Research example for first year STEM course

Course: CMB156: Discoveries in Cell & Molecular Biology: A Research Based Laboratory Course

1. **Course Overview:** Includes key information from syllabus to guide taxonomy evaluation.

Specific objectives – Students will be part of a team of researchers with a common goal of identifying genes involved in regeneration of the brain. Each student will generate dsRNA for their gene of interest, use RNAi to knockdown expression in the planarian flatworm, image and analyze phenotypes related to regeneration, and statistically analyze their results for a final presentation. Students will keep *meticulous* lab records of their semester long project and collaborate with scientists at GVSU and the University of Georgia.

Student learning objectives –After successful completion of the course the students will be able to 1) Interpret experimental data and communicate results through written and oral presentation. 2) Maintain a scientific laboratory notebook and understand the ethics of research record keeping. 3) Explain the basic biological concepts behind methods used in course experiments. 4) Develop professional skills in experimental design, critical thinking and laboratory techniques.

Course Information Video: https://youtu.be/sMNXGZCsQ80
Video includes interviews with our collaborator and student perspectives.

Tentative **Schedule for Semester with Major Assessments**

Week	General Topics	Specific Procedures	Deadlines
1	*Overview/expectations*	Imaging planarian with dissecting microscope; amputation and formulating a hypothesis	Pre-lab references
2	*DNA replication, Biotechnology tools*	Phenotypic analysis and imaging of amputations; pipetting; calculations	Pre-lab references **-BB quiz 1 (Week 2)**
3	*Generate dsDNA template*	PCR; Phenotypic analysis and imaging of amputations	Pre-lab references **-BB quiz 2 (Week 3)**
4	*Gel electrophoresis, bioinformatics*	Agarose gel analysis for PCR product; bioinformatics exercise for gene function	**-Master Mix Calculations -BB quiz 3 (Week 4)**
5	*DNA purification and spectroscopy*	PCR clean up; quantify DNA by spectroscopy	Pre-lab references **-BB quiz 4 (Week 5)**
6	*Transcription, RNAi method*	Transcription reaction (generate ssRNA); calculations; DNAse treatment; feeding and maintenance of planarian	Pre-lab references **-BB quiz 5 (Week 6) -Lab notebooks grading I**
7	RNA purification, annealing nucleic acids	ssRNA clean up; annealing step; quantify RNA by spectroscopy; formulating hypothesis for RNAi experiment	Pre-lab references **-Bioinformatics Exercise -BB quiz 6 (Week 7)**

8	*Experimental setup for RNAi, 1st feeding*	Discuss RNA gel results; First RNAi feeding; visualize and image planarian	Pre-lab references **-BB quiz 7 (Week 8)**
9	*RNAi 2nd feeding, image analysis*	Second RNAi feeding; visualize and image planarian; final presentation discussion	Pre-lab references **-BB quiz 8 (Week 9)**
10	Amputation	Amputation of planarian	**-Poster: Background, Hypothesis and Experimental Approach** **-Lab notebook grading II**
11	Regeneration analysis	Acquire images from amputation; continue Image J and statistics discussion	**-Poster Meetings** **-Image J practice exercise**
12	-	Compile results; Results and Conclusion discussion for final presentations **-Statistics and Graphs due by the end of class period.**	-**Area Measurements** **-Poster: Final Background, Hypothesis and Expt Approach**
13	***Thanksgiving***	**No class**	
14	-	Scientific Abstracts	**-Scientific Abstract**
15	-	Presentation preparation & practice, finalize posters	**-Lab Notebook: Overall Objective and Conclusion**
	Finals week	Final presentation mini-conference **Time/Date TBD: Will combine with other sections.**	**-Final poster (All sections)** **-Final presentations**

2. Evaluation of taxonomy for 8 quality elements

CMB 156: Existing Course since Fall 2018	CMB 156- Discoveries in Cell & Molecular Biology: A Research- Based Laboratory Course
Characteristic	**Examples where your course aligns with this characteristic as a high-impact practice (e.g. column 2 or beyond)?**
Appropriately high performance expectations	Expectations throughout the course are communicated in several ways and students are mentored to reach the expectations: • Pre-semester email explains the commitment to a semester long project. • Syllabus contains an additional section detailing the expectations (workload and attendance) for success in this course and expectations on how to prepare for each class meeting.

	• Rubrics and examples are provided for major products produced throughout the project (bioinformatics analysis, lab notebook, scientific poster and final presentation) and the details reviewed during class. • Students in the course have a graduate student and upper level undergraduate student modeling best practices and routinely providing feedback (both verbally in the lab and written for poster drafts). Mentoring and modeling helps students realize expectations regardless of prior experience. • Although students work collaboratively in the lab, each student is held accountable for all aspects of the work and individually present posters.
Significant investment of time/effort by students over extended time	The course is a semester long project that culminates in a professional scientific presentation. • Structure: Concepts, methods and results from each week build for the next week's work. • Sustained inquiry: First two weeks are introductory to the project with some basic training in techniques related to the research project. Remaining weeks are all dedicated to various aspects of the project (13 weeks of the semester). • Outside of class work guides students to make connections between their work and published literature. It also provides a weekly structure on preparing for the class meeting so that we can spend the full class time engaged in project work. • Poster preparation is an iterative process that extends over 5 weeks, not a final exam week assignment. More below with constructive feedback.
Faculty/peer interactions regarding substantive matters	Class size is capped at 20. Students interact with peers, faculty, a graduate assistant and an upper-level undergraduate student in every class period. Twice a semester, we meet virtually with our collaborators at the University of Georgia. • Students are part of a "Gene Team." Four students are studying the same gene and share information/results with the team. Two students are a group to perform experiments collaboratively. • Project is a collaboration with researchers at UGA. Two zoom meetings are scheduled in the semester to 1) share hypothesis and receive feedback from an expert in the field and 2) share results and receive feedback on their interpretation of the results. • A graduate student and an upper level UG (typically senior) are in the classroom at each meeting to mentor and work one on one with students. See below on how the instructor, GA and UG students also work with students on feedback and reflection.

	• Course instructor engages with students at every class meeting providing immediate one-on-one feedback on technique and course content.
Experiences with diversity **Definition: engage in activities and inquiry regarding diverse communities, cultures, and/or ideas**	Students share ideas with their Gene Team and determine a strategy to work as a team. • A reflective exercise on teamwork is used for students to identify where they feel their strengths will most benefit the team. • Students share their interpretation of published results and ideas for hypothesis with the team. Students collaborate with peers to problem solve results that are unexpected. • Community Building: On campus events and clubs are shared (faculty, grad student and undergrad contribute) to encourage students to engage in the campus community. Includes information from OURS, Pizza Tuesday hosted by CMB, CMB Club, Student Scholar Day, Senior Symposium, Undergraduate Research Fair, CMB Celebration, OURS Ambassador visits the class, etc.
Frequent, timely, and constructive feedback **All milestones assume that feedback is frequent, timely, and constructive.**	The course builds throughout the semester and students receive feedback at every step to improve their laboratory technique, write a scientific abstract and develop final presentations. • Introductory exercises in the first two weeks allow the students to practice methods until the student is comfortable, fully understands the purpose and instructors feel they are appropriately prepared to start the experiment. Students first work with an instructor (can be GA or upper level undergrad) who models the technique to a small group (2-4 students). Students practice with the instructor and on their own. Students show the instructor to move forward. • Throughout the experiment, students repeat methods/protocols multiple times. Instructors continue to give feedback to improve their technical skills at every class meeting. • Lab notebooks are used to keep a record of all activities, including interpretation of results and troubleshooting results. Instructor provides detailed feedback on lab notebooks informally each week and formally three times throughout the semester. • Poster development is an iterative process that follows the same expectations for when we prepare posters for an external research conference. 1st draft includes the first three sections (background, hypothesis and experimental approach). Students submit for credit based on effort to use the guidelines and complete all sections. Students receive detailed feedback from two instructors and a one-on-one meeting with an instructor. Revisions are submitted and additional feedback is provided. Importantly, effort to improve based on the first set of comments is part of the assessment. Final sections are added and students are given an opportunity to complete a final round of revisions.

	• Students use a six sentence process to write a 1st draft for their scientific abstract. Peer evaluation during class helps students identify ways to improve their own writing and connect how their project is part of the bigger question we are addressing as a group. Instructors provide written feedback on all abstracts. Students are provided with several self-editing tools. Students use comments from four evaluations and self-editing strategies to write a final draft.
Periodic & structured opportunities to reflect & integrate learning	Many forms of reflection are built into the course that require the student to make connections and consider the material deeper. In addition, students experience authentic scientific research early in their "Voyage," which has the potential to change the trajectory of their academic career. The E-portfolio will also be used to enhance reflective exercises. • Lab notebook- goals and interpretation of their own learning recorded weekly • Overall objective- connects their work to the larger community; specifically picked tissue regeneration in the brain as our focus for students to see relevance beyond the classroom. • Final conclusion and discussion- connects their work to published literature • Scientific Abstract- reflects on the entire semesters work to pull out the most relevant information and communicate this in a concise paragraph • Peer-evaluation- posters and abstracts • Self-evaluation- reflect on their contribution to team and how the work fits in with their career goals; next steps at GVSU.
Opportunities to discover relevance of learning through real-world applications	The project is authentic research aimed at answering a question that is important to the scientific and medical community. Current methods and data analysis used by leading researchers are applied to understand tissue regeneration in the brain. • A big question in biology is understanding how stem cells differentiate and how tissue is regenerated following injury. This is particularly challenging to understand in the human brain. Students use a model organism (planarians) that can regenerate their entire Central Nervous System. This course screens genes that we hypothesize play a role in the process of brain regeneration. The instructor does not know the results of the research. • Students collaborate with an external research group at the University of Georgia. This research group has expertise in stem cell biology and regeneration. • Students generate a hypothesis based on published literature. • Students use identical methods and technology to those with expertise in the field.

	• Students write a scientific abstract, produce a poster and present novel results. • Results have the potential for publication.
Public demonstration of competence	Students present their posters in a symposium with peers from the other sections. Opportunity to present externally in later semesters. • Outside faculty and students are invited (Associate Dean McBane has attended). • Students from all sections come together for a poster symposium. Assigned and structured peer evaluations to ensure interactions across the sections. • Students are given the opportunity to present at a Student Scholar Day (April annually) or the West Michigan Regional Undergraduate Science Research Conference @ Van Andel Institute (November annually). This is optional and requires additional practice with the instructor and potentially revisions to abstract and poster.