

**Health Science Career Cluster  
Essentials of Biotechnology  
Course Number 25.57000**

**Course Description:**

This is the second course in the career pathway that introduces students to the broad understanding of the fundamentals of biotechnology and the impact on society. The knowledge and skills in this course provide a basic overview of current trends and careers in biotechnology, with an emphasis on basic laboratory skills, along with the business, regulatory, and ethical aspects of biotechnology.

**Pre-requisite:**

Introduction to Healthcare Science.

**Course Standard 1**

**HS-EB-1**

The following standard is included in all CTAE courses adopted for the Career Cluster/Pathways. Teachers should incorporate the elements of this standard into lesson plans during the course. The topics listed for each element of the standard may be addressed in differentiated instruction matching the content of each course. These elements may also be addressed with specific lessons from a variety of resources. This content is not to be treated as a unit or separate body of knowledge but rather integrated into class activities as applications of the concept.

**Standard: Demonstrate employability skills required by business and industry.**

The following elements should be integrated throughout the content of this course.

**1.1 Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities.**

Person-to-Person Etiquette	Telephone and Email Etiquette	Cell Phone and Internet Etiquette	Communicating At Work	Listening
Interacting with Your Boss	Telephone Conversations	Using Blogs	Improving Communication Skills	Reasons, Benefits, and Barriers
Interacting with Subordinates	Barriers to Phone conversations	Using social media	Effective Oral Communication	Listening Strategies
Interacting with Co-workers	Making and Returning Calls		Effective Written Communication	Ways We Filter What We Hear
Interacting with Suppliers	Making Cold Calls		Effective Nonverbal Skills	Developing a Listening Attitude
	Handling Conference Calls		Effective Word Use	Show You Are Listening
	Handling Unsolicited Calls		Giving and Receiving Feedback	Asking Questions
				Obtaining Feedback
				Getting Others to Listen
Nonverbal Communication	Written Communication	Speaking	Applications and Effective Résumés	
Communicating Nonverbally	Writing Documents	Using Language Carefully	Completing a Job Application	
Reading Body Language and mixed Messages	Constructive Criticism in Writing	One-on-One Conversations	Writing a Cover Letter	
Matching Verbal and Nonverbal communication		Small Group Communication	Things to Include in a Résumé	
Improving Nonverbal Indicators		Large Group Communication	Selling Yourself in a Résumé	
Nonverbal Feedback		Making Speeches	Terms to Use in a Résumé	

**Georgia Department of Education**

Showing Confidence Nonverbally		Involving the Audience	Describing Your Job Strengths
Showing Assertiveness		Answering Questions	Organizing Your Résumé
		Visual and Media Aids	Writing an Electronic Résumé
		Errors in Presentation	Dressing Up Your Résumé

**1.2 Demonstrate creativity by asking challenging questions and applying innovative procedures and methods.**

<b>Teamwork and Problem Solving</b>	<b>Meeting Etiquette</b>
Thinking Creatively	Preparation and Participation in Meetings
Taking Risks	Conducting Two-Person or Large Group Meetings
Building Team Communication	Inviting and Introducing Speakers
	Facilitating Discussions and Closing
	Preparing Visual Aids
	Virtual Meetings

**1.3 Exhibit critical thinking and problem-solving skills to locate, analyze and apply information in career planning and employment situations.**

<b>Problem Solving</b>	<b>Customer Service</b>	<b>The Application Process</b>	<b>Interviewing Skills</b>	<b>Finding the Right Job</b>
Transferable Job Skills	Gaining Trust and Interacting with Customers	Providing Information, Accuracy and Double Checking	Preparing for an Interview	Locating Jobs and Networking
Becoming a Problem Solver	Learning and Giving Customers What They Want	Online Application Process	Questions to Ask in an Interview	Job Shopping Online
Identifying a Problem	Keeping Customers Coming Back	Following Up After Submitting an application	Things to Include in a Career Portfolio	Job Search Websites
Becoming a Critical Thinker	Seeing the Customer's Point	Effective Résumés:	Traits Employers are Seeking	Participation in Job Fairs
Managing	Selling Yourself and the Company	Matching Your Talents to a Job	Considerations Before Taking a Job	Searching the Classified Ads
	Handling Customer Complaints	When a Résumé Should be Used		Using Employment Agencies
	Strategies for Customer Service			Landing an internship
				Staying Motivated to Search

**1.4 Model work readiness traits required for success in the workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity.**

<b>Workplace Ethics</b>	<b>Personal Characteristics</b>	<b>Employer Expectations</b>	<b>Business Etiquette</b>	<b>Communicating at Work</b>
Demonstrating Good Work Ethic	Demonstrating a Good Attitude	Behaviors Employers Expect	Language and Behavior	Handling Anger
Behaving Appropriately	Gaining and Showing Respect	Objectionable Behaviors	Keeping Information Confidential	Dealing with Difficult Coworkers
Maintaining Honesty	Demonstrating Responsibility	Establishing Credibility	Avoiding Gossip	Dealing with a Difficult Boss
Playing Fair	Showing Dependability	Demonstrating Your Skills	Appropriate Work Email	Dealing with Difficult Customers
Using Ethical Language	Being Courteous	Building Work Relationships	Cell Phone Etiquette	Dealing with Conflict

## Georgia Department of Education

Showing Responsibility	Gaining Coworkers' Trust		Appropriate Work Texting	
Reducing Harassment	Persevering		Understanding Copyright	
Respecting Diversity	Handling Criticism		Social Networking	
Making Truthfulness a Habit	Showing Professionalism			
Leaving a Job Ethically				

### 1.5 Apply the appropriate skill sets to be productive in a changing, technological, diverse workplace to be able to work independently and apply teamwork skills.

Expected Work Traits	Teamwork	Time Management
Demonstrating Responsibility	Teamwork Skills	Managing Time
Dealing with Information Overload	Reasons Companies Use Teams	Putting First Things First
Transferable Job Skills	Decisions Teams Make	Juggling Many Priorities
Managing Change	Team Responsibilities	Overcoming Procrastination
Adopting a New Technology	Problems That Affect Teams	Organizing Workspace and Tasks
	Expressing Yourself on a Team	Staying Organized
	Giving and Receiving Constructive Criticism	Finding More Time
		Managing Projects
		Prioritizing Personal and Work Life

### 1.6 Present a professional image through appearance, behavior, and language.

On-the-Job Etiquette	Person-to-Person Etiquette	Communication Etiquette	Presenting Yourself
Using Professional Manners	Meeting Business Acquaintances	Creating a Good Impression	Looking Professional
Introducing People	Meeting People for the First Time	Keeping Phone Calls Professional	Dressing for Success
Appropriate Dress	Showing Politeness	Proper Use of Work Email	Showing a Professional Attitude
Business Meal Functions		Proper Use of Cell Phone	Using Good Posture
Behavior at Work Parties		Proper Use in Texting	Presenting Yourself to Associates
Behavior at Conventions			Accepting Criticism
International Etiquette			Demonstrating Leadership
Cross-Cultural Etiquette			
Working in a Cubicle			

## Support of CTAE Foundation Course Standards and Georgia Standards of Excellence L9-10RST 1-10 and L9-10WHST 1-10:

Georgia Standards of Excellence ELA/Literacy standards have been written specifically for technical subjects and have been adopted as part of the official standards for all CTAE courses.

## Course Standard 2

### HS-EB-2

#### Research required safety practices and standard operating procedures (SOP) for the classroom and laboratory environment.

- 2.1 Define and explain health and safety regulations, including Occupational Health and Safety, risks (i.e., blood-borne pathogens), precautions (i.e., Hep B vaccine), and radiation safety.
- 2.2 Identify current GHS pictogram and NFPA safety ratings and labels.
- 2.3 Demonstrate procedures for documenting and reporting hazards and compliance.
- 2.4 Demonstrate health and safety practices, including use of Safety Data Sheets (SDS), appropriate personal protective equipment (PPE), sterilization techniques, emergency equipment, reagents and

- compounds, and maintenance of equipment.
- 2.5 Discuss International Organization for Standardization (ISO) and Biosafety Levels (BSL).
  - 2.6 Identify disaster preparedness procedures related to biotechnology related emergencies.
  - 2.7 Exhibit standard precautions including proper storage of chemicals, documentation, handling and disposal of biohazardous materials and biotechnology related emergencies.
  - 2.8 Perform aseptic technique and demonstrate how to follow Standard Operating Procedures (SOP).

### Course Standard 3

#### HS-EB-3

##### **Analyze careers in research and development, human health, diagnostics, biomanufacturing, environmental applications, and agriculture that utilize biotechnology.**

- 3.1 Outline standard corporate structure, departments, and responsibilities.
- 3.2 Describe the educational, training and/or experience requirements for various positions within the biotechnology industry.
- 3.3 Compare and contrast careers within academic, government, and private sectors.
- 3.4 Identify and classify the steps involved in manufacturing a bioengineered product and the differences between small, medium, and large product development.
- 3.5 Specify the logical steps to develop a new biotech product from R&D, Pre-Clinical, Clinical Trials, small- and large-scale manufacturing to formulation, packaging, and warehousing.
- 3.6 Discuss the role of the Environmental Protection Agency (EPA), Food and Drug Administration (FDA), the U.S. Department of Agriculture (USDA), and other regulatory agencies for safety and legal compliance.
- 3.7 Identify the basic structure for the Code of Federal Regulations (CFR), guidelines for Corrective and Preventative Actions (CAPA) and current good practices (cGxP).
- 3.8 Emphasize the roles and responsibilities of the Quality Control and Quality Assurance professionals and departments within the context of the overall Quality Management System (QMS).
- 3.9 Explore the use of assays to ensure: Safety, Efficacy, Purity, Identity, Potency, Quality and Stability from R&D through manufacturing and delivery.
- 3.10 Practice formatting Laboratory Notebooks in compliance with good documentation procedures (GDP) according to FDA standards.
- 3.11 Identify and explore the essential structure of research papers and documentation (e.g., background, methods, results, interpretation/discussion). Practice reading and writing sections of scientific papers and why it is important to reference previous work.
- 3.12 Explore “validity” for research data and proper sourcing for scientific documentation.

### Course Standard 4

#### HS-EB-4

##### **Demonstrate how concepts of physical science connect to biochemical applications and techniques, including proficient use of standard biologics laboratory equipment.**

- 4.1 Calculate and prepare buffers, stock solutions, and reagents using mass per volume and volume per volume percent solution calculations as well as dilution percent solutions ( $C_1V_1=C_2V_2$ ). Review “dilution factors” and serial dilutions.
- 4.2 Apply the concepts of homeostasis, normality, and molar relationships to biochemical reactions.
- 4.3 Demonstrate reading and using graphs (using Microsoft Excel or equivalent software).
- 4.4 Demonstrate understanding of the role of solution pH, temperature, and salinity on protein function and structure.
- 4.5 Analyze enzyme activity using assays for reactants and products.
- 4.6 Demonstrate proficiency in the use of basic laboratory equipment, including electronic and analytical balances, autoclave, micro pipetting, pouring agarose/agar, centrifuge/microcentrifuge, incubators, water baths, and tabletop pH meters and other standard laboratory equipment.
- 4.7 Apply electrophoresis, chromatography, and microscopy techniques (including oil immersion) and spectrophotometry to identify, separate and draw conclusions about biological molecules.
- 4.8 Demonstrate using antibody specificity for antigens to test for the presence of protein (e.g., ELISA) (Western Blot and antibody staining removed as they are covered in the Applications course).

## Course Standard 5

### HS-EB-5

#### **Compare and contrast common organisms used in biotechnology and relate the manipulation of living organisms to product and procedure development.**

- 5.1 Distinguish between prokaryotic cells, eukaryotic cells, and non-living entities, such as viruses and how they may be used as vectors.
- 5.2 Describe the characteristics and life cycles of model organisms used in biotechnology, including bacteria (e.g., *E. coli* and insulin), fungi (e.g., yeasts and *Aspergillus*), and animals (e.g., *C. elegans*, fruit flies, and rodents).
- 5.3 Monitor how environmental factors affect the growth of cells and model organisms in the laboratory.
- 5.4 Prepare growth mediums and explore techniques used to culture prokaryotic cells in a biotechnology lab.
- 5.5 Discuss bacterial growth rates and explore optimal times to harvest colonies.
- 5.6 Apply the basic concepts of cell growth to manipulate cultures under aseptic conditions in the laboratory and demonstrate proficiency in prokaryotic gram staining, streaking culture plates and stock bacterial cultures.
- 5.7 Explore Koch's Postulates and other techniques to isolate and identify pathogenic versus non-pathogenic organisms.
- 5.8 Identify bacteria using morphology and metabolic analysis.

## Course Standard 6

### HS-EB-6

#### **Identify the basis for biotechnology products and how such products affect the quality of life.**

- 6.1 Explore the fundamentals of molecular biology, the structure of DNA and the central dogma of biology, including transcription, translation, and gene expression.
- 6.2 Describe the major scientific discoveries that lead to the development of recombinant DNA technology, including those in the fields of biology, chemistry, genetics, and microbiology.
- 6.3 Identify past and current discoveries and developments in fields such as agriculture, diagnostics, medical devices, pharmaceuticals, and research and development.
- 6.4 Discuss the implications of genomics on biotechnology, society, and healthcare.
- 6.5 Perform DNA isolation techniques and discuss recombinant genetics, gene splicing, genetic engineering, and genetically modified organisms.
- 6.6 Explain how the advances in DNA technology are used today in various fields or industries.
- 6.7 Perform DNA Fragmentation using restriction enzymes and DNA Fingerprinting using gel electrophoresis to compare genetic profiles. Show competence loading agarose gels and running a gel electrophoresis unit.
- 6.8 Describe investigational new drugs (INDs) and the future of genomics and proteomics using CRISPR/Cas9 and other recent techniques.
- 6.9 Introduce the basic concepts of mammalian cell research, gene therapy and "bespoke" therapies showing promise for customized and personalized therapeutics.

## Course Standard 7

### HS-EB-7

#### **Analyze economic, social, ethical, and legal issues related to the use of biotechnology.**

- 7.1 Differentiate between moral, ethical, and legal biotechnology issues.
- 7.2 Research ethical issues presented by evolving science, including genetically modified foods, cloning, bioterrorism, gene therapy, and mammalian cells.
- 7.3 Compare and contrast attitudes about the use of biotechnology regionally, nationally, and internationally.
- 7.4 Evaluate the regulatory policies impacting biotechnology research (e.g., use of animals in research and applications of recombinant DNA).

## Course Standard 8

### HS-EB-8

**Explore how related student organizations are integral parts of career and technology education courses through leadership development, school, and community service projects, entrepreneurship development, and competitive events.**

- 8.1 Research the history of the state supported healthcare science CTSO (Career Technical Student Organization).
- 8.2 Discuss the mission, purpose, motto, colors, official dress, and other distinguishing characteristics of the state supported healthcare science CTSO.
- 8.3 Explain how participation in the state supported healthcare science CTSO can promote lifelong responsibility for community service and professional growth and development.
- 8.4 Create a personal leadership plan to participate in programs, conferences, community service and competitive events on the local, state, and national level that align with the competencies, skills, and knowledge of this course.