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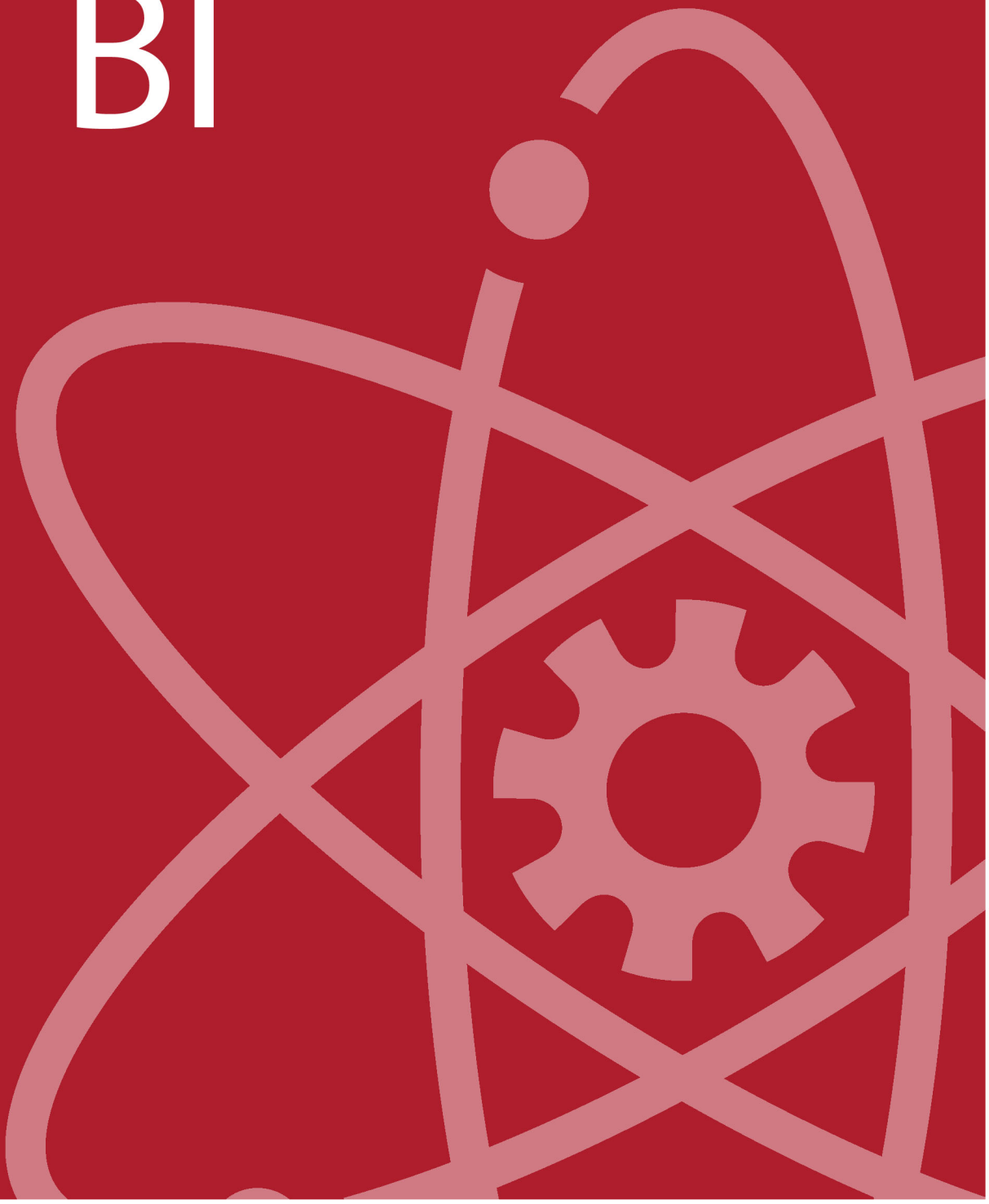

Biomedical Innovation Course Description

In this capstone course, students apply their knowledge and skills to answer questions or solve problems related to the biomedical sciences. Students design innovative solutions for the health challenges of the 21st century as they work through progressively challenging open-ended problems, addressing topics such as clinical medicine, physiology, biomedical engineering, and public health. They have the opportunity to work on an independent project and may work with a mentor or advisor from a university, hospital, physician's office, or industry. Throughout the course, students are expected to present their work to an adult audience that may include representatives from the local business and healthcare community.

Biomedical Innovation Detailed Outline

Problem One: Design of an Effective Emergency Room
Time Days (24 Days)

Concepts Addressed in Lesson:

1. Biomedical innovation is vital to treating disease and disability and to prolonging life in the face of illness and injury.
2. Internet and print resources must be evaluated for accurate content and reliability.
3. Producing effective presentations of scientific material relies on accurate content, effective delivery, and if applicable, visuals that support the key points.
4. Innovations in healthcare and medicine can help reduce wait time and promote efficient care in emergency rooms and emergency care centers.

Performance Objectives Addressed in Lesson:
It is expected that students will:

- Brainstorm unique solutions to the health and medical problems of this century.
- Complete an Internet scavenger hunt to review research techniques, assessment of credible web resources, and proper documentation of sources.
- Use online search engines and journal databases to locate scientific articles.
- Analyze the format of a presentation and list weaknesses in design.
- Compile a resource sheet listing tips for the creation and delivery of effective oral and visual presentations.
- Design an innovative emergency medicine delivery system.
- Diagnose a fictitious patient and demonstrate movement of this patient through an emergency room.
- Produce a Gantt chart to manage the work of the emergency design project.
- Present an innovative ER design to the class in a formal presentation.

Problem Two: Exploring Human Physiology
Time Days (23 Days)

Concepts Addressed in Lesson:

1. A variety of research study designs can be used to find answers to testable questions.
2. Statistics can be used inappropriately to manipulate data and/or mislead readers.
3. Research results presented in the popular media differ from research results presented in scientific literature.
4. Scientists use various statistical analysis methods to draw meaningful conclusions from experimental results.

Performance Objectives Addressed in Lesson:
It is expected that students will:

- Write a brief study design to investigate the association between an activity/treatment and disease pair.
- Investigate the various ways in which data can be manipulated.
- Present a short presentation to "sell" a fictitious product or medical intervention using at least three statistical fallacies.
- Critique science data presented in popular media and compare with science data presented in scientific journals.
- Complete statistical analysis for an assigned study.
- Design, conduct, and analyze an experimental study to find the answer to a question relating to one or multiple body systems.
- Create and present a poster presentation to display results of their experimental study.

Problem Three: Design of a Medical Innovation
Time Days (16 Days)

Concepts Addressed in Lesson:

1. The design process is a series of steps used to design a new product or system.
2. Research on what solutions currently exist for a problem must be completed before a new solution can be designed.
3. When designing a solution, all criteria need to be specified and all possible designs need to be explored.
4. Marketing is the process of introducing and promoting a product into the market.

Performance Objectives Addressed in Lesson:
It is expected that students will:

- Investigate the evolution of various biomedical products.
- Brainstorm ideas for a new biomedical product or for a way to improve an existing product.
- Research and compile information about their chosen problem and evaluate solutions of the past and present.
- Explore possible design solutions, select the best approach, and develop a design proposal.
- Create a model, prototype, or schematic for the chosen solution.
- Design a marketing plan to pitch their chosen solution to potential investors.

Problem Four: Investigating Water Contamination
Time Days (19 Days)

Concepts Addressed in Lesson:

1. Water contamination is a global health issue, although the type of contamination varies with the geographic region.
2. Water can be contaminated by a wide variety of chemicals and biological agents that have health implications for humans and animals.
3. Nonpoint source pollution is caused by runoff water picking up and carrying contaminants to locations far from the source of the contamination and is a major cause of water pollution.
4. Water can be tested for a wide variety of contaminants using specific assays.
5. The presence of coliform in water indicates contamination with human or animal fecal material.

Performance Objectives Addressed in Lesson:
It is expected that students will:

- Use a variety of chemical assays to detect specific contaminants in water samples.
- Perform and analyze a culture assay to detect coliform in water.
- Isolate bacterial DNA from a spiked water sample, amplify the DNA using a polymerase chain reaction assay, and analyze the results by gel electrophoresis.
- Research and propose reasonable solutions to prevent or treat the water contamination described in a fictitious case study.
- Prepare a written or oral report of the action plan to prevent or treat the case study water.

- Use a variety of chemical assays to analyze local water samples for contamination.
- Determine potential hazards or sources of contamination of the local water source by using local and Internet resources to investigate the condition of the water delivery system and the physical and geographic conditions surrounding water source.
- Prepare a written report on the quality of the local water, potential sources of contamination, possible health risks, and an action plan to prevent or treat water contamination.

Problem Five: Combating a Public Health Issue
Time Days (18 Days)

Concepts Addressed in Lesson:

1. Epidemiologists or other public health investigators analyze patient symptoms, results of diagnostic tests, and other clues relevant to person, place, and time of the outbreak to successfully pinpoint the specific nature of the disease as well as a source.
2. Measures of association such as relative risk and the odds ratio describe the correlation between specific risk factors and the development of disease.
3. Public health intervention plans may include education efforts, screening and diagnosis, treatment, distribution of medication or vaccinations, and research.

Performance Objectives Addressed in Lesson:
It is expected that students will:

- Design an organizer to catalog and compare symptoms of patients in a suspected outbreak.
- Examine evidence documents to determine the source of a mystery infection.
- Calculate measures of risk used to demonstrate a possible association between a risk factor and a disease.
- Map local, national, and global health issues.
- Write a detailed grant proposal outlining an intervention plan for a particular disease, illness, or injury.
- Present and defend the proposed intervention plan to a professional audience.

Problem Six: Molecular Biology in Action (Optional)
Time Days (19 or 45 Days)

Concepts Addressed in Lesson:

1. Plasmids, circular rings of DNA, that are cut with restriction enzymes can be joined or ligated to DNA (from any species) that has been cut with the same enzyme. This new genetic information becomes part of the plasmid DNA and provides the code for a new protein.
2. Plasmids can be mapped or described in terms of the location of their restriction sites, sites that are recognized and cut by specific restriction enzymes.
3. The results of a ligation experiment can be gauged by restriction analysis of an extracted plasmid and subsequent visualization of resultant bands via electrophoresis.

Performance Objectives Addressed in Lesson:
It is expected that students will:

- Solve restriction enzyme action logic problems.
- Ligate DNA from two organisms to create a unique plasmid vector.
- Draw and label possible ligation products and describe digestion results of each product.
- Insert a new plasmid into bacterial cells through the process of bacterial transformation.
- Isolate the plasmid DNA from the bacterial cells and analyze the composition of the plasmid using restriction enzymes and gel electrophoresis.
- Analyze a gene sequence using bioinformatics tools and databases (optional).

Problem Seven: Forensic Autopsy (Optional)
Time Days (12 Days)

Concepts Addressed in Lesson:

1. External and internal investigations of the body during an autopsy allow forensic pathologists to determine the cause of death.
2. Size measurements and weights of organs are used in an autopsy to determine any abnormalities.
3. Whether cause of death is natural, accident, or homicide, the body leaves clues to tell the story of how a person died.

Performance Objectives Addressed in Lesson:
It is expected that students will:

- Examine a fetal pig using the same protocol as a human autopsy, including examination of the tissues, organs, systems, and body fluids.

- Fill in an autopsy report for a fetal pig, including all size measurements and weights.
- Create a fictitious death scenario and showcase the clues left behind in the body to tell the story of how the fictional person died through an autopsy report, medical history forms, and other documents of their choosing.
- Solve a mysterious death scenario.

Problem Eight: Independent Project (Optional) Time Days (24+ Days)

Concepts Addressed in Lesson:

1. Biomedical sciences is a broad field and incorporates many fields of study including biology, molecular biology, genetics, anatomy, physiology, immunology, infectious diseases, medicine, and healthcare.
2. A long-term project requires planning in order to have the proper materials and to schedule the work to be completed in time.
3. Breaking a large project into many smaller tasks allows for modifications to be made as necessary and is a means to monitor progress towards completion of the project.

Performance Objectives Addressed in Lesson:
It is expected that students will:

- Use appropriate Internet search techniques to gather information about a topic from appropriate websites.
- Research a topic of their choice and develop a proposal for an independent project that adds to the knowledge base about the topic.
- Write a well-constructed project proposal that clearly articulates the purpose and plan for the project, and is free of grammar, spelling, or factual errors.
- Determine the necessary materials and supplies to complete the proposed project.
- Work with a teacher or mentor to establish a protocol, timeline, and a means to measure progress towards completing the project.
- Perform the work required to complete the project, including making a product, a written report, a portfolio, and an oral presentation.
- Demonstrate good time and project management skills by completing the approved project in the allotted time.
- Write a well-constructed final report that clearly informs the reader about why the project was chosen, what was done, and what conclusions were drawn by completing the project.

- Demonstrate an understanding of the elements of a good presentation, by giving an oral presentation about the project.