

**Pennsylvania High School Science
Academic Standards for Science and Technology and Engineering Education 2009**

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BIOLOGICAL SCIENCES		Boardworks High School Biology Presentations
3.1.A. Organisms and Cells		
3.1.B.A1. Common Characteristics of Life		
Describe the common characteristics of life.		–
Compare and contrast the cellular structures and degrees of complexity of prokaryotic and eukaryotic organisms.		Eukaryotic Cells Prokaryotic Cells
<i>Explain that some structures in eukaryotic cells developed from early prokaryotic cells (e.g., mitochondria, chloroplasts)</i>		–
3.1.B.A2. Energy Flow		
Identify the initial reactants, final products, and general purposes of photosynthesis and cellular respiration.		Aerobic Respiration Photosynthesis 1 Photosynthesis 2
Explain the important role of ATP in cell metabolism.		Aerobic Respiration
Describe the relationship between photosynthesis and cellular respiration in photosynthetic organisms.		Aerobic Respiration Photosynthesis 1 Photosynthesis 2
Explain why many biological macromolecules such as ATP and lipids contain high energy bonds.		Lipids
Explain the importance of enzymes as catalysts in cell reactions.		Enzymes
Identify how factors such as pH and temperature may affect enzyme function.		Enzymes
3.1.B.A3. Life Cycles		
Explain how all organisms begin their life cycles as a single cell and that in multicellular organisms, successive generations of embryonic cells form by cell division.		Cell Differentiation Cells to Organisms Mitosis
3.1.B.A4. Cell Cycles		
Summarize the stages of the cell cycle.		The Stages of Mitosis
<i>Examine how interactions among the different molecules in the cell cause the distinct stages of the cell cycle which can also be influenced by other signaling molecules.</i>		–
Explain the role of mitosis in the formation of new cells and its importance in maintaining chromosome number during asexual reproduction.		Mitosis
Compare and contrast a virus and a cell. Relate the stages of viral cycles to the cell cycle.		–
3.1.B.A5. Form and Function		

Relate the structure of cell organelles to their function (energy capture and release, transport, waste removal, protein synthesis, movement, etc).	Eukaryotic Cells Prokaryotic Cells
Explain the role of water in cell metabolism.	Aerobic Respiration Water
Explain how the cell membrane functions as a regulatory structure and protective barrier for the cell.	Eukaryotic Cells The Fluid Mosaic Model
Describe transport mechanisms across the plasma membrane.	Active Transport Diffusion Osmosis
3.1.B.A6. Organization	
Explain how cells differentiate in multicellular organisms.	Cell Differentiation
3.1.B.A7. Molecular Basis of Life	
Analyze the importance of carbon to the structure of biological macromolecules.	Lipids Monosaccharides Nucleic Acids Polysaccharides Proteins
Compare and contrast the functions and structures of proteins, lipids, carbohydrates, and nucleic acids.	DNA Lipids Monosaccharides Nucleic Acids Polysaccharides Proteins
Explain the consequences of extreme changes in pH and temperature on cell proteins.	Enzymes
3.1.B.A8. Unifying Themes	
Change and Consistency - Recognize that systems within cells and multicellular organisms interact to maintain homeostasis.	Glucoregulation Homeostasis Hormones Thermoregulation
Patterns - Demonstrate the repeating patterns that occur in biological polymers.	DNA Lipids Monosaccharides Nucleic Acids Polysaccharides Proteins
Systems - Describe how the unique properties of water support life.	Water
3.1.B Genetics	

3.1.B.B1. Heredity	
Explain that the information passed from parents to offspring is transmitted by means of genes which are coded in DNA molecules.	DNA Genes and Alleles Genetic Variation
Explain the basic process of DNA replication.	DNA Replication 1 DNA Replication 2
Describe the basic processes of transcription and translation.	Controlling Protein Synthesis Transcription and Translation
Explain how crossing over, jumping genes, and deletion and duplication of genes results in genetic variation.	Genetic Variation Meiosis
Explain how mutations can alter genetic information and the possible consequences on resultant cells.	Genetic Mutations
3.1.B.B2. Reproduction	
Describe how the process of meiosis results in the formation of haploid gametes and analyze the importance of meiosis in sexual reproduction.	Meiosis The Stages of Meiosis
Compare and contrast the function of mitosis and meiosis.	Meiosis Mitosis The Stages of Meiosis The Stages of Mitosis
Illustrate that the sorting and recombining of genes in sexual reproduction results in a great variety of possible gene combinations in offspring.	The Stages of Meiosis
3.1.B.B3. Molecular Basis of Life	
Describe the basic structure of DNA, including the role of hydrogen bonding.	Nucleic Acids
Explain how the process of DNA replication results in the transmission and conservation of the genetic code.	DNA Replication 1 DNA Replication 2
Describe how transmission and translation result in gene expression.	Controlling Protein Synthesis
Differentiate among the end products of replication, transcription, and translation.	Controlling Protein Synthesis DNA Replication 2 Transcription and Translation
<i>Cite evidence to support that the genetic code is universal.</i>	–
3.1.B.B4. Biotechnology	

Explain how genetic technologies have impacted the fields of medicine, forensics, and agriculture	Genetic Engineering Genetic Engineering for Health Care GM Organisms Understanding Genomes
3.1.B.B5.Unifying Themes	
PATTERNS	
Describe how Mendel's laws of segregation and independent assortment can be observed through patterns of inheritance.	Gregor Mendel
Distinguish among observed inheritance patterns caused by several types of genetic traits (dominant, recessive, codominant, sex-linked, polygenic, incomplete dominance, multiple alleles)	Gregor Mendel Incomplete Dominance and Codominance Patterns of Inheritance
CONSTANCY AND CHANGE	
Explain how the processes of replication, transcription, and translation are similar in all organisms.	–
Explain how gene actions, patterns of heredity, and reproduction of cells and organisms account for the continuity of life.	–
SCALE	
Demonstrate how inherited characteristics can be observed at the molecular, cellular, and organism levels.	Genes and Alleles Genetic Variation Understanding Genomes
3.1.C. Evolution	
3.1.B.C1. Natural Selection	
<i>Describe species as reproductively distinct groups of organisms.</i>	What is a Species?
<i>Analyze the role that geographic isolation can play in speciation.</i>	–
Explain how evolution through natural selection can result in changes in biodiversity through the increase or decrease of genetic diversity within a population.	Evolution The Process of Evolution
Describe how the degree of kinship between species can be inferred from the similarity in their DNA sequences.	Classification Understanding Genomes
3.1.B.C2. Adaptation	
<i>Describe the theory suggesting that life on Earth arose as a single, primitive prokaryote about 4 billion years ago and that for the next 2 billion years, a huge diversity of singlecelled organisms evolved.</i>	–
<i>Analyze how increasingly complex, multicellular organisms evolved once cells with nuclei developed.</i>	–
Describe how mutations in sex cells may be passed on to successive generations and that the resulting phenotype may help, harm, or have little or no effect on the offspring's success in its environment.	Genetic Mutations Inherited Disease
Describe the relationship between environmental changes and changes in the gene pool of a population.	Population Genetics
3.1.B.C3. Unifying Themes	

CONSTANCY AND CHANGE	
<i>Compare and contrast various theories of evolution.</i>	–
<i>Interpret data from fossil records, anatomy and physiology, and DNA studies relevant to the theory of evolution.</i>	–
PATTERNS	
<i>Discuss the implications of a universal genetic code for evolution.</i>	–

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BIOLOGICAL SCIENCES		Boardworks High School Biology Presentations
Grade 10		
A. Explain the structural and functional similarities and differences found among living things.		
Identify and characterize major life forms according to their placement in existing classification groups.		Classification
Explain the relationship between structure and function at the molecular and cellular levels.		Cell Differentiation Eukaryotic Cells Monosaccharide Nucleic Acids Polysaccharides Prokaryotic Cells Proteins Specialized Plant Cells
<i>Describe organizing schemes of classification keys.</i>		—
Identify and characterize major life forms by kingdom, phyla, class and order.		Classification
B. Describe and explain the chemical and structural basis of living organisms.		
Describe the relationship between the structure of organic molecules and the function they serve in living organisms.		Monosaccharide Nucleic Acids Polysaccharides Proteins
Identify the specialized structures and regions of the cell and the functions of each.		Eukaryotic Cells Prokaryotic Cells
Explain cell functions and processes in terms of chemical reactions and energy changes.		Aerobic Respiration Anaerobic Respiration Photosynthesis 1 Photosynthesis 2
C. Describe how genetic information is inherited and expressed.		
Compare and contrast the function of mitosis and meiosis.		Meiosis Mitosis The Stages of Meiosis The Stages of Mitosis

Describe mutations' effects on a trait's expression.	Genetic Mutations Genetic Variation Inherited Diseases
<i>Distinguish different reproductive patterns in living things (e.g., budding, spores, fission).</i>	–
Compare random and selective breeding practices and their results (e.g., antibiotic resistant bacteria).	Selective Breeding Superbugs The Process of Evolution
Explain the relationship among DNA, genes and chromosomes.	DNA Genes and Alleles Nucleic Acids
Explain different types of inheritance (e.g., multiple allele, sex-influenced traits).	Gregor Mendel Incomplete Dominance and Codominance Patterns of Inheritance
Describe the role of DNA in protein synthesis as it relates to gene expression.	Controlling Protein Synthesis Transcription and Translation
D. Explain the mechanisms of the theory of evolution.	
Analyze data from fossil records, similarities in anatomy and physiology, embryological studies and DNA studies that are relevant to the theory of evolution.	Fossil Record
Explain the role of mutations and gene recombination in changing a population of organisms.	Population Genetics
<i>Compare modern day descendants of extinct species and propose possible scientific accounts for their present appearance.</i>	–
Describe the factors (e.g., isolation, differential reproduction) affecting gene frequency in a population over time and their consequences.	Population Genetics
Describe and differentiate between the roles of natural selection and genetic drift.	Population Genetics
Describe changes that illustrate major events in the earth's development based on a time line.	
Explain why natural selection can act only on inherited traits.	The Process of Evolution
Apply the concept of natural selection to illustrate and account for a species' survival, extinction or change over time.	Darwin Evolution Extinction The Process of Evolution

Grade 12

A. Explain the relationship between structure and function at all levels of organization.	
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Identify and explain interactions among organisms (e.g., mutually beneficial, harmful relationships).	Ecosystems Ecosystems and Succession Host-Parasite Relationships, Predator-Prey Relationships,
Explain and analyze the relationship between structure and function at the molecular, cellular and organ-system level.	Blood and Blood Vessels Cells to Organisms Eukaryotic Cells Organelles Prokaryotic Cells The Respiratory System The Skeleton Types of Muscles
Describe and explain structural and functional relationships in each of the five (or six) kingdoms.	Classification
Explain significant biological diversity found in each of the biomes	Animal Adaptation Introduction to Biodiversity
B. Analyze the chemical and structural basis of living organisms.	
Identify and describe factors affecting metabolic function (e.g., temperature, acidity, hormones).	Aerobic Respiration Enzymes Homeostasis Thermoregulation
Evaluate metabolic activities using experimental knowledge of enzymes.	Enzymes Enzyme Shape
Evaluate relationships between structure and functions of different anatomical parts given their structure.	Blood and Blood Vessels Digestion The Kidneys The Nervous System The Respiratory System The Skeleton Types of Muscles
Describe potential impact of genome research on the biochemistry and physiology of life.	Genetic Engineering GM Organisms
C. Explain gene inheritance and expression at the molecular level.	

Analyze gene expression at the molecular level.	Controlling Protein Synthesis Genes and Alleles Proteins Protein Synthesis Transcription and Translation
Describe the roles of nucleic acids in cellular reproduction and protein synthesis.	Cell Differentiation Controlling Protein Synthesis Meiosis Mitosis Nucleic Acids Proteins The Stages of Mitosis The Stages of Meiosis
Describe genetic engineering techniques, applications and impacts.	Genetic Engineering Genetic Engineering for Health Care GM Organisms
<i>Explain birth defects from the standpoint of embryological development and/or changes in genetic makeup.</i>	–
D. Analyze the theory of evolution.	
<i>Examine human history by describing the progression from early hominids to modern humans.</i>	–
Apply the concept of natural selection as a central concept in illustrating evolution theory.	Darwin Evolution Extinction The Process of Evolution