Maryland
STATE DEPARTMENT OF EDUCATION

Program of Study Guide: Biomedical Science - DRAFT

Comprehensive guidelines and course standards for the Biomedical Science

Office of College and Career Pathways

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Purpose

1. **The purpose of this document is to communicate the required Career and Technical Education (CTE) academic standards for the Biomedical Science Program of Study. The academic standards in this document are theoretical and performance based. The standards contain content from multiple state departments of education, Biotechnology Aptitude & Competency Exam (BACE) standards, National Consortium for Health Science Education (NCHSE) National Health Science Standards, and Next Generation Science Standards (NGSS), and have been reviewed and vetted by members of the Maryland business and industry community.**

   In addition to academic standards, the Maryland State Department of Education (MSDE) has incorporated into this document Labor Market Information (LMI) definitions and explanations for the Program of Study; program aligned Industry Recognized Credentials; and Work-Based Learning resources and requirements by course level.

   This document is intended for use by educational administrators and practitioners. A similar document is available for each state-approved CTE Program of Study.

Standards Sources

Biomedical Science standards are based on various research-backed sources, best practices, and national frameworks that guide effective K-12 education. The following sources provide a rigorous foundation for the Biomedical Science standards, ensuring they are well-rounded, research-driven, and aligned with national expectations and young learners' unique needs.

Here are the primary sources that these standards draw from:

1. **Advance CTE Education Career Cluster Framework: Health and Human Services**
   A. **Description:** The Advance CTE Education Career Cluster Framework defines the knowledge and skills necessary for success in the Healthcare & Human Services Career Cluster. These standards emphasize whole health, addressing social determinants, leveraging health data, and promoting community well-being.
   B. **Usage:** The Healthcare & Human Services Career Cluster framework informs course standards for Biomedical Science I-IV, ensuring that content aligns with sector-wide competencies and prepares students for research, development, and clinical roles in healthcare.
   C. **Source:** Advance CTE Healthcare & Human Services Career Clusters.

2. **Biotechnology Aptitude & Competency Exam (BACE)**
   A. **Description:** The BACE, developed by the Florida Biomedical Research & Education Foundation and administered by Biotility at the University of Florida, measures foundational knowledge and laboratory skills in biotechnology.
   B. **Usage:** BACE competencies guide laboratory skill development, safety protocols, data analysis techniques, and industry-relevant practices integrated into Biomedical Science I-II, preparing students for credentialing by the end of the second course.
   C. **Source:** Biotechnology Aptitude & Competency Exam

3. **National Consortium for Health Science Education (NCHSE) National Health Science Standards**
   A. **Description:** The establishes a broad set of standards that define the knowledge and skills students need to pursue careers in healthcare, including communication, ethics, safety, and technical skills.
   B. **Usage:** These standards support foundational competencies in Biomedical Science courses, ensuring students acquire the core health science understandings necessary for advanced study, certifications, and professional practice.
   C. C. **Source:** NCHSE National Health Science Standards

4. **Next Generation Science Standards (NGSS)**
   A. **Description:** The NGSS establishes rigorous science education benchmarks, focusing on scientific inquiry, systems thinking, and the application of science concepts in real-world contexts.
   B. **Usage:** These standards support the integration of anatomy, physiology, pathophysiology, biology, and biotechnology to align with science education requirements.
   C. **Source:** Next Generation Science Standards

5. **Occupational Safety and Health Administration (OSHA) Healthcare Workplace Standards**
   A. **Description:** OSHA sets and enforces workplace safety standards, including those specific to healthcare environments, ensuring that employees and students learn to maintain safe and compliant laboratory and clinical conditions.
   B. **Usage:** Safety protocols, aseptic techniques, and proper handling of biological materials throughout Biomedical Science courses follow OSHA guidelines, fostering a culture of safety and responsibility.
   C. **Source:** OSHA Healthcare Standards

6. **Project Lead The Way (PLTW) Biomedical Science Curriculum**
   A. **Description:** PLTW provides a nationally recognized, project-based curriculum in Biomedical Science, integrating laboratory investigations, problem-solving, and critical thinking aligned with industry and post-secondary expectations.
   B. **Usage:** The Biomedical Science I-IV courses draw on PLTW frameworks to shape problem-based learning experiences, ensuring rigorous, hands-on activities that reinforce scientific inquiry, data analysis, and technical communication.
   C. **Source:** Project Lead The Way Biomedical Science

7. **Pharmacy Technician Certification Board (PTCB) Standards**
   A. **Description:** PTCB sets standards for Pharmacy Technician certification, verifying knowledge, skill, and abilities related to medications, pharmacy operations, and patient care.
   B. **Usage:** In Biomedical Science IV, aligned content supports students who may pursue Pharmacy Technician certification, introducing pharmacology basics, dosage calculations, and pharmacy law to broaden career readiness.
   C. **Source:** Pharmacy Technician Certification Board (PTCB)

8. **Centers for Disease Control and Prevention (CDC) Guidelines**
   A. **Description:** The CDC provides evidence-based guidance on disease prevention, laboratory safety, public health research, and data-driven healthcare interventions.
   B. **Usage:** Instructional content related to infectious diseases, epidemiology, public health measures, and lab biosafety in Biomedical Science courses aligns with CDC recommendations and best practices.
   C. **Source: Centers for Disease Control and Prevention (CDC)**

9. **National Institutes of Health (NIH) and National Library of Medicine (NLM)**
   A. **A. Description:** NIH and its NLM division offer extensive research, databases, and literature resources, including PubMed and Medline, supporting advanced scientific inquiry and evidence-based practice.
   B. **B. Usage:** Students utilize NIH and NLM resources to conduct background research, interpret peer-reviewed studies, and stay current on biomedical advances, integrating critical scientific analysis into coursework.
   C. **C. Source:** National Institutes of Health | National Library of Medicine

Course Descriptions

Course Level	Course Information	Description
Required Core: Course 1	Biomedical Science I SCED: <XX> Grades: 9-12 Prerequisite: None Credit: 1	Biomedical Science I introduces students to the fundamental principles, practices, and professional skills of the biomedical sciences. Through hands-on laboratory investigations, students learn essential techniques such as aseptic handling, DNA extraction, and microscopy, while developing competencies in scientific inquiry, data analysis, and effective communication. Students explore core concepts in cell biology, genetics, anatomy, infectious disease, and bioethics, gaining insight into how societal, environmental, and technological factors impact human health. Emphasizing teamwork, project management, and problem-solving, this foundational course prepares students for advanced studies, industry-recognized credentials, and meaningful careers in healthcare, biotechnology, and biomedical research.
Required Core: Course 2	Biomedical Science II SCED: <XX> Grades: 10-12 Prerequisite: Biomedical Science I Credit: 1	Biomedical Science II builds upon the foundational concepts and skills introduced in Biomedical Science I, guiding students into more advanced areas of biomedical research, diagnostics, and innovation. Through hands-on laboratory work, students refine essential techniques such as DNA extraction, protein analysis, and genetic engineering. They deepen their understanding of clinical testing, bioinformatics, and epidemiology, developing the ability to interpret complex data, propose evidence-based interventions, and address real-world healthcare challenges. Students also strengthen their professional competencies—collaboration, problem-solving, technical communication, and ethical decision-making—while exploring industry standards, regulatory considerations, and emerging technologies. By the end of Biomedical Science II, students will

		have honed a versatile skill set, positioning them for success on the BACE exam, future coursework, and meaningful contributions to the biomedical field.
Optional Flex: Course 1	Biomedical Science III SCED: <XX> Grades: 10-12 Prerequisite: Biomedical Science I and II Credit: 1	Biomedical Science III course advances students' exploration of the human body and healthcare innovation by building on the foundational skills and knowledge acquired in earlier coursework. In this course, students delve deeper into human anatomy and physiology at a level aligned with introductory college standards, examining each major body system to understand both normal functioning and disease states. They refine laboratory techniques—such as micropipetting and DNA gel electrophoresis—and apply specialized assessments, including EMG and spirometry, to investigate physiological processes and interpret clinical data. By integrating cutting-edge research tools, analytical software, and professional communication strategies, students strengthen their scientific reasoning and problem-solving abilities. They learn to design controlled experiments, accurately analyze results, and clearly present findings. This course prepares students for dual credit coursework, industry-recognized certifications like the BACE exam, and work-based learning experiences such as internships or apprenticeships.
Optional Flex: Course 2	Career Connected Learning I SCED: <XX> Grades: 11-12 Prerequisite: Biomedical Science I and II Credit: 1	This flexible, work-based learning course introduces students to real-world applications of classroom knowledge and technical skills through on-the-job experiences and reflective practice. Students engage in career exploration, skill development, and professional networking by participating in youth apprenticeships, registered apprenticeships, pre-apprenticeships, internships, capstone projects, or other approved career-connected opportunities. Variable credit (1–3) accommodates the required on-the-job training hours and related instruction. By integrating industry standards, employability skills,

		and personalized learning goals, Career Connected Learning I equips students to make informed career decisions, develop a professional portfolio, and build a strong foundation for success in postsecondary education, training, or the workforce.
Optional Flex: Course 3	Career Connected Learning II SCED: <XX> Grades: 11-12 Prerequisite: Career Connected Learning I Credit: 1	Building on the foundational experiences of Career Connected Learning I, this advanced work-based learning course provides students with deeper on-the-job practice, leadership opportunities, and refined career exploration. Students continue to enhance their technical and professional skills, expanding their industry networks and aligning personal goals with evolving career interests. Variable credit (1–3) remains aligned with the required training hours and related instruction. Through elevated responsibilities and skill application, Career Connected Learning II prepares students to confidently transition into higher-level postsecondary programs, apprenticeships, or the workforce.

Dual Enrollment and Career Connected Learning Experiences Must be Aligned to the CTE Core.

Industry-Recognized Credentials and Work-Based Learning

Industry-Recognized Credentials
By the end of Biomedical Science II: Biotechnology Aptitude & Competency Exam (BACE) **Optional Credentials (via the Flex Course options**): Dual Credit Options, Apprenticeships, Internships

Work-Based Learning Examples and Resources		
Biomedical Science I and II**: Career Awareness**	Biomedical Science III: **Career Preparation**	**Flex Courses: Career Preparation**
• Industry Visits • Guest Speakers • Participation in Career and Technical Student Organizations • Postsecondary Visits – Program Specific Site Tours • Mock Interviews	• All of Career Awareness plus the following: • Job Shadow • Paid and Unpaid Internships	• Paid and Unpaid Internships • Apprenticeships

Labor Market Information: Definitions and Data

Labor market information (LMI) plays a crucial role in shaping Career and Technical Education (CTE) programs by providing insights into industry demands, employment trends, and skills gaps. This data helps education leaders assess the viability of existing programs and identify opportunities for new offerings. By aligning CTE programs with real-time labor market needs, schools can better prepare students for in-demand careers and ensure that resources are effectively utilized to support pathways that lead to high-quality, sustainable employment.

Standard Occupational Code (SOC) and Aligned Industry:

Indicator	Definition	Pathway Labor Market Data
High Wage[1]	Those occupations that have a 25th percentile wage equal to or greater than the most recent MIT Living Wage Index for one adult in the state of Maryland, and/or leads to a position that pays at least the median hourly or annual wage for the DC-VA-MD-WV Metropolitan Statistical Area (MSA). *Note: A 25th percentile hourly wage of $24.74 or greater is required to meet this definition.*	**Standard Occupational Code:** 19-1029: Biological Scientists 29-1071 Physician Assistants 19-1022 Microbiologists 29-2018 Clinical Laboratory Technologists and Technicians: 29-2052 Pharmacy Technicians **Hourly Wage/Annual Salary:** Biological Scientists: 25th Percentile: $37.03 / $77,022.40 50th Percentile: $49.11 / $102,148.80 75th Percentile: $61.03 / $126,942.40 Physician Assistants: 25th Percentile: $41.65 / $86,632.00 50th Percentile: $61.45 / $127,816.00 75th Percentile: $66.73 / $138,798.40 Microbiologists: 25th Percentile: $36.58 / $76,086.40 50th Percentile: $49.11 / $102,148.80 75th Percentile: $63.73 / $132,558.40

[1] Living Wage Calculator: https://livingwage.mit.edu/states/24

		Clinical Laboratory Technologists and Technicians: 25th Percentile: $18.67 / $38,833.60 50th Percentile: $28.00 / $58,240.00 75th Percentile: $38.20 / $79,456.00 Pharmacy Technicians: 25th Percentile: $17.60 / $36,608.00 50th Percentile: $18.75 / $39,000.00 75th Percentile: $22.50 / $46,800.00
High Skill	Those occupations located within the DC-VA-MD-WV Metropolitan Statistical Area (MSA) with the following education or training requirements: completion of an apprenticeship program; completion of an industry-recognized certification or credential; associate's degree, bachelor's degree, or higher.	**Typical Entry-Level Education:** Biomedical Scientists - Bachelor's degree Physician Assistants – Master's degree Microbiologists - Bachelor's degree Clinical Laboratory Technologists and Technicians - Bachelor's degree Pharmacy Technicians – High School Diploma or equivalent
In-Demand	Annual growth plus replacement, across all Maryland occupations, is 405 openings between 2024-2029.	**Annual Openings** Biomedical Scientists - 498 Physician Assistants – 272 Microbiologists – 165 Clinical Laboratory Technologists and Technicians - 521 Pharmacy Technicians - 784

Labor Market Information Data Source

Lightcast Q4 2024 Data Set. Lightcast occupation employment data are based on final Lightcast industry data and final Lightcast staffing patterns. Wage estimates are based on Occupational Employment Statistics (QCEW and Non-QCEW Employees classes of worker) and the American Community Survey (Self-Employed and Extended Proprietors). Occupational wage estimates are also affected by county-level Lightcast earnings by industry. Foundational data for the state of Maryland is collected and reported by the Maryland Department of Labor.

Methodology for High Wage Calculations

To combine labor market data across multiple Standard Occupational Classifications (SOCs), a weighted average approach was used to ensure accurate representation of the marketplace. Median wages for each SOC were weighted based on their respective employment levels, reflecting the relative demand for each occupation. This method ensures that occupations with higher employment contribute proportionately to the overall wage calculation. Additionally, job openings from all relevant SOCs were summed to determine the total projected demand. For example, if Mechanical Engineers account for 67% of total employment and Electrical Engineers for 33%, their respective wages are weighted accordingly, and job openings are aggregated to provide a comprehensive view of labor market opportunities. This approach delivers a balanced and accurate representation of both wages and employment demand for the program.

Methodology for In-Demand Calculations

The baseline for annual job openings, taking into account new positions and replacement positions, was determined by taking the average of all annual job openings between 2024 and 2029 across all 797 career sectors at the 5-digit SOC code level. For the 2024-2029 period, average job openings (growth + replacement) is 405.

Course Standards: Biomedical Science I

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 9-12, and there are no prerequisites.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Health and Human Services Career Cluster promotes whole health in individuals and communities through diverse services. This sector includes technical, mental, and therapeutic services and personal care supported by medical and social sciences. By addressing social determinants of health and leveraging health data and science, this Cluster aims to enhance the overall health and resilience of individuals, families, and communities.
   C. The Biomedical Science Program of Study immerses students in scientific principles, laboratory techniques, clinical practices, and professional skills essential for success in today's healthcare and biotechnology fields. Throughout the program, students learn to address complex biomedical challenges, incorporate ethical and regulatory considerations, and remain adaptable to rapidly evolving technologies and healthcare demands. By completing the Biomedical Science program, graduates are well-prepared to advance into higher education, seek industry-recognized credentials, and contribute to developing innovative medical treatments, pharmaceuticals, devices, and solutions that enhance individuals', families', and communities' health and resilience.
   D. Biomedical Science I introduces students to the fundamental principles, practices, and professional skills of the biomedical sciences. Through hands-on laboratory investigations, students learn essential techniques such as aseptic handling, DNA extraction, and microscopy, while developing competencies in scientific inquiry, data analysis, and effective communication. Students explore core concepts in cell biology, genetics, anatomy, infectious disease, and bioethics, gaining insight into how societal, environmental, and technological factors impact human health. Emphasizing teamwork, project management, and problem-solving, this foundational course prepares students for advanced studies, industry-recognized credentials, and meaningful careers in healthcare, biotechnology, and biomedical research.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**

   A. The student demonstrates the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:
      1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work.

2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
3. Employ effective reading, writing, and technical documentation skills.
4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
5. Demonstrate leadership skills and collaborate effectively as a team member.
6. Implement safety procedures, including proper use of software and following privacy guidelines.
7. Exhibit an understanding of legal and ethical responsibilities in the biomedical science field, following copyright laws and regulations.
8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. The student identifies various career pathways in the biomedical science field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles in healthcare.
2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in biomedical science fields.

C. The student develops technology and digital literacy skills. The student is expected to:

1. Use technology as a tool for research, organization, communication, and problem-solving.
2. Use digital tools, including computers, mobile devices, collaboration platforms, and cloud services, to access, manage, and create information.
3. Demonstrate proficiency in using emerging and industry-standard technologies.
4. Understand ethical and legal considerations for technology use, including the principles of data protection, copyright, and responsible technology use.

D. The student integrates core academic skills into biomedical science practices. The student is expected to:

1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
2. Apply English concepts such as writing informative texts when documenting procedures and articulating goals.
3. Use mathematical concepts for measurement and conversion (Fahrenheit vs. Celsius), ratios and proportions as well as fraction and decimal conversions.

E. The student demonstrates competence in laboratory techniques and analytical methods essential to biomedical research and diagnostics. The student is expected to:

1. Practice aseptic technique to prevent contamination in laboratory settings.
2. Culture, plate, and identify bacteria, including performing Gram staining procedures.
3. Perform dissections with proper technique and anatomical understanding.
4. Extract DNA and separate nucleic acids using gel electrophoresis.
5. Analyze physical evidence such as fingerprints and hair samples.
6. Prepare and interpret karyotypes to identify chromosomal abnormalities.
7. Utilize applied mathematics to calculate concentrations, create standard curves, and interpret quantitative data.
8. Accurately measure and transfer liquids using micropipettors with precision.

9. Operate microscopes to view, analyze, and document microscopic specimens.

F. The student demonstrates foundational clinical skills and patient-focused methodologies that support health assessment and care. The student is expected to:

1. Conduct blood testing, typing, and basic bloodwork analysis.
2. Demonstrate proper blood drawing techniques and understand related safety protocols.
3. Measure and interpret vital signs, including blood pressure and heart rate.
4. Exhibit clinical empathy when interacting with patient cases and simulations.
5. Understand and apply HIPAA guidelines to maintain patient confidentiality.
6. Record patient information accurately and maintain clear, organized patient documentation.
7. Construct and analyze pedigrees to trace inheritance patterns of traits or conditions.
8. Apply controlled bleeding techniques and basic triage methods to simulated emergencies.

G. The student demonstrates proficiency in utilizing equipment, software, and computational tools to collect, analyze, and present biomedical data. The student is expected to:

1. Operate specialized software and tools such as ArcGIS, TinkerCAD, and Microsoft Office (Excel, Word, PowerPoint) to manage and display data.
2. Employ probes, sensors, and data acquisition software to measure physiological and environmental parameters.
3. Use and maintain a light microscope, gel electrophoresis apparatus, micropipettors, and electronic balances to ensure accurate and reliable data collection.

H. The student demonstrates scientific experimentation skills, employing systematic inquiry to design, conduct, analyze, and communicate experiments. The student is expected to:

1. Design and conduct reliable, repeatable scientific experiments that address testable research questions.
2. Analyze and interpret laboratory data, including constructing and interpreting graphs.
3. Interpolate and extrapolate data from graphical representations to identify trends and patterns.
4. Draw evidence-based conclusions supported by experimental data.
5. Communicate results and conclusions effectively, both orally and in writing.

I. The student demonstrates the ability to apply an iterative design process to solve biomedical problems or create innovative products. The student is expected to:

1. Use an iterative design process to identify problems, propose solutions, and refine outcomes.
2. Collaborate on a design team, sharing responsibilities and integrating diverse ideas.
3. Document the design process and create detailed design briefs.
4. Brainstorm to generate multiple potential solutions and evaluate them against established criteria and constraints.
5. Compare and select the best solution path, then evaluate the final design for effectiveness.

J. The student demonstrates professional skills that foster success in biomedical fields. The student is expected to:

1. Work effectively as part of a team, respecting others' viewpoints and contributions.

2. Engage in peer review and constructive feedback to improve work quality.
3. Manage projects efficiently through planning, organization, and adherence to deadlines.
4. Employ problem-solving strategies to address challenges in laboratory and research contexts.
5. Develop oral presentation skills and produce clear, technically accurate written documents.
6. Exercise ethical reasoning when confronted with biomedical dilemmas and research decisions.

K. The student demonstrates a broad understanding of core biomedical concepts, integrating foundational knowledge of human biology, disease, and the societal impact of biomedical science. The student is expected to:

1. Describe fundamental concepts in cell biology, anatomy, physiology, molecular biology, and genetics.
2. Explain principles of cancer biology, infectious diseases, and their prevention and treatment.
3. Understand the interplay among body systems, homeostasis, and disease states, as well as mechanisms like feedback loops.
4. Discuss inheritance patterns, including the application of Punnett squares and pedigree analysis.
5. Investigate forensic and crime scene techniques, manner and mechanism of death, and drug design principles.
6. Examine bioethical considerations, biomedical science careers, and the global implications of biomedical research.
7. Explore methods such as high throughput screening (HTS) and restriction fragment length polymorphism (RFLP) analysis and relate DNA structure and mutations to protein function and disease.

L. The student engages in varied experiences and activities that promote hands-on learning and real-world application of biomedical concepts. The student is expected to:

1. Participate in laboratory investigations, simulations, and instant challenges to solve problems.
2. Analyze case studies to connect theoretical knowledge with practical applications.
3. Engage in role-playing scenarios, digital design projects, and thought experiments.
4. Employ design thinking strategies to develop creative solutions to complex biomedical challenges.

Course Standards: Biomedical Science II

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 10-12, and Biomedical Science I is the prerequisite.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Health and Human Services Career Cluster promotes whole health in individuals and communities through diverse services. This sector includes technical, mental, and therapeutic services and personal care supported by medical and social sciences. By addressing social determinants of health and leveraging health data and science, this Cluster aims to enhance the overall health and resilience of individuals, families, and communities.
   C. The Biomedical Science Program of Study immerses students in scientific principles, laboratory techniques, clinical practices, and professional skills essential for success in today's healthcare and biotechnology fields. Throughout the program, students learn to address complex biomedical challenges, incorporate ethical and regulatory considerations, and remain adaptable to rapidly evolving technologies and healthcare demands. By completing the Biomedical Science program, graduates are well-prepared to advance into higher education, seek industry-recognized credentials, and contribute to developing innovative medical treatments, pharmaceuticals, devices, and solutions that enhance individuals', families', and communities' health and resilience.
   D. Biomedical Science II builds upon the foundational concepts and skills introduced in Biomedical Science I, guiding students into more advanced areas of biomedical research, diagnostics, and innovation. Students refine essential techniques such as DNA extraction, protein analysis, and genetic engineering through hands-on laboratory work. They deepen their understanding of clinical testing, bioinformatics, and epidemiology, developing the ability to interpret complex data, propose evidence-based interventions, and address real-world healthcare challenges. Students also strengthen their professional competencies—collaboration, problem-solving, technical communication, and ethical decision-making—while exploring industry standards, regulatory considerations, and emerging technologies. By the end of Biomedical Science II, students will have honed a versatile skill set, positioning them for success on the BACE exam, future coursework, and meaningful contributions to the biomedical field.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**
   A. The student demonstrates the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:

1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work.
2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
3. Employ effective reading, writing, and technical documentation skills.
4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
5. Demonstrate leadership skills and collaborate effectively as a team member.
6. Implement safety procedures, including proper use of software and following privacy guidelines.
7. Exhibit an understanding of legal and ethical responsibilities in the biomedical science field, following copyright laws and regulations.
8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. The student identifies various career pathways in the biomedical science field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles in healthcare.
2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in healthcare fields.

C. The student develops technology and digital literacy skills. The student is expected to:

1. Use technology as a tool for research, organization, communication, and problem-solving.
2. Use digital tools, including computers, mobile devices, collaboration platforms, and cloud services, to access, manage, and create information.
3. Demonstrate proficiency in using emerging and industry-standard technologies.
4. Understand ethical and legal considerations for technology use, including the principles of data protection, copyright, and responsible technology use.

D. The student integrates core academic skills into biomedical science practices. The student is expected to:

1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
2. Apply English concepts such as writing informative texts when documenting procedures and articulating goals.
3. Use mathematical concepts for measurement and conversion (Fahrenheit vs. Celsius), ratios and proportions as well as fraction and decimal conversions.

E. The student demonstrates the necessary skills to apply advanced laboratory techniques and bioanalytical methods to investigate and address biomedical challenges. The student is expected to:

1. Apply aseptic technique and bacterial plating methods to culture, isolate, and identify microorganisms in controlled settings.
2. Utilize micropipetting to ensure precise measurement and transfer of samples, supporting experiments such as DNA extraction, restriction enzyme digests, and DNA gel electrophoresis.

3. Perform protein gel electrophoresis and hydrophobic interaction chromatography (HIC) to purify and analyze proteins for therapeutic and diagnostic applications.
4. Conduct bacterial transformations and use recombinant DNA technology to explore genetic engineering and biomanufacturing processes.
5. Employ computational and analytical skills, including graphing software and applied math, to create standard curves, interpret laboratory data, and draw evidence-based conclusions from experimental results.

F. The student demonstrates the necessary skills to conduct clinical analyses and interpret biomedical data in ways that support patient-centered care and inform population health strategies. The student is expected to:

1. Perform karyotyping to identify chromosomal abnormalities and evaluate their implications for patient diagnosis and treatment.
2. Carry out quantitative ELISA procedures to detect biomolecules, analyze results, and understand their relevance in disease monitoring and public health interventions.
3. Interpret audiograms to assess hearing loss and consider appropriate medical interventions, including hearing assistive technologies and bioengineering solutions.
4. Execute blood typing and tissue typing procedures to guide safe transfusions, organ transplants, and immunological compatibility.
5. Integrate knowledge of bioethics, epidemiology, and the interrelationship between body systems and health/disease when proposing clinical interventions, reflecting on how social determinants of health influence patient outcomes.

G. The student demonstrates the necessary skills to operate laboratory equipment, software, and technology for reliable data acquisition, analysis, and decision-making in biomedical research. The student is expected to:

1. Use Microsoft Office (Excel, Word, PowerPoint) to compile, analyze, and present data, ensuring clear documentation and professional communication of findings.
2. Employ Vernier probes, sensors, and Logger Pro data acquisition software to measure physiological and environmental parameters accurately and consistently.
3. Operate microscopes, thermal cyclers, and other specialized laboratory instruments, ensuring fidelity in experimental protocols and reproducibility of results.
4. Apply bioinformatics and DNA sequence analysis tools to investigate infectious agents, genetic variations, and to inform the development of new biomedical interventions.
5. Troubleshoot equipment and software issues proactively, maintaining an organized and efficient laboratory environment that supports quality assurance and safety standards.

H. The student demonstrates the necessary skills to design, analyze, and communicate scientific experiments, leveraging scientific experimentation skills to inform innovative biomedical interventions. The student is expected to:

1. Design and conduct reliable scientific experiments that align with research questions related to topics such as infectious disease, antibiotic resistance, cancer diagnostics, and regenerative medicine.
2. Analyze and interpret laboratory data, constructing graphs by hand or using graphing software, and applying statistical methods to interpolate, extrapolate, and draw meaningful conclusions.
3. Communicate experimental results and conclusions both orally and in writing, employing technical writing and presentation skills that meet industry standards.

4. Incorporate bioethics, regulatory considerations, and intellectual property issues into research design and dissemination, reflecting the importance of responsible innovation.
5. Adapt experimental methodologies using problem-solving and creative thinking skills, refining approaches to enhance the accuracy, relevance, and impact of research findings.

I. The student demonstrates the necessary professional, collaborative, and forward-thinking skills to function effectively in interdisciplinary biomedical teams and adapt to current and future healthcare challenges. The student is expected to:

1. Work collaboratively, employing planning, organizing, time management, and decision-making techniques to support project goals, from vaccine production initiatives to gene therapy research.
2. Engage in peer review, providing constructive feedback and upholding professional standards in laboratory and clinical simulations, fostering an environment of continuous improvement.
3. Utilize problem-solving and creative thinking skills to address emerging challenges, such as antibiotic resistance or xenotransplantation, developing new interventions or refining existing medical technologies.
4. Reflect on the evolving landscape of biomedical science careers, understanding bioethics, the design process, and global impacts of health technologies, including organ allocation policies and clinical trial protocols.
5. Demonstrate professionalism and leadership by documenting the design process, managing projects efficiently, and communicating effectively with diverse stakeholders, ensuring that biomedical solutions are ethically sound, clinically relevant, and socially responsible.

J. The student applies critical thinking and problem-solving skills to enhance patient care outcomes. The student is expected to:

1. Identify and address patients' needs in a variety of healthcare scenarios, adapting techniques to specific situations.
2. Recognize symptoms of common diseases and conditions, including their implications for care planning and interventions.
3. Analyze social determinants of health and propose solutions to improve patient well-being.
4. Collaborate with interdisciplinary healthcare teams to develop patient-centered care plans.
5. Evaluate patient progress and adjust care strategies to meet changing health needs.

Course Standards: Biomedical Science III

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 10-12, and Biomedical Science I and II are the prerequisites.

2. **INTRODUCTION**

   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Health and Human Services Career Cluster promotes whole health in individuals and communities through diverse services. This sector includes technical, mental, and therapeutic services and personal care supported by medical and social sciences. By addressing social determinants of health and leveraging health data and science, this Cluster aims to enhance the overall health and resilience of individuals, families, and communities.
   C. The Biomedical Science Program of Study immerses students in scientific principles, laboratory techniques, clinical practices, and professional skills essential for success in today's healthcare and biotechnology fields. Throughout the program, students learn to address complex biomedical challenges, incorporate ethical and regulatory considerations, and remain adaptable to rapidly evolving technologies and healthcare demands. By completing the Biomedical Science program, graduates are well-prepared to advance into higher education, seek industry-recognized credentials, and contribute to developing innovative medical treatments, pharmaceuticals, devices, and solutions that enhance individuals', families', and communities' health and resilience.
   D. Biomedical Science III advances students' exploration of the human body and healthcare innovation by building on the foundational skills and knowledge acquired in earlier coursework. In this course, students delve deeper into human anatomy and physiology at a level aligned with introductory college standards, examining each major body system to understand normal functioning and disease states. They refine laboratory techniques—such as micropipetting and DNA gel electrophoresis—and apply specialized assessments, including EMG and spirometry, to investigate physiological processes and interpret clinical data. Students strengthen their scientific reasoning and problem-solving abilities by integrating cutting-edge research tools, analytical software, and professional communication strategies. They learn to design controlled experiments, accurately analyze results, and clearly present findings. This course prepares students for dual credit coursework, industry-recognized certifications like the BACE exam, and work-based learning experiences such as internships or apprenticeships.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a co-curricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**

   A. The student demonstrates the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:

1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work.
2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
3. Employ effective reading, writing, and technical documentation skills.
4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
5. Demonstrate leadership skills and collaborate effectively as a team member.
6. Implement safety procedures, including proper use of software and following privacy guidelines.
7. Exhibit an understanding of legal and ethical responsibilities in the biomedical science field, following copyright laws and regulations.
8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

A. The student identifies various career pathways in the biomedical science field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles in healthcare.
2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in healthcare fields.

B. The student develops technology and digital literacy skills. The student is expected to:

1. Use technology as a tool for research, organization, communication, and problem-solving.
2. Use digital tools, including computers, mobile devices, collaboration platforms, and cloud services, to access, manage, and create information.
3. Demonstrate proficiency in using emerging and industry-standard technologies.
4. Understand ethical and legal considerations for technology use, including the principles of data protection, copyright, and responsible technology use.

C. The student integrates core academic skills into biomedical science practices. The student is expected to:

1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
2. Apply English concepts such as writing informative texts when documenting procedures and articulating goals.
3. Use mathematical concepts for measurement and conversion (Fahrenheit vs. Celsius), ratios and proportions as well as fraction and decimal conversions.

D. The student demonstrates the necessary skills to perform and document advanced laboratory techniques with accuracy and professionalism. The student is expected to:

1. Practice precise micropipetting to measure and transfer small liquid volumes accurately.
2. Conduct DNA gel electrophoresis to analyze genetic material and interpret basic banding patterns.
3. Maintain clear, organized laboratory records that detail procedures, observations, and results.

E. The student demonstrates the necessary skills to conduct physiological assessments that inform understanding of human body systems. The student is expected to:

1. Perform EMG and spirometry measurements to assess muscular and respiratory function.
2. Use visual perception testing, urinalysis, and the ankle-brachial index to identify potential physiological abnormalities.
3. Relate collected data to normal and abnormal body system functions.

F. The student demonstrates knowledge of human anatomy and physiology at a level reflecting introductory college coursework. The student is expected to:

1. Identify major structures of the body's organ systems and explain their primary functions.
2. Describe how cells, tissues, and organs interact to maintain homeostasis.
3. Compare normal and diseased states, citing examples of how structural or functional changes impact overall health.

G. The student demonstrates proficiency in the use of equipment, software, and tools essential to biomedical research The student is expected to:

1. Employ microscopes and goniometers to observe tissue samples and measure joint angles.
2. Utilize Vernier probes, sensors, and Logger Pro software to collect and analyze physiological data.
3. Use Microsoft Office tools to organize, present, and report scientific findings.

H. The student demonstrates the ability to design and execute scientific experiments following best practices. The student is expected to:

1. Formulate testable hypotheses and identify independent and dependent variables.
2. Apply appropriate controls, replicate trials, and ensure sufficient sample size for reliable data.
3. Construct graphs and use basic statistical methods to interpret and present results.

I. The student demonstrates critical thinking and problem-solving skills to adapt experimental methods. The student is expected to:

1. Troubleshoot laboratory protocols when unexpected results occur.
2. Adjust experimental designs to improve data accuracy or relevance.
3. Consult scientific literature to inspire solutions or refine techniques.

J. The student demonstrates the ability to interpret clinical data and connect it to patient health outcomes. The student is expected to:

1. Analyze results from blood typing, EMG, spirometry, and other clinical tests to identify potential health conditions.
2. Relate data-driven findings to diagnostic criteria and possible treatment options.
3. Consider how social determinants of health influence patient risk factors and outcomes.

K. The student demonstrates familiarity with emerging biomedical technologies and their ethical implications. The student is expected to:

1. Investigate recent advances in regenerative medicine, gene therapy, or advanced imaging techniques.
2. Evaluate potential benefits and risks of new technologies for patients and communities.
3. Discuss basic ethical, legal, and social considerations related to biomedical innovation.

L. The student demonstrates professional skills that foster success in healthcare and research environments. The student is expected to:

1. Work collaboratively in teams, sharing tasks and responsibilities fairly.
2. Communicate findings clearly and professionally, both verbally and in writing.
3. Manage time effectively to meet project deadlines and maintain laboratory productivity.

M. The student demonstrates readiness for postsecondary opportunities and workplace experiences in biomedical science fields. The student is expected to:

1. Seek dual credit or other advanced academic courses to prepare for college-level studies.
2. Participate in internships, apprenticeships, or job shadowing opportunities to gain practical experience.
3. Build a professional portfolio highlighting technical, analytical, and communication skills.

N. The student demonstrates the capacity to continuously learn and adapt within the evolving biomedical industry. The student is expected to:

1. Stay informed about new research findings, emerging diseases, and updated best practices.
2. Consider pursuing relevant certifications, including the BACE exam, to validate skill mastery.
3. Reflect on personal career goals, identifying necessary education, training, and professional development opportunities.

Course Standards: Career Connected Learning I and II

Career connected learning is an educational approach that integrates classroom instruction with real-world experiences, enabling high school students to explore potential careers and develop relevant skills before graduation. By participating in work-based learning opportunities—such as apprenticeships, internships, capstone projects, and school-based enterprises—students apply academic concepts in authentic settings, gain practical industry knowledge, and build professional networks. This hands-on engagement helps students connect their studies to future career paths, strengthens their problem-solving and communication skills, and supports a smoother transition into college, vocational programs, or the workforce.

All Career and Technical Education Programs of Study include aspects of work-based learning, and almost all of the programs include two Career Connected Learning (CCL) courses. Below are the course descriptions for CCL I and CCL II. The CCL standards can be found via this link: