ARKANSAS DEPARTMENT OF EDUCATION

Dr. Tom W. Kimbrell
Commissioner

March 6, 2014

Ms. Ayesha N. Khan, Legal Director
Americans United for Separation of Church and State
1301 K Street NW
Suite 850 East Tower
Washington, DC 20005

Dear Ms. Khan:

I am in receipt of your February 10, 2014 letter detailing your concerns with the Biology curriculum at open-enrollment public charter schools operated in Arkansas by Responsive Education Solutions.

Unlike what may be in the case in other states, the Arkansas Department of Education (ADE) does not choose or endorse particular instructional materials (or curriculum) for use by any Arkansas public school, including public charter schools. Instead, the Arkansas State Board of Education (State Board) adopts curriculum standards for public schools to follow. A copy of the State Board of Education's curriculum standards for Biology is enclosed for your review.

The ADE monitors public schools' compliance with curriculum standards. For all public schools, including public charter schools, decisions regarding curriculum and instructional materials are made at the local level, not the state level. For these reasons, you should direct your specific concerns to the leadership of Responsive Education Solutions. That entity has the responsibility for selecting instructional materials that meet the State Board's curriculum standards.

I note that Responsive Education Solutions recently announced its decision to remove the Biology workbook in question from its inventory and to update its curriculum. A copy of a letter from Responsive Education Solutions to that effect is also enclosed. I trust that this letter adequately addresses your concerns.

Sincerely,

Tom W. Kimbrell, Ed.D.
Commissioner of Education

Enclosures

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Biology

Science Curriculum Framework

Revised 2005

Course Title: Biology
Course/Unit Credit: 1
Course Number: 420000
Teacher Licensure: Please refer to the Course Code Management System (https://adedata.arkansas.gov/ccms/) for the most current licensure codes.
Grades: 9-12

Biology should investigate the chemistry and role of cells in life processes, genetics, evolution and the diversity of life. Students should learn about the world through the study of behavioral relationships, ecology, and the global impact of ecological issues. Biology should continue to educate the student in the nature of science. Students should be expected to spend time viewing and classifying life forms. Field studies should be an integral part of the course as well as the process of collecting and analyzing data. Instruction and assessment should include both appropriate technology and the safe use of laboratory equipment. Students should be engaged in hands-on laboratory experiences at least 20% of the instructional time.

Strand	Content Standard
Molecules and Cells	
	1. Students shall demonstrate an understanding of the role of chemistry in life processes.
	2. Students shall demonstrate an understanding of the structure and function of cells.
	3. Students shall demonstrate an understanding of how cells obtain and use energy *(energetics)*.
Heredity and Evolution	
	4. Students shall demonstrate an understanding of *heredity*.
	5. Students shall investigate the molecular basis of genetics.
	6. Students shall examine the development of the *theory* of *biological evolution.*
Classification and the Diversity of Life	
	7. Students shall demonstrate an understanding that organisms are diverse.
Ecology and Behavioral Relationships	
	8. Students shall demonstrate an understanding of ecological and behavioral relationships among organisms.
	9. Students shall demonstrate an understanding of the ecological impact of global issues.
Nature of Science	
	10. Students shall demonstrate an understanding that science is a way of knowing.
	11. Students shall design and safely conduct a scientific inquiry to solve valid problems.
	12. Students shall demonstrate an understanding of current life science theories.
	13. Students shall use mathematics, science equipment, and *technology* as tools to communicate and solve life science problems.
	14. Students shall describe the connections between pure and applied science.
	15. Students shall describe various life science careers and the training required for the selected career.

Strand: Molecules and Cells

Standard 1: Students shall demonstrate an understanding of the role of chemistry in life processes.

MC.1.B.1	Describe the structure and function of the major organic molecules found in living systems: • *carbohydrates* • *proteins* • *enzymes* • *lipids* • *nucleic acids*
MC.1.B.2	Describe the relationship between an enzyme and its substrate molecule(s)
MC.1.B.3	Investigate the properties and importance of water and its significance for life: • surface tension • *adhesion* • *cohesion* • *polarity* • *pH*
MC.1.B.4	Explain the role of energy in chemical reactions of living systems: • *activation energy* • *exergonic reactions* • *endergonic reactions*

Key: MC.1.B.1 = Molecules and Cells. Standard 1. Biology. 1st Student Learning Expectation

Strand: Molecules and Cells

Standard 2: Students shall demonstrate an understanding of the structure and function of cells.

MC.2.B.1	Construct a hierarchy of life from cells to *ecosystems*
MC.2.B.2	Compare and contrast *prokaryotes* and *eukaryotes*
MC.2.B.3	Describe the role of sub-cellular structures in the life of a cell: ▪ *organelles* ▪ *ribosomes* ▪ *cytoskeleton*
MC.2.B.4	Relate the function of the *plasma (cell) membrane* to its structure
MC.2.B.5	Compare and contrast the structures of an animal cell to a plant cell
MC.2.B.6	Compare and contrast the functions of *autotrophs* and *heterotrophs*
MC.2.B.7	Compare and contrast *active transport* and *passive transport mechanisms:* ▪ *diffusion* ▪ *osmosis* ▪ *endocytosis* ▪ *exocytosis* ▪ *phagocytosis* ▪ *pinocytosis*
MC.2.B.8	Describe the main events in the *cell cycle,* including the differences in plant and animal cell division: ▪ *interphase* ▪ *mitosis* ▪ *cytokinesis*
MC.2.B.9	List in order and describe the stages of *mitosis:* ▪ *prophase* ▪ *metaphase* ▪ *anaphase* ▪ *telophase.*
MC.2.B.10	Analyze the meiotic maintenance of a constant *chromosome* number from one generation to the next
MC.2.B.11	Discuss *homeostasis* using *thermoregulation* as an example

Key: MC.2.B.1 = Molecules and Cells. Standard 2. Biology. 1st Student Learning Expectation

Strand: Molecules and Cells

Standard 3: Students shall demonstrate an understanding of how cells obtain and use energy (*energetics*).

MC.3.B.1	Compare and contrast the structure and function of *mitochondria* and *chloroplasts*
MC.3.B.2	Describe and model the conversion of stored energy in organic molecules into usable cellular energy (ATP): ▪ *glycolysis* ▪ *citric acid cycle* ▪ *electron transport chain*
MC.3.B.3	Compare and contrast *aerobic* and *anaerobic respiration:* ▪ *lactic acid fermentation* ▪ *alcoholic fermentation*
MC.3.B.4	Describe and model the conversion of light energy to chemical energy by photosynthetic organisms: ▪ *light dependent* reactions ▪ *light independent* reactions
MC.3.B.5	Compare and contrast *cellular respiration* and *photosynthesis* as energy conversion pathways

Key: MC.3.B.1 = Molecules and Cells. Standard 3. Biology. 1st Student Learning Expectation

Strand: Heredity and *Evolution*

Standard 4: Students shall demonstrate an understanding of *heredity*.

HE.4.B.1	Summarize the outcomes of Gregor Mendel's experimental procedures
HE.4.B.2	Differentiate among the *laws and principles of inheritance:* ▪ *dominance* ▪ *segregation* ▪ *independent assortment*
HE.4.B.3	Use the *laws* of probability and *Punnett squares* to predict *genotypic* and *phenotypic ratios*
HE.4.B.4	Examine different modes of inheritance: ▪ *sex linkage* ▪ *codominance* ▪ *crossing over* ▪ *incomplete dominance* ▪ *multiple alleles*
HE.4.B.5	Analyze the historically significant work of prominent geneticists
HE.4.B.6	Evaluate *karyotypes* for abnormalities: • monosomy • trisomy

Key: HE.4.B.1 = Heredity and Evolution. Standard 4. Biology. 1st Student Learning Expectation

Strand: Heredity and *Evolution*

Standard 5: Students shall investigate the molecular basis of genetics.

HE.5.B.1	Model the components of a *DNA nucleotide* and an *RNA nucleotide*
HE.5.B.2	Describe the Watson-Crick *double helix model* of *DNA,* using the *base-pairing rule* (*adenine-thymine*, *cytosine-guanine*)
HE.5.B.3	Compare and contrast the structure and function of *DNA* and *RNA*
HE.5.B.4	Describe and model the processes of replication, *transcription*, and *translation*
HE.5.B.5	Compare and contrast the different types of *mutation* events, including *point mutation*, *frameshift mutation*, *deletion*, and *inversion*
HE.5.B.6	Identify effects of changes brought about by *mutations:* ▪ beneficial ▪ harmful ▪ neutral

Key: HE.5.B.1 = Heredity and Evolution. Standard 5. Biology. 1st Student Learning Expectation

Strand: Heredity and *Evolution*

Standard 6: Students shall examine the development of the *theory* of *biological evolution.*

HE.6.B.1	Compare and contrast Lamarck's explanation of *evolution* with Darwin's *theory* of *evolution* by *natural selection*
HE.6.B.2	Recognize that *evolution* involves a change in allele frequencies in a *population* across successive generations
HE.6.B.3	Analyze the effects of *mutations* and the resulting *variations* within a *population* in terms of *natural selection*
HE.6.B.4	Illustrate *mass extinction* events using a time line
HE.6.B.5	Evaluate *evolution* in terms of evidence as found in the following: • fossil record • *DNA* analysis • *artificial selection* • morphology • embryology • viral *evolution* • geographic distribution of related *species* • *antibiotic* and *pesticide resistance* in various organisms
HE.6.B.6	Compare the processes of *relative dating* and *radioactive dating* to determine the age of fossils
HE.6.B.7	Interpret a *Cladogram*

Key: HE.6.B.1 = Heredity and Evolution. Standard 6. Biology. 1st Student Learning Expectation

Strand: Classification and the Diversity of Life

Standard 7: Students shall demonstrate an understanding that organisms are diverse.

CDL.7.B.1	Differentiate among the different *domains:* • Bacteria • Archaea • Eukarya
CDL.7.B.2	Differentiate the characteristics of the six kingdoms: • Eubacteria • Archaea • Protista • *Fungi* • Plantae • Animalia
CDL.7.B.3	Identify the seven major taxonomic categories: • kingdom • phylum • class • order • family • *genus* • *species*
CDL.7.B.4	Classify and name organisms based on their similarities and differences applying *taxonomic nomenclature* using *dichotomous keys*
CDL.7.B.5	Investigate Arkansas' *biodiversity* using appropriate tools and *technology*
CDL.7.B.6	Compare and contrast the structures and characteristics of *viruses* (*lytic* and *lysogenic cycles*) with non-living and living things
CDL.7.B.7	Evaluate the medical and economic importance of *viruses*
CDL.7.B.8	Compare and contrast life cycles of familiar organisms ▪ sexual reproduction ▪ asexual reproduction ▪ metamorphosis ▪ *alternation of generations*
CDL.7.B.9	Classify *bacteria* according to their characteristics and adaptations
CDL.7.B.10	Evaluate the medical and economic importance of *bacteria*

Key: CDL.7.B.1 = Classification and the Diversity of Life. Standard 7. Biology. 1st Student Learning Expectation

Strand: Classification and the Diversity of Life

Standard 7: Students shall demonstrate an understanding that organisms are diverse.

CDL.7.B.11	Describe the characteristics used to classify protists: ▪ plant-like ▪ animal-like ▪ *fungal*-like
CDL.7.B.12	Evaluate the medical and economic importance of protists
CDL.7.B.13	Compare and contrast *fungi* with other eukaryotic organisms
CDL.7.B.14	Evaluate the medical and economic importance of *fungi*
CDL.7.B.15	Differentiate between *vascular* and *nonvascular plants*
CDL.7.B.16	Differentiate among cycads, gymnosperms, and angiosperms
CDL.7.B.17	Describe the structure and function of the major parts of a plant: ▪ roots ▪ stems ▪ leaves ▪ flowers
CDL.7.B.18	Relate the structure of plant tissue to its function • epidermal • ground • vascular
CDL.7.B.19	Evaluate the medical and economic importance of plants
CDL.7.B.20	Identify the symmetry of organisms: ▪ radial ▪ bilateral ▪ asymmetrical
CDL.7.B.21	Compare and contrast the major invertebrate classes according to their nervous, respiratory, excretory, circulatory, and digestive systems
CDL.7.B.22	Compare and contrast the major vertebrate classes according to their nervous, respiratory, excretory, circulatory, digestive, reproductive and integumentary systems

Key: CDL.7.B.11 = Classification and the Diversity of Life. Standard 11. Biology. 1st Student Learning Expectation

Strand: *Ecology* and Behavioral Relationships

Standard 8: Students shall demonstrate an understanding of ecological and behavioral relationships among organisms.

EBR.8.B.1	Cite examples of abiotic and *biotic factors* of *ecosystems*
EBR.8.B.2	Compare and contrast the characteristics of *biomes*
EBR.8.B.3	Diagram the carbon, nitrogen, phosphate, and water cycles in an *ecosystem*
EBR.8.B.4	Analyze an *ecosystem's* energy flow through food chains, food webs, and *energy pyramids*
EBR.8.B.5	Identify and predict the factors that control *population*, including *predation*, *competition*, crowding, water, nutrients, and shelter
EBR.8.B.6	Summarize the symbiotic ways in which individuals within a *community* interact with each other: ▪ *commensalism* ▪ *parasitism* ▪ *mutualism*
EBR.8.B.7	Compare and contrast *primary succession* with *secondary succession*
EBR.8.B.8	Identify the properties of each of the five levels of *ecology:* ▪ organism ▪ *population* ▪ *community* ▪ *ecosystem* ▪ *biosphere*

Key: EBR.8.B.1 = Ecology and Behavioral Relationships. Standard 8. Biology. 1st Student Learning Expectation

Strand: *Ecology* and Behavioral Relationships

Standard 9: Students shall demonstrate an understanding of the ecological impact of global issues.

EBR.9.B.1	Analyze the effects of human *population* growth and *technology* on the environment/*biosphere*
EBR.9.B.2	Evaluate long range plans concerning resource use and by-product disposal in terms of their environmental, economic, and political impact
EBR.9.B.3	Assess current world issues applying scientific themes (e.g., global changes in climate, *epidemics*, *pandemics*, ozone depletion, UV radiation, natural resources, use of *technology*, and public policy)

Key: EBR.9.B.1 = Ecology and Behavioral Relationships. Standard 9. Biology. 1st Student Learning Expectation

Strand: Nature of Science

Standard 10: Students shall demonstrate an understanding that science is a way of knowing.

NS.10.B.1	Explain why science is limited to natural explanations of how the world works
NS.10.B.2	Compare and contrast *hypotheses*, *theories*, and *laws*
NS.10.B.3	Distinguish between a scientific *theory* and the term "*theory*" used in general conversation
NS.10.B.4	Summarize the guidelines of science: ▪ *explanations* are based on observations, evidence, and testing ▪ *hypotheses* must be testable ▪ understandings and/or conclusions may change with additional empirical data ▪ scientific knowledge must have peer review and verification before acceptance

Key: NS.10.B.1 = Nature of Science. Standard 10. Biology. 1st Student Learning Expectation

Strand: Nature of Science

Standard 11: Students shall design and safely conduct scientific inquiry.

NS.11.B.1	Develop and explain the appropriate procedure, controls, and variables (dependent and independent) in scientific experimentation
NS.11.B.2	Research and apply appropriate safety precautions (refer to ADE Guidelines) when designing and/or conducting scientific investigations
NS.11.B.3	Identify sources of bias that could affect experimental outcome
NS.11.B.4	Gather and analyze data using appropriate summary statistics
NS.11.B.5	Formulate valid conclusions without bias
NS.11.B.6	Communicate experimental results using appropriate reports, figures, and tables

Key: NS.11.B.1 = Nature of Science. Standard 11. Biology. 1st Student Learning Expectation

Strand: Nature of Science

Standard 12: Students shall demonstrate an understanding of current life science theories.

NS.12.B.1	Recognize that theories are scientific explanations that require empirical data, verification, and peer review
NS.12.B.2	Understand that scientific theories may be modified or expanded based on additional empirical data, verification, and peer review
NS.12.B.3	Summarize *biological evolution*
NS.12.B.4	Relate the development of the *cell theory* to current trends in cellular biology
NS.12.B.5	Describe the relationship between the *germ theory of disease* and our current knowledge of immunology and control of infectious diseases
NS.12.B.6	Relate the *chromosome theory of heredity* to recent findings in genetic research (e.g., *Human Genome Project-HGP, chromosome therapy)*
NS.12.B.7	Research current events and topics in biology

Key: NS.12.B.1 = Nature of Science. Standard 12. Biology. 1st Student Learning Expectation

Strand: Nature of Science

Standard 13: Students shall use mathematics, science equipment, and *technology* as tools to communicate and solve life science problems.

NS.13.B.1	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.13.B.2	Use appropriate equipment and *technology* as tools for solving problems (e.g., microscopes, centrifuges, flexible arm cameras, computer software and hardware)
NS.13.B.3	Utilize *technology* to communicate research findings

Key: NS.13.B.1 = Nature of Science. Standard 13. Biology. 1st Student Learning Expectation

Strand: Nature of Science

Standard 14: Students shall describe the connections between pure and *applied science*.

NS.14.B.1	Compare and contrast biological concepts in *pure science* and *applied science*
NS.14.B.2	Discuss why scientists should work within ethical parameters
NS.14.B.3	Evaluate long-range plans concerning resource use and by-product disposal for environmental, economic, and political impact
NS.14.B.4	Explain how the cyclical relationship between science and *technology* results in reciprocal advancements in science and *technology*

Key: NS.14.B.1 = Nature of Science. Standard 14. Biology. 1st Student Learning Expectation

Strand: Nature of Science

Standard 15: Students shall describe various life science careers and the training required for the selected career.

NS.15.B.1	Research and evaluate science careers using the following criteria: ▪ educational requirements ▪ salary ▪ availability of jobs ▪ working conditions

Key: NS.15.B.1 = Nature of Science. Standard 15. Biology. 1st Student Learning Expectation

Abiotic factor	Any nonliving component of an *ecosystem* (e.g., sunlight, air, water, soil)
Activation energy	The kinetic energy required to initiate a chemical reaction
Active transport	The movement of a substance across a plasma (cell) membrane against a concentration gradient
Adhesion	The property of sticking to some other substance
Aerobic respiration	Growing or metabolizing only in the presence of molecular oxygen
Alcoholic fermentation	The process by which pyruvic acid is converted to ethyl alcohol
Alleles	Alternate forms of a *gene* or *DNA* sequence, which occur on either of two homologous *chromosomes* in a diploid organism
Alternation of generation	Alternating sexual and asexual generation reproduction
Amino acid	Any of 20 basic building blocks of *proteins*--composed of a free amino (NH2) end, a free carboxyl (COOH) end, and a side group (R)
Anaerobic respiration	Growing or metabolizing only in the absence of molecular oxygen
Anaphase	Third phase of *mitosis*, beginning when sister *chromatids* separate from each other and ending when a complete set of daughter *chromosomes* have arrived at each of the two poles of the cell
Antibiotic resistance	The ability of a microorganism to produce a *protein* that disables an antibiotic or prevents transport of the antibiotic into the cell
Applied science	The practical use of scientific information to improve human life
Artificial selection	Breeding organisms by humans for specific phenotypic characteristics
Asexual reproduction	Nonsexual means of reproduction which can include grafting and budding
Autotroph	An organism that uses energy to synthesize organic molecules from inorganic substances
Bacteria	A single-celled, microscopic prokaryotic organism
Base pair (bp)	A pair of *complementary nitrogenous bases* in a *DNA* molecule
Biodiversity	The wide diversity and interrelatedness of earth organisms based on genetic and environmental factors
Biological *evolution*	Change in allele frequency of a *species* or *population* over time
Biome	A geographic area characterized by specific kinds of plants and animals
Biosphere	The area on and around Earth where life exists
Biotic factor	A living component of an *ecosystem*
Carbohydrates	Compound containing carbon, hydrogen, and oxygen in the approximate ratio of C:2H:O (e.g., sugars, starches, and cellulose)
Cell cycle	The events of cell division; includes *interphase*, *mitosis*, and *cytokinesis*
Cellular respiration	The process by which cells generate ATP through a series of redox (chemical) reactions
Cell theory	The *theory* that all living things are made of cells, that cells are the basic units of organisms, and that cells come only from existing cells
Centromere	The central portion of the *chromosome* to which the spindle fibers attach during mitotic and meiotic division
Chloroplasts	A plastid containing chlorophyll; the site of *photosynthesis*
Chromatid	Each of the two daughter strands of a duplicated *chromosome* joined at the *centromere* during *mitosis* and *meiosis*.

Chromosome	A single *DNA* molecule, a tightly coiled strand of *DNA*
Chromosome theory of heredity	The *theory* that states that *genes* are located on *chromosomes* and that each *gene* occupies a specific place on a *chromosome*
Citric acid cycle (Kreb's)	Series of chemical reactions in *aerobic respiration* in which a acetyl coenzyme A is completely degraded to carbon dioxide and water with the release of metabolic energy that is used to produce ATP; also known as Kreb's cycle
Cladogram	A branching diagram that illustrates taxonomic relationships based on the principles of claudistics
Codominance	An inheritance relationship in which neither of two *alleles* of the same *gene* totally mask the other
Cohesion	The property of sticking together; like substances sticking together
Commensalism	The close association of two or more dissimilar organisms where the association is advantageous to one and doesn't affect the other(s)
Community	All the *populations* in one area
Cytokinesis	The division of cytoplasm of one cell into two new cells
Cytoskeleton	Framework of the cell composed of a variety of filaments and fibers that support cell structure and drive cell movement
Deletion	*Chromosome* abnormality in which part of the *chromosome* is missing; loss of one or more *base pairs* from *DNA* which can result in a frameshift
Dichotomous key (classification key)	Classification tool used in identifying organisms or materials
Diffusion	The process by which molecules move from an area of greater concentration to an area of lesser concentration
DNA (Deoxyribonucleic acid)	An organic acid and polymer composed of four *nitrogenous bases*--adenine, thymine, cytosine, and guanine; the genetic material of most organisms; exists as a double-stranded molecule held together by *hydrogen bonds*
Domain	Taxonomic category that includes one or more kingdom (e.g., Bacteria, Archaea, Eukarya)
Dominance	A characteristic in which an allele that expresses its *phenotype* even in the presence of a recessive allele
Double helix	The *DNA* molecule, resembling a spiral staircase in which the paired bases form the steps and the sugar-phosphate backbones form the rails
Ecology	The study of the interactions of organisms with their environment and with each other
Ecosystem	The organisms in a plant *population* and the biotic and *abiotic factors* which impact on them
Electron transport chain	Series of chemical reactions in the thylakoid membrane or inner *mitochondrial* membrane during which hydrogens or their electrons are passed along with the release of energy
Endergonic reaction	A reaction requiring a net input of free energy
Endocytosis	The process by which a cell surrounds and engulfs substances
Energetics	Use of energy
Energy pyramid	Summarizes interactions of matter and energy at each trophic level
Enzymes	*Proteins* that control the various steps in all chemical reactions
Epidemic	An outbreak of a contagious disease that spreads widely and rapidly
Eukaryote	An organism whose cells possess a *nucleus* and other membrane-bound vesicles, including all members of the protist, fungi, plant and animal kingdoms; and excluding *viruses*, bacteria, and blue-green algae
Evolution	The long-term process through which a *population* of organisms accumulates genetic changes that enable its members to successfully adapt to environmental conditions and to better exploit food resources
Exergonic reaction	A reaction that gives off free energy

Exocytosis	The process in which a vesicle inside a cell fuses with a cell membrane and releases its contents to the external environment
Frameshift mutation	A *mutation* that results in the misreading of the code during *translation* because of the change in the reading frame
Fungi	Microorganisms that lacks chlorophyll
Gamete	A haploid sex cell, egg or sperm, that contains a single copy of each *chromosome*
Gene	The functional unit of heredity; a locus on a *chromosome* that encodes a specific *protein* or several related *proteins*
Genome	The complete genetic material contained in an individual; the genetic complement contained in the *chromosomes* of a given organism, usually the haploid *chromosome* state
Genotype	The structure of *DNA* that determines the expression of a trait
Genus	A category including closely related *species*; interbreeding between organisms within the same category can occur
Germ Theory of Disease (Koch's Postulates)	A set of criteria used to establish that a particular infectious agent causes a disease
Glycolysis	A pathway in which glucose is oxidized to pyruvic acid
Heterotroph	An organism that obtains organic food molecules by eating organisms or their by-products
Homeostasis	The stable internal conditions of a living thing
Host	Animal or plant on which or in which another organism lives
Human Genome Project	A project coordinated by the National Institutes of Health (NIH) and the Department of Energy (DOE) to determine the entire *nucleotide* sequence of the human *chromosomes*
Hydrogen bond	A relatively weak bond formed between any hydrogen atom (which is covalently bound to a nitrogen or oxygen atom) and a nitrogen or oxygen with an unshared electron pair
Hypotheses	Statement or predictions that can be tested
Incomplete dominance	A condition where a heterozygous off- spring has a *phenotype* that is distinctly different from, and intermediate to, the parental *phenotypes*
Independent assortment	The *law* stating that pairs of *genes* separate independently of one another in *meiosis*
Interphase	Period of time where a cell carries on metabolism and replicates *chromosomes* prior to cell division
Inversion	A *mutation* that occurs when a *chromosome* piece breaks off and reattaches in reverse orientation
k-strategist	*Species* characterized by slow maturation, few young, slow *population* growth and reproduction late in life
Karyotype	All of the *chromosomes* in a cell or an individual organism, visible through a microscope during cell division
Law	An observation that happens every time under a certain set of conditions
Lactic acid fermentation	The process by which pyruvic acid is converted to lactic acid
Light dependent	Reaction of *photosynthesis* that requires light; light energy is absorbed converted to chemical energy in the form of ATP and NADPH
Light independent	The fixing of carbon dioxide in a 3 carbon compound for use in sugar production or other end products
Lipid	Any of a group of organic compounds that are insoluble in water but soluble in nonpolar solvents; serve as energy storage and are important components of cell membranes
Lysogenic cycle	A type or phase of the *virus* life cycle during which the *virus* integrates into the *host chromosome* of the infected cell, often remaining essentially dormant for some period of time

Lytic cycle	A phase of the *virus* life cycle during which the *virus* replicates within the *host* cell, releasing a new generation of *viruses* when the infected cell lyses
Mass extinction	One of the brief periods of time during which large numbers of *species* disappeared
Meiosis	The reduction division process by which haploid *gametes* and *spores* are formed consisting of a single duplication of the genetic material followed by two mitotic divisions
Metaphase	Second phase of *mitosis* in which the *chromosomes* line up across the equator of the cell
Microbe	A microorganism
Mitochondria	*Organelles* that are the sites of *aerobic respiration* in eukaryotic cells
Mitosis	The replication of a cell to form two daughter cells with identical sets of *chromosomes*
Molecular biology	The study of the biochemical and molecular interactions within living cells
Molecular genetics	The branch of genetics that deals with the expression of *genes* by studying the *DNA* sequences of *chromosomes*
Multiple alleles	Three or more *alleles* of the same *gene* that code for a single trait
Mutation	An alteration in *DNA* structure or sequence of a *gene*
Mutualism	A form of *symbiosis* in which both organisms benefit from living together
Natural selection	The differential survival and reproduction of organisms with genetic characteristics that enable them to better utilize environmental resources
Nitrogenous bases	The purines (adenine and guanine) and pyrimidines (thymine, cytosine, and uracil) that comprise *DNA* and *RNA* molecules
Nonvascular plant	A plant that lacks vascular tissue and true roots, stems, and leaves
Nucleic acids	The two *nucleic acids*, deoxyribonucleic acid (*DNA*) and ribonucleic acid (*RNA*), are made up of long chains of molecules called *nucleotides*
Nucleotide	A building block of *DNA* and *RNA*, consisting of a nitrogenous base, a five-carbon sugar, and a phosphate group
Nucleus	The membrane-bound region of a eukaryotic cell that contains the *chromosomes*
Organelle	A cell structure that carries out a specialized function in the life of a cell
Osmosis	The *diffusion* of water across a selectively permeable membrane
Parasitism	The close association of two or more dissimilar organisms where the association is harmful to at least one
Passive transport	The movement of substances across a plasma (cell) membrane without the use of cell energy
Pandemic	An epidemic over a wide geographic area and affecting an exceptionally high proportion of the population
Pathogen	Organism which can cause disease in another organism
Pesticide	A substance that kills harmful organisms (e.g., an insecticide or fungicide)
pH	Indicates the relative concentration of hydrogen ions and hydroxide ions in a substance
Pinocytosis	A type of *endocytosis* in which a cell engulfs solutes of fluids
Phagocytosis	A type of *endocytosis* in which a cell engulfs large particles or whole cells
Phenotype	The observable characteristics of an organism, the expression of *gene alleles* (*genotype*) as an observable physical or biochemical trait
Phospholipids	A class of *lipid* molecules in which a phosphate group is linked to glycerol and two fatty acetyl groups; a chief component of biological membranes
Photosynthesis	The process by which light energy is converted to chemical energy stored in organic molecules
Plasma (cell) membrane	A selectively permeable surface that encloses the cell contents and through which all materials entering or leaving a cell must pass
Point mutation	A change in a single *base pair* of a *DNA* sequence in a *gene*
Polarity	Molecules having uneven distribution of charges

Population	A local group of organisms belonging to the same *species* and capable of interbreeding
Primary succession	Succession that occurs in a newly formed habitat that has never before sustained life
Prokaryote	A bacterial cell lacking a true *nucleus*; its *DNA* is usually in one long strand
Prophase	First phase of *mitosis* in which duplicated *chromosomes* condense and mitotic spindle fibers begin to form
Protein	An organic compound composed of one or chains of polypeptides which in turn are formed from *amino acids*
Protein synthesis	A formation of *proteins* using information coded on *DNA* and carried by *RNA*
Pure science	The gathering of new information or the discovery of a new relationship or fact for sake of knowledge
Punnett square	A type of grid used to show the gametes of each parent and their possible offspring; a type of grid that can indicate all the possible outcomes of a genetic cross
Radioactive dating	A method of determining the age of an object by measuring the amount of a specific radioactive isotope it contains
Recessive gene	Characterized as having a *phenotype* expressed only when both copies of the *gene* are mutated or missing
Relative dating	A method of determining the age of fossils by comparing them to other fossils in different layers of rock
Ribosome	A sub-cellular structure that is the site of *protein synthesis* during *translation*.
RNA (ribonucleic acid)	An organic acid composed of a single strand of *nucleotide* that acts as a messenger between *DNA* and the *ribosomes* and carries out the process of *protein synthesis*: composed units of adenine, guanine, cytosine, and uracil
Secondary succession	The sequential replacement of *population* in a disrupted habitat
Segregation	The *law* stating that pairs of *genes* separate in *meiosis* and each *gamete* receives one *gene* of a pair
Sex influenced	Description of a trait that is caused by a *gene* whose expression differs in male and females; (e.g., male patterned baldness)
Sex linkage	The presence of a *gene* on a sex *chromosome*; (e.g., hemophilia, color-blindness)
Sexual reproduction	The process where two cells (*gametes)* fuse to form one hybrid, fertilized cell
Species	A classification of related organisms that can freely interbreed
Spore	A form taken by certain *microbes* that enables them to exist in a dormant stage. It is an asexual reproductive cell
Symbiosis	The close association of two or more dissimilar organisms where both receive an advantage from the association
Taxonomic nomenclature	The procedure of assigning names to the kinds and groups of organisms according to their taxa
Technology	Practical use of scientific information to improve the quality of human life: see also *applied science*
Telophase	Final phase of *mitosis* during which *chromosomes* uncoil, a nuclear envelope returns around the chromatin, and a nucleolus becomes visible in each daughter cell
Theory	A well tested explanation of natural events
Thermoregulation	The maintenance of internal temperature within a range that allows cells to function efficiently
Translation	The process of converting the genetic code in *RNA* into the *amino acid* sequence that makes up a *protein*
Transcription	Process in which *RNA* is made from *DNA*
Vaccine	A preparation of dead or weakened *pathogen* that is used to induce formation of antibodies or immunity against the *pathogen*
Variation	Differences in the frequency of *genes* and traits among individual organisms within a *population*
Vascular plants	A plant that has phloem and xylem
Virus	An infectious particle composed of a *protein* capsule and a nucleic acid core, which is dependent on a *host* organism for replication

Appendix

Suggested Biology Labs

Strand	Suggested Labs
Molecules and Cells	test for organic compounds (starch, sugar, and *lipids*) *photosynthesis* fermentation lab/cellular Respiration test for variables that affect *enzymes* *diffusion* lab *osmosis* lab view microscopic cells *adhesion* and *cohesion* lab chromatography *meiosis* Lab/*mitosis* lab
Heredity and *Evolution*	paper lab-*transcription* replication/*protein synthesis* Mendelian genetic lab probability lab analysis of karotype *DNA* isolation radioactive decay *natural selection* and adaptation fossil lab
Classification and Diversity	*biodiversity*-scavenger hunt use of dichotomous keys (birds, mammals, trees, flowers) comparative animal anatomy lab plant anatomy lab (root, stem, leaf, seed) *fungi* lab (mushroom)
Ecology and Behavioral Relationships	water analysis soil analysis build a *biome*
Nature of Science	spread of infectious diseases

February 11, 2014

Via E-mail (mary.perry@arkansas.gov)
Ms. Mary Perry, Charter/Home Schools Coordinator
Arkansas Department of Education
Division of Learning Services
Four Capitol Mall, Room 304-B
Mail Slot 3
Little Rock, Arkansas 72201

Re: Challenge to Responsive Education Solutions' Biology Course

Dear Ms. Perry:

On February 10, 2014, Responsive Education Solutions ("ResponsiveEd") received a copy of a letter from Americans United for Separation of Church and State ("AU") that was addressed and forwarded to you via e-mail (attached). In the letter, AU asserts that ResponsiveEd's Biology course violates the United States Constitution by "aggressively undermin[ing] the theory of evolution and promot[ing] creationism."[1] The letter concludes with AU requesting that you either direct us to stop using the Biology course or revoke our charters.

As you are aware, on January 16, 2014, an article was published by Slate.com, making similar accusations. Specifically, the Slate article accused ResponsiveEd of violating both our charters and the United States Constitution by "[b]ringing creationism into [the] classroom" and "undermining evolution" in our Biology course. Because of the seriousness of the allegations, we removed the Biology workbook in question from our inventory and conducted an immediate and thorough review of the legal concerns expressed in the Slate article.

The first allegation contained in the article (and now being repeated in the AU letter) is that ResponsiveEd's Biology course unconstitutionally teaches creationism—i.e., that the references to creationism in ResponsiveEd's Biology course convey a message to the objective reader that ResponsiveEd is endorsing religion. After thoroughly reviewing the lessons in question, we identified only six passing references to creationism. And while we do not believe that these references violate either our charters or applicable law, we are currently updating the curriculum to avoid any misinterpretations that ResponsiveEd is endorsing—or disapproving of—religion.

The second allegation contained in the article (and now being repeated in the AU letter) is that ResponsiveEd is undermining evolution in its Biology course. Our Biology course does examine all sides of the scientific evidence relating to the theory of evolution—both for and

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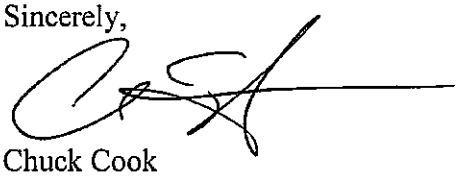
ResponsiveEd.com PremierHighSchools.com Vista-Academies.com iSchoolHigh.com QuestMiddleSchools.com FoundersClassical.com

against. And while we believe that the Biology course is constitutionally acceptable as written, we are currently updating the curriculum in an effort to ensure that the evidence for evolution is presented in an objective and unbiased manner.

In summary, over the past three and a half weeks ResponsiveEd has addressed the concerns that are now being expressed to you by AU regarding ResponsiveEd's Biology course. Specifically, while we do not believe that our Biology course violates either our charters or applicable law, ResponsiveEd has already removed the Biology workbook in question from our inventory and is currently updating it in order to: (1) ensure that the evidence for evolution is presented in an objective and unbiased manner, and (2) avoid any misinterpretations that ResponsiveEd is endorsing—or disapproving of—religion.

As always, please feel free to contact me directly should you have any questions.

Sincerely,



Chuck Cook
Chief Executive Officer

Enclosures

Cc: Mr. Jeremy Lasiter, General Counsel
Arkansas Department of Edcation
E-mail: jeremy.lasiter@arkansas.gov

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[1] In its letter, AU incorrectly asserts that ResponsiveEd's Biology course is being utilized at both Premier High School of Little Rock and Northwest Arkansas Classical Academy. In fact, the Biology course is being utilized only at Premier High School of Little Rock.

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February 10, 2014

By U.S. Mail & Email
Mary Perry, Charter/Home Schools Coordinator
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Division of Learning Services
Four Capitol Mall, Room 304-B
Mail Slot 3
Little Rock, AR 72201
Mary.Perry@arkansas.gov

RE: Anti-evolution and pro-creationism teachings in Responsive Education Solutions' biology curriculum

Dear Ms. Perry:

We have reviewed the biology curriculum used in charter schools operated in Arkansas by Responsive Education Solutions (Premier High School of Little Rock and Northwest Arkansas Classical Academy). The curricular materials attempt to aggressively undermine the theory of evolution and promote creationism. Promoting creationism in the public schools is forbidden by the Establishment Clause of the First Amendment to the U.S. Constitution. We therefore ask you to either direct Responsive Education Solutions to stop using these materials, or to revoke their charter.

The biology curriculum repeatedly attacks and undermines evolution, stating that it is "an unproved theory" which "has reached the level of dogma," that there are "holes" in the theory, and that it is impossible for scientists to ever provide experimental proof of evolution. Responsive Ed, *Biology Unit 4: Origins and Classifications of Life*, pgs. 2-3 (copy enclosed with hard-copy of this letter). The curriculum presents as fact common false assertions creationist texts employ in trying to discredit evolution. *See, e.g., id.* at pgs. 6, 9, 20, 37, 39-40. The curriculum also insinuates that proponents of evolution are willing to create fraudulent evidence. *See id.* at pgs. 34-35.

Alongside these attacks on evolution, the text tells students that "intelligent design or creationism" are "other theories on the origins of life." *Id.* at pg. 37. Indeed, the curriculum presents supernatural intervention as the baseline view of the origin of life and the universe, stating that "most people believed that God created everything" and that evolution is merely a "new idea" that "gave non-religious scientists a way to explain the diversity of life on the planet without resorting to creationism." *Id.* at pg. 2. The text then refers multiple times to supernatural creation as an alternative to evolution. *See id.* at pgs. 26, 27, 29.

The U.S. Supreme Court and the lower federal courts have consistently and unequivocally held that religious views on the origins of life, such as creationism, "creation science," and "intelligent design," cannot lawfully be advanced in the public schools as alternatives to the

scientific theory of evolution. *See Edwards v. Aguillard*, 482 U.S. 578, 591 (1987) (invalidating state statute requiring "balanced treatment" of evolution and creationism in public schools because statute's "preeminent purpose . . . was clearly to advance the religious viewpoint that a supernatural being created humankind"); *Epperson v. Arkansas*, 393 U.S. 97, 106 (1968) (striking down state statute prohibiting teaching of evolution because teaching and learning in public schools may not be tailored to religious views); *Freiler v. Tangipahoa Parish Bd. of Educ.*, 185 F.3d 337, 341 (5th Cir. 1997) (striking down disclaimer criticizing evolution and encouraging students to consider creationism as an alternative); *Peloza v. Capistrano Unified Sch. Dist.*, 37 F.3d 517, 522 (9th Cir. 1994) (holding that science teacher was properly forbidden to teach creationist views); *Daniel v. Waters*, 515 F.2d 485, 491 (6th Cir. 1975) (striking down statute that required schools teaching evolution to devote equal time to other views, including Biblical account of creation).

An Arkansas federal district court struck down a state statute that required public schools to provide equal time to creationism as an alternative to evolution, because the statute had the effect of promoting religion. *McLean v. Ark. Bd. of Educ.*, 529 F. Supp. 1255, 1258-64 (E.D. Ark. 1982). The court found that the creationist materials provided misinformation about evolution in an attempt to discredit the theory and then convince students to view creationism as a viable alternative explanation. *Id.* at 1269-71. The court concluded that the attacks on evolution were not scientifically sound, "that creation science has no scientific merit or educational value," and that therefore "the conclusion is inescapable that the only real effect [of the statute] is the advancement of religion." *Id.* at 1269-72. Responsive Education Solutions' curriculum has the same defects. Students here are being treated to an entire unit devoted to heaping aspersions onto evolution and leading students towards creationism.

Responsive Education Solutions' biology curriculum cannot withstand constitutional scrutiny. We therefore ask the Arkansas Department of Education to either direct Responsive Education Solutions to stop using these curricular materials, or to revoke their charter. We would appreciate a response to this letter within thirty days. You may contact Ian Smith at (202) 466-3234 or at *ismith@au.org* if you would like to discuss this matter.

Very truly yours,

Ayesha N. Khan, Legal Director
Alex J. Luchenitser, Associate Legal Director
Ian Smith, Staff Attorney

cc: Responsive Education Solutions
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