Biotechnology I

Subject: Career and Technical Education
Grade: 11
Expectations: 70
Breakouts: 245

(a) Introduction.

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.

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 laboratory and testing services and research and development services.

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 and make informed decisions using critical thinking, 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.

4. 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.

5. Students are expected to know that:

    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

    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 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

    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. 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)

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.

(b) Knowledge and Skills Statements

(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;

(i) demonstrate knowledge of how to dress appropriately

(ii) demonstrate knowledge of how to speak politely

(iii) demonstrate knowledge of how to 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;

(i) show the ability to cooperate as a member of a group in an effort to achieve a positive collective outcome

(ii) show the ability to contribute as a member of a group in an effort to achieve a positive collective outcome

(iii) show the ability to 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;

(i) present written communication in a clear manner

(ii) present written communication in a concise manner

(iii) present written communication in an effective manner

(iv) present oral communication in a clear manner

(v) present oral communication in a concise manner

(vi) present oral communication in an 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

(i) demonstrate time-management skills in prioritizing tasks in a way that produces efficient results

(ii) demonstrate time-management skills in following schedules in a way that produces efficient results

(iii) demonstrate time-management skills in performing goal-relevant activities in a way that produces efficient results

(E) demonstrate punctuality, dependability, reliability, and responsibility in performing assigned tasks as directed.

(i) demonstrate punctuality in performing assigned tasks as directed

(ii) demonstrate dependability in performing assigned tasks as directed

(iii) demonstrate reliability in performing assigned tasks as directed

(iv) demonstrate responsibility in performing assigned tasks as directed

(2) 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:

(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

(i) ask questions based on observations or information from text, phenomena, models, or investigations

(ii) 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;

(i) apply scientific practices to plan descriptive investigations

(ii) apply scientific practices to plan comparative investigations

(iii) apply scientific practices to plan experimental investigations

(iv) apply scientific practices to conduct descriptive investigations

(v) apply scientific practices to conduct comparative investigations

(vi) apply scientific practices to conduct experimental investigations

(vii) 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;

(i) use appropriate safety equipment during laboratory investigations as outlined in Texas Education Agency-approved safety standards

(ii) use appropriate safety equipment during classroom investigations as outlined in Texas Education Agency-approved safety standards

(iii) use appropriate safety equipment during field investigations as outlined in Texas Education Agency-approved safety standards

(iv) use appropriate safety practices during laboratory investigations as outlined in Texas Education Agency-approved safety standards

(v) use appropriate safety practices during classroom investigations as outlined in Texas Education Agency-approved safety standards

(vi) use appropriate safety practices during 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;

(i) use appropriate tools

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

(i) collect quantitative data using the International System of Units (SI)

(ii) collect quantitative data using United States customary units

(iii) collect 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;

(i) organize quantitative data using laboratory notebooks

(ii) organize quantitative data using written lab reports

(iii) organize quantitative data using graphs

(iv) organize quantitative data using charts

(v) organize quantitative data using tables

(vi) organize quantitative data using digital tools

(vii) organize quantitative data using diagrams

(viii) organize quantitative data using scientific drawings

(ix) organize quantitative data using student-prepared models

(x) organize qualitative data using laboratory notebooks

(xi) organize qualitative data using written lab reports

(xii) organize qualitative data using graphs

(xiii) organize qualitative data using charts

(xiv) organize qualitative data using tables

(xv) organize qualitative data using digital tools

(xvi) organize qualitative data using diagrams

(xvii) organize qualitative data using scientific drawings

(xviii) organize qualitative data using student-prepared models

(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

(i) develop models to represent phenomena, systems, processes, or solutions to engineering problems

(ii) use models to represent phenomena, systems, processes, or solutions to engineering problems

(H) distinguish between scientific hypotheses, theories, and laws.

(i) distinguish between scientific hypotheses, theories, and laws

(3) 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;

(i) identify advantages of models

(ii) identify limitations of models

(B) analyze data by identifying significant statistical features, patterns, sources of error, and limitations;

(i) analyze data by identifying significant statistical features

(ii) analyze data by identifying patterns

(iii) analyze data by identifying sources of error

(iv) analyze data by identifying limitations

(C) use mathematical calculations to assess quantitative relationships in data; and

(i) use mathematical calculations to assess quantitative relationships in data

(D) evaluate experimental and engineering designs.

(i) evaluate experimental designs

(ii) evaluate engineering designs

(4) 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;

(i) develop explanations supported by data and consistent with scientific ideas

(ii) develop explanations supported by data and consistent with scientific principles

(iii) develop explanations supported by data and consistent with scientific theories

(iv) develop explanations supported by models and consistent with scientific ideas

(v) develop explanations supported by models and consistent with scientific principles

(vi) develop explanations supported by models and consistent with scientific theories

(vii) propose solutions supported by data and consistent with scientific ideas

(viii) propose solutions supported by data and consistent with scientific principles

(ix) propose solutions supported by data and consistent with scientific theories

(x) propose solutions supported by models and consistent with scientific ideas

(xi) propose solutions supported by models and consistent with scientific principles

(xii) propose solutions supported by models and consistent with scientific theories

(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

(i) communicate explanations individually in a variety of settings

(ii) communicate explanations individually in a variety of formats

(iii) communicate explanations collaboratively in a variety of settings

(iv) communicate explanations collaboratively in a variety of formats

(v) communicate solutions individually in a variety of settings

(vi) communicate solutions individually in a variety of formats

(vii) communicate solutions collaboratively in a variety of settings

(viii) communicate solutions collaboratively in a variety of formats

(C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

(i) engage respectfully in scientific argumentation using applied scientific explanations

(ii) engage respectfully in scientific argumentation using empirical evidence

(5) 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;

(i) analyze scientific explanations and solutions by using empirical evidence so as to encourage critical thinking by the student

(ii) analyze scientific explanations and solutions by using logical reasoning so as to encourage critical thinking by the student

(iii) analyze scientific explanations and solutions by using experimental testing so as to encourage critical thinking by the student

(iv) analyze scientific explanations and solutions by using observational testing so as to encourage critical thinking by the student

(v) evaluate scientific explanations and solutions by using empirical evidence so as to encourage critical thinking by the student

(vi) evaluate scientific explanations and solutions by using logical reasoning so as to encourage critical thinking by the student

(vii) evaluate scientific explanations and solutions by using experimental testing so as to encourage critical thinking by the student

(viii) evaluate scientific explanations and solutions by using observational testing so as to encourage critical thinking by the student

(ix) critique scientific explanations and solutions by using empirical evidence so as to encourage critical thinking by the student

(x) critique scientific explanations and solutions by using logical reasoning so as to encourage critical thinking by the student

(xi) critique scientific explanations and solutions by using experimental testing so as to encourage critical thinking by the student

(xii) critique scientific explanations and solutions by using 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

(i) relate the impact of past research on scientific thought, including research methodology as related to the content;

(ii) relate the impact of past research on scientific thought, including cost-benefit analysis as related to the content

(iii) relate the impact of past research on scientific thought, including contributions of diverse scientists as related to the content

(iv) relate the impact of past research on scientific thought, including contributions of diverse engineers as related to the content; and

(v) relate the impact of past research on society, including research methodology as related to the content;

(vi) relate the impact of past research on society, including cost-benefit analysis as related to the content

(vii) relate the impact of past research on society, including contributions of diverse scientists as related to the content

(viii) relate the impact of past research on society, including contributions of diverse engineers as related to the content; and

(ix) relate the impact of current research on scientific thought, including research methodology as related to the content;

(x) relate the impact of current research on scientific thought, including cost-benefit analysis as related to the content

(xi) relate the impact of current research on scientific thought, including contributions of diverse scientists as related to the content

(xii) relate the impact of current research on scientific thought, including contributions of diverse engineers as related to the content; and

(xiii) relate the impact of current research on society, including research methodology as related to the content;

(xiv) relate the impact of current research on society, including cost-benefit analysis as related to the content

(xv) relate the impact of current research on society, including contributions of diverse scientists as related to the content

(xvi) relate the impact of current research on society, including contributions of diverse 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 STEM field.

(i) research STEM [careers]

(ii) explore resources [in order to investigate STEM careers]

(6) 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;

(i) define biotechnology

(ii) provide examples of biotechnology products

(B) compare 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;

(i) compare applications of bioinformatics

(C) research and identify career opportunities in genetics, bioinformatics, and in fields such as molecular, forensic, medical, regulatory, and agricultural biotechnology;

(i) research career opportunities in genetics

(ii) research career opportunities in bioinformatics

(iii) research career opportunities in [other] fields

(iv) identify career opportunities in genetics

(v) identify career opportunities in bioinformatics

(vi) identify career opportunities in [other] fields

(D) identify significant contributions of diverse scientists to biotechnology and explain their impact on society;

(i) identify significant contributions of diverse scientists to biotechnology

(ii) explain [the] impact [of significant contributions of diverse scientists] on society

(E) define bioethics and evaluate the applications of bioethics;

(i) define bioethics

(ii) evaluate the applications of bioethics

(F) evaluate different points of view about issues and current events in biotechnology;

(i) evaluate different points of view about issues in biotechnology

(ii) evaluate different points of view about current events in biotechnology

(G) identify applications in agricultural biotechnology such as genetically modified organisms (GMOs), plant propagation from tissue culturing, and aquaculture hydroponics;

(i) identify applications in agricultural biotechnology

(H) identify applications in medical biotechnology such as vaccines production, stem cells therapy, gene therapy, pharmaceutical production, pharmacogenetics, genomics, synthetic biology, and personalized medicine;

(i) identify applications in medical biotechnology

(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

(i) identify applications in forensic biotechnology

(J) identify solutions to waste through bioremediation and non-biotechnological standard solutions such as landfills, incineration, absorbent materials, and catalytic materials.

(i) identify solutions to waste through bioremediation

(ii) identify solutions to waste through non-biotechnological standard solutions

(7) 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, forensic, and research and development;

(i) identify the major sectors of the biotechnology industry

(B) identify the biotechnology laboratory procedures used in each sector such as selective breeding, genetic engineering, DNA analysis, and protein analysis; and

(i) identify the biotechnology laboratory procedures used in each [biotechnology] sector

(C) compare and contrast the different applications used in biotechnology laboratory procedures of each sector.

(i) compare and contrast the different applications used in biotechnology laboratory procedures of each [biotechnology] sector

(8) 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, nucleotides, mRNA, rRNA, tRNA, ribosomes, amino acids, transcription, translation, polymerase, and protein synthesis;

(i) explain terms related to molecular biology, including nucleic acids

(ii) explain terms related to molecular biology, including nitrogen bases

(iii) explain terms related to molecular biology, including nucleotides

(iv) explain terms related to molecular biology, including mRNA

(v) explain terms related to molecular biology, including rRNA

(vi) explain terms related to molecular biology, including tRNA

(vii) explain terms related to molecular biology, including ribosomes

(viii) explain terms related to molecular biology, including amino acids

(ix) explain terms related to molecular biology, including transcription

(x) explain terms related to molecular biology, including translation

(xi) explain terms related to molecular biology, including polymerase

(xii) explain terms related to molecular biology, including protein synthesis

(B) compare and contrast the structures and functions of DNA and ribonucleic acid (RNA), including nitrogen bases, nucleotides, the helical nature of DNA, and hydrogen bonding between purines and pyrimidines;

(i) compare and contrast the structures of DNA and ribonucleic acid (RNA), including nitrogen bases

(ii) compare and contrast the structures of DNA and ribonucleic acid (RNA), including nucleotides

(iii) compare and contrast the structures of DNA and ribonucleic acid (RNA), including the helical nature of DNA

(iv) compare and contrast the structures of DNA and ribonucleic acid (RNA), including hydrogen bonding between purines and pyrimidines

(v) compare and contrast the functions of DNA and ribonucleic acid (RNA), including nitrogen bases

(vi) compare and contrast the functions of DNA and ribonucleic acid (RNA), including nucleotides

(vii) compare and contrast the functions of DNA and ribonucleic acid (RNA), including the helical nature of DNA

(viii) compare and contrast the functions of DNA and ribonucleic acid (RNA), including hydrogen bonding between purines and pyrimidines

(C) distinguish between nuclear and mitochondrial DNA and their gamete sources;

(i) distinguish between nuclear and mitochondrial DNA and their gamete sources

(D) describe the DNA replication process in eukaryotic cells and prokaryotic cells, including leading and lagging strands, and Okazaki strands;

(i) describe the DNA replication process in eukaryotic cells, including leading and lagging strands

(ii) describe the DNA replication process in eukaryotic cells, including lagging strands

(iii) describe the DNA replication process in eukaryotic cells, including Okazaki fragments

(iv) describe the DNA replication process in prokaryotic cells, including leading strands;

(v) describe the DNA replication process in prokaryotic cells, including lagging strands;

(vi) describe the DNA replication process in prokaryotic cells, including Okazaki strands;

(E) illustrate the process of protein synthesis, including ribosomal subunits and the role of tRNA;

(i) illustrate the process of protein synthesis, including ribosomal subunits

(ii) illustrate the process of protein synthesis, including the role of tRNA

(F) describe the structures and functions of proteins, including three-dimensional folding, enzymes, and antibodies;

(i) describe the structures of proteins, including three-dimensional folding

(ii) describe the structures of proteins, including enzymes

(iii) describe the structures of proteins, including antibodies

(iv) describe the functions of proteins, including three-dimensional folding

(v) describe the functions of proteins, including enzymes

(vi) describe the functions of proteins, including antibodies

(G) explain the molecular structures of genes, including enhancers, promoters, exons, introns, and coding regions;

(i) explain the molecular structures of genes, including enhancers

(ii) explain the molecular structures of genes, including promoters

(iii) explain the molecular structures of genes, including exons

(iv) explain the molecular structures of genes, including introns

(v) explain the molecular structures of genes, including coding regions

(H) describe the different types of mutations, including inversions, deletions, duplications, and substitutions;

(i) describe the different types of mutations, including inversions

(ii) describe the different types of mutations, including deletions

(iii) describe the different types of mutations, including duplications

(iv) describe the different types of mutations, including substitutions

(I) explain the effects of mutation types on phenotype and gene function; and

(i) explain the effects of mutation types on phenotype

(ii) explain the effects of mutation types on gene function

(J) describe unique elements of the molecular structure of a chromosome such as short tandem repeats (STR), transposons, and methylation and acetylation of DNA.

(i) describe unique elements of the molecular structure of a chromosome

(9) 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;

(i) describe the fundamental steps in recombinant DNA technology

(B) explain how recombinant DNA technology such as nuclear transfer cloning is used to clone genes and create recombinant proteins;

(i) explain how recombinant DNA technology is used to clone genes

(ii) explain how recombinant DNA technology is used to create recombinant proteins

(C) explain the role of tissue cultures in genetic modification procedures;

(i) explain the role of tissue cultures in genetic modification procedures

(D) describe plant- and animal-tissue culture procedures;

(i) describe plant-tissue culture procedures

(ii) describe animal-tissue culture procedures

(E) compare and contrast growing conditions for plant and animal tissue cultures;

(i) compare and contrast growing conditions for plant and animal tissue cultures

(F) explain the role of restriction enzymes; and

(i) explain the role of restriction enzymes

(G) distinguish between vectors commonly used in biotechnology for DNA insertion, including plasmids, adenoviruses, retroviruses, and bacteriophages.

(i) distinguish between vectors commonly used in biotechnology for DNA insertion, including plasmids

(ii) distinguish between vectors commonly used in biotechnology for DNA insertion, including adenoviruses

(iii) distinguish between vectors commonly used in biotechnology for DNA insertion, including retroviruses

(iv) distinguish between vectors commonly used in biotechnology for DNA insertion, including bacteriophages

(10) 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 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

(i) discuss the relationship between the local, state, and federal agencies responsible for regulation of the biotechnology industry

(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.

(i) analyze policies used in the biotechnology industry

(ii) analyze procedures used in the biotechnology industry

(11) The student performs biotechnology laboratory procedures. The student is expected to:

(A) measure volumes and weights to industry standards with accuracy and precision;

(i) measure volumes to industry standards with accuracy

(ii) measure volumes to industry standards with precision

(iii) measure weights to industry standards with accuracy

(iv) measure weights to industry standards with precision

(B) analyze data and perform calculations and statistical analysis as it relates to biotechnology laboratory experiments;

(i) analyze data as it relates to biotechnology laboratory experiments

(ii) perform calculations as [they relate] to biotechnology laboratory experiments

(iii) perform statistical analysis as it relates to biotechnology laboratory experiments;

(C) demonstrate proficiency in pipetting techniques;

(i) demonstrate proficiency in pipetting techniques

(D) identify microorganisms using staining methods such as the Gram stain, methylene-blue stain, and acid-fast staining;

(i) identify microorganisms using staining methods

(E) prepare a restriction digest, isolate nucleic acids, and evaluate results using techniques such as gel and capillary electrophoresis, Northern blot analysis, and Southern blot analysis;

(i) prepare a restriction digest using techniques

(ii) isolate nucleic acids using techniques

(iii) evaluate results using techniques

(F) explain the importance of media components to the outcome of cultures;

(i) explain the importance of media components to the outcome of cultures

(G) isolate, maintain, and store microbial cultures safely;

(i) isolate microbial cultures safely

(ii) maintain microbial cultures safely

(iii) store microbial cultures safely

(H) prepare seed inoculum; and

(i) prepare seed inoculum

(I) perform plating techniques such as streak plating, spread plating, and the Kirby-Bauer method.

(i) perform plating techniques

(12) 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;

(i) demonstrate aseptic techniques for establishing a sterile work area

(ii) demonstrate aseptic techniques for maintaining a sterile work area

(B) prepare, dispense, and monitor physical properties of stock reagents, buffers, media, and solutions;

(i) prepare stock reagents

(ii) prepare buffers

(iii) prepare media

(iv) prepare solutions

(v) dispense stock reagents

(vi) dispense buffers

(vii) dispense media

(viii) dispense solutions

(ix) monitor physical properties of stock reagents

(x) monitor physical properties of buffers

(xi) monitor physical properties of media

(xii) monitor physical properties of solutions

(C) calculate and prepare a dilution series; and

(i) calculate a dilution series

(ii) prepare a dilution series

(D) determine optimum conditions of reagents for experimentation.

(i) determine optimum conditions of reagents for experimentation

(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

(i) perform validation testing on laboratory reagents

(ii) perform validation testing on laboratory equipment

(B) analyze data and perform calculations and statistical analysis on results of quality-control samples.

(i) analyze data on results of quality-control samples

(ii) perform calculations on results of quality-control samples

(iii) perform statistical analysis on results of quality-control samples