Scope & Sequence

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| Course Name: Biotechnology I **TSDS PEIMS Code:** 13036400 | | | **Course Credit:** 1.0  **Course Requirements:** Recommended for students in Grades 11-12.  **Prerequisite:** Biology.  **Recommended Prerequisites:** Principles of Biosciences and Chemistry. |
| **Course Description:** In Biotechnology I, students will apply advanced academic knowledge and skills to the emerging fields of biotechnology such as agricultural, medical, regulatory, and forensics. Students will have the opportunity to use sophisticated laboratory equipment, perform statistical analysis, and practice quality-control techniques. Students will conduct laboratory and field investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving. Students in Biotechnology I will study a variety of topics that include structures and functions of cells, nucleic acids, proteins, and genetics. Students must meet the 40% laboratory and fieldwork requirement. This course satisfies a high school science graduation requirement. | | | |
| **NOTE:** This is a suggested scope and sequence for the course content. This content will work with any textbook or instructional materials. If locally adapted, make sure all TEKS are covered. | | | |
| **Total Number of Periods**  **Total Number of Minutes**  **Total Number of Hours** | 175 Periods  7,875 Minutes  131.25 Hours | \*Schedule calculations based on 175/180 calendar days. For 0.5 credit courses, schedule is calculated out of 88/90 days. Scope and sequence allows additional time for guest speakers, student presentations, field trips, remediation, extended learning activities, etc. | |

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| **Unit Number, Title, and Brief Description** | **# of Class Periods\***  (assumes 45-minute periods)  Total minutes per unit | **TEKS Covered**  **130.415. (c) Knowledge and skills** |
| **Unit 1: Exploration of the Emerging STEM Field of Biotechnology**  In this unit, students will further their knowledge of the biotechnology field including products, applications and career opportunities. Students will explore applications of biotechnology in fields from genetics to agriculture and medicine.The unit culminates with an activity in which students define biotechnology and provide examples of biotechnology products. | 10 Periods  450 Minutes | (5) The student explores the emerging field of biotechnology. The student is expected to:  (A) define biotechnology and provide examples of biotechnology products such as recombinant proteins, fermented foods, biopharmaceuticals, and genetically modified foods;  (B) apply scientific processes and concepts outlined in the Texas essential knowledge and skills (TEKS) for Biology relevant to biotechnology, including all types of cells; cellular structures and functions; and viruses;  (C) explore applications of bioinformatics such as deoxyribonucleic acid (DNA) barcoding, phylogenetic relationships, and the use of online databases;  (D) research career opportunities in fields such as molecular, forensic, medical, regulatory, and agricultural biotechnology;  (E) research the history of biotechnology and contributions of scientists;  (F) define bioethics and research applications of bioethics;  (G) research applications in agricultural biotechnology such as tissue culturing, genetically modified foods, plant propagation, and hydroponics; and  (H) research applications in medical biotechnology such as vaccines, stem cells, microarrays, and pharmaceutical production. |
| **Unit 2: Biotechnology Basics**  Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions. In this unit, the student will plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting, handling, and maintaining appropriate equipment and technology. The culminating activity for this unit will have students demonstrate the use of course apparatus, equipment, techniques, and procedures. | 12 Periods  540 Minutes | (3) The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:  (A) know the definition of science and understand that it has limitations, as specified in subsection (b)(4) of this section;  (B) know that hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories;  (C) know that scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well-established and highly-reliable explanations, but they may be subject to change as new areas of science and new technologies are developed;  (D) distinguish between scientific hypotheses and scientific theories;  (E) plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting, handling, and maintaining appropriate equipment and technology;  (F) collect data individually or collaboratively, make measurements with precision and accuracy, record values using appropriate units, and calculate statistically relevant quantities to describe data, including mean, median, and range;  (G) demonstrate the use of course apparatus, equipment, techniques, and procedures;  (H) organize, analyze, evaluate, build models, make inferences, and predict trends from data;  (I) perform calculations using dimensional analysis, significant digits, and scientific notation; and  (J) communicate valid conclusions using essential vocabulary and multiple modes of expression such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports. |
| **Unit 3: Safety Precautions and Regulations in Biotechnology**  In this unit, students will comply with federal and state safety regulations as specified by Occupational Safety and Health Administration (OSHA) and other regulatory agencies. Students will identify and obey safety symbols and signs in the biotechnology industry. The culminating activity will have students demonstrate appropriate safety procedures, and guidelines, including chemical hygiene and personal protection. | 13 Periods  585 Minutes | (2) The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. These investigations must involve actively obtaining and analyzing data with physical equipment, but may also involve experimentation in a simulated environment as well as field observations that extend beyond the classroom. The student is expected to:  (A) demonstrate safe practices during laboratory and field investigations, including chemical, electrical, and fire safety, and safe handling of live and preserved organisms;  (B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials;  (C) demonstrate appropriate safety procedures, guidelines, and chemical hygiene plan;  (D) maintain required safety training, including location and understanding of interpretation of safety data sheets;  (E) comply with federal and state safety regulations as specified by Occupational Safety and Health Administration (OSHA) and other regulatory agencies as appropriate;  (F) identify and obey safety symbols and signs;  (G) maintain clean and well organized work areas;  (H) dispose of equipment, glassware, and biologics according to laboratory policies;  (I) recognize common laboratory hazards;  (J) observe procedures for the safe use of instruments, gas cylinders, and chemicals; and  (K) maintain safety and personal protection equipment. |
| **Unit 4: Scientific Reasoning in Biotechnology**  Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation can be experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked. In this unit, students will use critical thinking, scientific reasoning, and problem solving to make informed decisions. The unit will culminate with an activity where students will describe the connection between biotechnology and future careers*.* | 13 Periods  585 Minutes | (4) The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:  (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking;  (B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;  (C) draw inferences based on data related to promotional materials for products and services;  (D) evaluate the impact of research and technology on scientific thought, society, and the environment;  (E) evaluate models according to their limitations in representing biological objects or events;  (F) describe the connection between biotechnology and future careers; and  (G) research and describe the history of biotechnology and contributions of scientists. |
| **Unit 5: Comparing Biotechnology Laboratory Procedures and Applications in Each Sector**  The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services, including laboratory and testing services, and research and development services. In this unit, students will identify the major sectors of the biotechnology industry and compare the different applications used in those respective biotechnology laboratory procedures. Students will summarize their findings as they relate to the biotechnology industry. | 12 Periods  540 Minutes | (6) The student summarizes biotechnology laboratory procedures and their applications in the biotechnology industry. The student is expected to:  (A) identify the major sectors of the biotechnology industry;  (B) categorize the biotechnology laboratory procedures included in each sector; and  (C) compare the different applications used in biotechnology laboratory procedures of each sector. |
| **Unit 6: Genetics in Biotechnology**  A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment. In this unit, students will explore the system of genetics in the biotechnology industry. Students will engage in activities such as comparing and contrasting various structures and functions of deoxyribonucleic acid (DNA) as they relate to cells and viruses. The culminating activity for this unit will include illustrating and describing such systems such as DNA replication and protein synthesis. | 13 Periods  585 Minutes | (7) The student understands the role of genetics in the biotechnology industry. The student is expected to:  (A) explain terms related to molecular biology including nucleic acids, nitrogen bases, amino acids, transcription, translation, polymerase, and protein synthesis;  (B) describe the structure and function of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) in cells and viruses;  (C) compare and contrast the nitrogen bases of DNA and RNA;  (D) explain how nucleotides join together to form a DNA double helix;  (E) describe the DNA replication process in eukaryotic and prokaryotic cells;  (F) illustrate the process of protein synthesis; and  (G) describe the structure and function of proteins, including 3D folding, enzymes, and antibodies. |
| **Unit 7: The Importance of Recombinant DNA Technology and Genetic Engineering**  This unit will cover the fundamental steps in recombinant DNA technology and genetic modification procedures. Students will participate in activities from describing plant- and animal-tissue culture procedures to comparing and contrasting proper growing conditions for plant and animal tissue cultures. The culminating activity for this unit will have students explain the role of restriction enzymes and steps and components of the polymerase chain reaction. | 16 Periods  720 Minutes | (8) The student analyzes the importance of recombinant DNA technology and genetic engineering. The student is expected to:  (A) describe the fundamental steps in recombinant DNA technology;  (B) explain how recombinant DNA technology is used to clone genes and create recombinant proteins;  (C) explain the role of tissue cultures to genetic modification procedures;  (D) describe plant- and animal-tissue culture procedures;  (E) compare and contrast proper growing conditions for plant and animal tissue cultures;  (F) explain the role of restriction enzymes;  (G) distinguish among vectors commonly used in biotechnology for DNA insertion, including plasmids, retroviruses, and bacteriophages; and  (H) explain the steps and components of the polymerase chain reaction. |
| **Unit 8: Biotechnology Laboratory Procedures**  Students will conduct laboratory and field investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving. Students will practice measuring volumes and weights in industry standards, analyze data, and perform analysis of biotechnology experiments. The culminating activity for this unit will be to document laboratory results and prepare a restriction digest and analyze results using gel electrophoresis. | 15 Periods  675 Minutes | (10) The student performs standard biotechnology laboratory procedures. The student is expected to:  (A) identify and operate laboratory equipment, including a microscope, thermocycler, hood, pH meter, hot plate stirrer, balance, mixers, autoclave, power supply, micropipette, centrifuge, and electrophoresis unit;  (B) practice measuring volumes and weights to industry standards;  (C) analyze data and perform calculations and statistical analysis as it relates to biotechnology laboratory experiments;  (D) demonstrate proficiency pipetting techniques;  (E) identify microorganisms using staining methods such as the Gram stain, methylene-blue stain, and acid-fast staining;  (F) document laboratory results; and  (G) prepare a restriction digest and analyze results using gel electrophoresis. |
| **Unit 9:Biotechnology Laboratory Solutions and Reagents**  In this unit, students will prepare, dispense and monitor physical properties of stock reagents, buffers, media, and solutions. The culminating activity will have students determine optimum conditions of reagents for experimentation. | 15 Periods  675 Minutes | (11) The student prepares solutions and reagents for the biotechnology laboratory. The student is expected to:  (A) demonstrate techniques for establishing and maintaining a sterile work area;  (B) prepare, dispense, and monitor physical properties of stock reagents, buffers, media, and solutions;  (C) calculate and prepare a dilution series; and  (D) determine optimum conditions of reagents for experimentation. |
| **Unit 10: Advanced Biotechnology Laboratory**  Scientific decision-making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods (science methods) and ethical and social decisions that involve science (the application of scientific information). In this unit, students will perform advanced labs including isolating, maintaining, and storing microbial cultures safely and performing a bacterial transformation and analyzing gene expression. The culminating activity will have students amplify a DNA sequence using the polymerase chain reactions. | 15 Periods  675 Minutes | (12) The student performs advanced biotechnology laboratory procedures. The student is expected to:  (A) explain the importance of media components to the outcome of cultures;  (B) isolate, maintain, and store microbial cultures safely;  (C) prepare seed inoculum;  (D) perform plating techniques such as the Kirby-Bauer method;  (E) analyze proteins using techniques such as enzyme-linked immunosorbent assay (ELISA), spectrophotometry, and sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE);  (F) isolate a specific protein from a biological sample using chromatography;  (G) isolate nucleic acids and interpret gel electrophoresis results;  (H) perform a bacterial transformation and analyze gene expression; and  (I) amplify a DNA sequence using the polymerase chain reactions. |
| **Unit 11: Quality Control Analysis in Biotechnology Laboratory**  Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable. In this unit, students will conduct quality-control analysis during laboratory procedures. | 15 Periods  675 Minutes | (13) The student conducts quality-control analysis while performing biotechnology laboratory procedures. The student is expected to:  (A) perform validation testing on laboratory reagents and equipment; and  (B) analyze data and perform calculations and statistical analysis on results of quality-control samples such as trending of data. |
| **Unit 12: Employability Skills**  This unit offers students basic technical skills necessary to fulfill careers in the workforce.  Through group activities, students will demonstrate interpersonal skills, such as: communication, professionalism, decision-making, leadership, and conflict resolution. The unit culminates with a peer review evaluation and reflection upon skills needed for success in the workforce. | 13 Periods  585 Minutes | (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:  (A) demonstrate knowledge of how to dress appropriately, speak politely, and conduct oneself in a manner appropriate for the profession;  (B) show the ability to cooperate, contribute, and collaborate as a member of a group in an effort to achieve a positive collective outcome;  (C) present written and oral communication in a clear, concise, and effective manner;  (D) demonstrate time-management skills in prioritizing tasks, following schedules, and performing goal-relevant activities in a way that produces efficient results; and  (E) demonstrate punctuality, dependability, reliability, and responsibility in performing assigned tasks as directed. |
| **Unit 13: Extended Learning Experience**  In this unit, students are encouraged to expand their learning experiences through avenues such as STEM organizations and other leadership or extracurricular organizations. By connecting with these networks, students will be able to analyze policies and procedures and discuss the relationship between the local, state, and federal agencies responsible for regulation of the biotechnology industry. The culminating activity will have students reflect on careers in this field. | 13 Periods  585 Minutes | (9) The student examines federal, state, local, and industry regulations as related to biotechnology. The student is expected to:  (A) discuss the relationship between the local, state, and federal agencies responsible for regulation of the biotechnology industry; and  (B) analyze policies and procedures used in the biotechnology industry such as quality assurance, standard operating procedures (SOPs), Good Manufacturing Practices (GMPs), and International Organization for Standardization (ISO) quality systems. |