

Applications of Biotechnology Course Syllabus (2015-2016)



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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 (1st 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). 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](#) 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. 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.
- 1.2 Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.
- 1.3 Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations.
- 1.4 Model work readiness traits required for success in the workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity.
- 1.5 Apply the appropriate skill sets to be productive in a changing, technological, and diverse workplace to be able to work independently, interpret data, and apply team work skills.

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

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.

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.

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.

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.

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.