

GRADES 9-12  
1a

## Bio/Life: Cell Biology

The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:

Students know cells are enclosed within semipermeable membranes that regulate their interaction with their surroundings.

GRADES 9-12  
1b

## Bio/Life: Cell Biology

The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:

Students know enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings.

GRADES 9-12  
1C

## Bio/Life: Cell Biology

The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:

Students know how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.

GRADES 9-12  
1d

## Bio/Life: Cell Biology

The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:

Students know the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.

GRADES 9-12  
1e

## Bio/Life: Cell Biology

The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:

Students know the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins.

GRADES 9-12

1f

## Bio/Life: Cell Biology

The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:

Students know usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide.

GRADES 9-12  
1g

## Bio/Life: Cell Biology

The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:

Students know the role of the mitochondria in making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide.

GRADES 9-12  
1h

## Bio/Life: Cell Biology

The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:

Students know most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.

GRADES 9-12  
1i\*

## Bio/Life: Cell Biology

The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:

Students know how chemiosmotic gradients in the mitochondria and chloroplast store energy for ATP production.

GRADES 9-12  
1j\*

## Bio/Life: Cell Biology

The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:

Students know how eukaryotic cells are given shape and internal organization by a cytoskeleton or cell wall or both.

GRADES 9-12  
2a

## Bio/Life: Genetics

Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:

Students know meiosis is an early step in sexual reproduction in which the pairs of chromosomes separate and segregate randomly during cell division to produce gametes containing one chromosome of each type.

GRADES 9-12  
2b

## Bio/Life: Genetics

Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:

Students know only certain cells in a multicellular organism undergo meiosis.

GRADES 9-12  
2c

## Bio/Life: Genetics

Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:

Students know how random chromosome segregation explains the probability that a particular allele will be in a gamete.

GRADES 9-12  
2d

## Bio/Life: Genetics

Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:

Students know new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization).

GRADES 9-12  
2e

## Bio/Life: Genetics

Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:

Students know why approximately half of an individual's DNA sequence comes from each parent.

GRADES 9-12

2f

## Bio/Life: Genetics

Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:

Students know the role of  
chromosomes in determining an  
individual's sex.

GRADES 9-12

2g

## Bio/Life: Genetics

Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:

Students know how to predict possible combinations of alleles in a zygote from the genetic makeup of the parents.

GRADES 9-12  
3a

## Bio/Life: Genetics

A multicellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization. As a basis for understanding this concept:

Students know how to predict the probable outcome of phenotypes in a genetic cross from the genotypes of the parents and mode of inheritance (autosomal or X-linked, dominant or recessive).

GRADES 9-12  
3b

## Bio/Life: Genetics

A multicellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization. As a basis for understanding this concept:

Students know the genetic basis for Mendel's laws of segregation and independent assortment.

GRADES 9-12  
3C\*

## Bio/Life: Genetics

A multicellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization. As a basis for understanding this concept:

Students know how to predict the probable mode of inheritance from a pedigree diagram showing phenotypes.

GRADES 9-12  
3d\*

## Bio/Life: Genetics

A multicellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization. As a basis for understanding this concept:

Students know how to use data on frequency of recombination at meiosis to estimate genetic distances between loci and to interpret genetic maps of chromosomes.

GRADES 9-12  
4a

## Bio/Life: Genetics

*Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept:*

Students know the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA.

GRADES 9-12  
4b

## Bio/Life: Genetics

*Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept:*

Students know how to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.

GRADES 9-12  
4C

## Bio/Life: Genetics

*Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept:*

Students know how mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.

GRADES 9-12  
4d

## Bio/Life: Genetics

*Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept:*

Students know specialization of cells in multicellular organisms is usually due to different patterns of gene expression rather than to differences of the genes themselves.

GRADES 9-12  
4e

## Bio/Life: Genetics

*Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept:*

Students know proteins can differ from one another in the number and sequence of amino acids.

GRADES 9-12  
4f\*

## Bio/Life: Genetics

*Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept:*

Students know why proteins having different amino acid sequences typically have different shapes and chemical properties.

GRADES 9-12  
5a

## Bio/Life: Genetics

The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:

Students know the general structures and functions of DNA, RNA, and protein.

GRADES 9-12  
5b

## Bio/Life: Genetics

The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:

Students know how to apply base-pairing rules to explain precise copying of DNA during semiconservative replication and transcription of information from DNA into mRNA.

GRADES 9-12

5b

## Bio/Life: Genetics

The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:

Students know how to apply base-pairing rules to explain precise copying of DNA during semiconservative replication and transcription of information from DNA into mRNA.

GRADES 9-12  
5c

## Bio/Life: Genetics

The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:

Students know how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.

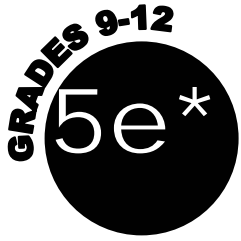
GRADES 9-12

5d\*

## Bio/Life: Genetics

The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:

Students know how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.



## Bio/Life: Genetics

The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:

Students know how exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products.

GRADES 9-12  
6a

## Bio/Life: Ecology

Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:

Students know biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats.

GRADES 9-12  
6b

## Bio/Life: Ecology

Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:

Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size.

GRADES 9-12

6C

## Bio/Life: Ecology

Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:

Students know how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death.

GRADES 9-12  
6d

## Bio/Life: Ecology

Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:

Students know how water, carbon, and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration.

GRADES 9-12

6e

## Bio/Life: Ecology

Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:

Students know a vital part of an ecosystem is the stability of its producers and decomposers.

GRADES 9-12

6f

## Bio/Life: Ecology

Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:

Students know at each link in a food web some energy is stored in newly made structures but much energy is dissipated into the environment as heat. This dissipation may be represented in an energy pyramid.



## Bio/Life: Ecology

Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:

Students know how to distinguish between the accommodation of an individual organism to its environment and the gradual adaptation of a lineage of organisms through genetic change.

GRADES 9-12  
7a

## Bio/Life: Evolution

The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:

Students know why natural selection acts on the phenotype rather than the genotype of an organism.

GRADES 9-12  
7b

## Bio/Life: Evolution

The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:

Students know why alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool.

GRADES 9-12  
7C

## Bio/Life: Evolution

The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:

Students know new mutations are constantly being generated in a gene pool.

GRADES 9-12  
7d

## Bio/Life: Evolution

The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:

Students know variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.

GRADES 9-12  
7e\*

## Bio/Life: Evolution

The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:

Students know the conditions for Hardy-Weinberg equilibrium in a population and why these conditions are not likely to appear in nature.

GRADES 9-12  
7f\*

## Bio/Life: Evolution

The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:

Students know how to solve the Hardy-Weinberg equation to predict the frequency of genotypes in a population, given the frequency of phenotypes.

GRADES 9-12  
8a

## Bio/Life: Evolution

Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:

Students know how natural selection determines the differential survival of groups of organisms.

GRADES 9-12  
8b

## Bio/Life: Evolution

Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:

Students know a great diversity of species increases the chance that at least some organisms survive major changes in the environment.

GRADES 9-12  
8C

## Bio/Life: Evolution

Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:

Students know the effects of genetic drift on the diversity of organisms in a population.

GRADES 9-12  
8d

## Bio/Life: Evolution

Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:

Students know reproductive or geographic isolation affects speciation.

GRADES 9-12

8e

## Bio/Life: Evolution

Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:

Students know how to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.

GRADES 9-12  
8f\*

## Bio/Life: Evolution

Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:

Students know how to use comparative embryology, DNA or protein sequence comparisons, and other independent sources of data to create a branching diagram (cladogram) that shows probable evolutionary relationships.



## Bio/Life: Evolution

Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:

Students know how several independent molecular clocks, calibrated against each other and combined with evidence from the fossil record, can help to estimate how long ago various groups of organisms diverged evolutionarily from one another.

GRADES 9-12  
9a

## Bio/Life: Physiology

As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:

Students know how the complementary activity of major body systems provides cells with oxygen and nutrients and removes toxic waste products such as carbon dioxide.

GRADES 9-12  
9b

## Bio/Life: Physiology

As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:

Students know how the nervous system mediates communication between different parts of the body and the body's interactions with the environment.

GRADES 9-12  
9C

## Bio/Life: Physiology

As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:

Students know how feedback loops in the nervous and endocrine systems regulate conditions in the body.

GRADES 9-12  
9d

## Bio/Life: Physiology

As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:

Students know the functions of the nervous system and the role of neurons in transmitting electrochemical impulses.

GRADES 9-12

9e

## Bio/Life: Physiology

As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:

Students know the roles of sensory neurons, interneurons, and motor neurons in sensation, thought, and response.

GRADES 9-12  
9f\*

## Bio/Life: Physiology

As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:

Students know the individual functions and sites of secretion of digestive enzymes (amylases, proteases, nucleases, lipases), stomach acid, and bile salts.



## Bio/Life: Physiology

As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:

Students know the homeostatic role of the kidneys in the removal of nitrogenous wastes and the role of the liver in blood detoxification and glucose balance.

GRADES 9-12  
9h\*

## Bio/Life: Physiology

As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:

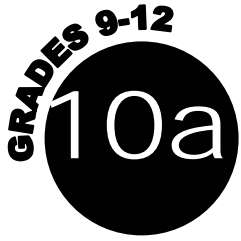
Students know the cellular and molecular basis of muscle contraction, including the roles of actin, myosin,  $Ca^{+2}$ , and ATP.

GRADES 9-12  
9i\*

## Bio/Life: Physiology

As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:

Students know how hormones (including digestive, reproductive, osmoregulatory) provide internal feedback mechanisms for homeostasis at the cellular level and in whole organisms.



## Bio/Life: Physiology

Organisms have a variety of mechanisms to combat disease.  
As a basis for understanding the human immune response:

Students know the role of the skin in  
providing nonspecific defenses against  
infection.

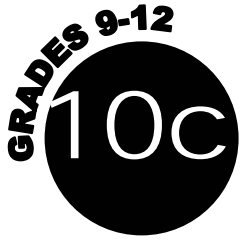
GRADES 9-12

10b

## Bio/Life: Physiology

Organisms have a variety of mechanisms to combat disease.  
As a basis for understanding the human immune response:

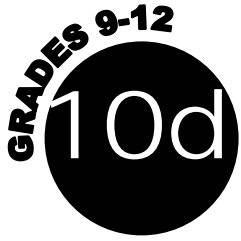
Students know the role of antibodies  
in the body's response to infection.



## Bio/Life: Physiology

Organisms have a variety of mechanisms to combat disease.  
As a basis for understanding the human immune response:

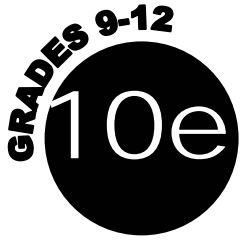
Students know how vaccination  
protects an individual from infectious  
diseases.



## Bio/Life: Physiology

Organisms have a variety of mechanisms to combat disease.  
As a basis for understanding the human immune response:

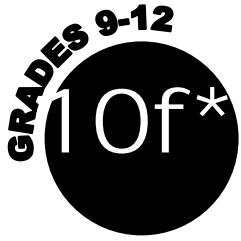
Students know there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections.



## Bio/Life: Physiology

Organisms have a variety of mechanisms to combat disease.  
As a basis for understanding the human immune response:

Students know why an individual with a compromised immune system (for example, a person with AIDS) may be unable to fight off and survive infections by microorganisms that are usually benign.



## Bio/Life: Physiology

Organisms have a variety of mechanisms to combat disease.  
As a basis for understanding the human immune response:

Students know the roles of  
phagocytes, B-lymphocytes, and T-  
lymphocytes in the immune system.