

**Science Standard**  
**Catalina Foothills School District**  
**High School: Biology – Biotechnology Foundations**

Biology: Biotechnology Foundations is an inquiry-based laboratory course that incorporates the technology and principles that are used in the biotechnology industry. Students will use modern molecular laboratory techniques such as DNA extraction, DNA amplification and visualization of DNA on electrophoresis gels to investigate authentic research questions. A diverse range of topics such as cellular biology, genetics, evolution, and ecology are included in the course. Students will be engaged in activities that promote analytical thinking, systems thinking, scientific inquiry, and the development of higher-level cognitive skills. The course will make use of sophisticated laboratory equipment, technological resources, and media equipment to enhance the inquiry process.

---

### **INDUSTRY SAFETY PROCEDURES**

---

BIOTECH.1.1 Adhere to industry safety standards and material preparation in the classroom and laboratory setting for personal safety and the safety of others (required: SOPs for biological, biohazardous, and chemical materials).

BIOTECH.1.2 Safely operate and perform care and routine maintenance of equipment (for example: maintain equipment log, report unsafe and nonfunctioning equipment).

BIOTECH.1.3 Apply compliancy procedures for state, local, and industry regulations (for example: OSHA [occupational safety and health administration] SDS [safety data sheets], EPA [Environmental Protection Act], FDA [Federal Drug Administration], NIH [National Institute for Health], AZDEQ [Arizona Department of Educational Quality], safety data sheets [SDSs] for chemicals).

---

### **RESEARCH AND INVESTIGATIVE SKILLS**

---

BIOTECH.2.1 Summarize findings from patents, peer-reviewed articles, white papers, and technical bulletins, following the structure and convention of a scientific paper.

BIOTECH.2.2 Evaluate the scientific merit and commercial viability of prior work and its relevance to experimental design.

---

### **ETHICAL AND LEGAL CONDUCT**

---

BIOTECH.3.1 Comply with legal, regulatory, and accreditation standards or codes.

BIOTECH.3.2 Examine codes of ethics and protocols used by various organizations that apply to confidentiality and security.

BIOTECH.3.3 Adhere to standards for harassment, labor, and employment laws (for example: EPA, FDA, OSHA, NIH, AZDEQ).

---

### **SCIENTIFIC INQUIRY**

---

#### **SCIENTIFIC INQUIRY: GENERATING SCIENTIFIC QUESTIONS**

BIOTECH.4a.1 Frame testable questions showing evidence of observations and connections to prior knowledge.

BIOTECH.4a.2 Develop a testable question appropriate to the scientific domain being investigated.

#### **SCIENTIFIC INQUIRY: FORMULATING HYPOTHESES**

BIOTECH.4b.1 Develop a testable hypothesis based upon evidence of scientific principles, probability and/or modeling.

BIOTECH.4b.2 Distinguish relationships between variables (required: cause and effect or correlation) within a testable hypothesis.

#### **SCIENTIFIC INQUIRY: DESIGNING INVESTIGATIONS**

BIOTECH.4c.1 Use industry-recognized observational methods and skills.

BIOTECH.4c.2 Specify the parameters of measurement.

BIOTECH.4c.3 Describe suitable controls for the investigation.

BIOTECH.4c.4 Design procedures that appropriately address the hypothesis (for example: sample size, multiple trials).

BIOTECH.4c.5 Set up and maintain lab documentation according to standard operating procedures (SOPs) (for example: paper and/or electronic notebook).

#### **SCIENTIFIC INQUIRY: DATA COLLECTION**

BIOTECH.4d.1 Demonstrate proper use of laboratory equipment (for example: glassware, balances, micropipettes, spectrophotometers, thermal cyclers, and autoclaves).

BIOTECH.4d.2 Use units of measurement with appropriate degree of accuracy.

BIOTECH.4d.3 Create procedures that appropriately and adequately address the hypothesis (for example: adequate sample size, multiple trials).

BIOTECH.4d.4 Create a suitable method for collecting and recording data (including documentation of quality control testing using SOPs).

#### **SCIENTIFIC INQUIRY: ANALYSIS**

BIOTECH.4e.1 Interpret data to describe relationships between variables (for example: positive, negative, no relationship).

BIOTECH.4e.2 Incorporate mathematical analysis, where appropriate.

BIOTECH.4e.3 Perform appropriate statistical analysis (for example: mean, median, mode, range, standard deviation, linear regression).

BIOTECH.4e.4 Critique the investigation for possible sources of error and suggests corrections.

BIOTECH.4e.5 Construct, interpret, and apply graphs using software tools.

#### **CONCLUSIONS AND EXTENSIONS**

BIOTECH.4f.1 Make evidence-based predictions (for example: extrapolations and interpolations).

BIOTECH.4f.2 Evaluate whether the data support the hypothesis.

BIOTECH.4f.3 Communicate results of scientific investigations in oral, written, and graphical form.

---

## **INTERACTION OF SCIENCE AND SOCIETY**

---

BIOTECH.5.1 Describe the interaction of science, human curiosity and societal needs (for example: investigating the cell cycle to find out why cancer occurs and how to develop cures for it).

BIOTECH.5.2 Critically analyze the science concepts behind societal issues (for example: analyzing the ecological effects of land use).

---

## **SYSTEMS THINKING (CFSD Deep Learning Proficiency – DLP)**

---

BIOTECH.6a.1 Demonstrate critical thinking and scientific problem solving skills.

### **SYSTEMS THINKING: CHANGE OVER TIME**

BIOTECH.6b.1 Explains how a system's components change over time (for example: evolution of a species).

### **SYSTEMS THINKING: INTERDEPENDENCIES**

BIOTECH.6c.1 Explain the causal relationships in a system as being either positive or negative feedback relationships (for example: population fluctuation in predator and prey systems; protein feedback on gene transcription).

### **SYSTEMS THINKING: SYSTEM-AS-CAUSE**

BIOTECH.6d.1 Explain reasons why specific behaviors result from the organization of a system (for example: how plants balance photosynthesis with water loss) (System-As-Cause).

---

## **STRUCTURE AND FUNCTION OF CELLS**

---

BIOTECH.7.1 Describes the interaction of cell organelles in prokaryotes and eukaryotes.

BIOTECH.7.2 Analyzes the relationship between surface area-to-volume ratio and cell size.

BIOTECH.7.3 Compares and contrasts methods of cellular transport (required: diffusion, osmosis, active transport, passive transport).

BIOTECH.7.4 Describes the response of a cell in various environments.

---

## **MOLECULES, MACROMOLECULES, AND CELLS**

---

BIOTECH.8.1 Compare the structure, properties, function, and size of proteins, lipids, nucleic acids, carbohydrates, water, atoms, molecules, and macromolecules.

BIOTECH.8.2 Describe the spatial relationship and interaction of an organism's components, from atom to organism.

BIOTECH.8.3 Use the Bradford and Lowry methods to perform protein assays.

---

## **METABOLISM IN CELLS**

---

BIOTECH.9.1 Explain the system of ATP production (required: cellular respiration).

BIOTECH.9.2 Explain the purpose of photosynthesis (see Ecology).

BIOTECH.9.3 Examine the purpose and process of protein synthesis.

---

## **CELL CYCLES**

---

BIOTECH.10.1 Describe the system of DNA replication.

BIOTECH.10.2 Describe the cell cycle and how it maintains genetic continuity.

BIOTECH.10.3 Describe meiosis and fertilization and how they lead to genetic variation.

---

## **GENETICS**

---

BIOTECH.11.1 Outline the relationships among nucleic acids, genes, chromosomes and karyotype in viruses, prokaryotes, and eukaryotes.

BIOTECH.11.2 Perform basic molecular biology techniques (for example: transformation and optimized protein production).

BIOTECH.11.3 Apply the laws of Mendelian genetics (required: calculate the probability of phenotype and genotype from a monohybrid cross using a Punnett square).

BIOTECH.11.4 Describe the causes of genetic variation, cancer, and genetic disorders.

---

## **EVOLUTION**

---

BIOTECH.12.1 Provide evidence to support biogenesis.

BIOTECH.12.2 Explain the effects of major events in the evolution of earth and life.

BIOTECH.12.3 Provide evidence to support evolutionary theory.

---

## **PHYLOGENY AND THE TREE OF LIFE**

---

BIOTECH.13.1 Analyze the degree of relatedness among various species using cladistics, phylogeny, morphology, and DNA analysis.

BIOTECH.13.2 Explain the relationship of mutations, adaptation and environmental change with natural selection, speciation and biodiversity.

BIOTECH.13.3 Access and interpret gene and genome maps.

---

## **ECOLOGY**

---

BIOTECH.14.1 Analyze the relationships and dynamics among levels of organization (required: organism to biosphere) within the biosphere.

BIOTECH.14.2 Relate biogeochemical cycles and energy flow (required: nitrogen, carbon, phosphorous, water, rock, food webs, process of photosynthesis).

BIOTECH.14.3 Describe the process of photosynthesis.

BIOTECH.14.4 Evaluate human effects on environment and resources.

---

### **WORKPLACE EMPLOYABILITY: PROFESSIONALISM**

---

BIOTECH.15.1 Represent the school [organization] in a positive manner, demonstrating the school's [or organization's] mission and core values.

BIOTECH.15.2 Demonstrate respect for personal and professional boundaries (distinguish between personal and work-related matters).

BIOTECH.15.3 Interact respectfully with others and act with integrity.

BIOTECH.15.4 Produce high quality work that reflects professional pride and contributes to organizational success.

BIOTECH.15.5 Take initiative to develop skills to improve work performance.

---

### **WORKPLACE EMPLOYABILITY: COMMUNICATION**

---

BIOTECH.16.1 Communicate effectively in preparation for a diverse work environment (required: style and format appropriate to audience/culture/generation, purpose and context; accuracy; use of appropriate technical language; to resolve conflicts; address intergenerational differences/challenges; persuade others).

BIOTECH.16.2 Use appropriate technologies and social media to enhance or clarify communication.

BIOTECH.16.3 Use a variety of interpersonal skills, including tone of voice and appropriate physical gestures (for example: eye contact, facing the speaker, active listening) during conversations and discussions to build positive rapport with others.

BIOTECH.16.4 Pose and respond to questions, building upon others' ideas in order to enhance the discussion; clarify, verify, or challenge ideas and conclusions with diplomacy.

---

### **WORKPLACE EMPLOYABILITY: SELF-REGULATION**

---

BIOTECH.17.1 Apply the skills and mindset of self-regulation to accomplish a project.

BIOTECH.17.2 Select and use appropriate technologies to increase productivity.

BIOTECH.17.3 Exercise initiative and leadership (for example: recognize and engage individual strengths, plan for unanticipated changes, pursue solutions/improvements).

---

### **WORKPLACE EMPLOYABILITY: CRITICAL THINKING AND PROBLEM SOLVING**

---

BIOTECH.18.1 Identify problems and use strategies and resources to innovate and/or devise plausible solutions.

BIOTECH.18.2 Take action or make decisions supported by evidence and reasoning.

BIOTECH.18.3 Transfer knowledge/skills from one situation/context to another

---

## **WORKPLACE EMPLOYABILITY: COLLABORATION**

---

BIOTECH.19.1 Perform any role on a team and accurately describe and perform the duties of each role, including leadership.

BIOTECH.19.2 Integrate diverse ideas, opinions, and perspectives of the team and negotiate to reach workable solutions.

BIOTECH.19.3 Prioritize and monitor individual and team progress toward goals, making sufficient corrections and adjustments when needed.

BIOTECH.19.4 Submit high-quality products that meet the specifications for the assigned task.

Note: This is a CTE/JTED course