Texas CTE: Health Science

Biotechnology II

Implementation. A

1 The provisions of this section shall be implemented by school districts beginning with the 2023- 2024 school year. A.1

2 School districts shall implement the employability skills student expectations listed in §127.15(d)(2) of this chapter (relating to Career and Technical Education Employability Skills) as an integral part of this course. A.2

General requirements. This course is recommended for students in Grades 11 and 12. Prerequisites: one credit in chemistry and Biotechnology I. This course satisfies a high school science graduation requirement. Students shall be awarded one credit for successful completion of this course. B

b General requirements. This course is recommended for students in Grades 11 and 12. Prerequisites: one credit in chemistry and Biotechnology I. This course satisfies a high school science graduation requirement. Students shall be awarded one credit for successful completion of this course. B

Introduction. C

1 Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions. C.1

2 The Health Science Career Cluster focuses on planning, managing, and providing therapeutic services, diagnostics services, health informatics, support services, and biotechnology research and development. C.2

3 Biotechnology II has the components of any rigorous scientific or bioengineering program of study. 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. C.3

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cience, 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. C.4

5 **Students are expected to know that:** C.5

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 C.5.A

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. C.5.B

6 **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.** C.6

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. C.6.A

B Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models. C.6.B

7 **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).** C.7

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.** C.8

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9 **Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other organizations that foster leadership and career development in the profession such as student chapters of related professional associations.** C.9

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.10

Knowledge and skills. D

1 **The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:** D.1

A ask questions and define problems based on observations or information from text, phenomena, models, or investigations; D.1.A

B apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems; D.1.B

C use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards; D.1.C

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; D.1.D

E collect quantitative data using the International System of Units (SI) and United States customary units and qualitative data as evidence; D.1.E

F organize quantitative and qualitative data using laboratory notebooks, written lab reports, graphs, charts, tables, digital tools, diagrams, scientific drawings, and student-prepared models; D.1.F

G develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and D.1.G

H distinguish between scientific hypotheses, theories, and laws. D.1.H

2 **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:** D.2

A identify advantages and limitations of models such as their size, scale, properties, and materials; D.2.A

B analyze data by identifying significant statistical features, patterns, sources of error, and limitations; D.2.B

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C use mathematical calculations to assess quantitative relationships in data; and D.2.C

D evaluate experimental and engineering designs. D.2.D

3 The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to: D.3

A develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories; D.3.A

B communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and D.3.B

C engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence. D.3.C

4 The student knows the contributions of scientists and recognizes the importance of scientific research and innovation on society. The student is expected to: D.4

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; D.4.A

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 D.4.B

C research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a STEM field. D.4.C

5 The student prepares for an entry-level career in biotechnology. The student is expected to: D.5

A research and identify career opportunities in genetics, bioinformatics, and fields such as molecular, forensic, medical, regulatory, and agricultural biotechnology; D.5.A

B identify the significance of recent advances in molecular, forensic, medical, regulatory, and agricultural biotechnology; D.5.B

C discuss current bioethical issues related to the field of biotechnology; D.5.C

D create a job-specific resume; and D.5.D

E develop a career plan. D.5.E

6 The student analyzes academic and professional journals and technical reports. The student is expected to: D.6

A identify the scientific methodology used by a researcher; D.6.A

B examine a prescribed research design and identify dependent and independent variables; D.6.B

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C evaluate a prescribed protocol to determine the purpose for each of the procedures performed; and D.6.C

D interpret data and evaluate conclusions. D.6.D

7 The student explores assay design in the field of biotechnology. The student is expected to: D.7

A define assay requirements and optimizations; D.7.A

B perform statistical analysis on assay design and experimental data such as linearity, system sustainability, limit of detection, and R2 values; D.7.B

C determine an unknown protein concentration using a standard curve and technique such as a Bradford assay; and D.7.C

D evaluate enzyme kinetics using a colorimetric assay. D.7.D

8 The student explores applications related to protein expression in the field of biotechnology. The student is expected to: D.8

A describe the fundamental steps in recombinant deoxyribonucleic acid (DNA) technology; D.8.A

B produce a recombinant protein such as green fluorescent protein (GFP); D.8.B

C analyze proteins using techniques such as enzyme-linked immunosorbent assay (ELISA), spectrophotometry, and sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE); and D.8.C

D isolate a specific protein from a biological sample using techniques such as chromatography and Western blot analysis. D.8.D

9 The student explores applications of recombinant DNA technology and genetic engineering. The student is expected to: D.9

A prepare and maintain tissue cultures commonly used in genetic modification procedures; D.9.A

B evaluate the effects of changes to growing conditions such as pH, temperature, and growth media; D.9.B

C evaluate the results of a bacterial transformation using a restriction enzyme digest and Southern blot analysis; D.9.C

D compare and contrast vectors commonly used in biotechnology applications, including plasmids, adenoviruses, retroviruses, and bacteriophages; D.9.D

E explain the steps and components of the polymerase chain reaction (PCR); and D.9.E

F explain applications of CRISPR/Cas9 technology in gene editing and diagnostics. D.9.F

10 The student prepares solutions and reagents for the biotechnology laboratory. The student is expected to: D.10

A demonstrate aseptic techniques for establishing and maintaining a sterile work area; D.10.A

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B prepare, dispense, and monitor physical properties of stock reagents, buffers, media, and solutions; D.10.B

C calculate and prepare a dilution series; D.10.C

D determine acceptability and optimum conditions of reagents for experimentation; and D.10.D

E prepare multi-component solutions of given molarity or concentration and volume. D.10.E

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11 The student investigates the role of quality in the biotechnology industry, The student is expected to: D.11

A describe the product pipeline in the biotechnology industry; D.11.A

B describe the importance of quality assurance and quality control; D.11.B

C explain the importance of documentation to quality assurance and quality control; D.11.C

D describe the importance of corrective and preventive action (CAPA); D.11.D

E describe Quality Management Systems (QMS) components, including inspection, audit, surveillance, and prevention; D.11.E

F describe Good Manufacturing Practices (GMP), Good Clinical Practices (GCP), Good Documentation Practices (GDP), Good Lab Practices (GLP), and International Organization for Standardization (ISO); D.11.F

G perform validation testing on laboratory reagents and equipment; D.11.G

H analyze data and perform calculations and statistical analysis on results of quality-control samples such as standard deviation and percent error; and D.11.H

I apply and create industry protocols such as laboratory method protocols, standard operating procedures (SOPs), and validation forms. D.11.I