Applications of Biotechnology Course Syllabus

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**Course Description:**

This course further introduces students to the fundamentals of biotechnology. Included in this course are additional applications and techniques in biotechnology, which expand and increase the student’s comprehension of how biotechnology utilizes living systems to create products and enhance lives. Further, laboratory applications learned in this course form the pivotal component distinguishing science theory from its

application in bioscience much 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.

**Grading Policy: (Subject to change based county policy)**

A 90-100 B 80-89 C 70-79 F below 70

60% summative, 20% formative, 20% final exam

**Textbook:** *Biotechnology* by J. Kirk Brown (2nd Edition; Bio-Rad Laboratories)

**End of Pathway Assessment (EOPA)**: Students will take a comprehensive assessment at the end of this course to obtain pathway credit. This assessment is created by Precision Exams ([www.precisionexams.com](http://www.precisionexams.com)). Credit is given to students scoring 80% or higher. There is a folder on the website labeled (EOPA) with more details on the content of the assessment, or [click here](http://www.paulding.k12.ga.us/olc/folder.aspx?id=67892&c=14395&s=2505) if you are viewing this syllabus electronically. Students that do not score 80% or higher will still receive full credit for the courses. The exam includes questions from Essentials of Healthcare, as that course is technically part of the pathway.

**Class/Lab Procedures and Rules:** All school policies in the student handbook and the freshman academy will be followed, as well as all lab safety rules and teacher policies. Tardy policy will be followed as listed in the handbook.

**Performance Assessments** will include but will not be limited to student learning objective assessments (SLOs), quizzes, unit tests, lab reports, research projects, lab practicals, and final exams.

**Recommended Materials:** Students must have a graph paper composition notebook. Many students will continue to use their notebooks from Essentials.

**Applications of Biotechnology Georgia Performance Standards:**

**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. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities.
  2. Demonstrate creativity by asking challenging questions and applying innovative procedures and methods.
  3. Exhibit critical thinking and problem-solving skills to locate, analyze and apply information in career planning and employment situations.
  4. Model work readiness traits required for success in the workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity.
  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.

**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. 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 Discus 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).

**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.

**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.

**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.

**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. Georgia 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.

**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.

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