Career and Technical Education TEKS Review Draft Recommendations

Texas Essential Knowledge and Skills (TEKS) for Career and Technical Education Draft Recommendations

Science, Technology, Mathematics, and Engineering (STEM) Cluster

Programs of Study:

Biomedical Sciences

The document reflects draft recommendations to the career and technical education Texas Essential Knowledge and Skills (TEKS) that have been recommended by the State Board of Education's TEKS review work groups for the following programs of study from the STEM Career Cluster: **Biomedical Sciences**.

Proposed additions are shown in green font with underline (additions). Proposed deletions are shown in red font with strikethroughs (~~deletions~~). Text proposed to be moved from its current student expectation is shown in purple italicized font with strikethrough (*~~moved text~~*) and is shown in the proposed new location in purple italicized font with underlines (*new text location*). Numbering for the knowledge and skills statements in the document will be finalized when the proposal is prepared to file with the *Texas Register*.

Comments in the right-hand column provide explanations for the proposed changes. The following notations may be used as part of the explanations.

Skills Gap/Gap Analysis:	refers to gap analysis report on essential knowledge and skills aligned to in-demand high-wage occupations
CCRS:	refers to the College and Career Readiness Standards
MV:	refers to multiple viewpoints expressed by work group members

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§130.403. Principles of Biosciences.		
	TEKS with edits	Work Group Comments/Rationale
(a)	General requirements. This course is recommended for students in Grades 9 and 10. Students shall be awarded one credit for successful completion of this course.	
(b)	Introduction.	
(1)	Career and technical education instruction provides content aligned with challenging academic standards, industry ~~and~~ relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and ~~or~~ emerging professions.	Edits from Introduction Subcommittee.
(2)	The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services~~,~~ such as ~~including~~ laboratory and testing services, and research and development services.	Edits from Introduction Subcommittee.
(3)	Principles of Biosciences provides an overview of biotechnology, bioengineering, and related fields. Topics related to genetics, proteins, and nucleic acids reinforce the applications of Biology content. ~~Principles of Biosciences is a strong reinforcement of Biology content that provides an overview of biotechnology, bioengineering, and related fields. Topics include genetics, cell structure, proteins, nucleic acids, and the impact of immunological events in biotechnology.~~ Students will further study the increasingly important agricultural, environmental, economic, and political roles of bioenergy and biological remediation; the roles of nanoscience and nanotechnology in biotechnology medical research; and future trends in biological science and biotechnology.	The order of statements was changed to emphasize the purpose of the course followed by how it can support the Biology course.
(4)	Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.	
(5)	Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.	
(c)	Knowledge and skills.	
(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;	More active verb choice because students should demonstrate the standards and skills.
(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.	
(2)	The student explores biotechnology career opportunities. The student is expected to:	
(B)~~(A)~~	determine interests in the field of biotechnology through explorations such as career assessments, interactions with biotechnology professionals, media, and literature ~~and aptitudes through conversations with biotechnology professionals~~;	Interests in any field can be explored using a variety of accessible resources. Multiple possible illustrative examples were added. Aptitudes was deleted because they can be determined in subsequent courses.
(A)~~(B)~~	identify career options in the field of biotechnology;	It is more logical to explore career options before determining career interests.
(C)	identify reliable sources of career information;	
(D)	research and communicate interests, knowledge, educational level, abilities, and skills needed in a biotechnology-related occupation;	Communicating research about a biotechnology-related occupation with peers and instructors can enhance biotechnology career exploration while improving college and career readiness skills.
~~(E)~~	~~seek a mentor in the biotechnology area;~~	This skill would be more appropriate for more senior students.
(E)~~(F)~~	identify conventional and non-conventional career opportunities that match interests and aptitudes;	
(F)~~(G)~~	research applications of biotechnology ~~and biomaterials~~ ~~***such as***~~ ~~the areas of~~ in medicine, ~~and~~ the environment, and ***settings*** ***such as*** pharmaceutical, agricultural, and industrial ~~***settings***~~; ~~and~~	Streamlined grammar and deleted biomaterials as it was superfluous.
(G)~~(H)~~	use technology to research biotechnology topics, including identifying and selecting appropriate scholarly references; and ~~identify pertinent scientific articles, obtain articles of interest, and write a formal research paper in the format used by academic and professional journals and magazines.~~	Information gathering and evaluation is more important at a freshman level than creating a formal research paper.
(H)	analyze and discuss professional publications such as academic and peer-reviewed journals and technical reports.	Expanded to include professional publication and peer-reviewed journals based on industry feedback. CCRS: ELA V.B.1-3

(3)	The student evaluates ethical and legal issues in biotechnology. The student is expected to:	CCRS: Science IV.B1-2
(A)	identify current ethical and legal issues;	
(B)	describe the history of biotechnology and related current ethical and legal issues;	Added "ethical and legal" to better clarify what types of issues to concentrate on.
(C)	discuss legal and technology issues for at least two biotechnology related areas; and	
(D)	analyze ~~compare and contrast~~ examples of ***biotechnology views*** supported by objective and subjective sources such as scientific data, economic data, and sociocultural contexts ~~political data and positions used to defend~~ ~~***biotechnology views***~~.	Replaced "compare and contrast" with the broader term "analyze". Clarified that the intent is to analyze biotechnology views using possible illustrative examples. Removed "political data and positions" to make the focus on a range of sources of objective and subjective data. Aligned to Math CCRS VI.(B)(C)
(4)	The student examines federal, state, local, and industry regulations as applied to biotechnological ~~biotechnical~~ processes through researching credible sources ~~library research and Internet research~~. The student is expected to:	Revised to include credible sources as an integral part of the research process. Replaced "biotechnical" with "biotechnological", a more appropriate and aligned adjective.
(A)	identify local, state, and federal agencies responsible for regulating the biotechnology industry such as the U.S. Department of Agriculture (USDA), the Environmental Protection Agency (EPA), the U.S. Food and Drug Administration (FDA), and the Centers for Disease Control and Prevention (CDC);	
(B)	identify professional organizations participating in the development of biotechnology policies;	
(C)	identify and define terms related to biotechnology regulations such as Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP), and Globally Harmonized System (GHS); and	Added illustrative examples.
(D)	outline the methods and procedures used in biotechnology laboratories to follow ~~and enforce~~ local, state, and federal regulations such as those in the agricultural and health areas.	Typically, laboratories are not the entities responsible for enforcing regulations.
(5)	The student demonstrates knowledge of the business climate for biotechnology industry sectors in the current market. The student is expected to:	
(A)	identify professional publications;	
(B)	identify the various biotechnology industry sectors; ~~and~~	
(C)	investigate and report on career opportunities in the biotechnology industry sectors~~.~~; and	

(D)	identify professional organizations such as those at the local, state, and national levels.	Identifying professional organizations is a key aspect of learning about industry sectors and networking. Professional organizations provide extended learning experiences mentioned in Introduction statement §130.403 (b)(4).
(6)	The student researches and exhibits employability skills that support a career in the biotechnology industry. The student is expected to:	
(A)	demonstrate verbal, nonverbal, written, and electronic communication skills;	
(B)	demonstrate skills used to secure and maintain employment;	
(C)	demonstrate appropriate workplace etiquette; and	
(D)	display productive work habits and attitudes.	
(E)	identify appropriate safety equipment and practices as outlined in Texas Education Agency-approved and industry-approved safety standards, such as the use of Personal Protective Equipment (PPE) and Safety Data Sheets (SDS)	Added to emphasize safe working practices in the CCRS I.C.2 Addressed the skills gap of ensuring compliance with policies or regulations.
(7)	The student investigates how biotechnology impacts the origins of waste and ~~examines the relationship of biotechnology to~~ resource recovery. The student is expected to:	Streamlined language to reduce the original two phrases to one single phrase.
(A)	Identify ~~investigate~~ ***biotechnology manufacturing processes*** ~~at least three~~ and their end products, including waste and marketable products ~~from~~ ~~***biotechnology manufacturing processes***~~;	Clarifies the association between processes and types of end products.
(B)	Explore ~~investigate~~ the impacts ~~effects~~ of waste on biotic and abiotic factors in the environment such as effects on ***biological life cycles and*** pollution from nonbiodegradable single-use materials and microplastics ~~environmental~~ ~~***and biological life cycles***~~;	Adding clarity to the types of pollution found in biotechnology and giving topical examples for teachers new to the field.
~~(C)~~	~~investigate the impacts of waste on the environment;~~	Combined with (7)(B).
(C)~~(D)~~	analyze the results of manufacturing refuse;	
(D)~~(E)~~	explain the negative impacts of waste with respect to the individual, society, and the global population;	
(E)~~(F)~~	investigate ~~research~~ solutions to ~~biological~~ waste ~~with respect to commercial applications~~ through ~~investigation of various pollution waste treatments using natural organisms~~ bioremediation; and	Bioremediation is the most commonly used term to describe the statement that was deleted. Commercial applications was removed to allow a broader interpretation outside of the business sector.

~~(G)~~	~~investigate biotechnology as it relates to health and well-being; and~~	The "negative impacts" mentioned in (7)(D) can include impacts on health and well-being, so this student expectation is redundant and not necessary.
(F)~~(H)~~	Investigate ~~cite~~ evidence supporting waste management through ~~regarding~~ regulations, ~~patents and~~ public policy, ~~design development and testing,~~ and technology development ~~safety~~.	Investigate is a higher level verb than citing evidence. Technology development includes patents, design development, and testing. Clarification on the purpose of the student expectation, focusing on the history of biotechnological waste and its effects and the regulation created to prevent it. Waste management was added to clarify the context of the related Knowledge Skills statement.
(8)	The student examines the relationship of biotechnology to the development of commercial products. The student is expected to:	
~~(A)~~	~~identify the ability to change or enhance genetic characteristics;~~	Re-organized topics by broad industry sectors in new 8(A), (B), (C) and (D) to improve clarity and provide illustrative examples.
~~(B)~~	~~identify applications of genetic engineering;~~	Added the applications of genetic engineering to (8)(A)-(F).
~~(C)~~	~~identify applications of nanotechnology in biotechnology;~~	Added the applications of nanotechnology to (8)(E) and (F).
~~(D)~~	~~identify applications of bioinformatics in biotechnology;~~	Added the applications of bioinformatics to (8)(E) and (F).
(A)	identify applications of agricultural biotechnology such as selective breeding of livestock and plants, aquaculture, horticultural products, and genetically modified organisms;	
(B)	identify applications of industrial biotechnology such as fermented food and beverages, genetically engineered proteins for industry, biocatalysts, bio polymers, biosensors, bioremediation, and biofuels;	
(C)	identify applications of medical and pharmaceutical biotechnology such as genetically modified cells, antibodies, vaccine and gene therapy, genetic testing for human disease/disorders, 3D bio printing, and medicines from plants, animals, fungi, and bacteria;	

(D)	identify applications of research and development in biotechnology such as DNA and protein synthesis and sequencing, genetic testing and screening, DNA identification, RNAi, siRNA, miRNA, the CRISPR/Cas system, and synthetic biology;	
(E)	identify the applications of biotechnology in the fields ~~such as medicine,~~ of forensics~~, and~~ law enforcement, nanotechnology, and bioinformatics; and	Medicine was deleted because it is a focus of (8)(C). Bioinformatics was added based on industry feedback.
(F)	research ethical considerations, laws, and regulations ~~governing~~ for biotechnological applications such as bioinformatics, genetic engineering and nanotechnology.	Emphasized the focus on applications and expanded possible illustrative examples to include bioinformatics. Addressed the skills gap of ensuring compliance with policies or regulations.
(G)	identify the function of laboratory equipment, including a microscope, thermocycler, pH meter, hot plate stirrer, electronic balance, autoclave, centrifuge, transilluminator, micropipette, incubator, electrophoresis unit, vortex mixer, water baths, laboratory glassware, biosafety cabinet, and chemical fume hood.	Identifying the function of common biotechnology laboratory equipment, including equipment from the Biotechnology I course, was added. CCRS; I.C.3, I.D.3

§130.415. Biotechnology I (One Credit), Adopted 2015.		
	TEKS with edits	Work Group Comments/Rationale
(a)	General requirements. This course is recommended for students in Grades 11 and 12. Prerequisite: Biology. Recommended prerequisites: Principles of Biosciences and Chemistry. Students must meet the 40% laboratory and fieldwork requirement. This course satisfies a high school science graduation requirement. Students shall be awarded one credit for successful completion of this course.	
(b)	Introduction.	
(1)	Career and technical education instruction provides content aligned with challenging academic standards, industry ~~and~~ relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and ~~or~~ emerging professions.	Edits from Introduction Subcommittee.
(2)	The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services~~,~~ such as ~~including~~ laboratory and testing services, and research and development services.	Edits from Introduction Subcommittee.
(3)	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 *and* the engineering design process. Students in Biotechnology I will study a variety of topics that include structures and functions of cells, nucleic acids, proteins, and genetics.	The suggested deletion allows for the possibility of other methods, including engineering and scientific practices, during investigations; scientific problem solving is mentioned at the end of the sentence.
(4)	Nature of science. 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 currently scientifically testable. ~~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.~~	

(5)	Scientific hypotheses and theories. Students are expected to know that: ~~Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation are experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.~~	
(A)	hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories; and	
(B)	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.	
(6)	Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified. ~~Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information).~~	
(A)	Scientific practices. Students should be able to ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models.	
(B)	Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models.	
(7)	Science and social ethics. Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information). ~~A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in 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.~~	
(8)	Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. All systems have basic properties that can be described in 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, while models allow for boundary specification and provide a tool for understanding the ideas presented. 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.	
(9)~~(8)~~	Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.	
(10)~~(9)~~	Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.	
(c)	Knowledge and skills.	
(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.	
(2)	Scientific and engineering practices. The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to explain phenomena, or design solutions using appropriate tools and models. The student is expected to:	Scientific and engineering practices approved for science high school courses.
(A)	ask questions and define problems based on observations or information from text, phenomena, models, or investigations;	

(B)	apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;	
(C)	use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;	
(D)	use appropriate tools such as microscopes, thermocyclers, pH meters, hot plate stirrers, glass bulb thermometers, timing devices, electronic balances, vortex mixers, autoclaves, micropipettes, centrifuges, gel and capillary electrophoresis units, cameras, data collection probes, spectrophotometers, transilluminators, incubators, water baths, laboratory glassware, biosafety cabinets, and chemical fume hoods;	Moved equipment from 10(A) and added additional course specific equipment.
(E)	collect quantitative data using the International System of Units (SI) and United States customary units and qualitative data as evidence;	
(F)	organize quantitative and qualitative data using laboratory notebooks, written lab reports, graphs, charts, tables, digital tools, diagrams, scientific drawings, and student-prepared models;	Added data organization methods used in science course TEKS.
(G)	develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and	
(H)	distinguish among scientific hypotheses, theories, and laws.	
(3)	Scientific and engineering practices. The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:	
(A)	identify advantages and limitations of models such as their size, scale, properties, and materials;	
(B)	analyze data by identifying significant statistical features, patterns, sources of error, and limitations;	
(C)	use mathematical calculations to assess quantitative relationships in data; and	
(D)	evaluate experimental and engineering designs.	
(4)	Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:	
(A)	develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;	
(B)	communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and	

(C)	engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.	
(5)	Scientific and engineering practices. The student knows the contributions of scientists and recognizes the importance of scientific research and innovation on society. The student is expected to:	
(A)	analyze, evaluate, and critique scientific explanations and solutions by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student;	
(B)	relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists and engineers as related to the content; and	
(C)	research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a science, technology, engineering, and mathematics (STEM) field ~~in order to investigate STEM~~.	
~~(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:~~	Replaced with scientific and engineering practices
~~(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.~~	
~~(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.~~	
~~(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.~~	
(6)~~(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;~~	
(B)~~(C)~~	compare ~~explore~~ applications of bioinformatics such as deoxyribonucleic acid (DNA) barcoding, sequencing, National Center for Biotechnology Information (NCBI) tools, ClinVar, Genemonon Mastermind, genetic testing, phylogenetic relationships, and the use of online databases;	The NCBI is commonly used in industry to access biomedical and genomic information and added recommendations from science reviewers and industry feedback. CCRS: 3.D.1
(C)~~(D)~~	research and identify career opportunities in genetics, bioinformatics, and in fields such as molecular, forensic, medical, regulatory, and agricultural biotechnology;	Added genetics and bioinformatics based on industry feedback.
(D)~~(E)~~	identify significant contributions of diverse scientists to biotechnology and explain their impact on society ~~research the history of biotechnology and contributions of scientists~~;	Added diverse to be inclusive of different contributions and changed the verb to make it more measurable. CCRS: 4.A.1, 4.C.(1)(2)
(E)~~(F)~~	define bioethics and evaluate the ~~research~~ applications of bioethics;	Changed “research” to “evaluate” to increase cognitive complexity based on feedback from science reviewers. CCRS: 4.B.1
(F)~~(G)~~	evaluate different points of view about issues and current events in biotechnology;	Added-based on a recommendation from science reviewers.
(G)	identify ~~research~~ applications in agricultural biotechnology such as ~~tissue culturing,~~ genetically modified organisms (GMOs)~~foods~~, plant propagation from tissue culturing, and aquaculture ~~hydroponics~~; ~~and~~	Keep agricultural for consistency between courses and to be more inclusive. GMOs includes plant and animal organisms.

		We did not choose to move the terms because we clarified elements within the standard.
(H)	identify ~~research~~ applications in medical biotechnology such as vaccine~~s~~ production, stem cell~~s~~ therapy, gene therapy, ~~microarrays,~~ ~~*and*~~ pharmaceutical production, pharmacogenetics, genomics, synthetic biology, *and* personalized medicine;	Clarified language and added relevant modern applications in medicine. CCRS: 4.A.1
(I)	identify applications in forensic biotechnology such as capillary electrophoresis, real-time polymerase chain reaction, DNA fingerprinting, restriction fragment length polymorphisms (RFLP) analysis, toxicology, and serology; and	Suggested by content advisor, science reviewers, and industry feedback. Changed the verb for measurability.
(J)	identify and evaluate solutions to waste through bioremediation and non-biotechnological standard solutions such as landfills, incineration, absorbent materials, and catalytic materials.	This application is included in the Principles of Biosciences course. It is an important example that is worth adding to this course. Added based on a recommendation from science reviewers.
(7)~~(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 such as medical and pharmaceutical, agricultural, industrial, forensics, and research and development;	Improve clarity and provide illustrative examples.
(B)	identify ~~categorize the~~ biotechnology laboratory procedures used ~~included~~ in each sector such as selective breeding, genetic engineering, DNA analysis, and protein analysis; and	Improve clarity of the statement; some procedures are used in multiple sectors. Added illustrative examples based on recommendation from science reviewers.
(C)	compare and contrast the different applications used in biotechnology laboratory procedures of each sector.	Added based on a recommendation from science reviewers.
(8)~~(7)~~	The student understands the role of genetics in the biotechnology industry. The student is expected to:	Science CCRS: VI.D.3
(A)	explain terms related to molecular biology, including nucleic acids, nitrogen bases, nucleotides, mRNA, rRNA, tRNA, ribosomes, amino acids, transcription, translation, polymerase, and protein synthesis;	Expanded the list to include relevant terms important to molecular biology.
(B)	compare and contrast ~~describe~~ the structure and function of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA), ~~in cells and viruses~~ including nitrogen bases, nucleotides, the helical nature of DNA, and hydrogen bonding between purines and pyrimidines;	Combined (7)(C) and (7)(D) with (7)(B) based on recommendations from science reviewers. The components of the two deleted student expectations below are necessary elements of the structure and function.
(C)	distinguish between nuclear and mitochondrial DNA and their gamete sources;	Added based on a recommendation from a content advisor and industry feedback.
~~(C)~~	~~compare and contrast the nitrogen bases of DNA and RNA;~~	

~~(D)~~	~~explain how nucleotides join together to form a DNA double helix;~~	
(D)~~(E)~~	describe the DNA replication process in eukaryotic and prokaryotic cells, including leading and lagging strands and Okazaki fragments;	Added more specificity related to DNA strands based on a recommendation from the content advisor.
(E)~~(F)~~	illustrate the process of protein synthesis, including ribosomal subunits and the role of tRNA; ~~and~~	Added specific components involved in the process that must be mastered.
(F)~~(G)~~	describe the structure and function of proteins, including 3D folding, enzymes, and antibodies;~~.~~	
(G)	explain the molecular structure of genes, including enhancers, promoters, exons, introns, and coding regions;	Added based on a recommendation from the content advisor.
(H)	describe the different types of mutations including inversions, deletions, duplications, and substitutions;	Added based on recommendation from science reviewers and industry feedback.
(I)	explain the effects of mutation types on phenotype and gene function; and	Added based on a recommendation from science reviewers and industry feedback.
(J)	describe unique elements of the molecular structure of a chromosome such as short tandem repeats (STR), transposons, and methylation and acetylation of DNA.	Added based on recommendation from a content advisor, science reviewers and industry feedback.
(9)~~(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 such as nuclear transfer cloning;	Added based on a recommendation from science reviewers.
(C)	explain the role of tissue cultures in ~~to~~ genetic modification procedures;	Change based on a recommendation from a content advisor.
(D)	describe plant- and animal-tissue culture procedures;	
(E)	compare and contrast ~~proper~~ growing conditions for plant and animal tissue cultures;	Effective growing conditions can vary.
(F)	explain the role of restriction enzymes; and	
(G)	distinguish among vectors commonly used in biotechnology for DNA insertion, including plasmids, adenoviruses, retroviruses, and bacteriophages.~~; and~~	Added based on recommendation from industry feedback.
~~(H)~~	~~explain the steps and components of the polymerase chain reaction (PCR); and.~~	Moved to Biotechnology II based on science reviewer recommendations.
~~(I)~~	~~explain applications of CRISPR/Cas9 technology in gene editing and diagnostics.~~	Moved to Biotechnology II based on science reviewer recommendations.

(10)~~(9)~~	The student examines federal, state, local, and industry regulations as related to biotechnology. The student is expected to:	CCRS Science IV.B.1,2 CCRS Science I.C.2
(A)	discuss the relationship between the local, state, and federal agencies responsible for regulation of the biotechnology industry such as the U.S. Department of Agriculture (USDA), the Environmental Protection Agency (EPA), the U.S. Food and Drug Administration (FDA), and the Centers for Disease Control and Prevention (CDC); 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.	
(11)~~(10)~~	The student performs ~~standard~~ biotechnology laboratory procedures. The student is expected to:	Combined all laboratory procedures into one knowledge and skills statement.
~~(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;*~~	Moved to 2(B).
(A)~~(B)~~	measure ~~practice measuring~~ volumes and weights to industry standards with accuracy and precision;	Clarified the verb to be measurable; practice is implied. Accuracy and precision terms were added to clarify how measurements should be performed.
(B)~~(C)~~	analyze data and perform calculations and statistical analysis as it relates to biotechnology laboratory experiments;	
(C)~~(D)~~	demonstrate proficiency in pipetting techniques;	Fix grammatical error.
(D)~~(E)~~	identify microorganisms using staining methods such as the Gram stain, methylene-blue stain, and acid-fast staining;	
~~(F)~~	~~document laboratory results; and~~	Addressed in 2(D).
(E)~~(G)~~	prepare a restriction digest, *isolate nucleic acids,* and ~~analyze~~ evaluate results using techniques such as gel and capillary electrophoresis, Northern blot analysis, and Southern blot analysis;	Combined with components of (12)(G) and added recommendations from science reviewers and industry feedback.
(F)	*explain the importance of media components to the outcome of cultures;*	Moved from (12)(A).
(G)	*isolate, maintain, and store microbial cultures safely;*	Moved from (12)(B).
(H)	*prepare seed inoculum;* and	
(I)	*perform plating techniques such as* streak plating, spread plating and *the Kirby-Bauer method.*~~;~~	Moved from (12)(D) and recommendations of science reviewers.

(12)~~(11)~~	The student prepares solutions and reagents for the biotechnology laboratory. The student is expected to:	
(A)	demonstrate aseptic techniques for establishing and maintaining a sterile work area;	Added clarification.
(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.	
~~(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;*~~	Moved to (10).
~~*(B)*~~	~~*isolate, maintain, and store microbial cultures safely;*~~	Moved to (10).
~~*(C)*~~	~~*prepare seed inoculum;*~~	Moved to (10).
~~*(D)*~~	~~*perform plating techniques such as the Kirby-Bauer method;*~~	Moved to (10).
~~(E)~~	~~analyze proteins using techniques such as enzyme-linked immunosorbent assay (ELISA), spectrophotometry, and sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE);~~	Based on science reviewer feedback, protein-related concepts and skills were moved to Biotechnology II in order to allow appropriate time and maximize mastery of other concepts and skills in Biotechnology I.
~~(F)~~	~~isolate a specific protein from a biological sample using chromatography;~~	Moved protein related concepts to Biotechnology II based on science reviewer feedback.
~~(G)~~	~~*isolate nucleic acids*~~ ~~and~~ ~~*interpret*~~ ~~gel electrophoresis results;~~	Moved to (10).
~~(H)~~	~~perform a bacterial transformation and analyze gene expression; and~~	Moved protein related concepts to Biotechnology II based on science reviewer feedback.
~~(I)~~	~~amplify a DNA sequence using the polymerase chain reactions.~~	Moved protein related concepts to Biotechnology II based on science reviewer feedback.
(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~~.	Illustrative examples are unnecessary.

§130.416. Biotechnology II (One Credit), Adopted 2015.		
	TEKS with edits	Work Group Comments/Rationale
(a)	General requirements. This course is recommended for students in Grades 11 and 12. Prerequisites: Biotechnology I and Chemistry. Students must meet the 40% laboratory and fieldwork requirement. Students shall be awarded one credit for successful completion of this course.	
(b)	Introduction.	
(1)	Career and technical education instruction provides content aligned with challenging academic standards, industry ~~and~~ relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and ~~or~~ emerging professions.	Edits from Introduction Subcommittee.
(2)	The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services~~,~~ such as ~~including~~ laboratory and testing services, and research and development services.	Edits from Introduction Subcommittee.
(3)	Biotechnology II has the components of any rigorous scientific or bioengineering program of study ~~from the problem identification, investigation design, data collection, data analysis, and formulation and presentation of the conclusions~~. This course applies the standard skills mastered in Biotechnology I and includes additional skills related to assay design, protein analysis, applications of genetic engineering, and quality management. After taking this course, students should be prepared for entry-level lab technician jobs.	Removed course components no longer present in the course and added a description of the biotechnology topics added to the course.
(4)	Nature of science. 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 currently scientifically testable. ~~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.~~	
(5)	Scientific hypotheses and theories. Students are expected to know that: ~~Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation are experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.~~	

(A)	hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories; and	
(B)	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.	
(6)	Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified. ~~Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information).~~	
(A)	Scientific practices. Students should be able to ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models.	
(B)	Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models.	
(7)	Science and social ethics. Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information). ~~A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in 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.~~	

(8)	Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. All systems have basic properties that can be described in 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, while models allow for boundary specification and provide a tool for understanding the ideas presented. 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.	
(9)	Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.	
(10)	Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.	
(c)	Knowledge and skills.	
(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.	
(2)	Scientific and engineering practices. The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to explain phenomena, or design solutions using appropriate tools and models. The student is expected to:	
(A)	ask questions and define problems based on observations or information from text, phenomena, models, or investigations;	
(B)	apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;	

(C)	use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;	
(D)	use appropriate tools such as microscopes, thermocyclers, pH meters, hot plate stirrers, glass bulb thermometers, timing devices, electronic balances, vortex mixers, autoclaves, micropipettes, centrifuges, gel and capillary electrophoresis units, cameras, data collection probes, spectrophotometers, transilluminators, incubators, water baths, laboratory glassware, biosafety cabinets, and chemical fume hoods;	Added additional course specific equipment based on content advisor recommendations and industry feedback.
(E)	collect quantitative data using the International System of Units (SI) and United States customary units and qualitative data as evidence;	Edits from Scientific and Engineering Practices Subcommittee.
(F)	organize quantitative and qualitative data using laboratory notebooks, written lab reports, graphs, charts, tables, digital tools, diagrams, scientific drawings, and student-prepared models;	Added data organization methods used in science course TEKS.
(G)	develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and	
(H)	distinguish among scientific hypotheses, theories, and laws.	
(3)	Scientific and engineering practices. The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:	
(A)	identify advantages and limitations of models such as their size, scale, properties, and materials;	
(B)	analyze data by identifying significant statistical features, patterns, sources of error, and limitations;	
(C)	use mathematical calculations to assess quantitative relationships in data; and	
(D)	evaluate experimental and engineering designs.	
(4)	Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:	
(A)	develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;	
(B)	communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and	
(C)	engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.	

(5)	Scientific and engineering practices. The student knows the contributions of scientists and recognizes the importance of scientific research and innovation on society. The student is expected to:	
(A)	analyze, evaluate, and critique scientific explanations and solutions by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student;	
(B)	relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists and engineers as related to the content; and	Edits from Scientific and Engineering Practices Subcommittee.
(C)	research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a science, technology, engineering, and mathematics (STEM) field ~~in order to investigate STEM~~.	Edits from Scientific and Engineering Practices Subcommittee.
~~(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; and~~	
~~(B)~~	~~demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.~~	
~~(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 scientific 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 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 making observations, asking well-defined questions, formulating testable hypotheses, identifying variables, selecting appropriate equipment and technology, and evaluating numerical answers for reasonableness;~~	
~~(F)~~	~~collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as calculators, spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, electronic balances, gel electrophoresis apparatuses, micropipettors, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, cameras, and meter sticks;~~	
~~(G)~~	~~analyze, evaluate, make inferences, and predict trends from data;~~	
~~(H)~~	~~identify and quantify causes and effects of uncertainties in measured data;~~	
~~(I)~~	~~organize and evaluate data and make inferences from data, including the use of tables, charts, and graphs; and~~	
~~(J)~~	~~communicate valid conclusions supported by the data through various methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.~~	
~~(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)~~	~~explain the impacts of the scientific contributions of a variety of historical and contemporary scientists on scientific thought and society;~~	
~~(E)~~	~~evaluate models according to their limitations in representing biological objects or events;~~	
~~(F)~~	~~research and describe the connections between science and future careers; and~~	
~~(G)~~	~~express and interpret relationships symbolically to make predictions and solve problems mathematically, including problems requiring proportional reasoning and graphical vector addition.~~	

~~(5)~~	~~The student formulates hypotheses to guide investigation and data collection. The student is expected to:~~	Deleted statements (5)-(9) since the statements are not specific to skills mastered in Biotechnology I, are similar to the separate Scientific Research & Design course TEKS, and do not address the goal of preparing students for entry-level lab technician jobs. Science reviewers agreed that deleting these components of the Biotechnology II course increases the clarity of the course.
~~(A)~~	~~perform background research with respect to an investigative problem; and~~	
~~(B)~~	~~examine hypotheses generated to guide a research process by evaluating the merits and feasibility of the hypotheses.~~	
(6)	The student prepares for an entry-level career in biotechnology. The student is expected to:	
(A)	research and identify career opportunities in genetics, bioinformatics, and in fields such as molecular, forensic, medical, regulatory, and agricultural biotechnology;	Added genetics and bioinformatics based on industry feedback.
(B)	identify the significance of recent advances in molecular, forensic, medical, regulatory, and agricultural biotechnology;	CCRS: 4.A.1, 4.C.(1)(2)
(C)	discuss current bioethical issues related to the field of biotechnology;	feedback from science reviewers. CCRS: 4.B.1
(D)	create a job specific resume; and	
(E)	develop a career plan.	
(7)~~(6)~~	The student analyzes academic and professional journals and technical reports ~~published research~~. The student is expected to:	Attempted to match strand to actual expectations of entry-level lab technician jobs. CCRS: ELA V.B.2
(A)	identify the scientific methodology used by a researcher;	
(B)	examine a prescribed research design and identify dependent and independent variables;	
(C)	evaluate a prescribed protocol ~~research design~~ to determine the purpose for each of the procedures performed; and	Entry-level lab technician jobs often require the use of various types of journals and technical reports.
(D)	interpret ~~determine if the~~ data and evaluate conclusions. ~~support the hypothesis~~.	Entry-level lab technician jobs often require the use of various types of journals and technical reports.
~~(7)~~	~~The student develops and implements appropriate investigative designs. The student is expected to:~~	

~~(A)~~	~~interact and collaborate with scientific researchers or other members of the scientific community to complete a research project;~~	
~~(B)~~	~~identify and manipulate relevant variables within research situations;~~	
~~(C)~~	~~use a control in an experimental process; and~~	
~~(D)~~	~~design procedures to test hypotheses.~~	
~~(8)~~	~~The student collects, organizes, and evaluates qualitative and quantitative data obtained through experimentation. The student is expected to:~~	
~~(A)~~	~~differentiate between qualitative and quantitative data;~~	
~~(B)~~	~~acquire, manipulate, and analyze data using appropriate equipment and technology, following the rules of significant digits;~~	
~~(C)~~	~~identify sources of random error and systematic error and differentiate between both types of error;~~	
~~(D)~~	~~report error of a set of measured data in various formats, including standard deviation and percent error;~~	
~~(E)~~	~~construct data tables to organize information collected in an experiment;~~	
~~(F)~~	~~record observations as they occur within an investigation; and~~	
~~(G)~~	~~evaluate data using statistical methods to recognize patterns, trends, and proportional relationships.~~	
~~(9)~~	~~The student knows how to synthesize valid conclusions from qualitative and quantitative data. The student is expected to:~~	
~~(A)~~	~~synthesize and justify conclusions supported by research data;~~	
~~(B)~~	~~consider and communicate alternative explanations for observations and results; and~~	
~~(C)~~	~~identify limitations within the research process and provide recommendations for additional research.~~	
~~(10)~~	~~The student communicates with conclusions clearly and concisely to an audience of professionals in the field of biotechnology. The student is expected to:~~	(10) is addressed in the Scientific and Engineering Practices. After reviewing the science reviewers' problems with a lack of clarity for the course we provided a detailed clarification of each of the main ideas of the course.

~~(A)~~	~~interact with communicate experimental results clearly and effectively, including oral presentation of original findings of a research project to an audience of peers and professionals in the field of biotechnology.; and~~	
~~(B)~~	~~suggest alternative explanations from observations or trends evident within the data or from prompts provided by a review panel.~~	
(8)~~(11)~~	The student explores assay design in the field of biotechnology. The student is expected to:	
(A)	define assay requirements and optimizations;	
(B)	perform statistical analysis on assay design and experimental data such as linearity, system sustainability, limit of detection, and R2 values;	
(C)	determine an unknown protein concentration using *a standard curve* and a technique~~s~~ such as ~~*a standard curve*~~ ~~and a spectrophotometer~~ a Bradford assay; and	Clarified and added an illustrative example based on science reviewer feedback.
(D)	~~use~~ ~~*a colorimetric assay*~~ ~~to~~ evaluate enzyme kinetics using *a colorimetric assay*.	Clarified language and increased rigor. CCRS: Chemistry VII.E.6.AB
(9)~~(12)~~	The student explores applications related to protein expression ~~systems~~ in the field of biotechnology. The student is expected to:	
(A)	describe the fundamental steps in recombinant DNA technology;	Moved from Biotechnology I based on science reviewer comments that this advanced level skill was more appropriate for this course.
(B)~~(A)~~	perform a recombinant protein production such as *green fluorescent protein* (GFP);	
~~(B)~~	~~isolate a protein from a biological sample using hydrophobic interaction column chromatography; and~~	
~~(C)~~	~~analyze protein purification methods using spectrophotometry, sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) and Western blotting.~~	
(C)	analyze proteins using techniques such as enzyme-linked immunosorbent assay (ELISA), spectrophotometry, and sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE);	Moved from Biotechnology I based on science reviewer comments that this advanced level skill was more appropriate for this course.
(D)	isolate a specific protein from a biological sample using techniques such as chromatography and Western blot analysis;	Moved from Biotechnology I based on science reviewer comments that this advanced level skill was more appropriate for this course.

(10)	The student explores applications of recombinant DNA technology and genetic engineering. The student is expected to:	Added this KS statement and strand from Biotechnology I to ensure vertical alignment with the mastery of skill-based techniques expected in Biotechnology II.
(A)	prepare and maintain tissue cultures commonly used in genetic modification procedures;	Adapted from Biotechnology I with a performance-based verb.
(B)	evaluate the effects of changes to growing conditions such as pH, temperature, and growth media;	Adapted from Biotechnology I with a more rigorous verb and added illustrative examples.
(C)	evaluate the results of a bacterial transformation using a restriction enzyme digest and Southern blot analysis;	Adapted from Biotechnology I with a performance-based expectation.
(D)	compare and contrast vectors commonly used in biotechnology applications, including plasmids, adenoviruses, retroviruses, and bacteriophages;	Adapted from Biotechnology I with a more rigorous verb and added illustrative examples.
(E)	explain the steps and components of the polymerase chain reaction (PCR); and	Moved from Biotechnology I based on science reviewer feedback.
(F)	explain applications of CRISPR/Cas9 technology in gene editing and diagnostics.	Moved from Biotechnology I based on science reviewer feedback.
~~(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;*~~	Moved to (12)(G).
~~*(B)*~~	~~*analyze data and perform calculations and statistical analysis on results of quality-control samples such as trending of data; and*~~	Moved to (12)(H).
~~*(C)*~~	~~*apply and create industry protocols such as standard operating procedures (SOPs) and validation forms.*~~	Moved to (12)(I).
(11)~~(14)~~	The student prepares solutions and reagents for the biotechnology laboratory. The student is expected to:	
(A)	demonstrate aseptic techniques for establishing and maintaining a sterile work area;	Added clarification.
(B)	prepare, dispense, and monitor physical properties of stock reagents, buffers, media, and solutions;	CCRS: Chemistry V11.I.2
(C)	calculate and prepare a dilution series;	
(D)	determine acceptability and optimum conditions of reagents for experimentation; and	
(E)	prepare multi-component solutions of given molarity or concentration and volume.	

(12)~~(13)~~	The student investigates ~~conducts quality-control analysis while performing~~ the role of quality in the biotechnology industry ~~laboratory procedures.~~ The student is expected to:	Adapted language from Biotechnology I and generalized the KS to include the range of SEs in this strand.
(A)	describe the product pipeline in the biotechnology industry;	Adapted TEKS from the “Quality Assurance for the Biosciences” innovative course enhances the Biotechnology II course.
(B)	describe the importance of quality assurance and quality control;	Adapted TEKS from the “Quality Assurance for the Biosciences” innovative course enhances the Biotechnology II course.
(C)	explain the importance of documentation to quality assurance and quality control;	Adapted TEKS from the “Quality Assurance for the Biosciences” innovative course enhances the Biotechnology II course.
(D)	describe the importance of corrective and preventive action (CAPA);	Adapted TEKS from the “Quality Assurance for the Biosciences” innovative course enhances the Biotechnology II course.
(E)	describe Quality Management Systems (QMS) components, including inspection, audit, surveillance, and prevention; and	Adapted TEKS from the “Quality Assurance for the Biosciences” innovative course enhances the Biotechnology II course.
(F)	describe Good Manufacturing Practices (GMP), Good Clinical Practices (GCP), Good Documentation Practices (GDP), Good Lab Practices (GLP), and International Organization for Standardization (ISO).	Adapted TEKS from the “Quality Assurance for the Biosciences” innovative course enhances the Biotechnology II course.
(G)~~(A)~~	*perform validation testing on laboratory reagents and equipment;*	
(H)~~(B)~~	*analyze data and perform calculations and statistical analysis on results of quality-control samples such as* standard deviation and percent error; ~~trending of data; and~~	Illustrative examples are industry standards or often used in publications from the field of biotechnology. CCRS: Math V.C.1-4
(I)~~(C)~~	*apply and create industry protocols such as* laboratory method protocols, *standard operating procedures (SOPs) and validation forms*~~.~~;	Applying and creating laboratory method protocols are necessary for success in the biotechnology industry. CCRS: Science I.C.3