

Florida Department of Education  
Curriculum Framework

**Program Title:** Industrial Biotechnology  
**Program Type:** Career Preparatory  
**Career Cluster:** Manufacturing

**Secondary – Career Preparatory**

|                            |   |
|----------------------------|---|
| Program Number             | 8736000                                       |
| CIP Number                 | 0626061601                                    |
| Grade Level                | 9-12  |
| Standard Length            | 3 credits                                     |
| Teacher Certification      | Refer to the <b>Program Structure</b> section |
| CTSO                       | SkillsUSA, FL-TSA                             |
| SOC Codes (all applicable) | 19-4021 – Biological Technicians              |

**Purpose**

This program offers a sequence of courses that provides coherent and rigorous content aligned with challenging academic standards and relevant technical knowledge and skills needed to prepare for further education and careers in the manufacturing career cluster; provides technical skill proficiency, and includes competency-based applied learning that contributes to the academic knowledge, higher-order reasoning and problem-solving skills, work attitudes, general employability skills, technical skills, and occupation-specific skills, and knowledge of all aspects of the manufacturing career cluster.

Industrial Biotechnology is a program offering students science credit through an applied science education, to prepare them for entry level positions in the cutting edge industry of Biotechnology. While meeting the state standards for science, the coursework will focus on developing science and bio-technical skills that are current and in demand for this rapidly growing occupation.

Upon completion of the integrated program, students will be able to explain and perform bio-technical skills used by Industrial, Medical, Agricultural, and Research facilities that develop and produce marketable products and processes.

**Additional Information** relevant to this Career and Technical Education (CTE) program is provided at the end of this document.

## Program Structure

This program is a planned sequence of instruction consisting of three credits.

It is **strongly recommended** that the following scope, sequence, and course recommendations be followed.

To teach the course(s) listed below, instructors must hold the teacher certification(s) indicated for that course.

The following table illustrates the secondary program structure:

| Course Number | Course Title    | Teacher Certification  | Length   | SOC Code | Level | Graduation Requirement |
|---------------|-----------------|--|----------|----------|-------|------------------------|
| 3027010       | Biotechnology 1 | BIOLOGY & BIOTECH 7G<br><b>or</b><br>CHEMISTRY & BIOTECH 7G  | 1 credit | 19-4021  | 3     | EQ                     |
| 3027020       | Biotechnology 2 | BIOLOGY & BIOTECH 7G<br><b>or</b><br>CHEMISTRY & BIOTECH 7G  | 1 credit | 19-4021  | 3     | EQ                     |
| 8736030       | Biotechnology 3 | BIOLOGY<br><b>or</b><br>CHEMISTRY<br><b>or</b><br>BIOTECH 7G | 1 credit | 19-4021  | 3     |                        |

*(Graduation Requirement Abbreviations- EQ= Equally Rigorous Science, PA= Practical Arts, EC= Economics)*

## **Common Career Technical Core – Career Ready Practices**

Career Ready Practices describe the career-ready skills that educators should seek to develop in their students. These practices are not exclusive to a Career Pathway, program of study, discipline or level of education. Career Ready Practices should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectation as a student advances through a program of study.

1. Act as a responsible and contributing citizen and employee.
2. Apply appropriate academic and technical skills.
3. Attend to personal health and financial well-being.
4. Communicate clearly, effectively and with reason.
5. Consider the environmental, social and economic impacts of decisions.
6. Demonstrate creativity and innovation.
7. Employ valid and reliable research strategies.
8. Utilize critical thinking to make sense of problems and persevere in solving them.
9. Model integrity, ethical leadership and effective management.
10. Plan education and career path aligned to personal goals.
11. Use technology to enhance productivity.
12. Work productively in teams while using cultural/global competence.

## **Standards**

After successfully completing this program, the student will be able to perform the following:

### **Academic Knowledge Standards:**

- 01.0 Apply knowledge of the nature of science and scientific habits of mind to solve problems, and employ safe and effective use of laboratory technologies.
- 02.0 Demonstrate understanding of the roles of matter, energy, in the chemical processes of cells, organisms.
- 03.0 Demonstrate an understanding of the structure and processes of the cell, with emphasis on reproduction and communication.
- 04.0 Demonstrate an understanding of the fundamentals of biochemistry including protein synthesis and reproduction.
- 05.0 Demonstrate an understanding of genetics, including the principles of, molecular basis, diversity, and applications to biotechnology.
- 06.0 Demonstrate an understanding of the levels of organization, from atoms to molecular DNA to organisms, classification, taxonomy.
- 07.0 Demonstrate an understanding of genetic diversity, selection, adaptations, and changes through time.
- 08.0 Demonstrate an understanding of the legal and ethical responsibilities associated with working with biological specimens for research or industry, bioethics.
- 09.0 Demonstrate an understanding of the connection between the various industry sectors of biotechnology (agricultural, food, and medical technologies) and careers.

### **CTE Performance Standards:**

- 11.0 Demonstrate knowledge of the history, career fields, and benefits of biotechnology.
- 12.0 Recognize and practice safety procedures.
- 13.0 Recognize and follows quality control procedures and regulatory guidelines.
- 14.0 Demonstrate the ability to communicate and use interpersonal skills effectively.
- 15.0 Apply basic skills in scientific inquiry, calculations, and analysis.
- 16.0 Demonstrate knowledge of organism structure and function.
- 17.0 Utilize materials processing and standard laboratory operating procedures for biotechnology.
- 18.0 Apply biotechnical materials analysis skills.
- 19.0 Demonstrates knowledge of basic chemistry as applied to biotechnology procedures.
- 20.0 Utilizes basic knowledge of microbiology and blood-borne diseases, including AIDS.
- 21.0 Demonstrate knowledge of legal and ethical responsibilities.
- 22.0 Demonstrate literacy and computer skills applicable to the biotechnology industry.
- 23.0 Demonstrate employability skills.

### **Academic Knowledge Standards:**

- 24.0 Apply knowledge of the nature of science and scientific habits of mind to solve problems, and employ safe and effective use of laboratory technologies.
- 25.0 Demonstrate understanding of the chemical processes in biotechnology, pH, solutions, dilutions, molarity.
- 26.0 Demonstrate an understanding of cell propagation, growth and cultures for biotechnology.
- 27.0 Demonstrate an understanding of the fundamentals of biochemistry including protein synthesis, recombinants, and reproduction, analysis, western blot.
- 28.0 Demonstrate an understanding of genetics and biotechnology, gene selection, transformation, analysis, PCR, Northern and Southern blot.
- 29.0 Demonstrate knowledge of the structure and function and reproduction of various organisms used as genetic models.

- 30.0 Demonstrate an understanding of the interdependence of organisms, humans, and the environment.
- 31.0 Demonstrate an understanding of genetic diversity, natural and genetic selection.
- 32.0 Demonstrate an understanding of bioethics.
- 33.0 Demonstrate an understanding of the connection between the various industry sectors of biotechnology (agricultural, food, and medical technologies) and careers.

**CTE Performance Standards:**

- 34.0 Demonstrate knowledge of the history, career fields, and benefits of biotechnology.
- 35.0 Recognize and practice safety procedures.
- 36.0 Recognize and follows quality control procedures and regulatory guidelines.
- 37.0 Demonstrate the ability to communicate and use interpersonal skills effectively.
- 38.0 Apply basic skills in scientific inquiry, calculations, and analysis.
- 39.0 Demonstrate knowledge of organism structure and function.
- 40.0 Utilize materials processing and standard laboratory operating procedures for biotechnology.
- 41.0 Apply biotechnical materials analysis skills.
- 42.0 Demonstrates knowledge of basic chemistry as applied to biotechnology procedures.
- 43.0 Utilizes basic knowledge of microbiology and blood-borne diseases, including AIDS.
- 44.0 Demonstrate knowledge of legal and ethical responsibilities.
- 45.0 Demonstrate literacy and computer skills applicable to the biotechnology industry.
- 46.0 Demonstrate employability skills.

**CTE Performance Standards:**

- 47.0 History, career fields, and benefits of biotechnology.
- 48.0 Safety procedures.
- 49.0 Quality control procedures and regulatory guidelines.
- 50.0 Communicate and use interpersonal skills effectively.
- 51.0 Basic skills in scientific inquiry, calculations, and analysis.
- 52.0 Organism structure and function.
- 53.0 Materials processing and standard laboratory operating procedures for biotechnology.
- 54.0 Biotechnical materials analysis skills.
- 55.0 Basic chemistry as applied to biotechnology procedures.
- 56.0 Microbiology and blood-borne diseases, including AIDS.
- 57.0 Legal and ethical responsibilities.
- 58.0 Literacy and computer skills applicable to the biotechnology industry.
- 59.0 Employability skills.

**Florida Department of Education  
Student Performance Standards**

**Course Title:** Biotechnology 1  
**Course Number:** 3027010  
**Course Credit:** 1 Science

It is **strongly recommended** that the following scope, sequence, and course recommendations be followed.

**Recommended Prerequisite:** None  
**Recommended Grade Level:** 9<sup>th</sup>/10<sup>th</sup>

**Course Description:** This course provides exploratory experience combining laboratory and real-life applications in the field of biotechnology. The content includes, but is not limited to, the following:

- The nature of science
- Matter, energy, chemical processes of cells, organisms
- Cell molecular structure and function, membranes, DNA, plasmids, reproduction, communication
- Fundamentals of biochemistry, protein synthesis, germ theory,
- Molecular genetics and biotechnology, restriction digest, DNA analysis, PCR
- Levels of organization, molecular to organismal, classification, and taxonomy
- Interdependence of organisms, humans, and the environment,
- Genetic diversity, selection, adaptations, and changes through time
- Bioethics
- Connection between Biotechnology, agricultural, food, and medicine and careers

This course shall integrate the Goal 3 Student Performance Standards of the Florida System of School Improvement and Accountability as appropriate to the content and processes of the subject matter.

Laboratory investigations that include scientific inquiry, research, measurement, problem solving, emerging technologies, tools and equipment, as well as, experimental quality, and safety procedures will be an integral part of this course. Students will interact with materials and primary sources of data or with secondary sources of data to observe and understand the natural world. Students will develop an understanding of measurement error, and develop the skills to aggregate, interpret, and present the data and resulting conclusions. Equipment and supplies will be provided to enhance these hands-on experiences for students. A minimum of 20% of classroom time will be dedicated to laboratory experiences.

## CTE Standards and Benchmarks

### Academic Knowledge Standards:

|       |   |
|-------|---|
| 01.0  | Apply knowledge of the nature of science and scientific habits of mind to solve problems, and employ safe and effective use of laboratory technologies.--The student will be able to:   |
| 01.01 | Describe general reasons for scientific investigations, which advance a process or improve scientific understanding.  |
| 01.02 | Understand that from time to time, major shifts occur in the scientific view of how the world works, but that more often, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge.                       |
| 01.03 | Understand that the potential for bias exists within individuals and scientific teams, and therefore scientists are expected to seek out possible sources of bias in the design of their investigations and in their data analysis.                         |
| 01.04 | Understand that new ideas in science are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and usually grow slowly from many contributors.                 |
| 01.05 | Understand how new theories are evaluated by the range of observations they explain and their effectiveness in predicting new findings when compared to existing scientific thought.  |
| 01.06 | Understand that scientists assume that the universe is a vast system in which basic rules exist that may range from very simple to extremely complex but that scientists operate on the belief that the rules can be discovered by careful, systemic study. |
| 01.07 | Understand the difference between laws, theories, and facts.  |
| 02.0  | Demonstrate understanding of the roles of matter, energy, in the chemical processes of cells, organisms.--The student will be able to:  |
| 02.01 | Understand that the electron configuration in atoms determines how a substance reacts and how much energy is involved in its reactions.   |
| 02.02 | Understand that the vast diversity of the properties of materials is primarily due to variations in the forces that hold molecules together.  |
| 02.03 | Understands that a change from one phase of matter to another involves a gain or loss of energy.  |
| 02.04 | Understand that connections (bonds) form between substances when outer-shell electrons are either transferred or shared between their atoms, changing the properties of substances.   |
| 02.05 | Understand that the number and configuration of electrons will equal the number of protons in an electrically neutral atom and when an atom gains or loses electrons the charge is unbalanced.  |
| 02.06 | Understand the difference between an element, a molecule, ion, and a compound   |
| 02.07 | Identify the usefulness of the periodic table and identify properties of specific groups.   |
| 02.08 | Understand that biological systems obey the same laws of conservation as physical systems.  |
| 02.09 | Understand that organisms respond to internal and external stimuli.   |
| 03.0  | Demonstrate an understanding of the structure and processes of the cell, with emphasis on reproduction and communication.--The student will be able to:   |
| 03.01 | Understand that body structures are uniquely designed and adapted for their function.   |

## CTE Standards and Benchmarks

|       |   |
|-------|---|
|       | 03.02 Understand that living systems are complex and that interactions between internal (metabolism etc.) and external sources can influence cell behavior.   |
| 04.0  | Demonstrate an understanding of the fundamentals of biochemistry including protein synthesis and reproduction.--The student will be able to:  |
| 04.01 | Understand that body processes involve specific biochemical reactions governed by biochemical principles, and that pathways have been identified through advances in molecular analyses, which have led to better understanding, diagnosis, and treatment of disease. |
| 04.02 | Understand that membranes are sites for chemical synthesis and essential energy conversions.  |
| 04.03 | Understand the complex interactions among the different kinds of molecules in the cell cause distinct cycles of activity governed by proteins.  |
| 05.0  | Demonstrate an understanding of genetics, including the principles of, molecular basis, diversity, and applications to biotechnology.--The student will be able to:   |
| 05.01 | Understand the mechanism of asexual and sexual reproduction and knows the different genetic advantages and disadvantages of sexual and asexual reproduction.  |
| 05.02 | Understand that every cell contains a “blueprint” coded in DNA molecules which follow the central dogma of biology from DNA to RNA, to protein assembly; from transcription to translation.   |
| 06.0  | Demonstrate an understanding of the levels of organization, from atoms to molecular DNA to organisms, classification, taxonomy.--The student will be able to:   |
| 06.01 | Understand that chemical elements that make up the molecules of living things are combined and recombined in different ways.  |
| 07.0  | Demonstrate an understanding of genetic diversity, selection, adaptations, and changes through time.--The student will be able to:  |
| 07.01 | Understand the mechanisms of change (e.g., mutation and natural selection) that lead to adaptations in a species and their ability to survive naturally in changing conditions and to increase species diversity.   |
| 07.02 | Understand the great diversity and interdependence of living things.  |
| 07.03 | Understands how genetic variation of offspring contributes to natural selection.  |
| 08.0  | Demonstrate an understanding of the legal and ethical responsibilities associated with working with biological specimens for research or industry, bioethics.--The student will be able to:   |
| 08.01 | Understand the importance of a sense of responsibility, a commitment to peer review, truthful reporting of the methods and outcomes of investigations, and making the public aware of the findings.   |
| 08.02 | Understand that scientists first define then control conditions in order to obtain evidence, but when that is not possible for practical or ethical reasons, they try to observe a wide range of natural occurrences to discern patterns.                             |
| 08.03 | Understand that performance testing is often conducted using small-scale models, computer simulations, or analogous systems to reduce the chance of system failure.   |
| 08.04 | Understand that scientific knowledge is used by those who engage in design and technology to solve practical problems, taking human values and limitations into account.  |



## CTE Standards and Benchmarks

08.05 Discuss the extended impact of involving animal and human subjects in research with respect to humane treatment, providing full disclosure to clinical trial participants, ensuring patient confidentiality, and participants, ensuring patient.

08.06 Understand the purpose of clinical trials.

08.07 Understand the purpose of Good Laboratory Practices (GLP) as related to product testing and approval.

09.0 Demonstrate an understanding of the legal and ethical responsibilities associated with working with biological specimens for research or industry, bioethics.--The student will be able to:

09.01 Understand that scientists can bring information, insights, and analytical skills to matters of public concern and help people understand the possible causes and effects of events.

09.02 Understand that funds for science research come from federal government agencies, industry, private investors, and private foundations and that this funding often influences the areas of discovery.

09.03 Provide examples of industry trends related to Biotechnology.

### CTE Performance Standards:

10.0 Demonstrate knowledge of the history, career fields, and benefits of biotechnology.--The student will be able to:

10.01 Describe major historic developments in biotechnology fields such as pharmaceuticals, biopharmaceuticals, agriculture, diagnostics, industrial products, devices, instrumentation, and research and development.

10.02 Identify several products obtained through recombinant DNA technology and other biotechnology advances.

10.03 Describe the major steps in a product's move through a company's product pipeline.

10.04 Explain how companies decide on the research and development targets and potential products.

10.05 Give examples of how the biotechnology revolution has had an impact on current science and manufacturing practices, as well as how new discoveries in science have in turn impacted biotechnology.

10.06 Illustrate examples of how biotechnology has led to benefits and risks to society and how biotechnical advances affect human lives on a personal level.

11.0 Recognize and practice safety procedures.--The student will be able to:

11.01 Identify safety symbols and signs.

11.02 Identify appropriate safety procedures and guidelines.

11.03 Demonstrate an understanding of the emergency procedures in case of fire, burn, chemical spill or other hazardous situations.

11.04 Recognize laboratory safety hazards and avoid them.

11.05 Locate and identify emergency equipment, including first aid.

## CTE Standards and Benchmarks

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| 11.06 | Use laboratory apparatus, materials, and technology in an appropriate and safe manner.  |
| 11.07 | Locate a Safety Data Sheet (SDS) and use the information to operate in a safe manner.   |
| 11.08 | Demonstrate knowledge of universal precautions for blood-borne pathogens.   |
| 12.0  | Recognize and follows quality control procedures and regulatory guidelines.--The student will be able to:   |
| 12.01 | Identify the need for and function of regulatory agencies such as those in government, industry, and society.   |
| 12.02 | Describe appropriate attire for different biotechnology workplaces including the office, laboratory and cleanroom environments.   |
| 12.03 | Monitor, use, store and dispose of hazardous materials properly.  |
| 12.04 | Clean, organize, and sterilize materials and equipment.   |
| 12.05 | Understand the role of the employer to provide a safe and healthful workplace. (OSHA regulations)   |
| 13.0  | Demonstrate the ability to communicate and use interpersonal skills effectively.--The student will be able to:  |
| 13.01 | Follow all oral and written instructions.   |
| 13.02 | Demonstrate good listening, writing, and verbal communication skills and procedures.  |
| 13.03 | Appropriately use and respond to verbal and non-verbal cues.  |
| 13.04 | Use correct spelling, grammar, and format in all written communication.   |
| 13.05 | Use appropriate scientific terminology and abbreviations.   |
| 13.06 | Recognize the importance of courtesy and respect and maintain good interpersonal relationships.   |
| 13.07 | Read and discuss technical material.  |
| 13.08 | Read and present a scientific paper for discussion, including an overview of the objective, experimental methods, results, and conclusions.   |
| 14.0  | Apply basic skills in scientific inquiry, calculations, and analysis.--The student will be able to:   |
| 14.01 | Demonstrate knowledge of the scientific method.   |
| 14.02 | Use a variety of methods including literature searches in libraries, computer databases, or on-line, for gathering background information, making observations, and collecting and organizing data. |
| 14.03 | Use the scientific method to conduct a valid experiment, including hypothesis formation, data collection, data analysis including results and discussion, and conclusion.                           |

## CTE Standards and Benchmarks

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| 14.04 | Maintain a scientific notebook per industry best practices (objectives, procedures, data, materials, sources of error, and conclusions).   |
| 14.05 | Properly and safely operate scientific equipment including graduates, hoods, microscopes, pipets, micropipets, electronic balance, pH meters, incubators, centrifuges, water baths, power supplies and electrophoresis chambers. |
| 14.06 | Make and use measurements in both traditional and metric units.  |
| 14.07 | Measure time, temperature, distance, capacity and mass/weight.   |
| 14.08 | Make estimates and approximations in order to test the reasonableness of the result.   |
| 14.09 | Evaluate the validity of results obtained during experimentation and product development.  |
| 14.10 | Interpret and use graphs, charts and tables used to collect and analyze data.  |
| 14.11 | Interpret quantitative and qualitative data.   |
| 14.12 | Demonstrate ability to evaluate and draw conclusions.  |
| 14.13 | Follow guidelines to prepare a scientific report.  |
| 15.0  | Demonstrate knowledge of organism structure and function.--The student will be able to:  |
| 15.01 | Recognize and distinguish between the following based upon the hierarchy of organization of organisms: atom, molecule, cells, tissue, organs, organ system, and organism.  |
| 15.02 | Outline the life cycle and characteristics of certain model organisms used in the biotechnology industry, including bacterial, yeast, and mammalian cells, and viruses.  |
| 15.03 | Differentiate between prokaryotic and eukaryotic cells.  |
| 15.04 | Describe the cell (both prokaryotes and eukaryotes) as the basic unit of life.   |
| 15.05 | Analyze the difference between plant and animal cells.   |
| 15.06 | Describe cell structure and function.  |
| 15.07 | Differentiate between mitosis and meiosis.   |
| 15.08 | Describe the role of DNA, RNA, and ribosomes in protein synthesis.   |
| 16.0  | Utilize materials processing and standard laboratory operating procedures for biotechnology.--The student will be able to:   |
| 16.01 | Maintain a clean and organized work area.  |
| 16.02 | Follow written protocols and oral directions to perform a variety of laboratory and technical tasks.   |

## CTE Standards and Benchmarks

|       |   |
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| 16.03 | Determine appropriate equipment and units of measurement for a given task.  |
| 16.04 | Discuss and perform disinfection and sterilization techniques.  |
| 17.0  | Apply biotechnical materials analysis skills.--The student will be able to:   |
| 17.01 | Isolate DNA from a variety of cells.  |
| 17.02 | Explain the principles involved in agarose gel electrophoresis.   |
| 17.03 | Prepare, load, run, visualize, and analyze DNA samples on an agarose gel.   |
| 17.04 | Describe the meaning in differences in DNA and peptide bands seen on agarose gels.  |
| 17.05 | Explain the difference between analyzing PCR products on conventional gels vs. using a realtime PCR system.                     |
| 17.06 | Discuss sources of environmental contamination and methods of detection in controlled environments.                             |
| 18.0  | Demonstrates knowledge of basic chemistry as applied to biotechnology procedures.--The student will be able to:                 |
| 18.01 | Demonstrate that the rate of chemical reactions depend on reactant concentration or temperature, or the presence of a catalyst. |
| 19.0  | Utilizes basic knowledge of microbiology and blood-borne diseases, including AIDS.--The student will be able to:                |
| 19.01 | Differentiate between aerobic vs. anaerobic bacteria, viruses, bacteriophage, and mycoplasma.                                   |
| 19.02 | Discuss microbial taxonomy and classification.  |
| 19.03 | Practice aseptic techniques as required.  |
| 19.04 | Discuss sterilization and isolation techniques.   |
| 19.05 | Discuss techniques of inoculation and transfer of cultures.   |
| 19.06 | Describe conditions that promote cell growth under aseptic conditions in the laboratory and workplace.                          |
| 19.07 | Identify "at risk" behaviors which promote the spread of diseases caused by blood borne pathogens.                              |
| 19.08 | Discuss differences between sterilization, decontamination, and disinfection.   |
| 19.09 | Demonstrate proper protocol for the disposal of biohazardous waste and microorganisms.  |
| 20.0  | Demonstrate knowledge of legal and ethical responsibilities.--The student will be able to:                                      |
| 20.01 | Discuss ethical, legal and social issues raised by biotechnology.   |

## CTE Standards and Benchmarks

21.0 Demonstrate literacy and computer skills applicable to the biotechnology industry.--The student will be able to:

21.01 Define terms and demonstrate basic computer skills.

21.02 Describe the uses of computers in the biotechnology industry.

21.03 Use the Internet to gather and share scientific and regulatory information.

22.0 Demonstrate employability skills.--The student will be able to:

22.01 Demonstrate appropriate responses to criticism and coaching from employer, supervisor, or other persons.

22.02 Demonstrate appropriate methods for asking questions, and providing constructive criticism and feedback.

22.03 Use several resources including the internet to gather information about job opportunities in the biotechnology field.

22.04 Outline the opportunities for careers in biotechnology in health, industry, medicine, genetics, agriculture, etc.

22.05 Identify and demonstrate acceptable work habits and health habits.

22.06 Follow acceptable work habits, personal characteristics and hygiene habits for the biotechnology workplace.

**Florida Department of Education  
Student Performance Standards**

**Course Title:** Biotechnology 2  
**Course Number:** 3027020  
**Course Credit:** 1 Science

**It is strongly recommended that the following scope, sequence, and course recommendations be followed.**

**Recommended Prerequisite:** Biotechnology 1, Biology 1, Honors Biology, or Biology Technology  
**Recommended Grade Level:** 10<sup>th</sup>/11<sup>th</sup>

**Course Description:** This course provides exploratory experience combining laboratory and real-life applications in the field of biotechnology. The content includes, but is not limited to, the following:

- The nature of science
- Chemical processes in biotechnology, pH, solutions, molarity
- Cell propagation, growth and cultures for biotechnology
- Biochemistry, proteins, enzymes, plasmids, recombinants, blood borne pathogens
- Genetics and biotechnology, gene selection, transformation, analysis
- Structure and function of various organisms used as genetic models
- Interdependence of organisms, humans, and the environment,
- Genetic diversity and selection
- Connection between biotechnology, agricultural, food, and medicine and careers
- Bioethics

This course shall integrate the Goal 3 Student Performance Standards of the Florida System of School Improvement and Accountability as appropriate to the content and processes of the subject matter.

Laboratory investigations that include scientific inquiry, research, measurement, problem solving, emerging technologies, tools and equipment, as well as, experimental quality, and safety procedures will be an integral part of this course. Students will interact with materials and primary sources of data or with secondary sources of data to observe and understand the natural world. Students will develop an understanding of measurement error, and develop the skills to aggregate, interpret, and present the data and resulting conclusions. Equipment and supplies will be provided to enhance these hands-on experiences for students. A minimum of 20% of classroom time will be dedicated to laboratory experiences.

## CTE Standards and Benchmarks

### Academic Knowledge Standards:

|       |   |
|-------|---|
| 23.0  | Apply knowledge of the nature of science and scientific habits of mind to solve problems, and employ safe and effective use of laboratory technologies.--The student will be able to:   |
| 23.01 | Understand that investigations are conducted to explore new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories.   |
| 23.02 | Understand that from time to time, major shifts occur in the scientific view of how the world works, but that more often, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge.   |
| 23.03 | Understand that no matter how well one theory fits observations, a new theory might fit them as well or better, or might fit a wider range of observations, because in science, the testing, revising, and occasional discarding of theories, new and old, never ends and leads to an increasingly better understanding of how things work in the world, but not to absolute truth. |
| 23.04 | Understand that the potential for bias exists within individuals and scientific teams, and therefore scientists are expected to seek out possible sources of bias in the design of their investigations and in their data analysis.   |
| 23.05 | Understand that new ideas in science are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and usually grow slowly from many contributors.   |
| 23.06 | Understand that in the short run, new ideas that do not mesh well with mainstream ideas in science often encounter vigorous criticism and that in the long run, theories are judged by how they fit with other theories, the range of observations they explain, how well they explain observations, and how effective they are in predicting new findings.                         |
| 23.07 | Understand that scientists assume that the universe is a vast system in which basic rules exist that may range from very simple to extremely complex but that scientists operate on the belief that the rules can be discovered by careful, systemic study.   |
| 24.0  | Demonstrate understanding of the chemical processes in biotechnology, pH, solutions, dilutions, molarity.--The student will be able to:   |
| 24.01 | Experiments and determines that the rates of reaction among atoms and molecules depend on the concentration, pressure, and temperature of the reactants and the presence of absence of catalysts.   |
| 24.02 | Understand how knowledge of energy is fundamental to all the scientific disciplines (e.g., the energy required for biological processes in living organisms and the energy required for the building, erosion, and rebuilding of the Earth).  |
| 24.03 | Understand that there is conservation of mass and energy when matter is transformed.  |
| 24.04 | Understands that membranes are sites for chemical synthesis and essential energy conversions.   |
| 24.05 | Understands that biological systems obey the same laws of conservation as physical systems.   |

## CTE Standards and Benchmarks

25.0 Demonstrate an understanding of cell propagation, growth and cultures for biotechnology.--The student will be able to:

25.01 Understand the mechanisms of asexual and sexual reproduction and know the different genetic advantages and disadvantages of asexual and sexual reproduction.

26.0 Demonstrate an understanding of the fundamentals of biochemistry including protein synthesis, recombinants, and reproduction, analysis, western blot.--The student will be able to:

26.01 Define monoclonal antibodies and hybridoma technology.

26.02 Understand the complex interactions among the different kinds of molecules in the cell cause distinct cycles of activity governed by proteins.

26.03 Understand that cell behavior can be affected by molecules from other parts of the organism or even from other organisms.

27.0 Demonstrate an understanding of genetics and biotechnology, gene selection, transformation, analysis, PCR, northern and southern blot.--The student will be able to:

27.01 Understand that the chemical elements that make up the molecules of living things are combined and recombined in different ways.

27.02 Understand that every cell contains a "blueprint" coded in DNA molecules which follow the central dogma of biology from DNA to RNA, to protein assembly; from transcription to translation.

28.0 Demonstrate a knowledge of the structure and function and reproduction of various organisms used as genetic models.--The student will be able to:

28.01 Understand that body structures are uniquely designed and adapted for their function.

28.02 Describe animal models used in research, and the types of studies they are optimally used for.

29.0 Demonstrate an understanding of the interdependence of organisms, humans, and the environment.--The student will be able to:

29.01 Understand the interdependence exists between both the biotic and abiotic components of any system.



## CTE Standards and Benchmarks

30.0 Demonstrate an understanding of genetic diversity, natural and genetic selection.--The student will be able to:

30.01 Understand the mechanisms of change (e.g., mutation and natural selection) that lead to adaptations in a species and their ability to survive naturally in changing conditions and to increase species diversity.

30.02 Understand of the great diversity and interdependence of living things, and the value of biodiversity.

30.03 Understands how genetic variation of offspring contributes to natural selection.

31.0 Demonstrate an understanding of bioethics.--The student will be able to:

31.01 Understand the importance of a sense of responsibility, a commitment to peer review, truthful reporting of the methods and outcomes of investigations, and making the public aware of the findings.

31.02 Understand that scientists first define then control conditions in order to obtain evidence, but when that is not possible for practical or ethical reasons, they try to observe a wide range of natural occurrences to discern patterns.

31.03 Understand that performance testing is often conducted using small-scale models, computer simulations, or analogous systems to reduce the chance of system failure.

31.04 Understand that scientific knowledge is used by those who engage in design and technology to solve practical problems, taking human values and limitations into account.

32.0 Demonstrate an understanding of the connection between the various industry sectors of biotechnology (agricultural, food, and medical technologies) and careers.--The student will be able to:

32.01 Understand that funds for science research come from federal government agencies, industry, and private foundations and that this funding often influences the areas of discovery.

32.02 Understand that scientists can bring information, insights, and analytical skills to matters of public concern and help people understand the possible causes and effects of events.

32.03 Discuss how scientists contribute to and promote science-based policy in US government.

32.04 Discuss the correlation between scientific discovery and product development, based on societal benefit vs. financial benefit to a company.

### CTE Performance Standards:

33.0 Demonstrate knowledge of the history, career fields, and benefits of biotechnology.--The student will be able to:

33.01 Understand that technologies used in biotechnology continue to be developed and improved, with respect to advances in discoveries, applications, and demand for increased efficiency.

33.02 Compare the developments in two biotechnology fields and make predictions for future developments in those areas.

33.03 Identify several local biotechnology companies specializing in the production of pharmaceuticals, agricultural products, industrial products, and research instruments and reagents.

## CTE Standards and Benchmarks

|       |   |
|-------|---|
| 33.04 | Compare the benefits of products derived from biotechnological advances (including DNA technology), to an environment devoid of biotechnological products or applications.  |
| 33.05 | Demonstrate knowledge of various career fields in the biotechnology industry, including but not limited to research and development, pre-clinical and clinical trials, manufacturing, facilities and equipment, quality control, quality assurance, regulatory affairs, marketing, and sales. |
| 34.0  | Recognize and practice safety procedures.--The student will be able to:   |
| 34.01 | Define Biological Safety Levels 1 through 4 and their differences.  |
| 34.02 | Describe appropriate attire for Biological Safety Levels 1 through 4.   |
| 34.03 | Identify potential biohazards and relate how to deal with a variety of biohazards.  |
| 34.04 | Use appropriate safety procedures and guidelines and demonstrate knowledge of emergency procedures.   |
| 34.05 | Maintain equipment and material logs for all apparatus, materials, and technology.  |
| 34.06 | Maintain Safety Data Sheet (SDS) notebook and appropriately reference for each activity.  |
| 34.07 | Follow approved protocols for all activities which may cause exposure to blood-borne pathogens.   |
| 34.08 | Describe strategies used in a cleanroom to minimize the introduction of contaminating microorganisms or particulates.   |
| 35.0  | Recognize and follows quality control procedures and regulatory guidelines.--The student will be able to:   |
| 35.01 | Describe the need for and function of regulatory agencies such as those in government, industry, and society.   |
| 35.02 | Discuss quality control and assurance with respect to documentation.  |
| 35.03 | Discuss quality control in relation to inspection results and specifications, procedures, testing methods, process control, regulatory specifications and documentation, and internal audits.   |
| 35.04 | Utilize quality control methods in relation to hazardous and non-hazardous materials.   |
| 36.0  | Demonstrate the ability to communicate and use interpersonal skills effectively.--The student will be able to:  |
| 36.01 | Demonstrate ability to give and follow oral and written directions.   |
| 36.02 | Recognize potential errors in protocol and address them with colleagues and the appropriate supervisor.   |
| 36.03 | Maintain thorough documentation of tasks and procedures.  |
| 36.04 | Work effectively in a research, manufacturing, quality control, or quality assurance team with a defined responsibility.  |
| 36.05 | Incorporate appropriate scientific terminology and abbreviations into all technical documents.  |

## CTE Standards and Benchmarks

36.06 Prepare, analyze, and discuss technical material.

37.0 Apply basic skills in scientific inquiry, calculations, and analysis.--The student will be able to:

37.01 Develop scientific questions, hypotheses, and experimental plans.

37.02 Properly and safely operate scientific equipment including mixers, analytical balances, stirrers, shakers, conductivity meters, and a hemocytometer.

37.03 Calculate ratios used for making chemical dilutions or plate counting.

37.04 Compose a thorough concluding statement outlining the results of an experiment with evidence, explanations, error analysis, and practical applications.

37.05 Evaluate scientific reports with well-supported, clearly presented opinions.

37.06 Consistently analyze and properly uses a variety of valid literature resources.

37.07 Set-up and maintain a legal scientific notebook that includes an account of all laboratory procedures, data, conclusions, and appropriate signatures.

37.08 Measure time, temperature, distance, capacity, mass/weight, flow rates and growth rates.

37.09 Create graphs, charts and tables used to record, analyze, and convey scientific data.

37.10 Critically analyze quantitative and qualitative data.

37.11 Organize and communicate clear, concise written and oral reports of scientific findings.

38.0 Demonstrate knowledge of organism structure and function.--The student will be able to:

38.01 Discuss the makeup of chromosomes.

38.02 Describe the processes of nucleic acid transfer.

38.03 Describe the relationship of cellular science and biotechnology.

38.04 Describe how enzymes regulate all aspects of protein synthesis.

38.05 Explain how the structure of nucleic acid affects its isolation from cells and solutions.

38.06 Describe how cells are engineered to express recombinant proteins.

38.07 Identify groups of proteins based on their functions, citing specific examples of proteins in each group.

38.08 Use the Internet to find information about the structure and function of specific proteins.

## CTE Standards and Benchmarks

39.0 Utilize materials processing and standard laboratory operating procedures for biotechnology.--The student will be able to:

39.01 Maintain a professional laboratory space following standard operating procedures.

39.02 Perform a variety of biological tests and chemical assays, collect data, perform calculations, and statistical analysis.

39.03 Discuss classification, composition and preparation of culture media.

39.04 Discuss collection and handling of specimens for fungal, bacterial, mammalian cells and viral specimens, and parasites.

40.0 Apply biotechnical materials analysis skills.--The student will be able to:

40.01 Outline the steps in cell culture, aseptic technique and media preparation.

40.02 Isolate DNA from cells and analyze its purity and concentration.

40.03 Outline the steps in production, product testing, and delivery of a product made through recombinant DNA technology.

40.04 Explain the principles' involved in polyacrylamide and agarose gel electrophoresis.

40.05 Prepare, load, run, visualize, and analyze protein samples on a polyacrylamide or agarose gel.

40.06 Prepare protein solutions and dilutions at specific concentrations and pH.

40.07 Use protein indicator solutions to identify the presence and concentration of protein in solution.

40.08 Describe the meaning in differences in DNA and peptide bands seen on polyacrylamide or agarose gels.

40.09 Prepare and maintain plate and broth cultures of bacteria. Explain how polyacrylamide gel electrophoresis (PAGE) is used with column chromatography to monitor protein product.

40.10 Describe the steps in harvesting protein product from fermentation cell culture.

40.11 Outline the steps of using a visible light spectrophotometer.

40.12 Prepare a serial dilution of protein and measure absorbance at a given wavelength.

40.13 Use a standard curve to determine the concentration of an unknown protein solution.

40.14 Explain the protocol and application for isolating plasmids.

40.15 Explain the process and application of inserting genes that code for antibiotic resistance into a plasmid.

40.16 Demonstrate the ability to culture, propagate, and harvest bacteria.

40.17 Understand the bacterial growth stages in culture.

## CTE Standards and Benchmarks

40.18 Understand components of growth media such as energy source, and antibiotics, and incubation parameters: time, temp, atmospheric concentration.

40.19 Explain the process of utilizing restriction enzymes and DNA ligase to insert a new gene into a plasmid.

40.20 Explain the process of replicating plasmids.

40.21 Practice environmental monitoring using agar plates.

41.0 Demonstrates knowledge of basic chemistry as applied to biotechnology procedures.--The student will be able to:

41.01 Use the periodic table to calculate molarity.

41.02 Balance equations to show that there is a conservation of matter. Explain hydrogen and polar bonding.

41.03 Discuss and use techniques that identify and separate components of a homogenous mixture.

41.04 Explain and use the function of pH in the preservation, purification, and functioning of proteins.

41.05 Use pH paper or pH meter to measure and adjust pH.

41.06 Calculate how to prepare solutions based on % mass/volume.

41.07 Calculate how to prepare solutions based on molar concentrations.

41.08 Use stoichiometry and molarity to prepare solutions of any volume and concentration.

41.09 Prepare dilutions of concentrated solutions.

42.0 Utilizes basic knowledge of microbiology and blood-borne diseases, including AIDS.--The student will be able to:

42.01 Discuss bacterial metabolism, reproduction, cell structures and their functions.

42.02 Perform microbiology techniques in controlled environments.

42.03 Demonstrate techniques of microscope use related to oil immersion and slide preparation.

42.04 Discuss uses for different microscopy methods, including light, fluorescent, phase-contrast, and electron.

42.05 Demonstrate the preparation and interpretation of Gram stains.

42.06 Perform various preparation and staining techniques.

42.07 Perform disinfection and aseptic techniques.

42.08 Perform sterilization and isolation techniques.

## CTE Standards and Benchmarks

42.09 Prepare artificial culture media.

42.10 Perform techniques of inoculation and transfer of cultures.

42.11 Use various methods to monitor the growth of cell cultures.

42.12 Discuss the immune system and the normal immune response.

42.13 Perform antigen and antibody testing.

42.14 Discuss methods that utilize the antigen/antibody complex as tools for research, diagnosis, and testing.

42.15 Discuss the ABO, Rh and other blood group systems.

42.16 Distinguish between fact and fallacy about the transmission and treatment of diseases caused by blood borne pathogens including Hepatitis B.

42.17 Identify community resources and services available to the individuals with diseases caused by blood borne pathogens.

42.18 Demonstrate knowledge of the legal aspects of AIDS, including testing.

42.19 Describe how blood-borne pathogens are avoided in manufacturing.

43.0 Demonstrate knowledge of legal and ethical responsibilities.--The student will be able to:

43.01 Recognize ethical issues of the biotechnology workplace such as employee privacy, employee safety, animal testing, etc.

43.02 List the local, regional, state and federal agencies who oversee safety, ethics, and manufacturing.

43.03 Provide examples of the appropriate professional traits of a worker in biotechnology.

43.04 Outline the proper protocol for reporting unsafe or unethical behavior.

44.0 Demonstrate literacy and computer skills applicable to the biotechnology industry.--The student will be able to:

44.01 Use the Internet to gather and share scientific and regulatory information.

44.02 Use a variety of methods including literature searches in libraries, in computer databases, and on-line for gathering background information, making observations, and collecting and organizing data.

44.03 Use a computer spreadsheet, word processing, and presentation programs to collect, analyze and report information or data.

45.0 Demonstrate employability skills--The student will be able to:

45.01 Conduct a job search.

**CTE Standards and Benchmarks**

45.02 Develop a portfolio that demonstrates proficiency in specific biotechnology workplace tasks including writing samples and performance-based lab and computer skills.

45.03 Describe the opportunities for careers in biotechnology in health, industry, medicine, genetics, agriculture, etc.

45.04 Identify or demonstrate appropriate responses to criticism from employer, supervisor, or other persons.

45.05 Analyze the impact that work and health habits play in the biotechnology industry.

45.06 Recognize appropriate professional behavior.

45.07 Explain the roles of different departments and the employees within each department at an industry site.

45.08 Describe the departmental functions in a typical biotechnology company.

Florida Department of Education  
Student Performance Standards

Course Title:                Biotechnology 3  
Course Number:            8736030  
Course Credit:             1

It is strongly recommended that the following scope, sequence, and course recommendations be followed.

Recommended Prerequisite:    Biotechnology 1 and Biotechnology 2  
Recommended Grade Level:    11<sup>th</sup>/12<sup>th</sup>

Biotechnology 3 is a course designed to provide students with intense laboratory and research skills in preparation for continued education and/or entry into the biotechnology industry. Students will build upon the skills attained in Biotechnology 1 and Biotechnology 2 as they design and conduct experiments relevant to current biotechnology. A close association with local industry and postsecondary institutions will provide additional opportunities for development and application of biotechnology practices.

| <b>CTE Standards and Benchmarks</b>      |  |
|--|--|
| <u><b>CTE Performance Standards:</b></u> |  |
| 47.0                                     | History, career fields, and benefits of biotechnology.--The student will be able to:   |
| 47.01                                    | Identify a recent advancement in a biotechnological tool or method, and compare it to its predecessor.   |
| 47.02                                    | Select and evaluate the potential of a product based on industry criteria.   |
| 47.03                                    | Explain how biotechnology practices, procedures, and philosophies have evolved to current high technology and integrated disciplines.                        |
| 47.04                                    | Illustrate examples of how biotechnology has led to benefits and risks to society and how biotechnical advances affect human lives on a personal level.      |
| 47.05                                    | Graph a history timeline with medical advances due to technology advances.   |
| 47.06                                    | Research and analyze career opportunities available in biotechnology and select the career pathway best suited to your interests, abilities, and objectives. |
| 47.07                                    | Discuss medical, agricultural, forensic, and environmental applications of biotechnology.  |
| 48.0                                     | Safety procedures.--The student will be able to:   |
| 48.01                                    | Identify safety symbols and signs.   |



## CTE Standards and Benchmarks

48.02 Use appropriate safety procedures and guidelines.

48.03 Demonstrate an understanding of the emergency procedures in case of fire, burn, chemical spill or other hazardous situations.

48.04 Recognize laboratory safety hazards and avoid them.

48.05 Locate and be able to use emergency equipment, including first aid.

48.06 Identify potential biohazards and relate how to deal with a variety of biohazards.

48.07 Use laboratory apparatus, materials, and technology in an appropriate and safe manner.

48.08 Locate a Safety Data Sheet (SDS) and use the information to operate in a safe manner.

48.09 Follow universal precautions for blood-borne pathogens.

49.0 Quality control procedures and regulatory guidelines.--The student will be able to:

49.01 Evaluate the need for and function of regulatory agencies such as those in government, industry, and society.

49.02 Understand that all products intended to be used for the diagnosis, cure, mitigation, treatment, or prevention of disease must go through a regulatory approval process that is based on documented research and testing to ensure the product is safe and efficacious (works).

49.03 Describe the purpose of current Good Manufacturing Practices, and how they are supported by guidance from the International Organization for Standardization.

49.04 Analyze experimental data and/or manufacturing processing documentation from the perspective of quality assurance.

49.05 Discuss quality control in relation to inspection results and specifications, procedures, testing methods, process control, regulatory specifications and documentation, and internal audits.

49.06 Monitor, use, store and dispose of hazardous materials properly.

49.07 Check and maintain equipment and logs.

49.08 Clean, organize, and sterilize materials.

49.09 Manage material and supply inventories.

49.10 Define/chart the process of receiving an unqualified (or qualified) raw material and follow it through the manufacturing process into the finished product.

50.0 Communicate and use interpersonal skills effectively.--The student will be able to:

## CTE Standards and Benchmarks

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|-------|--|
| 50.01 | Follow all oral and written instructions.  |
| 50.02 | Demonstrate ability to give oral and written directions.   |
| 50.03 | Demonstrate good listening, writing, and verbal communication skills and procedures.   |
| 50.04 | Recognize potential errors in protocol and address them with colleagues and the appropriate supervisor.  |
| 50.05 | Maintain thorough documentation of tasks and procedures.   |
| 50.06 | Work effectively in a research, manufacturing, quality control, or quality assurance team with a defined responsibility.   |
| 50.07 | Develop basic observational skills and related documentation strategies in written and oral form.  |
| 50.08 | Identify characteristics of successful and unsuccessful communication.   |
| 50.09 | Appropriately use and respond to verbal and non-verbal cues.   |
| 50.10 | Use correct spelling, grammar, and format in all written communication.  |
| 50.11 | Use appropriate scientific terminology and abbreviations.  |
| 50.12 | Recognize the importance of courtesy and respect and maintain good interpersonal relationships.  |
| 50.13 | Interpret technical material and prepare a journal article related to the development of a process or product on which the student has worked.   |
| 51.0  | Basic skills in scientific inquiry, calculations, and analysis.--The student will be able to:  |
| 51.01 | Demonstrate knowledge of the scientific method in general and biotechnology research in manufacturing and quality control.   |
| 51.02 | Understand the applicability of Koch's postulates.   |
| 51.03 | Consistently analyze and properly uses valid literature resources.   |
| 51.04 | Set-up and maintain a legal scientific notebook that includes an account of all laboratory procedures, data, conclusions, and appropriate signatures.  |
| 51.05 | Properly and safely operate scientific equipment including graduates, hoods, microscopes, pipets, micropipets, electronic balance, pH meters, incubators, centrifuges, water baths, power supplies and electrophoresis chambers. |
| 51.06 | Properly and safely operate scientific equipment including mixers, analytical balances, stirrers, shakers, conductivity meters, and a hemocytometer.   |

## CTE Standards and Benchmarks

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| 51.07 | Describe how to properly and safely use scientific equipment including spectrophotometer, autoclave, thermocycler, plate reader/fluorometer, and sterile hood/ biosafety cabinet. |
| 51.08 | Understand why sometimes equipment is dedicated to one specific room, assay, or process.  |
| 51.09 | Describe how to properly and safely use scientific equipment including polarimeter, chart recorder, particle counter, and hybridization oven.                                     |
| 51.10 | Make and use measurements in both traditional and metric units.   |
| 51.11 | Calculate ratios used for making chemical dilutions or plate counting.  |
| 51.12 | Measure time, temperature, distance, capacity, mass/weight, flow rates and growth rates.  |
| 51.13 | Describe the relationship between 12 and 24 hour time and be able to convert between the two.   |
| 51.14 | Make estimates and approximations in order to test the reasonableness of the result.  |
| 51.15 | Evaluate the validity of results obtained during experimentation and product development.   |
| 51.16 | Interpret and create graphs, charts and tables used to collect and analyze data.  |
| 51.17 | Interpret and critically analyze quantitative and qualitative data.   |
| 51.18 | Demonstrate ability to evaluate and draw conclusions.   |
| 51.19 | Organize and communicate clear, concise written and oral reports of scientific findings.  |
| 51.20 | Evaluate scientific reports with well-supported, clearly presented opinions. Monitor scientific equipment by conducting and documenting preventative maintenance and calibration. |
| 51.21 | Correctly identify positive and negative controls in an experiment and evaluate the validity of the result in the light of controls.  |
| 52.0  | Organism structure and function.--The student will be able to:  |
| 52.01 | Discuss the makeup of chromosomes.  |
| 52.02 | Discuss the process of nucleic acid transfer.   |
| 52.03 | Describe the relationship of cellular science and biotechnology.  |
| 52.04 | Explain how the structure of nucleic acid affects its isolation from cells and solutions.   |
| 52.05 | Describe how cells are engineered to express recombinant proteins.  |

## CTE Standards and Benchmarks

53.0 Materials processing and standard laboratory operating procedures for biotechnology.--The student will be able to:

53.01 Maintain a clean and organized work area.

53.02 Follow written protocols and oral directions to perform a variety of laboratory and technical tasks.

53.03 Determine appropriate equipment and units of measurement for a given task.

53.04 Discuss the various sections of a Standard Operating Procedure (SOP), with respect to safety, equipment, reagents, procedural steps, result analysis, reporting, and troubleshooting.

53.05 Perform a variety of biological tests and chemical assays, collect data, perform calculations and statistical analysis.

53.06 Discuss and perform disinfection and sterilization techniques.

53.07 Outline the steps in cell culture, aseptic technique and media preparation.

53.08 Discuss classification, composition and preparation of culture media.

53.09 Discuss collection and handling of specimens for fungal, bacterial, mammalian cells and viral specimens.

53.10 Prepare and examine specimens, and identify ova and parasites as indicated.

54.0 Biotechnical materials analysis skills.--The student will be able to:

54.01 Describe the characteristics of proteins that allow for their purification after cloning transformed cells.

54.02 Explain how polyacrylamide gel electrophoresis (PAGE) is used with column chromatography to monitor protein product.

54.03 Describe the steps in harvesting protein product from fermentation cell culture.

54.04 Summarize the steps in manufacturing and product testing and FDA approval for new drugs produced through genetic engineering.

54.05 Outline the steps of using a visible light spectrophotometer.

54.06 Prepare a serial dilution of protein and measure absorbance at a given wavelength.

54.07 Use a standard curve to determine the concentration of an unknown protein solution.

54.08 Do a linear regression to calculate protein concentration using a computer spreadsheet.

54.09 Discuss techniques of chemistry related to standardization of procedure and use of standards, blanks and controls.

54.10 Explain the protocol and application for isolating plasmids.

54.11 Explain the process and application of inserting genes that code for antibiotic resistance into a plasmid.

## CTE Standards and Benchmarks

54.12 Demonstrate the ability to culture, propagate, and harvest bacteria.

54.13 Explain the process of utilizing restriction enzymes and DNA ligase to insert a new gene into a plasmid.

54.14 Explain the process of replicating plasmids.

54.15 Practice environmental monitoring using agar plates.

54.16 Discuss sources of environmental contamination and methods of detection in controlled environments.

54.17 Demonstrate knowledge of and perform enzyme assays.

55.0 Basic chemistry as applied to biotechnology procedures.--The student will be able to:

55.01 Use the periodic table to predict valence electron configuration, and physical and chemical characteristics of elements.

55.02 Use the periodic table to calculate molarity.

55.03 Balance equations to show that there is a conservation of matter.

55.04 Explain hydrogen and polar bonding.

55.05 Discuss and use techniques that identify and separate components of a homogenous mixture.

55.06 Explain and use the function of pH in the preservation, purification, and functioning of proteins.

55.07 Use pH paper or pH meter to measure and adjust pHSC.

55.08 Calculate how to prepare solutions based on % mass/volume.

55.09 Calculate how to prepare solutions based on molar concentrations.

55.10 Use stoichiometry and molarity to prepare solutions of any volume and concentration.

55.11 Prepare dilutions of concentrated solutions.

56.0 Microbiology and blood-borne diseases, including AIDS.--The student will be able to:

56.01 Discuss microbial taxonomy and classification.

56.02 Perform microbiology techniques in controlled environments.

56.03 Perform disinfection techniques.

56.04 Practice aseptic techniques as required.

## CTE Standards and Benchmarks

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| 56.05 | Perform sterilization techniques.  |
| 56.06 | Discuss isolation techniques.  |
| 56.07 | Prepare artificial culture media.  |
| 56.08 | Discuss techniques of inoculation and transfer of cultures   |
| 56.09 | Use various methods to monitor the growth of cell cultures.  |
| 56.10 | Describe conditions that promote cell growth under aseptic conditions in the laboratory and workplace.                     |
| 56.11 | Discuss methods for the isolation, purification, and quantification of DNA and plasmid DNA.                                |
| 56.12 | Perform antigen and antibody testing.  |
| 56.13 | Identify community resources and services available to the individuals with diseases caused by blood borne pathogens.      |
| 56.14 | Demonstrate knowledge of the legal aspects of AIDS, including testing.   |
| 56.15 | Describe how blood-borne pathogens are avoided in manufacturing.   |
| 56.16 | Discuss methods of microbial detection, isolation, quantification (enumeration), and identification.                       |
| 57.0  | Legal and ethical responsibilities.--The student will be able to:  |
| 57.01 | Investigate an ethical, social, or legal issues facing biotechnology today and suggest an approach to solving it.          |
| 57.02 | Provide examples of the appropriate professional traits of a worker in biotechnology.                                      |
| 57.03 | Outline the proper protocol for reporting unsafe or unethical behavior.  |
| 57.04 | Describe a Code of Ethics consistent with the biotechnology industry   |
| 57.05 | Discuss the importance of maintaining confidentiality of information, including computer information.                      |
| 57.06 | Recognize and report illegal and unethical practices of health care workers.   |
| 58.0  | Literacy and computer skills applicable to the biotechnology industry.--The student will be able to:                       |
| 58.01 | Use the Internet to gather and share scientific and regulatory information.  |
| 58.02 | Use a computer spreadsheet, word processing, and presentation programs to collect, analyze and report information or data. |

## CTE Standards and Benchmarks

58.03 Use a variety of methods including literature searches in libraries, in computer databases, and on-line for gathering background information, making observations, and collecting and organizing data.

59.0 Employability skills.--The student will be able to:

59.01 Conduct a job search.

59.02 Use several resources including the Internet to gather information about job opportunities in the biotechnology field.

59.03 Create an appropriate resume for use in applying for job opportunities in a biotechnology company.

59.04 Use 'keywords' in a resume to match job description and rank higher when analyzed by resume scanning software.

59.05 Complete a job application form correctly.

59.06 Identify documents that may be required when applying for a job.

59.07 Develop a portfolio that demonstrates proficiency in specific biotechnology workplace tasks including writing samples and performance-based lab and computer skills.

59.08 Identify or demonstrate appropriate responses to criticism from employer, supervisor, or other persons.

59.09 Evaluate the overall condition of personal work habits and health habits and the effect, (if any) these habits might have in the biotechnology workplace.

59.10 Recognize appropriate professional behavior.

59.11 Explain the roles of different departments and the employees within each department at an industry site.

59.12 Describe the departmental functions in a typical biotechnology company.

59.13 Respond to potential interview questions.

## **Additional Information**

### **Laboratory Activities**

This program is designed to provide students with intense laboratory and research skills in preparation for continued education and/or entry into the biotechnology industry. Students will build upon the skills attained as they design and conduct experiments relevant to current biotechnology. A close association with local industry and postsecondary institutions will provide additional opportunities for development and application of biotechnology practices.

Laboratory investigations that include scientific inquiry, research, measurement, problem solving, emerging technologies, tools and equipment, as well as, experimental, quality, and safety procedures are an integral part of this career and technical program/course. Laboratory investigations benefit all students by developing an understanding of the complexity and ambiguity of empirical work, as well as the skills required to manage, operate, calibrate and troubleshoot equipment/tools used to make observations. Students understand measurement error; and have the skills to aggregate, interpret, and present the resulting data. Equipment and supplies should be provided to enhance hands-on experiences for students.

### **Academic Alignment**

Secondary Career and Technical Education courses are pending alignment to the B.E.S.T. (Benchmarks for Excellent Student Thinking) Standards for English Language Arts (ELA) and Mathematics that were adopted by the State Board of Education in February 2020. Academic alignment is an ongoing, collaborative effort of professional educators that provide clear expectations for progression year-to-year through course alignment. This initiative supports CTE programs by improving student performance through the integration of academic content within CTE courses.

### **Florida Standards for English Language Development (ELD)**

English language learners communicate for social and instructional purposes within the school setting. ELD.K12.SI.1.1

English Language Development (ELD) Standards Special Notes:

Teachers are required to provide listening, speaking, reading and writing instruction that allows English language learners (ELL) to communicate for social and instructional purposes within the school setting. For the given level of English language proficiency and with visual, graphic, or interactive support, students will interact with grade level words, expressions, sentences and discourse to process or produce language necessary for academic success. The ELD standard should specify a relevant content area concept or topic of study chosen by curriculum developers and teachers which maximizes an ELL's need for communication and social skills.

For additional information on the development and implementation of the ELD standards, please contact the Bureau of Student Achievement through Language Acquisition.



## **Special Notes**

MyCareerShines is an interactive resource to assist students in identifying their ideal career and to enhance preparation for employment. Teachers are encouraged to integrate this resource into the program curriculum to meet the employability goals for each student.

## **Career and Technical Student Organization (CTSO)**

SkillsUSA and Florida Technology Student Association (FL-TSA) are the intercurricular career and technical student organizations for providing leadership training and reinforcing specific career and technical skills. Career and Technical Student Organizations provide activities for students as an integral part of the instruction offered.

## **Cooperative Training – OJT**

On-the-job training is appropriate but not required for this program. Whenever offered, the rules, guidelines, and requirements specified in the OJT framework apply.

## **Accommodations**

Federal and state legislation requires the provision of accommodations for students with disabilities as identified on the secondary student's Individual Educational Plan (IEP) or 504 plan or postsecondary student's accommodations' plan to meet individual needs and ensure equal access. Accommodations change the way the student is instructed. Students with disabilities may need accommodations in such areas as instructional methods and materials, assignments and assessments, time demands and schedules, learning environment, assistive technology and special communication systems. Documentation of the accommodations requested and provided should be maintained in a confidential file.

In addition to accommodations, some secondary students with disabilities (students with an IEP served in Exceptional Student Education (ESE)) will need modifications to meet their needs. Modifications change the outcomes or what the student is expected to learn, e.g., modifying the curriculum of a secondary career and technical education course. Note: postsecondary curriculum and regulated secondary programs cannot be modified.

Some secondary students with disabilities (ESE) may need additional time (i.e., longer than the regular school year), to master the student performance standards associated with a regular course or a modified course. If needed, a student may enroll in the same career and technical course more than once. Documentation should be included in the IEP that clearly indicates that it is anticipated that the student may need an additional year to complete a Career and Technical Education (CTE) course. The student should work on different competencies and new applications of competencies each year toward completion of the CTE course. After achieving the competencies identified for the year, the student earns credit for the course. It is important to ensure that credits earned by students are reported accurately. The district's information system must be designed to accept multiple credits for the same course number for eligible students with disabilities.