associated with a gene that is located on one of the sex chromosomes (e.g., color blindness, hemophilia).
Silent Mutation	A genetic mutation that results in a codon that does not change the amino acid sequence that occurs, codes for the same amino acid, or codes for a different amino acid that does not cause any functional change in the proteins that are produced.
Speciation	A process typically caused by the genetic isolation from a main population resulting in a new genetically distinct species.
Species	The lowest taxonomic level of biological classification consisting of organisms capable of reproduction that results in fertile offspring.
Specific Heat	The measure of the heat energy required to increase the temperature of a unit quantity of a substance by a certain temperature interval.
Substrate	A substance on which an enzyme acts.
Succession	A series of predictable and orderly changes within an ecosystem over time.

Symbiotic Relationship	A relationship between two organisms (i.e., mutualism, in which both organisms benefit; parasitism, in which one organism benefits and the other organism is harmed; and commensalism, in which one organism benefits and the other organism does not benefit or is not harmed).
System	A set of interacting or interdependent components, real or abstract, that form an integrated whole. An open system is able to interact with its environment. A closed system is isolated from its environment.
Temperature	A measure of the average kinetic energy (energy of motion) of particles in a sample of matter. This physical property can determine the rate and extent to which chemical reactions can occur within living systems. It is commonly measured in degrees Celsius (°C) or Fahrenheit (°F).
Terrestrial	A term that can describe an organism associated with a land environment.
Theory (Scientific)	An explanation of observable phenomena based on available empirical data and guided by a system of logic that includes scientific laws; provides a system of assumptions, accepted principles, and rules of procedure devised to analyze, predict, or otherwise explain the nature or behavior of a specific set of phenomena.
Thermoregulation	The maintenance of internal homeostasis by keeping an organism's body temperature within a certain range, even when external environmental temperatures vary.
Tissue	An anatomical unit composed of cells organized to perform a similar function.
Transcription	The process in which a strand of messenger RNA (mRNA) is synthesized by using the genetic information found on a strand of DNA as a template.
Translation	The process in which the messenger RNA (mRNA) molecule on a ribosome is decoded to produce a sequence of amino acids for protein synthesis.
Translocation	The process in which a segment of a chromosome breaks off and attaches to another chromosome.

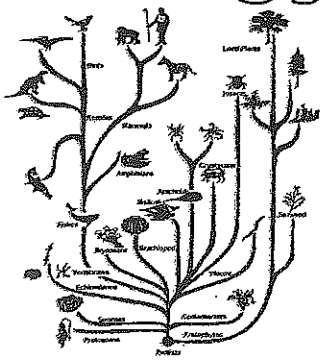
Transpiration	The movement of water from within a plant, typically through the leaves and stems, to the atmosphere in the form of water vapor.
Trophic Level	The position of an organism in relation to the flow of energy and inorganic nutrients through an ecosystem (e.g., producer, consumer, and decomposer).
Unicellular	Made up of a single cell.
Vestigial Structure	A physical characteristic in organisms that appears to have lost its original function as a species has changed over time.

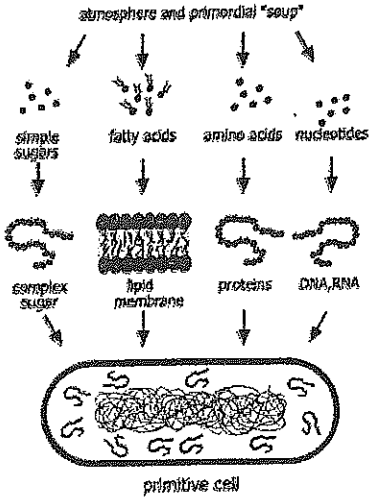


BIG Ideas in Biology

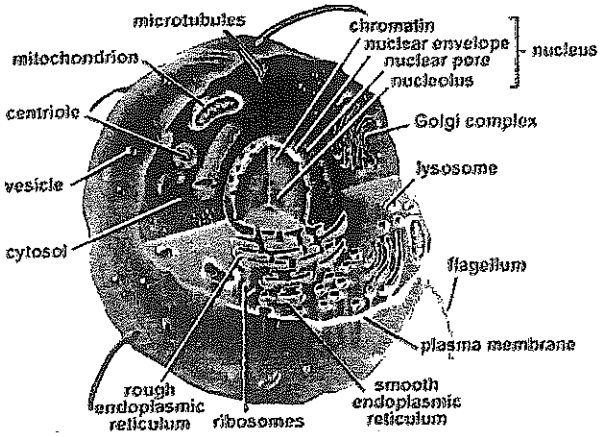


#1: Organisms share *common* characteristics of life.

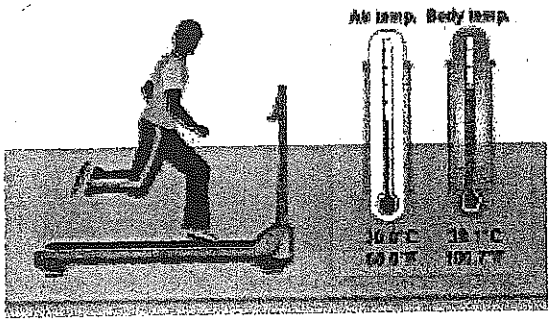




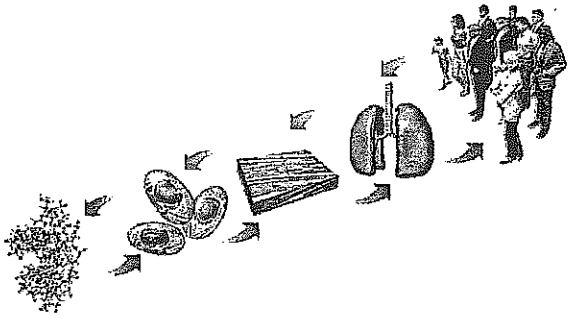
#2: Life emerges due to the chemical organization of matter into **cells**.



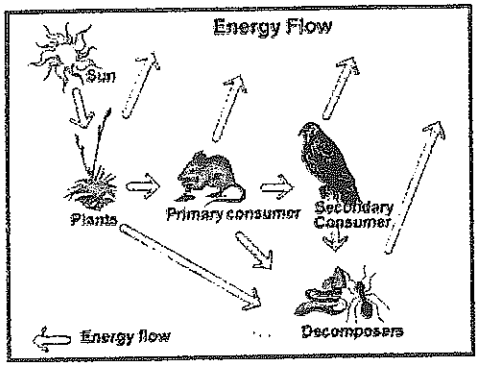
#3: **Cells** are the basic unit of structure and function for all organisms.



#4: Through a variety of mechanisms organisms seek to maintain a biological balance between their internal and external environments (**homeostasis**).

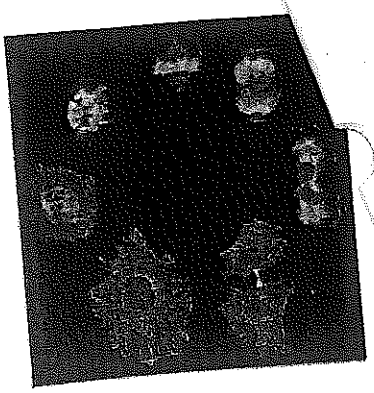


#5: Eukaryotic cells can **differentiate** and organize making it possible for multicellularity.

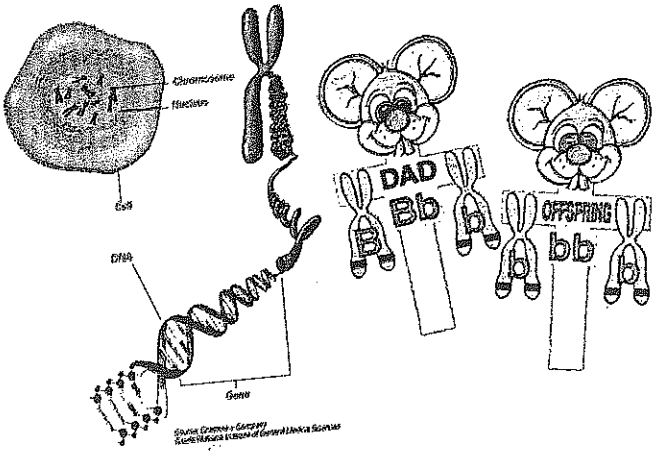


#6: Organisms obtain and use *energy* to carry out their life processes.

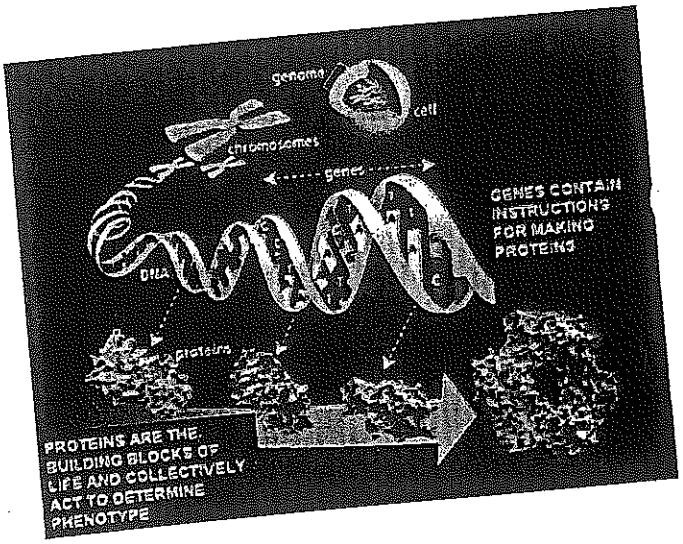
Module B



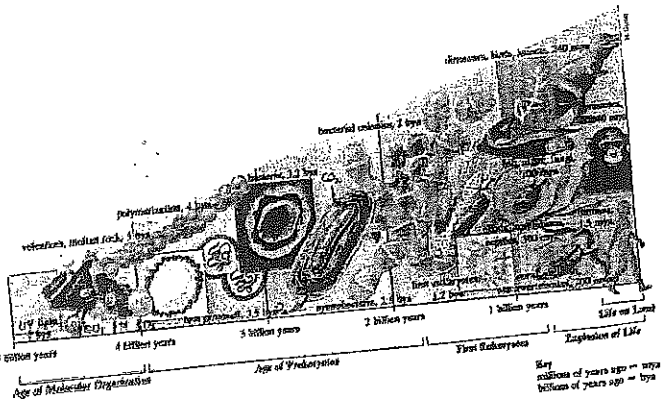
#7: New **cells** arise from the division of pre-existing cells.



#8: Hereditary information in **genes** is transmitted across generations via **DNA**.

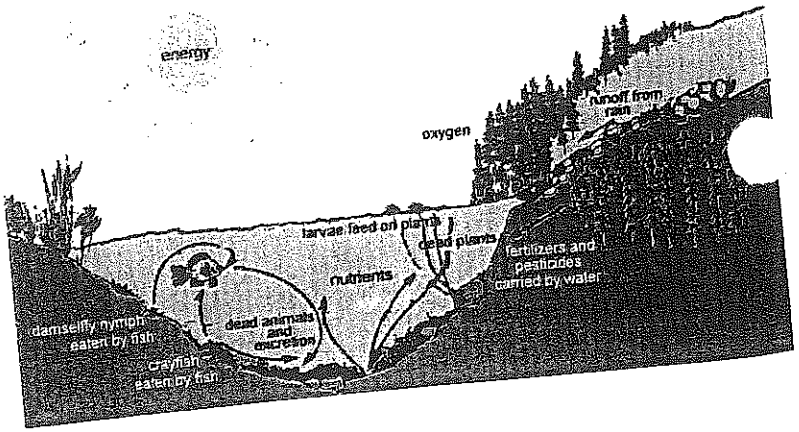


#9: **DNA** segments contain information for the production of **proteins** necessary for growth and function of **cells**.



#10: **Evolution** is the result of many random processes selecting for the survival and reproduction of a population.

#11: Organisms on Earth interact and depend in a variety of ways on other living and nonliving things in their environments (**ecology**).



Basic Biological Principles

Module A Anchor 1

Key Concepts:

- Living things are made of units called cells, are based on a universal genetic code, obtain and use materials and energy, grow and develop, reproduce, respond to their environment, maintain a stable internal environment, and change over time.

- Prokaryotic cells do not separate their genetic material within a nucleus. In eukaryotic cells, the nucleus separates the genetic material from the rest of the cell.

- The cells of multicellular organisms become specialized for particular tasks and communicate with one another.

Vocabulary:

Homeostasis	Evolution	Asexual reproduction
Eukaryote	Nucleus	Sexual reproduction
Cell membrane	DNA	Membrane-bound organelles
Cell	Prokaryote	Cell specialization

Key

Basic Biological Principles

Module A Anchor 1

Characteristics of Life:

1. List the characteristics of life common to all living things.

Living things are made of cells, are based on a universal genetic code, obtain and use materials and energy, grow and develop, reproduce, respond to their environment, maintain a stable internal environment, and change over time.

2. If an organism lacks any of these characteristics, is it considered living? Why or why not?

No – nonliving things can contain some of the characteristics of life. For example, a chemical can react to the environment.

3. Which of the following characteristics of living things explains why birds fly south for the winter?

A. *Living things respond to their environment*

4. Which characteristic(s) of living things is more important to the survival of the species as a whole, rather than the individual organism? Why?

Reproduction – ensures the continuation of the species, but has no direct benefit to the organism
Change over time – refers to evolution, which occurs to species and not to individual organisms. Individual organisms survive or do not survive, altering the species as a whole and allowing it to continue existing.

Prokaryotes vs. Eukaryotes:

1. Compare and contrast prokaryotes and eukaryotes in terms of structures; list specific organelles which are present in each, as well as other structural similarities and differences.

Prokaryotes – No nucleus, no membrane-bound organelles, unicellular

Eukaryotes – contain genetic material within nucleus, contain membrane-bound organelles, can be unicellular or multicellular

Both – contain cell-membrane, cell wall, ribosomes, contain genetic material

2. Compare and contrast prokaryotes and eukaryotes in terms of genetic material.

Prokaryotes do not contain their genetic material within a nucleus. Contain circular pieces of DNA concentrated within a nucleoid. Some contain plasmids, which can be shared with other prokaryotes.

Eukaryotes contain their genetic material in chromosomes within a nucleus.

3. How are the similarities and differences between prokaryotic and eukaryotic cells dependent on their size?

Prokaryotic cells are smaller, therefore have a more favorable surface-area to volume ratio. This makes transport of materials into and out of the cell much easier. Prokaryotes are therefore able to lack membrane-bound organelles and have less complex internal structure. Eukaryotes are generally larger than prokaryotes, and have a less favorable surface-area to

volume ratio. This makes transport more complicated, requiring them to contain a larger variety of organelles.

4. How do the structures of prokaryotic and eukaryotic cells influence their functions?
Prokaryotes contain everything necessary to carry out life processes; however, they do lack the complex internal structure of eukaryotes. The more complex internal structure of eukaryotes allows them to perform a larger array of functions, including those requiring multicellularity.

5. Not all cells are alike. Which of the following is NOT a true statement about differences between cells?
D. Most cells have a membrane, but some do not

Levels of Organization:
1. Describe the relationship between organelles, cells, tissues, organs, and organ systems.
Groups of a variety of organelles make up cells. Groups of the same cell type make up tissues. Groups of multiple tissues make up organs. Groups of organs with the same overall purpose working together make up organ systems.

2. Cells in multicellular organisms have many sizes and shapes. These differences are referred to as cell specialization. Cell specialization allows cells to:
B. Perform different functions

3. The cells of unicellular organisms are:
C. Able to perform all the functions necessary for life

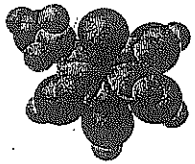
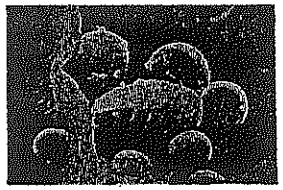
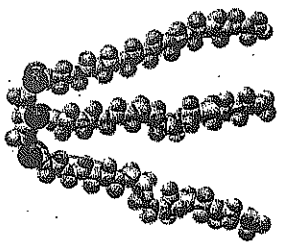
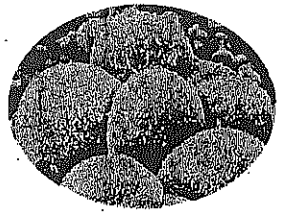
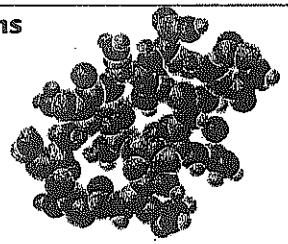
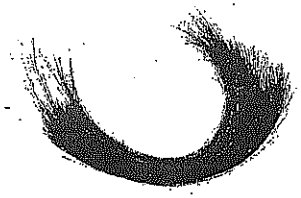
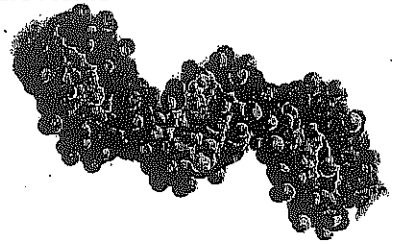
4. Give an example of changes that take place as cells in a multicellular organism differentiate.
Organisms originally begin as undifferentiated stem cells. These stem cells are capable of differentiating into any cell type. A number of factors influence the type of cell into which a stem cell differentiates. These factors are not all fully understood. Once a cell reaches its final differentiated state, it can no longer naturally change.

5. Explain the relationship between cell specialization, multicellular organisms, and homeostasis.
Multicellular organisms are large and complex; therefore, they require more complicated systems in order to maintain homeostasis. Multicellular organisms accomplish this by designating particular functions to particular cells. This allows different cells to work together to maintain homeostasis within a larger organism.

6. How are unicellular and multicellular organisms alike? How are they different?
Alike – both are able to perform all of the functions necessary for life. Both can perform a large array of functions.

Different – the cell of a unicellular organism is capable of performing all its necessary functions. A multicellular organism, due to its large size and complex structure, differentiates different cells for different functions.

Classes of Macromolecules

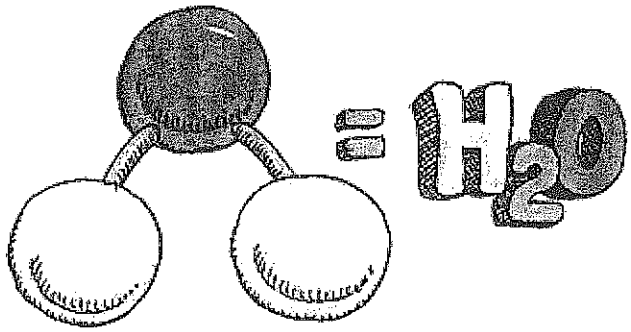
Class	~~Subunit~~ Monomer	Function	Example	
Carbohydrates 	Sugar	Stores energy (short term)	Starch, glycogen	 Starch granules
		Structural component	Cellulose, chitin	
Lipids 	Fatty acid	Stores energy (long term)	Body fat	 Human fat cells
		Membrane bilayer	Plasma membrane	
		Steroid hormones	Testosterone	
		Pigments	Chlorophyll	
Proteins 	Amino acid	Catalysis by means of enzymes	Lactase	 Hair
		Structural component	Hair, cartilage	
		Peptide hormone	Insulin	
Nucleic Acids 	Nucleotide	Stores genetic information	DNA	 Chromosomes
		Makes proteins	RNA	

Division of Water Resources Water Education

Water Science
Teacher Resources
Water Cycle
Water in Utah
Utah Waters Van
Water Conservation
Games
Young Artists

Water Education
Water Resources

The properties of water



Like all matter, water is made up of atoms. Atoms attach together, or bond, to form molecules. Two hydrogen atoms bonded to an oxygen atom form a water molecule. Water has several properties that make it a very unique substance.

Polarity

When electrons are not shared equally in a covalent bond, the molecule is described as polar. Water molecules are ploar. This means that while water molecules are neutral as a whole, one end of the water molecule tends to have a positive charge while the o[illegible] has a negative charge. The oxygen end has a slight negative charge while the hydr[illegible] end has a slight positive charge. Each end of a water molecule is attracted to the opposite charged end of another water molecule. Water's polarity is responsible for the "stickiness" or cohesion between the molecules.

Capillary Action

Cohesion of water causes capillary attraction, which is the ability of water to move upward in small spaces. Cohesion makes it possible for water to move up the fibers of a plant. This is how plants get the water they need to survive. In addition, it moves water upwards in soil. Cohesion of water also causes surface tension, water's invisible skin which allows water striders to walk on water

Surface Tension

Water is considered the "universal solvent" because its bipolar molecule enables it to dissolve a wide variety of substances. Solubility is affected by polarity. Polar substances can dissolve other polar substances. Non-polar substances dissolve other non-polar substances. Polar substances and non-polar substances, however, do not mix.

Density

Another property of water is density during phase changes. The density of most substances increases when a liquid becomes a solid. Solid water is actually less de[illegible] than liquid water. It is for this reason that ice floats. Can you imagine a world whe[illegible] ice sank? Lakes would freeze from the bottom up, killing many fish. Frozen water in the polar regions would sink and change the ocean levels. The fact that ice floats is essential for the survival of many aquatic ecosystems and ultimately life on Earth.

Chemical Basis of Life

Module A Anchor 2

Key Concepts:

- Water is a polar molecule. Therefore, it is able to form multiple hydrogen bonds, which account for many of its special properties.
- Water's polarity gives it the ability to dissolve both ionic compounds and other polar molecules.
- Carbon can bond with many elements, including hydrogen, oxygen, phosphorus, sulfur, and nitrogen to form the molecules of life.
- The function of macromolecules is directly related to their chemical structure.
- Living things use carbohydrates as their main source of energy. Plants, some animals, and other organisms also use carbohydrates for structural purposes.
- Lipids can be used to store energy. Some lipids are important parts of biological membranes and waterproof coverings.
- Nucleic acids store and transmit hereditary, or genetic, information.
- Some proteins control the rate of reactions and regulate cell processes. Some proteins build tissues such as bone and muscle. Others transport materials or help fight disease.
- Chemical reactions always involve changes in the chemical bonds that join atoms in compounds.
- Chemical reactions that release energy often occur spontaneously. Chemical reactions that absorb energy will not occur without a source of energy.
- Enzymes speed up chemical reactions that take place in cells. This function is directly related to their structure, with each enzyme being specifically shaped to catalyze one particular reaction. Loss of structure causes loss of function.
- Temperature, pH, and regulatory molecules can affect the activity of enzymes.

Vocabulary:

Hydrogen bond	solution	pH scale	cohesion
Adhesion	polarity	freezing point	monomer
Heat of vaporization	polymer	nucleic acid	nucleotide
Carbohydrate	monosaccharide	polysaccharide	lipid
Triglyceride	phospholipid	steroid	wax
Fatty acid	protein	amino acid	primary structure
Secondary structure	tertiary structure	quaternary structure	chemical reaction
Enzyme	catalyst	activation energy	active site
Substrate	product	reactant	

Key

Chemical Basis of Life

Module A Anchor 2

Properties of Water:

1. Describe the following properties of water and explain how each is important to living things: cohesion, adhesion, polarity, heat of vaporization, freezing point.

Cohesion – attraction between molecules of the same substance, water bonds to water

Adhesion – attraction between molecules of different substances, water bonds to another Molecule

Cohesion and adhesion help life in a variety of ways: they aid in the transport of liquids in plants, provide surface tension for aquatic organisms, etc.

Polarity – Polar molecules have ends with opposite charges. The oxygen atom of a water molecule more strongly attracts the electrons involved in the covalent bonds between oxygen and hydrogen. This gives the oxygen a slight negative charge and the hydrogen a slight positive charge. The polar nature of water makes it the universal solvent.

Heat of vaporization – it takes a large amount of energy to change the state of water. This benefits aquatic organisms, as bodies of water maintain fairly stable temperature conditions.

2. How is polarity related to cohesion and adhesion?

The attraction between molecules that causes cohesion and adhesion is the result of polarity. Polarity creates molecules with charged ends. Opposite charges attract, causing cohesion and adhesion.

3. Compared to most other substances, a great deal of heat is needed to raise the temperature of water by a given amount. This is because water

C. has a high heat capacity

4. Frozen water is less dense than liquid water. Explain why this is important for aquatic organisms.

Frozen water floats, create a buffer for aquatic organisms in winter. This buffer prevents the entire body of water from freezing and killing the organisms within it.

Macromolecules:

1. How is the structure of carbon related to its function in macromolecules? Think about the types of shapes carbon can form and why.

Carbon atoms have four valance electrons. This allows them to form strong covalent bonds with a number of elements. Carbon can also bond with itself, allowing it to form long chains or rings of carbon atoms.

2. Describe the processes of hydrolysis and dehydration synthesis. How are they related to each other?

Hydrolysis – molecules are broken into smaller pieces. Water is added.

Dehydration synthesis – oxygen and hydrogen are removed from two molecules, opening up bonding sites where they can join. The oxygen and hydrogen are joined to form water.

They are opposite processes.

3. List and draw the monomer and polymer units of each macromolecule along with their function in living things: carbohydrates, proteins, nucleic acids.

Carbohydrate – monomer: monosaccharide polymer: polysaccharide
function: energy and structure

Protein – monomer: amino acid polymer: polypeptide
function – highly varied

Nucleic acid – monomer: nucleotide polymer: nucleic acid
function: store and transmit hereditary information

5. List and draw the types of lipids, along with the subunits and uses of each.

Phospholipid – consists of fatty acid, phosphate group, glycerol, used in cell membranes
Wax – subunits are alcohol and fatty acids, used in structure and water-proofing
Steroid – carbon-ring structure, used as chemical messenger
Triglyceride – subunits are glycerol and three fatty acids, used for energy storage

6. Why are carbohydrates, proteins, and nucleic acids considered polymers, while lipids are not?
Carbohydrates, proteins, and nucleic acids are all composed of one repeating subunit. Lipids have a variety of subunits, and are grouped only by their shared nonpolar nature.

7. How is the structure of each of the four macromolecules related to its function in living things?
Carbohydrate – *Energy is stored in bonds. Carbohydrates contain large numbers of bonds.*

Nucleic acid – *Nucleic acids are well-suited to store information in the repeating sequences of their base pairs. They are also structured to split and replicate easily, allowing the genetic information to be easily passed on to offspring.*

Protein – *Proteins have 20 different amino acids, which can be arranged in any order. Proteins also have four levels of structure: primary, secondary, tertiary, and quaternary. An alteration in any of these levels alters the function of the protein. This allows for a large variety of function.*

Lipid – *Lipids are nonpolar, allowing them to function in cell membranes and waterproofing. Triglycerides contain large numbers of bonds, making them ideal for energy storage.*

8. How does the structure of a protein make it capable of such a large range of function?
Proteins have 20 different amino acids, which can be arranged in any order. Proteins also have four levels of structure: primary, secondary, tertiary, and quaternary. An alteration in any of these levels alters the function of the protein. This allows for a large variety of function.

Enzymes:

1. What occurs during a chemical reaction?
Bonds are broken and reformed; atoms are rearranged.

2. What is the difference between a product and a reactant?
Reactants go in to a chemical reaction; products are formed by a chemical reaction.

3. Energy is used differently in different types of chemical reactions. Explain how energy use differs in energy-releasing and energy-absorbing reactions. Which type often requires a catalyst?
Energy-releasing reactions produce more energy than they require to start, therefore they generally occur spontaneously
Energy-absorbing reactions require more energy to start than they produce, often requiring large amounts of activation energy. This often necessitates a catalyst.

How is energy related to the products and reactants of a chemical reaction?
Energy is required to break apart the reactants and to form the products.

4. What is the role of an enzyme in living organisms?
Enzymes act as biological catalysts.

5. In what way do enzymes increase the rate of reactions? How do enzymes accomplish this task?
Enzymes provide a location for the reaction to occur. They lower the activation energy needed to start the reaction, allowing it to occur more quickly.

6. Describe the cycle in which enzymes and substrate interact.
Substrate bonds to the active site of the enzyme. The reaction occurs, converting substrate/reactant into product. The product is then released. The active site of the enzyme is left unchanged. This allows the enzyme to continuously catalyze reactions.

7. How/Why is the structure of an enzyme so important to its function in living things? Why does the structure of an enzyme determine the type of reaction it will catalyze?
The active site of an enzyme is specifically shaped to hold only one specific set of substrates. Enzymes are therefore substrate specific, meaning they will only catalyze one type of reaction. If the active site of an enzyme is not designed for a particular substrate, it will not catalyze that reaction.

8. What happens to enzyme function when the temperature or pH conditions change? Why?
Changes in temperature or pH can cause denaturation of the enzyme, changing the shape of the active site and destroying the function.

9. The energy needed to get a reaction started is the:
B. activation energy

Homeostasis and Transport

Module A Anchor 4

Key Concepts:

- Buffers play an important role in maintaining homeostasis in organisms.
- To maintain homeostasis, unicellular organisms grow, respond to the environment, transform energy, and reproduce.
- The cells of multicellular organisms become specialized for particular tasks and communicate with one another to maintain homeostasis.
- All body systems work together to maintain homeostasis.
- Passive transport (including diffusion and osmosis) is the movement of materials across the cell membrane without cellular energy.
- The movement of materials against a concentration differences is known as active transport. Active transport requires energy.
- The structure of the cell membrane allows it to regulate movement of materials into and out of the cell. The structure also determines how materials move through the cell membrane.

Vocabulary:

Buffer	homeostasis	diffusion	isotonic
Hypertonic	hypotonic	facilitated diffusion	osmosis
Endocytosis	exocytosis	Concentration gradient	feedback mechanism
Plasma membrane	channel proteins	feedback inhibition	solute
Fluid mosaic model	equilibrium	multicellular	unicellular
Endoplasmic reticulum		Golgi apparatus	vesicle
vacuole			

Key

Homeostasis and Transport

Module A Anchor 4

Plasma Membrane and Organelles:

1. What is the phospholipid bilayer? How does the structure of a phospholipid relate to its function in plasma membranes?
The phospholipid bilayer is a double layer of lipids which form into membranes. Phospholipids have a polar head and a nonpolar tail. The watery environment outside of cells causes the tails to turn in towards each other, forming a double layer.

2. What is the fluid mosaic model?
A mosaic is a piece of art comprised of many small tiles pieced together. A cell membrane is comprised of many smaller parts pieced together. It is fluid in that the pieces are not fixed, and can move around within the membrane.

3. What are the basic parts of the fluid mosaic model of the plasma membrane? Describe each in terms of structure and function.
Phospholipid bilayer – forms a barrier around the cell, controls movement into the cell
Carbohydrate markers – serve as chemical identifiers
Channels and pumps – function in transport of materials into and out of the cell

4. What is the function of the plasma membrane?
Controls the flow of substances into and out of the cell

5. The cell membrane contains channels and pumps which help in transport. What are these materials made of?
C. Protein

6. Explain how each of the following organelles is involved in cell transport:
Vacuoles and vesicles – *store materials for transport*

Golgi apparatus – *modifies, stores, and packages molecules for storage or transport*

Endoplasmic reticulum – *assembles proteins and lipids*

Cytoskeleton – *transport*

7. Explain the relationship between the endoplasmic reticulum and Golgi apparatus in terms of cell transport.
The ER makes the proteins and lipids, the Golgi modifies and stores them

Transport Mechanisms:

1. How do passive and active transport differ?
Active requires energy, passive does not.

2. List and describe the types of passive transport.
Diffusion – substances move from high to low concentration, passing directly through the membrane unassisted
Facilitated diffusion – substances move from high to low concentration, but cannot pass Directly through the membrane, instead passing through protein channels
Osmosis – facilitated diffusion of water

3. Why do some molecules require the use of protein channels, as in facilitated diffusion?
Charged or large molecules do not dissolve well in the lipid interior of the phospholipid membrane. They therefore require the use of protein channels.

4. Diffusion occurs because:
B. molecules constantly move and collide into one another

5. During diffusion, when the concentration of molecules on both sides of the membrane is equal, molecules will:
C. continue to move across the membrane in both directions

6. Explain equilibrium.
In equilibrium, the concentration of solute:solvent is equal on both sides of the membrane. Molecules continue to move back and forth across the membrane in equal quantities.

7. What is the relationship between diffusion and osmosis?
Osmosis is a type of diffusion, specifically the facilitated diffusion of water.

8. Compare and contrast hypertonic, hypotonic, and isotonic solutions.
Hypertonic solutions have a greater solute concentration than the cell, causing water to move out of the cell
Hypotonic solutions have a lower concentration of solution than the cell, causing water to move in to the cell
Isotonic solutions have an equal concentration of solute inside and outside the cell, causing no net gain or loss of water

9. Explain, in terms of osmosis, why a raisin placed in a cup of pure water overnight will puff up.
The water is hypotonic to the raisin, causing water to move into the raisin.

10. Two solutions are placed on either side of a selectively permeable membrane. The membrane is permeable to solute. There is a higher concentration of solute particles on the left side of the membrane. In which direction will the solute particles move? Why?
The molecules will move to the right side until equilibrium is reached, then continue to move back and forth with no net change in concentration. This will occur because the membrane is soluble to solute, which will move from high to low concentration.

11. List and describe the types of active transport.
Molecular transport – small molecules move against the concentration gradient through pumps in the cell membrane

Bulk transport – exo- and endocytosis, large materials are moved in or out of the cell via vesicles.

12. Compare and contrast endocytosis and exocytosis.
In both instances, the item to be transported is in a vacuole which fuses with the cell membrane. In exocytosis, substances are moving out. In endocytosis, substances are moving in.

13. How do active transport and facilitated diffusion differ?
Both require protein channels or pumps. However, facilitated diffusion still moves substances from high to low concentration and does not require energy. Active transport moves from low to high concentration, requiring energy.

Homeostasis:
1. Which of the following activities is NOT a way for unicellular organisms to maintain homeostasis?
C. cell specialization

2. Explain the relationship between multicellular organisms, cell specialization, and homeostasis.
Multicellular organisms are large and complex; therefore, they require more complicated systems in order to maintain homeostasis. Multicellular organisms accomplish this by designating particular functions to particular cells. This allows different cells to work together to maintain homeostasis within a larger organism.

3. What do unicellular organisms do to maintain homeostasis?
Grow, respond to the environment, transform energy, and reproduce.

4. The contractile vacuole is an organelle found in paramecia, a group of single-celled organisms. Contractile vacuoles pump out fresh water that accumulates in the organisms by osmosis. Explain how this is an example of the way paramecia maintain homeostasis.
One way in which an organism can NOT maintain a stable environment is through excessive water intake. Water constantly moves from high to low concentration, thus it is constantly moving into the aquatic amoeba. The amoeba pumps the water back out to ensure that water concentrations remain stable.

5. How do buffers help an organism to maintain homeostasis?
Prevent rapid changes in pH.

6. In what way are the characteristics of living things related to homeostasis?
Obtain and use materials:
Obtain materials necessary for life processes

Obtain and use energy:
Energy is required for all cell activities

Grow and develop:
Can develop such things as multicellularity

Reproduce:
Reduces size in unicellular organisms

Respond to environment:
Can obtain needed materials or move from those which threaten to destabilize their internal conditions

7. What is a feedback mechanism/feedback inhibition? What is the role of a feedback mechanism in maintaining homeostasis?
Process in which a stimulus produces a response that opposes the original stimulus. The feedback mechanism corrects the issue which destabilized the internal environment of the organism.

8. Briefly explain how animal body systems work together to maintain homeostasis.
Nervous system – recognizes and coordinates the body's responses to changes in internal and external environments
Integumentary system - regulates temperature
Immune/lymphatic system – protects body from disease, maintains fluid balance in circulatory system
Muscular system – moves blood and food
Circulatory system – transports oxygen, nutrients, and hormones to cells, removes wastes, fights infection, helps regulate temperature
Respiratory system – brings in oxygen and removes excess carbon dioxide
Digestive system – breaks down food, absorbs nutrients, eliminates wastes
Endocrine system – controls growth, development, and metabolism; maintains homeostasis