

**California Standards Grades 9–12
Science Contents Standards Mapping**

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BIOLOGY	Boardworks High School Biology Presentation
Cell Biology	
1. 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:	
1a. Students know cells are enclosed within semi permeable membranes that regulate their interaction with their surroundings.	Eukaryotic Cells Organelles Osmosis Prokaryotic Cells The Fluid Mosaic Theory
1b. 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.	Enzymes Enzyme shape
1c. Students know how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.	Eukaryotic Cells HIV and AIDS Organelles Prokaryotic Cells
1d. 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.	Controlling of Protein Synthesis Organelles Protein Synthesis Transcription and Translation
1e. Students know the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins.	Eukaryotic Cells
1f. Students know usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide.	Photosynthesis1 Photosynthesis2
1g. 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.	Aerobic respiration Eukaryotic Cells Organelles

1h. Students know most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.	Carbon Cycle Digestion Nucleic acids Polysaccharides Proteins Transcription and translation
1i. Students know how chemiosmotic gradients in the mitochondria and chloroplast store energy for ATP production.	–
1j. Students know how eukaryotic cells are given shape and internal organization by a cytoskeleton or cell wall or both.	Eukaryotic Cells Organelles
Genetics	
2. Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:	
2a. 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.	Meiosis The Stages of Meiosis
2b. Students know only certain cells in a multi cellular organism undergo meiosis.	Meiosis
2c. Students know how random chromosome segregation explains the probability that a particular allele will be in a gamete.	Genetic Variation Meiosis The Stages of Meiosis
2d. Students know new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization).	Meiosis
2e. Students know why approximately half of an individual's DNA sequence comes from each parent.	Genetic Variation Genes and Alleles
2f. Students know the role of chromosomes in determining an individual's sex.	Boy or Girl
2g. Students know how to predict possible combinations of alleles in a zygote from the genetic makeup of the parents.	Patterns of Inheritance
3. A multi cellular 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:	
3a. 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).	Gregor Mendel Genes and Alleles Incomplete Dominance and Co-dominance Inherited Diseases Patterns of Inheritance
3b. Students know the genetic basis for Mendel's laws of segregation and independent assortment.	Gregor Mendel
3c. Students know how to predict the probable mode of inheritance from a pedigree diagram showing phenotypes.	Patterns of Inheritance

3d. 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.	–
4. 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:	
4a. Students know the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA.	Controlling Protein Synthesis Protein Synthesis Transcription and Translation
4b. Students know how to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.	Controlling Protein Synthesis Protein Synthesis Transcription and Translation
4c. 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.	DNA Replication 1 DNA Replication 2 Genetic Mutations Inherited Diseases
4d. Students know specialization of cells in multi cellular organisms is usually due to different patterns of gene expression rather than to differences of the genes themselves.	Cell Differentiation Controlling Protein Synthesis
4e. Students know proteins can differ from one another in the number and sequence of amino acids.	Protein Synthesis Proteins
4f. Students know why proteins having different amino acid sequences typically have different shapes and chemical properties.	Proteins
5. The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:	
5a. Students know the general structures and functions of DNA, RNA, and protein.	DNA Nucleic Acids Proteins Protein Synthesis
5b. Students know how to apply base-pairing rules to explain precise copying of DNA during semi conservative replication and transcription of information from DNA into mRNA.	DNA Replication 1 DNA Replication 2 Transcription and Translation
5c. Students know how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.	Genetic Engineering Genetic Engineering for Health Care GM Organisms

5d. Students know how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.	Genetic Engineering
5e. Students know how exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products.	Genetic Engineering Genetic Engineering for Health Care
Ecology	
6. Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:	
6a. Students know bio diversity is the sum total of different kinds of organisms and is affected by alterations of habitats.	Extinction Loss of Diversity Introduction to Biodiversity
6b. 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.	Human Impact on the Environment Over-fishing Water Pollution Describing Populations
6c. Students know how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death.	Ecosystems Predator-Prey relationships Describing Populations
6d. 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.	Aerobic respiration Carbon Cycle Decomposers Ecosystem Energy Loss in Food Chains Food Chains Nitrogen Cycle Photosynthesis1 Photosynthesis2 Recycling nutrients Water Cycle
6e. Students know a vital part of an ecosystem is the stability of its producers and decomposers.	Decomposers Ecosystems Food Chains Food Webs

6f. 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.	Energy Loss in Food Chains Energy Transfer Food Chains Food Webs
6g. 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.	Environmental variation Evolution The Process of Evolution
Evolution	
7. 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:	
7a. Students know why natural selection acts on the phenotype rather than the genotype of an organism.	Darwin Environmental variation Evolution The Process of Evolution
7b. Students know why alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool.	Genes and Alleles Inherited Diseases
7c. Students know new mutations are constantly being generated in a gene pool.	DNA Replication 1 DNA Replication 2 Genetic Mutation
7d. Students know variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.	Evolution Extinction The Process of Evolution
7e. Students know the conditions for Hardy-Weinberg equilibrium in a population and why these conditions are not likely to appear in nature.	Population Genetics
7f. Students know how to solve the Hardy-Weinberg equation to predict the frequency of genotypes in a population, given the frequency of phenotypes.	Population Genetics
8. Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:	
8a. Students know how natural selection determines the differential survival of groups of organisms.	Evolution Darwin Superbugs The Process of Evolution

8b. Students know a great diversity of species increases the chance that at least some organisms survive major changes in the environment.	Evolution Extinction Genetic Variation The Process of Evolution
8c. Students know the effects of genetic drift on the diversity of organisms in a population.	Population Genetics
8d. Students know reproductive or geographic isolation affects speciation.	Population Genetics
8e. Students know how to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.	Fossil Record
8f. <i>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.</i>	–
8g. <i>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.</i>	–
Physiology	
9. 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:	
9a. 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.	Diffusion Digestion The Respiratory System
9b. Students know how the nervous system mediates communication between different parts of the body and the body's interactions with the environment.	Nerve Impulses Reflexes The Brain The Nervous System
9c. Students know how feedback loops in the nervous and endocrine systems regulate conditions in the body.	Homeostasis Hormones The Endocrine System
9d. Students know the functions of the nervous system and the role of neurons in transmitting electrochemical impulses.	Nerve Impulses The Nervous System
9e. Students know the roles of sensory neurons, interneurons, and motor neurons in sensation, thought, and response.	Nerve Impulses The Nervous System
9f. Students know the individual functions and sites of secretion of digestive enzymes (amylases, proteases, nucleases, lipases), stomach acid, and bile salts.	Digestion Enzymes
9g. 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.	Glucoregulation The Kidneys

9h. Students know the cellular and molecular basis of muscle contraction, including the roles of actin, myosin, Ca^{+2} , and ATP.	–
9i. Students know how hormones (including digestive, reproductive, osmoregulatory) provide internal feedback mechanisms for homeostasis at the cellular level and in whole organisms.	Diabetes Glucoregulation Hormones The Kidneys
10. Organisms have a variety of mechanisms to combat disease. As a basis for under-standing the human immune response:	
10a. Students know the role of the skin in providing nonspecific defenses against infection.	Infectious Disease Immune System
10b. Students know the role of antibodies in the body's response to infection.	Antibodies and Vaccination Immune System Immune Responses
10c. Students know how vaccination protects an individual from infectious diseases.	Antibodies and Vaccination Vaccination
10d. 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.	HIV and AIDS Immune Responses Immune System Infectious Disease Tuberculosis
10e. 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.	HIV and AIDS Immune System Tuberculosis
10f. Students know the roles of phagocytes, B-lymphocytes, and T-lymphocytes in the immune system.	Immune Responses Immune System