BIOSCIENCE 41.0100.00
EMBEDDED SCIENCE CREDIT CROSSWALK

The Bioscience program has been recognized by the Arizona State Board of Career and Technical Education (CTE) as being eligible for consideration by local governing boards to grant 1 credit in high school science. This document is the result of a committee analysis completed in April 2022.

Note: AZ High School Science Standards are highlighted in yellow.

STANDARD 1.0 MAINTAIN A SAFE WORK ENVIRONMENT

1.1 Identify and wear appropriate lab attire and personal protective equipment (e.g., safety glasses or goggles, lab coat, gloves, and closed-toe shoes)
1.2 Identify emergency contacts and practice emergency protocols (e.g., fire procedure, shower safety, eyewash practice, and evacuation procedure)
1.3 Identify and follow handling instructions/information and usage of chemicals as identified in the safety data sheets (SDSs)
1.4 Identify and explain the importance of routine maintenance of equipment and reporting unsafe or nonfunctioning equipment
1.5 Maintain equipment log (i.e., eyewash, autoclave, laminar flow hood, etc.)
1.6 Identify biological, biohazardous, and chemical materials and explain appropriate handling (i.e., body fluids, ethidium bromide, sodium hypochlorite, etc.)
1.7 Identify and comply with safety signage and the significance of SDS symbols
1.8 Distinguish the characteristics of biosafety levels (e.g., BSL-1 to BSL-4)
1.9 Identify standard operating procedures (SOPs) for monitoring, using, storing, and disposal of biological, biohazardous, and chemical materials
1.10 Identify standard operating procedures (SOPs) for biological, biohazardous, and chemical spills, including broken glass

STANDARD 2.0 DEMONSTRATE STANDARD OPERATING PROCEDURE (SOPS) IN THE LABORATORY

2.1 Discuss the importance of state, local, and industry regulations (i.e., EPA, FDA, OSHA, NIH, AZDEQ, etc.)
2.2 Set up, maintain, and practice lab documentation (research approaches and observations) according to standard operating procedures (SOPs) (e.g., paper and/or electronic notebook)
2.3 Describe protocols for securing the integrity of samples and data
2.4 Explain the impact of social media and mobile communications technology on confidentiality, risks, and disclosures of information
2.5 Practice recording all research approaches and observations

STANDARD 3.0 DEMONSTRATE QUALITY CONTROL PROCEDURES

3.1 Perform and document quality tests on reagents prepared or used in the lab to ensure reproducibility (i.e., pH, conductivity, spectrophotometry, etc.)
3.2 Describe manufacturing practices pertaining to quality control (e.g., standards and control chart ramifications)
3.3 Demonstrate reproducibility from an SOP and characterize variation across samples (i.e., trend analysis)

STANDARD 4.0 DEMONSTRATE CRITICAL THINKING AND PROBLEM-SOLVING SKILLS

4.1 Identify and access scientific and technical literature (i.e., patents, peer-reviewed articles, white papers, and technical bulletins), including databases (i.e., Google Scholar, PubMED), assess the scientific merit, and create a literature review
4.2 Identify and use observational methods and skills (i.e., records, checklists, frequency count, work samples, etc.)
4.3 Design a research question with attention to relevant prior knowledge and develop a testable hypothesis
4.4 Design an experiment or a series of experiments based on prior research that is/are suitable to the hypothesis
4.5 Test the hypothesis using appropriate experimental design (analytical and statistical), distinguishing between control and experimental variables
4.6 Collect, record, and analyze data and analysis procedures
4.7 Develop conclusions based on evidence
4.8 Communicate results of scientific investigations in oral, written, digital, and graphical form using relevant technology and terminology

STANDARD 5.0 DEMONSTRATE ETHICAL AND LEGAL CONDUCT

5.1 Discuss codes of ethics and ethical protocols that apply to confidentiality and security in bioscience research, development, and manufacturing

Life Science HS.L3U3.26 Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of a current genetic technology.
Chemistry HS.P1U3.4 Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications.

Rationale: Investigate genetic technology (e.g., locating, isolating, and sequencing DNA) and the impact of DNA modifications to society.

5.2 Identify laboratory behaviors and practices that could result in liability, negligence, or loss of research integrity (i.e., sample manipulation, data omission/falsification, etc.)

Life Science HS.L1U3.23 Obtain, evaluate, and communicate the ethical, social, economic and/or political implications of the detection and treatment of abnormal cell function

HS.L3U3.26 Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of a current genetic technology.
Chemistry HS.P1U3.4 Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications.

Rationale: Study how stem cells and cell line research have ethical, economic and political implications. Investigate genetic technology (e.g., locating, isolating, and sequencing DNA) and the impact of the modification of DNA to society. Lesson examples: lab protocol documentation, testing lab SOPs, calibrating tool log, lab safety, and labeling.

5.3 Examine implications of bioethical issues (e.g., the use of GMOs and the HeLa privacy issue)

Chemistry HS.P1U3.4 Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications.

Life Science HS.L2U3.18 Obtain, evaluate, and communicate about the positive and negative ethical, social, economic, and political implications of human activity on the biodiversity of an ecosystem.

HS.L1U3.23 Obtain, evaluate, and communicate the ethical, social, economic and/or political implications of the detection and treatment of abnormal cell function.
HS.L3U3.26 Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of a current genetic technology.

Rationale: Study how stem cells and cell line research have ethical, economic, and political implications. Investigate genetic technology (e.g., locating, isolating, and sequencing DNA) and the impact of the modification of DNA to society. Discuss implications of genetic technology and manipulation (e.g., gene therapy, personalized medicine, cloning, and in vivo / ex vivo genetic modifications).

5.4 Apply risk management practices and policies to incident reporting

5.5 Identify and comply with legal, regulatory, and accreditation standards or codes

5.6 Identify standards for harassment, labor, and employment laws (i.e., OSHA, ADA, DOL, USAGov, etc.)

5.7 Identify applicable intellectual property protections (e.g., patents, trademark protections, and copyrights)

5.8 Discuss privacy and protections of human subjects (i.e., HIPAA rules, IRB-regulated research protocols/informed consent, etc.)

5.9 Discuss regulations for the ethical treatment and use of living organisms

Life Science HS.L3U3.26 Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of a current genetic technology.
Rationale: Applications of science often have ethical, social, economic, and/or political implications.

5.10 Apply ethical considerations to disclosure regulations (i.e., cancer and smoking research, Tuskegee experiments, etc.)

Life Science HS.L1U3.23 Obtain, evaluate, and communicate the ethical, social, economic and/or political implications of the detection and treatment of abnormal cell function.
Rationale: Study ethical, social, economic implications disclosure regulations.

STANDARD 6.0 EXAMINE THE ROLE OF LIVING ORGANISMS IN BIOSCIENCE RESEARCH

6.1 Discuss the benefits, limitations, and ethics of using model organisms and cell lines in research (e.g., C. elegans, Arabidopsis, fruit flies, yeast, E. coli, mice, and, as well, HeLa and CHO cells)

Life Science HS.L3U3.26 Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of a current genetic technology.
HS.L1U3.23 Obtain, evaluate, and communicate the ethical, social, economic and/or political implications of the detection and treatment of abnormal cell function.

Rationale: Investigate genetic technology (e.g., locating, isolating, and sequencing DNA) and the impact of DNA modification to society. Study how cell line research have ethical, economic and political implications.

6.2 Compare and contrast standards of practice for treatment, care, maintenance, and propagation of different living organisms (i.e., invertebrate, vertebrate, cell lines, etc.)

Life Science HS.L1U3.23 Obtain, evaluate, and communicate the ethical, social, economic and/or political implications of the detection and treatment of abnormal cell function.

HS.L1U1.20 Ask questions and/or make predictions based on observations and evidence to demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.
HS.L2U1.21 Obtain, evaluate, and communicate data showing the relationship of photosynthesis and cellular respiration; flow of energy and cycling of matter.

Rationale: Study how cell line research have ethical, economic and political implications. Investigate genetic technology (e.g., locating, isolating, and sequencing DNA) and the impact of the modification of DNA to society. Discuss propagation of plants, C elegans, and bacterial culture. Pre-requisite knowledge of antibiotic resistance labs, structure of cells, and transference of genes. Lab examples: Fast plant lab - changes in light of water to affect growth, fermentation labs, and mitochondria studies.

STANDARD 7.0 DEMONSTRATE BASIC LAB SKILLS IN THE USE OF EQUIPMENT AND INSTRUMENTATION

7.1 Use software for scientific analyses and documentation (e.g., spreadsheet, presentation, and word processing)

7.2 Identify and demonstrate proper use of laboratory glassware

7.3 Identify and demonstrate proper use of laboratory balances

7.4 Identify and demonstrate proper use of micropipettes

7.5 Identify and demonstrate proper use of spectrophotometers, including creating a standard curve relating absorbance and concentration

Physics HS.P4U1.10 Construct an explanation about the relationships among the frequency, wavelength, and speed of waves traveling in various media, and their applications to modern technology.

Rationale: Generate a standard curve to discover the relationships among frequency, wavelength, and speed of waves through media. Prerequisite knowledge in how to select the correct instrument (vis or UV).

7.6 Identify, balance, and operate centrifuges

7.7 Describe the purpose of and how to operate an autoclave

7.8 Describe the purpose of and how to operate fume and laminar flow hoods

7.9 Prepare microscopic specimens and interpret results using appropriate microscopes (i.e., dissecting, compound, digital, etc.)

7.10 Identify and demonstrate proper use of hot plate/stirrers

7.11 Identify and demonstrate proper use of incubators, including shaking incubators

7.12 Identify and demonstrate proper use of water baths and heat blocks

7.13 Use a pH meter and explain the logarithmic nature of the pH scale

STANDARD 8.0 DEMONSTRATE MICROBIOLOGY SKILLS

8.1 Demonstrate sterile technique (i.e., maintain lab and equipment hygiene, etc.)

8.2 Identify, prepare, sterilize, dispense, and store culture media

8.3 Identify, propagate, and quantify microorganisms and cells

Life Science HS.L1U1.20 Ask questions and/or make predictions based on observations and evidence to demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.

Rationale: Identify and categorize cells based on their structure and function through a variety of chemical and observational techniques. Homeostasis is inferred.

8.4 Identify techniques for short- and long-term cultures (e.g., stabs, slants, liquid nitrogen, and glycerol stocks)

8.5 Isolate, maintain, and store pure cultures

Life Science HS.L1U1.20 Ask questions and/or make predictions based on observations and evidence to demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.
Rationale: Identify and categorize cells based on their structure and function through a variety of chemical and observational techniques.

8.6 Transform and maintain bacteria (e.g., E. coli)

Life Science HS.L1U1.20 Ask questions and/or make predictions based on observations and evidence to demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.
Rationale: Identify and categorize cells based on their structure and function through a variety of chemical and observational techniques.

8.7 Decontaminate and dispose of equipment, glassware, and biologicals, including disinfection with 0.5% sodium hypochlorite solution and sterilization using the autoclave

8.8 Identify bacteria types (i.e., gram staining, catalase activity, DNA sequencing)

Life Science HS.L1U1.20 Ask questions and/or make predictions based on observations and evidence to demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.
Rationale: Identify and categorize cells based on their structure and function through a variety of chemical and observational techniques.

STANDARD 9.0 DEMONSTRATE PROTEIN TECHNIQUES

9.1 Compare and contrast methods to detect proteins (e.g., Western Blot, ELISA, and immunohistochemical methods)

Chemistry HS.P1U1.1 Develop and use models to explain the relationship of the structure of atoms to patterns and properties observed within the periodic table and describe how these models are revised with new evidence.
Rationale: Explain phenomena using evidence obtained from observations and or scientific investigations.

9.2 Extract proteins

9.3 Separate and characterize proteins (e.g., column chromatography and SDS-PAGE)

Chemistry HS.P1U1.3 Ask questions, plan, and carry out investigations to explore the cause-and-effect relationship between reaction rate factors.
Rationale: Separation of proteins is based on the forces and interactions within and between molecules.

9.4 Perform protein assays and compare to protein standards (i.e., Bradford and Lowry methods, etc.)

Chemistry HS.P1U1.3 Ask questions, plan, and carry out investigations to explore the cause- and-effect relationship between reaction rate factors.
Life Science HS+L1U1.5 Analyze and interpret data that demonstrates the relationship between cellular function and the diversity of protein functions.
Rationale: Identify enzymatic activity and protein concentration by changing several variables including concentration, temperature, and pH. Understand how protein types affect cellular functions.

STANDARD 10.0 DEMONSTRATE MATERIAL PREPARATION AND STORAGE

10.1 Calculate and prepare solutions and buffers (e.g., mass/volume, %, molarity, and pH)

10.2 Calculate and prepare dilutions, including serial dilutions

10.3 Calculate the molar mass of a given compound using a Periodic Table of Elements

Chemistry HS.P1U1.1 Develop and use models to explain the relationship of the structure of atoms to patterns and properties observed within the periodic table and describe how these models are revised with new evidence.
Rationale: Explain phenomena using evidence obtained from observations and/or scientific investigations.

10.4 Label and store solutions and buffers (e.g., ingredients, preparer's initials, dates, concentration, lots, storage conditions, sterility, hazards, and special directions)

10.5 Use scientific sources to find appropriate solution preparation protocols

10.6 Explain the control inventory process for materials and supplies

STANDARD 11.0 DEMONSTRATE THE USE OF BIOINFORMATIC RESOURCES

11.1 Access and analyze gene and genome maps (i.e., FlyBase, NCBI, genome.org)

11.2 Access and evaluate protein structures in PDB (e.g., hemoglobin)

Life Science HS+L1U1.5 Analyze and interpret data that demonstrates the relationship between cellular function and the diversity of protein functions.
Rationale: Identify and evaluate protein structures.

11.3 Use BLAST to identify and retrieve homologous/similar DNA or protein sequences from sequence databases (e.g., NCBI)

11.4 Explain the purpose of different BLAST searches including interpreting E-values and Scores (e.g., NCBI)

Life Science HS.L3U3.26 Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of a current genetic technology.
Rationale: Identify and classify living organisms using BLAST, Bioinformatics, and DNA barcodes.

11.5 Use PCR primer sequences to perform database searches and determine the nature and size of expected PCR fragments (e.g., NCBI)

11.6 Use alignment tools to determine sequence relationships (i.e., DNA Subway, NCBI, MEGA, etc.)

Life Science HS.L3U3.26 Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of genetic technology.
Rationale: Use tools to make decisions. Investigate the CODIS system.

11.7 Identify and evaluate genetic variation (i.e., SNPs, inversions, translocations, copy number variations) (e.g., NCBI)

Life Science HS.L3U1.25 Obtain, evaluate, and communicate information about the causes and implications of DNA mutation.

Rationale: Detect and identify by using DNA Barcodes to classify living organisms.

STANDARD 12.0 DEMONSTRATE NUCLEIC ACID TECHNIQUES

12.1 Explain the structure of DNA (e.g., DNA miniprep/plasmid and genomic DNA)

Life Science HS.L3U1.25 Obtain, evaluate, and communicate information about the causes and implications of DNA mutation.
HS+B.L3U1.11 Construct an explanation for how the structure of DNA and RNA determine the structure of proteins that perform essential life functions.
Rationale: Investigate how diverse protein characteristics determine cellular functions.

12.2 Perform and analyze restriction digests

12.3 Perform and explain gel electrophoresis (e.g., electrolysis, buffer selection and preparation, and gel concentration preparation)

Chemistry HS.P1U1.2 Develop and use models for the transfer or sharing of electrons to predict the formation of ions, molecules, and compounds in both natural and synthetic processes.
HS.P1U1.3 Ask questions, plan, and carry out investigations to explore the cause-and-effect relationship between reaction rate factors.
Rationale: Construct standard curve for Hind III cut DNA and explain the relationship between number of base pairs and distance migrated before calculating the size of the DNA fragments cut with EcoRI. Define electrophoresis and distinguish between vertical and horizontal gel electrophoresis. Model pouring molten agarose and loading DNA samples into agarose gels. Separate DNA Fragments using agarose gel electrophoresis and explain how methylene blue stains DNA.

12.4 Identify and troubleshoot common gel electrophoresis errors (e.g., punctured well during loading, overloaded well, nuclease contamination, and poor separation of bands)

12.5 Describe DNA sequencing methods, including Sanger and next-generation sequencing, and compare the advantages and disadvantages of each method

12.6 Compare and contrast PCR method to the cellular process of DNA replication

12.7 Optimize and perform PCR protocols

Chemistry HS.P1U1.2 Develop and use models for the transfer or sharing of electrons to predict the formation of ions, molecules, and compounds in both natural and synthetic processes.
HS.P1U1.3 Ask questions, plan, and carry out investigations to explore the cause-and-effect relationship between reaction rate factors.
Rationale: Determine the limiting factor in a PCR Reaction, balance concentrations of dNTPs, primer concentration, temperatures, and number of cycles.

12.8 Perform basic molecular biology techniques (e.g., cloning, gene expression, and protein production)

Life Science HS.L3U1.25 Obtain, evaluate, and communicate information about the causes and implications of DNA mutation
HS.L2U1.19 Develop and use models that show how changes in the transfer of matter and energy within an ecosystem and interactions between species may affect organisms and their environment.
HS.L1U1.20 Ask questions and/or make predictions based on observations and evidence to demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.
HS.L3U1.24 Construct an explanation of how the process of sexual reproduction contributes to genetic variation.
Rationale: Perform genetic technology such as locating, isolating, and sequencing DNA. Modify DNA using transformation/gene therapy. Understand the implications to society.

12.9 Explain gene structure and regulation (e.g., lac operon and trp operon, introns and exons, and alternative splicing)

Chemistry HS.P1U1.2 Develop and use models for the transfer or sharing of electrons to predict the formation of ions, molecules, and compounds in both natural and synthetic processes.
HS.P1U1.3 Ask questions, plan, and carry out investigations to explore the cause-and-effect relationship between reaction rate factors.
Life Science HS.L1U1.20 Ask questions and/or make predictions based on observations and evidence to demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.
Rationale: Use a model to predict formation of molecules in natural processes. Gather evidence to explain and demonstrate gene regulation related to homeostasis and cellular structure and function.

12.10 Design PCR primers

Chemistry HS.P1U1.2 Develop and use models for the transfer or sharing of electrons to predict the formation of ions, molecules, and compounds in both natural and synthetic processes.
Rationale: Understand molecular structure and create the PCR primer. Lab example: Chromosome 16: PV92 PCR Informatics Kit.

12.11 Prepare a standard curve based on a DNA ladder to estimate DNA size

STANDARD 13.0 DEMONSTRATE SCIENTIFIC MEASURE

13.1 Perform calculations and solve problems using scientific notation

13.2 Utilize appropriate SI (International System of Units) base units and prefixes for all measurements (e.g., milli, micro, and nano)

13.3 Construct, interpret, and apply graphs using software tools (e.g., spreadsheets)

13.4 Calculate appropriate statistics (e.g., mean, median, mode, range, standard deviation, and linear regression)