

Course Title:**Integrating inquiry-based labs and biotechnology into high school life science classes
Spring 2022**

Please note that the required workshops are scheduled to be in-person at LabCentral, 700 Main St, Cambridge, MA 02139.

Instructors:

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Timeframe of the course: January - May 2021:

- 3 Workshops - each consisting of 6 hours of laboratory time plus 2-3 hours for each workshop outside of class. Workshops schedule shown below.
- Online Course assignment 12-20 hours
- Capstone project composed of Mastery Unit plan (summary, daily lesson plans, and supporting material) 16 hours outside of class.

January 6	4:00 – 5:00 PM	Mandatory introductory class meeting via ZOOM	Required
January 22	9:00 AM – 3:00 PM	<u>Basic Biotechnology Skills and Equipment for your classroom.</u> This is the first required workshop for teachers enrolled in the graduate course. Participants will explore gel electrophoresis by separating dye molecules and determining antibiotic resistance phenotype of bacterial cells. Participants will also complete a bacterial transformation.	Required
March 5	9:00 AM – 3:00 PM	Restriction Enzyme analysis of unknown plasmid DNA and PCR This is the second required workshop for teachers enrolled in the graduate course. Participants will identify the antibiotic resistance phenotype of different bacterial cells using PCR and identify two unknown plasmids using restriction enzymes and gel electrophoresis.	Required
April 9	9:00 AM – 3:00 PM	Exploring Personal Genetics This is one of two possibilities for meeting the final workshop requirement for teachers enrolled in the graduate course. Participants will perform PCR on their own DNA to determine their genotype at one locus and perform gel electrophoresis on simulated PCR samples to solve a crime.	Optional*
May 9-19	May 9, 4:00 – 5:00 PM May 19, 4:00 – 5:00 PM Also requires asynchronous completion of online assignments	Biotechnology, Beyond the Basics This is one of two possibilities for meeting the final workshop requirement for teachers enrolled in the graduate course. Participants will manipulate sequences using SnapGene Viewer (a free online program), practice PCR primer design, learn about different DNA and cloning methods. In addition, participants will explore the BLAST Sequence Analysis Tool and review gel electrophoresis techniques to ensure best results.	Optional*

*You must attend one of these

Number of graduate credits:

3 graduate credits offered through Westfield State University (approximately \$105/credit hour)

Course Description:

Participants will increase their understanding of key life sciences concepts through hands-on molecular biology and biotechnology laboratory activities and be guided to develop inquiry-based lab activities focused on molecular biology and biotechnology for life sciences classes. To accomplish this, participants will 1) review molecular biology content knowledge through online lectures, problem sets, and interactive tools, and 2) attend molecular biology workshops, demonstrate proficient use of molecular biology and biotechnology equipment and techniques and complete accompanying pre- and post-workshop assignments. In addition, each participant will choose topics and labs from these workshops and 3) develop a Mastery Unit Plan (unit summary, daily lesson plans and associated materials)

Objectives:

- Participants will be able to define biotechnology and describe applications.
- Participants will develop/strengthen molecular biology and biotechnology content knowledge through online lectures, problem sets, and active participation in three laboratory workshops.
- Participants will develop/strengthen biotechnology skills to support the use of modern biotechnology tools and equipment in their classes.
- Participants will use modern biotechnology tools and equipment to answer specific questions related to biotechnology, human health, genetics or genetically modified organisms.
- Participants will design experiments based upon modern biotechnology tools and equipment.
- Participants will develop a Mastery Unit Plan (summary, daily lesson plans and associated materials) based upon the content and technologies presented in the workshops.

Learning Outcomes:

By the end of the course, participants will be able to:

1. Use modern biotechnology tools and equipment to answer specific questions related to biotechnology, human health, genetics or genetically modified organisms.
2. Design experiments based upon modern biotechnology tools and equipment.
3. Support the use of modern biotechnology tools and equipment in their classes.
4. Effectively communicate the importance of biotechnology and applications of biotechnology to human health, agriculture, and biofuels.
5. Effectively teach molecular biology and biotechnology content knowledge through lectures, innovative homework, laboratories and activities.
6. Develop/strengthen biotechnology skills to support the use of modern biotechnology tools and equipment in their classes.
7. Guide students to an understanding of fundamental concepts in biology through hands on activities and laboratories using the tools and techniques of biotechnology.
8. Implement inquiry-based laboratories into their classrooms.
9. Reconfigure current laboratory activities to incorporate inquiry-based learning.
10. Develop a Mastery Unit Plan (summary, daily lesson plans and associated materials) based upon the content and technologies presented in the workshops

Outcomes Linked to Assessment:

Component	Learning outcomes (listed above)	Assessment
Workshops	Outcomes 1, 6	Workshop participation and laboratory practicums.
	Outcome 2	Pre- and Post- Workshop Assignments.
Online lessons	Outcomes 4, 5	Engaging the lectures through viewing and “test yourself” questions. Completion of online problem sets.
Capstone Project	Outcomes 4, 5, 7, 9, 10	Mastery Unit Plan with supporting activities. See model.

Instructional Strategies:

<u>X</u> Lecture	<u>X</u> Data Collection and Analysis
<u>X</u> Discussion forum/Questioning	— Case Study Analysis
<u>X</u> Laboratory	— Role Playing/Simulation
<u>X</u> Problem Finding/Solving	<u>X</u> Independent Learning
<u>X</u> Discovery/Inquiry	<u>X</u> Power point
— Interviewing	<u>X</u> Computer Applications
<u>X</u> Collaborative Learning Groups	<u>X</u> Viewing or Listening to Followed by
<u>X</u> Reflective Responses	Discussing
— Creating Visual Illustrations of Concepts	<u>X</u> Readings
<u>X</u> Action Plan	
<u>X</u> Classroom Implementation	

Participants will utilize technology as:

- X a research tool
- X an instructional tool
- X a communication method (email/online forum)
- X an enhancement tool for the design of lessons and curriculum units

Prerequisites, Required Texts and/or materials:

Participants must have a strong understanding of basic biological concepts, a working knowledge of molecular biology, and be currently teaching one or more life sciences courses in grades 8-12. Participants must have the ability to access online videos and problem sets and participate in online discussion boards and forums.
No text is required.

Course Schedule/Outline/Requirements:

Workshops,

All graduate credit applicants must attend the workshops as listed on page 1. Each workshop will have pre- and post-workshop assignments. The pre-assignment must be completed in advance of the scheduled workshop; the post-workshop assignments are due 1 week after the workshop. It is expected that the pre and post-workshop assignments for each workshop can be completed in less than 2 hours

Online Lectures and Problem sets

The online assignment will use materials developed for the edX course, 7.00x. Applicant engagement time with lecture videos and embedded questions can be tracked, assigned problem sets are automatically graded. With a background in cell and molecular biology, it is expected that the online assignment can be completed in less than 20 hours. Access to the online materials will be granted as soon as Westfield State University registration has been finalized. The deadline for completing the online assignment is March 1, 2022.

Capstone Project: Mastery Unit Plan

All graduate credit applicants must create a Mastery Unit Plan based upon the content and activities presented in the workshops. Each unit will include:

1. A unit summary outlining the content to be covered, the prior learning that connects to this content and class/course information. This should include the unit Big Idea(s) and Objectives
2. Three or more abbreviated lesson plans for other key days in this unit related to the lab activity. One of these lesson plans must be for the day of the lab implementation.
3. A full lesson plan for the day preceding the lab that demonstrates how the students will be introduced to and prepared for the lab procedure and content. (see model)
4. Five questions (including at least two open response) relating to the unit and lab that you would use on a test/quiz to evaluate the effectiveness of the activities in addressing the big ideas and objectives and measuring the students' understanding of the content.

A comprehensive draft of the Capstone Project is due in advance of March 18th, 2021. We have provided you with an example of the Capstone Project. Your draft should contain all elements of the Capstone Project and is worth 10% of the total Capstone grade. Your draft must be approved by one of the course instructors before you execute on the final capstone assignment. The final capstone assignment must be submitted by April 30th, 2021.

Participant Evaluation:

Component	Grading Breakdown		% of Grade
Workshops	55%	Lab Activities Feb-March	40%
		Pre-workshop assignments	5%
		Post-workshop assignments	10%
On-line lessons	15%	Lectures and completion of "test yourself" questions	5%
		Problem sets	10%
Capstone Project	30%	Draft Mastery Unit Plan with supporting activities (please refer to model documents)	10%
		Final Mastery Unit Plan with supporting activities	20%

Grading Rubrics:

Workshops 55% = 55 points

Criteria	Below Standard (0-25 points)	Meets Standard (25-34 points)	Exceeds Standard (35-40 points)
Lab Activities	<ul style="list-style-type: none"> Lacks understanding of the biological question that the lab addresses. Fails to execute one or more of the labs or activities. Lacks some ability to analyze and interpret data gathered in the lab. Does not demonstrate appropriate use of equipment, tools and techniques. 	<ul style="list-style-type: none"> Shows understanding of the biological question that the lab addresses. Executes all labs and activities and shows some ability to adapt and trouble-shoot protocols. Effectively analyzes and interprets standard data gathered in the lab. Demonstrates appropriate use of equipment, tools and techniques. 	<ul style="list-style-type: none"> Shows understanding of the biological question that the lab addresses and can provide additional examples of related biological questions. Can apply tools and techniques to novel biological problems. Executes all labs and activities and shows strong ability to adapt and trouble-shoot protocols. Effectively analyzes and interprets standard and unexpected data gathered in the lab and can offer relevant explanations for unexpected results. Demonstrates appropriate use of equipment, tools and techniques. Extends or modifies presented lab or activity. Demonstrates the ability to apply tools and techniques to biological problems beyond those presented.

Criteria	Below Standard Pre-assignments (0-4 points) Post-assignments and Proposal (0-7 points)	Meets Standard Pre-assignments (5 points) Post-assignments and Proposal (8-10 points)
Pre-Assignments	<ul style="list-style-type: none"> Does not answer all questions or respond to all prompts on or before the deadline. Provides incomplete answers some or all of the questions. 	<ul style="list-style-type: none"> Answers all questions and responds to all prompts on or before the deadline. Provides complete answers to all of the question.
Post-Assignments	<ul style="list-style-type: none"> Does not answer all questions or respond to all prompts fully and completely on or before the deadline. 	<ul style="list-style-type: none"> Answers all questions or responds to all prompts fully and completely on or before the deadline.
Mastery Unit Plan Proposal	<ul style="list-style-type: none"> Unit summary is not complete and/or the selected lab is not appropriate. Fails to explain how the lab enhances the student learning of content 	<ul style="list-style-type: none"> Unit summary is complete and/or the selected lab is appropriate. Clearly explain how the lab enhances the student learning of content

Online Lessons, 15% = 15 points

Criteria	Below Standard Lectures (0-4 points) Problem Sets (0-8)	Meets Standard Lectures (5 points) Problem Sets (9-10)
Lectures	<ul style="list-style-type: none"> Does not answer all embedded questions or requires more than 3 attempts to answer questions on or before the deadline. 	<ul style="list-style-type: none"> Answers all embedded questions in less than three attempts and responds to all prompts on or before the deadline.
Problem Sets	<ul style="list-style-type: none"> Does not answer all questions or respond to all prompts on or before the deadline. Answers less than 80% of questions correctly. 	<ul style="list-style-type: none"> Answers all questions or responds to all prompts on or before the deadline. Answers 80% or more of questions correctly.

Capstone Project, Mastery Unit Plan 30% = 30 points

Criteria	Below Standard (0-20 points)	Meets Standard (20-24 points)	Exceeds Standard (25-30 points)
Unit Summary			
Content and Background	<ul style="list-style-type: none"> • Little or no explanation of the content • Little or no description of past learning 	<ul style="list-style-type: none"> • Summary of the content is provided • Past learning is described with some connections to the current content 	<ul style="list-style-type: none"> • Complete summary of the unit • Past learning is described with thorough explanation of how it relates to the current content
Big Ideas and Essential Questions	<ul style="list-style-type: none"> • Big Ideas and /or Essential Questions are missing or if present are poorly written 	<ul style="list-style-type: none"> • Big Idea(s) is appropriate and obtainable through implementation of lessons and activities. • Most of the Essential Questions are written so as to encourage students to seek more information and ask additional questions 	<ul style="list-style-type: none"> • Big Idea(s) is appropriate and obtainable through implementation of lessons and activities. • All of the Essential Questions are written so as to encourage students to seek more information and ask additional questions.
Standards (National, state or district)	<ul style="list-style-type: none"> • Few standards identified or ones that have been included are not relevant to topic. 	<ul style="list-style-type: none"> • Most related standards are identified. 	<ul style="list-style-type: none"> • All related standards are identified.
Complete Lesson Plan (for day preceding the implementation of the lab)			
Lesson Plan and Objectives	<ul style="list-style-type: none"> • Lesson plan included and objectives identified. • Lesson objectives are not clear and/or are difficult to measure. • Connection to standard(s) and content is not evident. • Students' learning progression is not apparent. 	<ul style="list-style-type: none"> • Lesson plan included with most of the appropriate lesson objectives are identified. • Lesson objectives are clear and measurable. • Connection to standard(s) and content is evident. • Student's learning progression is apparent. • Lesson incorporates hands-on learning activities. 	<ul style="list-style-type: none"> • Lesson plans include and all of the appropriate lesson objectives are identified. • Lesson objectives are clear and measurable. • Connection to standard(s) and content is evident. • Student's learning progression is apparent • Lesson incorporate true inquiry-based learning activities.
Instructional Sequence	<ul style="list-style-type: none"> • Introduction: little or no connection to prior knowledge or engaging student interest. • Development: activities have little or no connection to learning objectives. Teacher provides few or no models or examples. • Closure: little or no wrap up of lesson's key points, limited suggestions for preparation for next 	<ul style="list-style-type: none"> • Introduction: connection to prior knowledge and engages student interest. • Development: activities connect to objectives and provide students with opportunities for guided and independent practice. Teacher provides modeling and examples. • Closure: activities provide wrap up of key content points and connections to the next lesson. 	<ul style="list-style-type: none"> • Introduction: strong connection to prior knowledge and engages student interest. • Development: activities connect to objectives and provide students with ample opportunities for guided and independent practice. Teacher provides modeling and examples that engage students in their learning progression. Teacher addresses common misconceptions. • Closure: activities provide a wrap up of key content points and connections to the next lesson. Student learning is assessed

Capstone Project, Mastery Unit Plan 30% = 30 points, continued

Criteria	Below Standard	Meets Standard	Exceeds Standard
Evidence of student learning	<ul style="list-style-type: none"> • Little or no assessment of student learning 	<ul style="list-style-type: none"> • Student learning is assessed through a variety of mechanisms and verbal feedback is expected. • Students have the opportunity to self-assess and monitor their progress. • Variable assessments for students with language modifications and special education plans are available. 	<ul style="list-style-type: none"> • Student learning is assessed through a variety of mechanisms, and verbal and written feedback is expected. • Students have the opportunity to self-assess and monitor their progress through a variety of mechanisms. • Variable assessments for students with language modifications and special education plans are available. A lab practicum or extension activity may be included in the assessment.
Materials and Integration of Technology	<ul style="list-style-type: none"> • List of materials is not complete. • Use of technology is limited. 	<ul style="list-style-type: none"> • List of materials is complete. • All handouts are attached to the lesson plans (both teacher-generated and those used from other sources). All source material is cited appropriately. • Technology is used to enhance the lesson. • Teacher has modified laboratory/activity handout to accommodate most learning styles. 	<ul style="list-style-type: none"> • List of materials is complete. • All handouts are attached to the lesson plans (both teacher-generated and those used from other sources). All source material is cited appropriately. • The use of the handouts is referenced in the lesson plan when used. • The use of technology is creative and enhances the student learning. • Teacher has modified laboratory/activity handout to accommodate all learning styles.

Capstone Project, Mastery Unit Plan 30% = 30 points, continued

Abbreviated Lesson Plans (for any three other key days in the unit)			
Criteria	Below Standard	Meets Standard	Exceeds Standard
Objectives	<ul style="list-style-type: none"> Lesson objectives are not clear and/or are difficult to measure. 	<ul style="list-style-type: none"> Lesson objectives are clear and measurable 	<ul style="list-style-type: none"> Lesson objectives are clear and measurable
Instructional Sequence	<ul style="list-style-type: none"> Introduction: little or no connection to prior knowledge or engaging student interest. Development: activities have little or no connection to learning objectives. Teacher provides few or no models or examples. Closure: little or no wrap up of lesson's key points, limited suggestions for preparation for next lesson. 	<ul style="list-style-type: none"> Introduction: connection to prior knowledge and engages student interest. Development: activities connect to objectives and provide students with opportunities for guided and independent practice. Teacher provides modeling and examples. Closure: activities provide wrap up of key content points and connections to the next lesson. 	<ul style="list-style-type: none"> Introduction: strong connection to prior knowledge and engages student interest. Development: activities connect to objectives and provide students with ample opportunities for guided and independent practice. Teacher provides modeling and examples that engage students in their learning progression. Teacher addresses common misconceptions. Closure: activities provide a wrap up of key content points and connections to the next lesson. Student learning is assessed through closure activity.
Evidence of student learning	<ul style="list-style-type: none"> Little or no assessment of student learning 	<ul style="list-style-type: none"> Student learning is assessed through a variety of mechanisms and verbal feedback is expected. Students have the opportunity to self-assess and monitor their progress. Variable assessments for students with language modifications and special education plans are available. 	<ul style="list-style-type: none"> Student learning is assessed through a variety of mechanisms, and verbal and written feedback is expected. Students have the opportunity to self-assess and monitor their progress through a variety of mechanisms. Variable assessments for students with language modifications and special education plans are available. A lab practicum or extension activity may be included in the assessment.

Evaluation/Grading:

- A: 90-100
- B: 81- 89
- B-: 73-80
- F: 0-72

ACADEMIC HONESTY

Please go the following link (<http://www.westfield.ma.edu/prospective-students/campus-life/student-handbook/academic-life/academic-honesty-policy/>) and become familiar with the Westfield State University Academic Honesty Policy. This is your responsibility.