

**Health Science Career Cluster
Applications of Biotechnology
Course Number 25.56900**

Course Description:

This course further introduces students to the fundamentals of biotechnology. Included in this course are additional applications and techniques in biotechnology that expand and increase the student’s comprehension of how biotechnology utilizes living systems to create products and enhance lives. In addition, laboratory applications learned in this course form the pivotal component distinguishing science theory from application in bioscience, like that of engineering and mathematics. Bioscience and the application of laboratory techniques to the manipulation of living systems is a cornerstone of pharmaceutical, medical device, forensic science, environmental science, agriculture, alternative fuel, and green chemistry.

Pre-requisites:

Introduction to Healthcare Science and Essentials of Biotechnology.

Course Standard 1

HS-AB-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

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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
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.

Teamwork and Problem Solving	Meeting Etiquette
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.

Problem Solving	Customer Service	The Application Process	Interviewing Skills	Finding the Right Job
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.

Workplace Ethics	Personal Characteristics	Employer Expectations	Business Etiquette	Communicating at Work
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

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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
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-AB-2

Describe how characteristics of living organisms are integrated with advanced biotechnology techniques to lead to discovery or production.

2.1 Describe how cell membrane structure may be manipulated to allow passage of macromolecules, including electroporation, micro projectile, and ionic stress.

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- 2.2 Demonstrate how DNA structure and function may be exploited in genetic engineering to produce specific genetic constructs.
- 2.3. Compare and contrast transformation, transduction, and transfection.
- 2.4 Discuss gene expression for prokaryotic cells (operons) and the structure and importance of plasmids.
- 2.5 Explore the manipulation of nucleic acids through selecting, excising, ligating, and cloning of plasmid or viral vectors for development of molecular delivery systems.
- 2.6 Perform transformations, including competency, selection, antibiotic resistance, and analysis of transformation efficiency.
- 2.7 Determine density of bacteria in a liquid culture using OD₆₀₀ spectrophotometry.
- 2.8 Discuss plasmid isolation, purification, and recapture methods:
 - a. Isolate plasmids and purify through standard mini prep techniques.
 - b. Verify purity using A₂₆₀/A₂₈₀ or other standard assays.
- 2.9 Discuss protein structure and function in detail including synthesis (i.e., transcription and translation), including optimal conditions for enzymic activity and causes for denaturation.
- 2.10 Simulate enzymatic replication of nucleic acids utilizing real-time or traditional PCR, including primer design.
- 2.11 Isolate and prepare DNA samples for sequencing.
- 2.12 Manage and analyze DNA sequence data using bioinformatics tools (e.g., GenBank and BLAST).
- 2.13 Relate principles of macromolecule structure, physical chemistry, and composition to strategies for isolating, analyzing, and characterizing protein and DNA.
- 2.14 Perform methods of protein extraction and purification such as chromatography or antibody purification.
- 2.15 Design and perform methods of protein measurement, quantification, and characterization such as: SDS-PAGE, ELISA, and UV/VIS spectrophotometry (e.g., as used in simulated testing and confirming of samples as hepatitis B and Lyme disease).
 - a. Isolate and purify proteins such as GFP through HIC column chromatography or other standard techniques for recapture.
- 2.16 Apply the principles of electricity and ionization to successfully migrate charged molecules in ionic buffering systems.
- 2.17 Describe principles of phase separation in physical chemistry used in high performance liquid chromatography (HPLC) and gas chromatography (GC) for separating mixed analytes.
- 2.18 Apply the basic concepts of cell growth and homeostasis to systems for culturing cells.
- 2.19 Describe the different cell types and culture methods (e.g., bacteria, yeast, animal, and plant) as used in biotechnology.
- 2.20 Research the standard growth mediums and various protocols for culturing eukaryotic cells (e.g., plant or mammalian cells).
- 2.21 Review sterile culture technique and apply it to growing eukaryotic cells in a lab to confluency (e.g., mammalian cells) or as an explant (e.g., meristematic plant tissue).

Course Standard 3

HS-AB-3

Demonstrate how advanced techniques in biotechnology contribute to our quality of life.

- 3.1 Describe how biotechnology has contributed to the advancement of biology impacting human well-being, such as disease management through vaccines, food production, materials science, and molecular identification.
- 3.2 Explore immunology, epidemiology, and immunological responses.
- 3.3 Research and explore recent healthcare applications of bioengineering including vaccines, monoclonal antibody therapy, Investigational New Drugs (INDs), mammalian cell research, gene therapy and “bespoke” therapies showing promise for customized and personalized therapeutics.
- 3.4 Utilize biotechnology for diagnostic applications (e.g., hepatitis, HIV, BRAC, rapid streptococcus).
- 3.5 Explore the difference between direct and indirect ELISA and practice identification assays.
- 3.6 Describe how bioinformatics can be used to predict disease and determine treatment.
- 3.7 Investigate the principles of genetic mapping applied to healthcare or phylogenetics and evolution

- (e.g., Amplified fragment-length polymorphism (AFLP, SNPs, etc.).
- 3.8 Describe the non-medical applications of biotechnology, including enzyme production, biofuel and biomaterials discovery and manufacturing. Review flow cytometry.
 - 3.9 Explore environmental research applications of biotechnology such as DNA barcoding, eDNA and STR PCR techniques.

Course Standard 4

HS-AB-4

Utilize statistical analyses to evaluate molecular separations and manipulations.

- 4.1 Discuss the importance of appropriate controls, standards, and statistical planning in laboratory applications and experimental design, leading to the use of multiple and varied methods to verify results and the use of data to make decisions and solve problems.
- 4.2 Assess the quality of data including possible sources of bias in their investigations' hypotheses, observations, data analyses, and interpretations.
- 4.3 Compare the standard deviation and the mean of efficacy testing data of two or more biotechnology products.
- 4.4 Apply linear regression to [deleted] spectrophotometry calibration curve or ELISA standard curve.
- 4.5 Represent data using Gaussian distributions (normal populations).
- 4.6 Explain the reliability of data and construct confidence intervals for pH measurements and pipetting accuracy.
- 4.7 Establish measurement parameters and accuracy determination for real-time PCR or chromatography (HPLC or GC) detection data interpretation.
- 4.8 Apply significant figures to laboratory assessments and calculations to fall within established criteria.

Course Standard 5

HS-AB-5

Incorporate required safety practices and procedures in performing tasks encountered in the laboratory setting.

- 5.1 Apply laboratory safety techniques to electrophoresis, microbiological manipulations, and biological sample handling.
- 5.2 Analyze case studies of lab accidents and biohazards in various settings (i.e., include dangers of gases, explosions, electrical shock, biohazards, infectious disease, and genetically modified organisms or any other topics as suggested by current events).
- 5.3 Demonstrate ways to prevent or manage lab accidents and biohazards in various workplace settings.
- 5.4 Apply safe methods for transporting chemicals, grounding electrical equipment, sharps disposal, monitoring gas pressures (pressurized tanks) and using secondary containment systems for transport (safe shipping methods).
- 5.5 Describe Biosafety Levels 1, 2, 3 and 4 (BSL1, BSL 2, BSL3 and BSL4) and the facility design associated with each level.
- 5.6 Research laminar flow and high efficiency particulate air (HEPA) filtration, and the purpose of biosafety cabinets relative to managing biological hazards.

Course Standard 6

HS-AB-6

Assess current trends, ethical, legal, and regulatory issues related to the development of biotechnology products.

- 6.1 Monitor scientific journals, internet sources, mass media, and industry associations to identify current trends and policy issues in biotechnology.
- 6.2 Distinguish between marketing material and experimentally validated information.
- 6.3 Describe the concept of integrity and the ethical use of statistics, controls, and standards.
- 6.4 Demonstrate bioethical/legal issues to various scenarios, including clinical trials, Institutional Review Boards (IRB) applications, privacy (HIPAA), choice of genetic traits, and use of genetic testing data.

- 6.5 Describe intellectual property rights, technology transfer, and how biotechnology is funded.
- 6.6 Explain the meaning of human dignity and informed consent in biotechnology and healthcare.
- 6.7 Explain ethical ramifications involved in abiding by regulations set forth by federal regulatory agencies and the Code of Federal Regulations applicable to biotechnology (e.g., FDA [Food and Drug Administration], 21 CFR [Code of Federal Regulations], EPA [Environmental Protection Agency], NIH [National Institute of Health], USDA [United States Department of Agriculture], etc.) and the relationship to international regulatory systems (e.g., ICH, etc.).
- 6.8 Review the role and purpose of quality assurance, quality control, method validation, documentation, current Good Manufacturing Practices and Good Laboratory Practices.
- 6.9 Document and keep accurate records (including laboratory notes) according to regulatory requirements.

Course Standard 7

HS-AB-7

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.

- 7.1 Research the history of the state supported healthcare science CTSO (Career Technical Student Organization).
- 7.2 Discuss the mission, purpose, motto, colors, official dress, and other distinguishing characteristics of the state supported healthcare science CTSO.
- 7.3 Explain how participation in the state supported healthcare science CTSO can promote lifelong responsibility for community service and professional growth and development.
- 7.4 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.