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 technique to the manipulation of living systems is a cornerstone of pharmaceutical, medical device, forensic science, environmental science, agriculture, alternative fuel, and green chemistry.

The prerequisites for this course for students in the Healthcare Science Career Pathway are Biotechnology Research and Development, 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.

<table>
<thead>
<tr>
<th>Person-to-Person Etiquette</th>
<th>Telephone and Email Etiquette</th>
<th>Cell Phone and Internet Etiquette</th>
<th>Communicating At Work</th>
<th>Listening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interacting with Your Boss</td>
<td>Telephone Conversations</td>
<td>Using Blogs</td>
<td>Improving Communication Skills</td>
<td>Reasons, Benefits, and Barriers</td>
</tr>
<tr>
<td>Interacting with Subordinates</td>
<td>Barriers to Phone conversations</td>
<td>Using Social Media</td>
<td>Effective Oral Communication</td>
<td>Listening Strategies</td>
</tr>
<tr>
<td>Interacting with Co-workers</td>
<td>Making and Returning Calls</td>
<td></td>
<td>Effective Written Communication</td>
<td>Ways We Filter What We Hear</td>
</tr>
<tr>
<td>Interacting with Suppliers</td>
<td>Making Cold Calls</td>
<td></td>
<td>Effective Nonverbal Skills</td>
<td>Developing a Listening Attitude</td>
</tr>
<tr>
<td></td>
<td>Handling Conference Calls</td>
<td></td>
<td>Effective Word Use</td>
<td>Show You Are Listening</td>
</tr>
<tr>
<td></td>
<td>Handling Unsolicited Calls</td>
<td></td>
<td>Giving and Receiving Feedback</td>
<td>Asking Questions</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Obtaining Feedback</td>
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<td></td>
<td>Getting Others to Listen</td>
</tr>
</tbody>
</table>
1.2 Demonstrate creativity by asking challenging questions and applying innovative procedures and methods.

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

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

<table>
<thead>
<tr>
<th>Problem Solving</th>
<th>Customer Service</th>
<th>The Application Process</th>
<th>Interviewing Skills</th>
<th>Finding the Right Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transferable Job Skills</td>
<td>Gaining Trust and Interacting with Customers</td>
<td>Providing Information, Accuracy and Double Checking</td>
<td>Preparing for an Interview</td>
<td>Locating Jobs and Networking</td>
</tr>
<tr>
<td>Becoming a Problem Solver</td>
<td>Learning and Giving Customers What They Want</td>
<td>Online Application Process</td>
<td>Questions to Ask in an Interview</td>
<td>Job Shopping Online</td>
</tr>
<tr>
<td>Identifying a Problem</td>
<td>Keeping Customers Coming Back</td>
<td>Following Up After Submitting an Application</td>
<td>Things to Include in a Career Portfolio</td>
<td>Job Search Websites</td>
</tr>
<tr>
<td>Becoming a Critical Thinker</td>
<td>Seeing the Customer’s Point</td>
<td>Effective Résumés: Traits Employers are Seeking</td>
<td>Participation in Job Fairs</td>
<td></td>
</tr>
<tr>
<td>Managing</td>
<td>Selling Yourself and the Company</td>
<td>Matching Your Talents to a Job</td>
<td>Considerations Before Taking a Job</td>
<td>Searching the Classified Ads</td>
</tr>
<tr>
<td></td>
<td>Handling Customer Complaints</td>
<td>When a Résumé Should be Used</td>
<td>Using Employment Agencies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strategies for Customer Service</td>
<td></td>
<td>Landing an Internship</td>
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<td></td>
<td></td>
<td></td>
<td>Staying Motivated to Search</td>
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</tbody>
</table>
1.4 Model work readiness traits required for success in the workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity.

<table>
<thead>
<tr>
<th>Workplace Ethics</th>
<th>Personal Characteristics</th>
<th>Employer Expectations</th>
<th>Business Etiquette</th>
<th>Communicating at Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrating Good Work Ethic</td>
<td>Demonstrating a Good Attitude</td>
<td>Behaviors Employers Expect</td>
<td>Language and Behavior</td>
<td>Handling Anger</td>
</tr>
<tr>
<td>Behaving Appropriately</td>
<td>Gaining and Showing Respect</td>
<td>Objectionable Behaviors</td>
<td>Keeping Information Confidential</td>
<td>Dealing with Difficult Coworkers</td>
</tr>
<tr>
<td>Maintaining Honesty</td>
<td>Demonstrating Responsibility</td>
<td>Establishing Credibility</td>
<td>Avoiding Gossip</td>
<td>Dealing with a Difficult Boss</td>
</tr>
<tr>
<td>Playing Fair</td>
<td>Showing Dependability</td>
<td>Demonstrating Your Skills</td>
<td>Appropriate Work Email</td>
<td>Dealing with Difficult Customers</td>
</tr>
<tr>
<td>Using Ethical Language</td>
<td>Being Courteous</td>
<td>Building Work Relationships</td>
<td>Cell Phone Etiquette</td>
<td>Dealing with Conflict</td>
</tr>
<tr>
<td>Showing Responsibility</td>
<td>Gaining Coworkers’ Trust</td>
<td></td>
<td>Appropriate Work Texting</td>
<td></td>
</tr>
<tr>
<td>Reducing Harassment</td>
<td>Persevering</td>
<td></td>
<td>Understanding Copyright</td>
<td></td>
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<tr>
<td>Respecting Diversity</td>
<td>Handling Criticism</td>
<td></td>
<td>Social Networking</td>
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<tr>
<td>Making Truthfulness a Habit</td>
<td>Showing Professionalism</td>
<td></td>
<td></td>
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<tr>
<td>Leaving a Job Ethically</td>
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</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>On-the-Job Etiquette</th>
<th>Person-to-Person Etiquette</th>
<th>Communication Etiquette</th>
<th>Presenting Yourself</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using Professional Manners</td>
<td>Meeting Business Acquaintances</td>
<td>Creating a Good Impression</td>
<td>Looking Professional</td>
</tr>
<tr>
<td>Introducing People</td>
<td>Meeting People for the First Time</td>
<td>Keeping Phone Calls Professional</td>
<td>Showing Success</td>
</tr>
<tr>
<td>Appropriate Dress</td>
<td>Showing Politeness</td>
<td>Proper Use of Work Email</td>
<td>Showing a Professional Attitude</td>
</tr>
<tr>
<td>Business Meal Functions</td>
<td></td>
<td>Proper Use of Cell Phone</td>
<td>Using Good Posture</td>
</tr>
<tr>
<td>Behavior at Work Parties</td>
<td></td>
<td>Proper Use in Texting</td>
<td>Presenting Yourself to Associates</td>
</tr>
<tr>
<td>Behavior at Conventions</td>
<td></td>
<td></td>
<td>Accepting Criticism</td>
</tr>
<tr>
<td>International Etiquette</td>
<td></td>
<td></td>
<td>Demonstrating Leadership</td>
</tr>
<tr>
<td>Cross-Cultural Etiquette</td>
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</tbody>
</table>
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.
2.2 Demonstrate how DNA structure and function may be exploited in genetic engineering to produce specific genetic constructs.
2.3 Engineer nucleic acids through selecting, excising, ligating and cloning of plasmid or viral vectors for development of molecular delivery systems.
2.4 Simulate enzymatic replication of nucleic acids utilizing real-time or traditional PCR including primer design.
2.5 Isolate and prepare DNA samples for sequencing.
2.6 Manage and analyze DNA sequence data using bioinformatics tools (e.g. Genbank and BLAST).
2.7 Relate principles of macromolecule structure, physical chemistry and composition to strategies for isolating, analyzing and characterizing protein and DNA.
2.8 Perform methods of protein extraction and purification such as salt precipitation and dialysis, chromatography or antibody purification.
2.9 Design and perform methods of protein measurement, quantification, and characterization such as: Western blot, polyacrylamide gel electrophoresis, ELISA, and UV/VIS spectrophotometry (e.g. as used in simulated testing and confirming of samples as hepatitis B and Lyme disease).
2.10 Apply the principles of electricity and ionization to successfully migrate charged molecules in ionic buffering systems.
2.11 Describe principles of phase separation in physical chemistry used in high performance liquid chromatography (HPLC) and gas chromatography (GC) for separating mixed analytes.
2.12 Apply the basic concepts of cell growth and homeostasis to systems for culturing cells.
2.13 Describe the different cell types and culture methods (e.g., bacteria, yeast, animal and plant) as used in biotechnology.
2.14 Review sterile culture technique and apply it to growing eukaryotic cells in culture (e.g., plant cell culture).
2.15 Distinguish between the culture environments needed for single-celled organisms and cells from multicellular organisms.

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 Apply biotechnological techniques to forensics including materials analysis, DNA fingerprinting and sample collection.
3.3 Utilize biotechnology for healthcare applications.
3.4 Utilize biotechnology for diagnostic applications (e.g. hepatitis, HIV, BRAC, rapid streptococcus).
3.5 Explain the role of biotechnology in therapeutics (e.g., gene therapy, vaccines, antibody therapy, cell therapy).
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.

**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.
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; also 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 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.  
Demonstrate CPR, First Aid, and the AED utilizing current standards.  

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 Describe the role of 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 Explain the phases of clinical trials and requirements for obtaining FDA product approval.  
6.9 Define the purpose of quality assurance, quality control, method validation, documentation, current Good Manufacturing Practices and Good Laboratory Practices.  
6.10 Document and keep accurate records according to regulatory requirements.