BIOSCIENCE 41.0100.00

TECHNICAL STANDARDS

An Industry Technical Standards Validation Committee developed and validated these standards on May 4 and May 14, 2021. The Arizona Career and Technical Education Quality Commission, the validating authority for the Arizona Skills Standards Assessment System, endorsed these standards on July 28, 2021.

Note: Arizona's Professional Skills are taught as an integral part of the Bioscience program.

The Technical Skills Assessment for Bioscience is available SY2022-2023.

Note: In this document i.e. explains or clarifies the content and e.g. provides examples of the content that must be taught.

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

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.)

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

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

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

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)

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.)

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

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

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

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

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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)

STANDARD 9.0 DEMONSTRATE PROTEIN TECHNIQUES

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

9.2 Extract proteins

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

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

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

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)

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)

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.)

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

STANDARD 12.0 DEMONSTRATE NUCLEIC ACID TECHNIQUES

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

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)

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

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

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

12.10 Design PCR primers

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)

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