UMBC UGC New Course Request: BIOL 429: Advanced Topics in Molecular Biology

Date Submitted: 9/19/2018 Proposed Effective Date: Spring 2019

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COURSE INFORMATION:

Course Number(s)	BIOL 429
Formal Title	Advanced Topics in Molecular Biology
Transcript Title (≤30c)	Topics in Molecular Biology
Recommended Course Preparation	
Prerequisite **NOTE:** Unless otherwise indicated, a prerequisite is assumed to be passed with a "D" or better.	BIOL 302 and BIOL 303, both with a grade of "C" or better.
# of Credits Must adhere to the UMBC Credit Hour Policy	4.00
Repeatable for additional credit?	☒ Yes ☐ No
Max. Total Credits	16.00 This should be equal to the number of credits for courses that cannot be repeated for credit. For courses that may be repeated for credit, enter the maximum total number of credits a student can receive from this course. E.g., enter 6 credits for a 3 credit course that may be taken a second time for credit, but not for a third time. Please note that this does NOT refer to how many times a class may be retaken for a higher grade.
Grading Method(s)	☒ Reg (A-F) ☐ Audit ☐ Pass-Fail

PROPOSED CATALOG DESCRIPTION (Approximately 75 words in length. Please use full sentences.):
This advanced course analyzes principles of and current topics in molecular biology, which concerns the study of biology at the molecular level and focuses on the structure, function and regulation of macromolecules including DNA, RNA and proteins. Topics will vary across semesters according to current research and the interests of faculty. Representative topics may include Representative topics may include: technological advances in molecular biology and biotechnology, genome editing, gene therapy, genetically-modified organisms, and the molecular genetics of human disease. The course is a mix of lectures, problem-based learning, and student-led presentations of articles from the primary research literature.

RATIONALE FOR NEW COURSE:
The Department of Biological Sciences currently offers Advanced Topics courses in Cell Biology, Comparative Physiology, Developmental Biology, and Evolutionary Biology, but we do not currently offer an option for molecular biology. By adding a topics course in molecular biology, we wish to expand the electives available to our majors. Upon completion of the four "core" courses in the biology curriculum, students then have multiple choices for intermediate and upper-level elective courses.

Upper level classes in this sub-discipline are underrepresented, but the few available are very popular and consistently reach, if not exceed, enrollment capacity. Additional classes of this topic are clearly in demand. This course would also provide flexibility for faculty in the department who specialize in molecular biology, allowing faculty to stay abreast of recent developments in the field while offering student an opportunity to engage in this dynamic field. This course will be offered on an ad hoc basis, at the discretion of new and existing faculty interests.

The material covered is advanced and uses critical analysis of the current scientific literature at an accelerated pace, with only some review of foundational principles that can be found in other courses, making it a 4XX-level course. The pre-requisties for this course include BIOL 302 – Genetics & Molecular Biology and BIOL 303 – Cell Biology. All BIOL 4XX-level courses have BIOL 302 and BIOL 303, the last two upper-level lecture courses needed for the Biology Core, as a pre-req. We would like to keep those 4XX-level pre-reqs consistent for all BIOL courses.

This course is designed with the standard A-F grading scale, with appropriate emphasis on exams, in-class work, problem sets, and presentations. Finally, the course will use the established student-centered pedagogical techniques already in existing departmental course offerings (see Student Assessment section of syllabus). Course is repeatable for credit, as long as different topics are taken.

ATTACH COURSE SYLLABUS (mandatory):
See attached for example syllabus.

BIOL 429: Advanced Topics in Molecular Biology (4 Credits)
Molecular Biotechnology
Spring 2019
MW: 9:00-10:50 am
Biological Sciences, Rm. 004

Course Instructor:

Laura Ott, Ph.D.
Director, Science Education Research Unit
leott@umbc.edu
(410) 455-8089
Office: University Center, Rm. 116D (please sign in at front kiosk for office hours or an appointment)
Office Hours: Monday, 11 am -12 pm, or by appointment

Course Topic: Molecular Biotechnology

Course Description:
This advanced course analyzes principles of and current topics in molecular biology, which concerns the study of biology at the molecular level and focuses on the structure, function and regulation of macromolecules including DNA, RNA and proteins. Topics will vary across semesters according to current research and the interests of faculty. Representative topics may include Representative topics may include: technological advances in molecular biology and biotechnology, genome editing, gene therapy, genetically-modified organisms, and the molecular genetics of human disease. The course is a mix of lectures, problem-based learning, and student-led presentations of articles from the primary research literature.

Topic Description:

This course pursues in depth the techniques and applications of recombinant protein expression for biomedical purposes. A recombinant protein is a protein that is produced by cloning a gene into a heterologous expression system that will transcribe, translate, and if appropriate, post-translationally modify the protein to be used for industrial, agricultural, or biomedical purposes. The course will first discuss the history of recombinant protein expression for medical purposes and then move into current molecular methods of cloning recombinant DNA, and expression and purification of recombinant protein. The course will focus on the following expression systems: bacterial, yeast, plant, insect, mammalian tissue culture, and transgenic animals. Therapeutic recombinant approaches, including monoclonal antibodies and CAR-T cells, will be discussed, to include the ethical and regulatory aspects of the therapy. Students will be exposed to recent advances and current research in recombinant protein expression for biomedical purposes through the critical evaluation of primary scientific literature. The exact content of the course will vary depending on the current status of research in the field.

Pre-Requisites:

Students must complete BIOL 302 (Genetics) and BIOL 303 (Cell Biology), receiving a grade of C or better.

Course Learning Objectives:

Upon completion of this course, students will be able to:

1. Design strategies to manipulate DNA to create new proteins
2. Develop a strategy to recombinantly express protein in prokaryotes and eukaryotes
3. Compare and contrast different recombinant protein expression systems
4. Discuss the development and applications of monoclonal antibodies, chimeric proteins, and engineered cellular therapies
5. Debate the ethical and regulatory issues related to recombinant protein expression for biomedical purposes
6. Analyze and interpret primary literature sources

Required Text:

There is not a required text for this course, with all reading materials made available to students via Blackboard. Reading materials provided will include (but not limited to):

- Primary scientific articles for the weekly journal clubs (details below)
- Review articles that students are strongly encouraged to read.

Course Structure:

This class is going to involve active learning, with much of class time devoted to students working on problem sets and activities, reviewing case studies, and analyzing primary literature either independently or in groups. Before each class session, students will need to watch a short video or lecture that will be posted to Blackboard; a quiz will be given at the start of each class (via clickers) that is related to the video/lecture. A Journal Club will take place the last hour of class on Wednesday/Thursday, where a primary literature source will be discussed.

Grading:

The final grades for the course will be curved, based on the distribution of final weighted grades earned in the class.

At a minimum, the following grades will be guaranteed:
A=90+%; B=80.0-89.9%; C=70.0-79.9%; D=60.0-69.9%; F=59.9% or below

Student Assessments:

Midterm Exam 1 - 15%
    Group take-home – 7.5%
    Individual in-class – 7.5%
Midterm Exam 2 - 15%
    Group take-home – 7.5%
    Individual in-class – 7.5%
Cumulative Final Exam - 20%
Experimental Design Strategy - 10%
Opinion papers (5) - 20%
Clicker Quizzes - 10%

Class Activities – 10%

Clicker Quizzes:

To help students assess their understanding of the required videos/lectures that they will watch before class, each session will start with a clicker quiz. Clicker quizzes that take place on a journal club day may also include questions relevant to the paper to be discussed. Ten (10) % of each student's the lowest scoring clicker quizzes will be dropped (*i.e.*, students' scores will be based on the best 90% of the clicker questions answered for the semester). Note, students must be present at the start of class to receive points for the clicker quiz that day. Students who violate this policy will be in violation of the UMBC academic integrity policy. Students are responsible for ensuring that their clicker questions for each session are appropriately recorded in Blackboard.

All clicker questions will be posted to Blackboard at the conclusion of class. Refer to the "Important Academic Policies and Services" section for more details on clickers.

Clickers - Class Activities:

This class will involve numerous in-class activities (case studies, review of experimental data) and abilities to practice problems. Students engagement in these activities will be assessed by responding to clicker questions (these clicker questions are separate from the clicker questions outlined above). The clicker questions for the in-class activities will be graded based on participation, with 10% of each students' clicker sessions being dropped.

Journal Clubs:

A journal club (JC) will take place during the last hour of class on Wednesday/Thursday of each week (articles will be posted to Blackboard). During the JC, a primary literature article relevant to topics discussed in class that week will be discussed. For the JC, students should be prepared to discuss the following:

- The overall question of the paper and why the authors posed this question
- For each figure (or subfigure):
    - The experimental question
    - The method(s) used
    - The results and interpretation of findings
- The overall conclusion of the paper and possible future directions

Participation in the JC will count towards a student's Participation & Attendance grade.

Opinion Papers:

Students will write a brief (approx. 1-full page) position paper on an ethnical or regulatory aspect of a recombinant protein expression technology or application discussed in class. This paper should discuss the pros/cons of the issue and should cite at least one primary literature source that students find on their own that supports their argument. These papers should be prepared in Microscoft Word, using 1-inch margins, size 11 Arial, Times New Roman, Helvetica, or Calibri fonts, and references should be cited with both in-text and end-of-document citations (any citation style can be used, as long as the style is consistent). A rubric that will be used to assess the position papers will be posted on Blackboard for students to refer to.

Mid-term Exams:

Take home component: The take-home component of Exam 1 and 2 will be completed in instructor-assigned teams. One document will be submitted per group, but an individual member can submit an individual answer to a question if they disagree with the rest of the group (to be included in the single document). Each student is responsible for contributing to each answer and students are encouraged to discuss any concerns regarding unequal contributions made by other team members with the instructor. Teams may not divide up the questions among each other; this will only hurt you because the same concepts will be tested in the in-class exam.

The take home exam component must be typed and students are allowed to use appropriately cited outside resources for the exam. They are due at the beginning of the period in which the in-class exam will take place. Groups will be given 2-weeks to complete the take-home exams and note that material on the take home exam may be covered in the 2 weeks between when the exam is posted and the exam is due. Begin working on them EARLY, as they are more time-consuming than they appear at first glance. No late take home exams will be accepted; any exam that is not turned in on time will receive a zero for the entire group.

In-class component: The in-class component of each exam is given on the due date of the corresponding take-home component (refer to course schedule below). They are short answer and/or multiple choice questions that cover the same concepts as the take home. They are *closed-book* and are *taken individually*.

Note that the take home and in-class component of the exam will be weighted equally.

Take-home/In-class exam 1 topics: History of insulin and genetically modified organisms, expression vs. cloning vectors, protein tags, blue/white screening, PCR, primer design, agarose gel electrophoresis, post-translational modifications, GenBank, codon usage bias, reading frame, restriction digestion, ligation and transformation in *E. coli*, antibiotic selection

Take-home/In-class exam 2 topics: Gibson Assembly, screening methods, induction of protein expression, protein purification methods (affinity purification), recombinant protein expression in yeast, Baculovirus/insect cells, and plants

Experimental Design Strategy

Students will develop an experimental strategy to clone, express, and purify a protein of their choice in any of the expression systems discussed in class. Detailed instructions will be posted on Blackboard and will involve students submitting an introduction outlining the proposed application(s) for the chosen recombinant protein to be expressed and purified and an outline of the proposed experimental strategy mid-way through the semester. The instructor will provide feedback on this before the final experimental strategy is due. Refer to the guidelines and rubric posted on Blackboard for more details of this assignment.

Course Policies

Course Attendance: For students to learn the course material, attendance to class is essential (and mandatory!). Each student will be allowed 2 unexcused absences to class (note, no clicker quiz points will be awarded for students on unexcused absences). Each unexcused absence beyond the allowable 2 absences will result in 2% points docked from the students' overall course grade (after the curve). For students to be granted an excused absence, the student must communicate the absence in writing (i.e., email) in advance and provide appropriate documentation (i.e., doctor's note). The burden to provide documentation for an excused absence is on the student. The instructor will provide an alternative method for students to make up clicker quiz points for excused absences (pending that the instructor receives appropriate documentation).

Late Assignments: All assignments are due at the start of class on their scheduled due date posted below. Late assignments will not be accepted (i.e., students will receive a zero for submission of late assignments).

Cell phones and computers: A recent study (Glass and Kant (2018). *Educational Psychology*) found that cell phone use in class not only interrupts the learning of the user, but also those around them. Therefore, cell phones are strictly prohibited and should be put on silent for the duration of the class. Students will occasionally need their computers for class. Students may use their personal computer during class, pending that they are working on class-related materials (i.e., taking notes, engaging in activities relevant to class activity). If the instructor finds a student using their computer for non-course related activities, they may lose their computer privileges for the remainder of the semester.

Videos and recorded lectures: Each class will require students to watch a short video or recorded lecture, which will be posted to Blackboard. These videos will be posted no later than 48 hours before class.

Lecture slides: Lecture slides used in class will be posted to Blackboard (see "Lecture Slide Folder" under class materials) no later than 5pm on the evening before class. Students may wish to print the slides and bring with them to take notes on. Please note that posted slides may have slight adjustments from what will be presented in class and clicker questions will not be presented in the slides posted in advance of class. Within 24 hours of class, the clicker questions from that session will be posted on Blackboard in the "Clicker Question Folder".

Important Dates

Students are responsible for keeping track of assignment due dates. All assignments are submitted via Blackboard at the start of class, unless otherwise denoted.

Course Schedule

The course schedule is subject to change at the digression of the instructor. Students will be notified of any changes in advance via email.

Week	Monday/Tuesday	Wednesday/Thursday
1	**Course introduction and syllabus review; Intro to recombinant protein expression**	**History of insulin production; Genetically modified organisms** [Jan 30 or Jan 31]

	[Jan 28 or Jan 29]	Suggested readings: Overton (2009). Recombinant protein production in bacterial hosts. *Drug Discovery Today* 5: 590 Anderson and Krummen (2002). Recombinant protein expression for therapeutic applications. *Current Opinion in Biotechnology* 13: 117
2	**Expression vs. cloning vectors; Protein tags; Blue/White screening** [Feb 4 or Feb 5] Opinion paper 1: *Should golden rice be used to combat vitamin A deficiency in communities of need?*	**Polymerase chain reaction; Agarose gel electrophoresis** [Feb 6 or Feb 7] Journal Club: Xie, *et al.* (2017). An external substrate-free blue/white screening system in Escherichia coli. *Applied Microbiology and Biotechnology* 101: 3811
3	**Post-translational modifications; GenBank; Codon usage bias** [Feb 11 or Feb 12] Suggested Reading: Mizukami, et al. (2018). Platforms for Recombinant Therapeutic Glycoprotein Production. *Methods in Molecular Biology* 1674: 1-14 (Clifton, NJ)	**Primer design** [Feb 13 or Feb 14] Journal Club: Baeza, *et al.* (2015). Codon usage and codon context bias in *Xanthophyllomyces dendrorhous*. *BMC Genomics* 16: 293 Take Home Exam 1 posted
4	**Restriction digestion; Reading frame; Ligation** [Feb 18 or Feb 19] Opinion paper 2: *Could codon usage bias cause health issues for patients who take recombinantly produced therapeutics?*	***E. coli* transformation and antibiotic selection** [Feb 20 or Feb 21] Journal Club: Shafiee, *et al.* (2016). Expression and purification of truncated diphtheria toxin, DT386, in *Escherichia coli*: An attempt for production of new vaccine against diphtheria. *Research in Pharmaceutical Sciences* 11: 428
5	**Gibson Assembly** [Feb 25 or Feb 26]	Take Home Exam 1 due In-class Exam 1 [Feb 27 or Feb 28]
6	**Screening techniques; Induction of protein expression; Protein purification methods**	**Affinity purification** [March 6 or March 7]

	[March 4 or March 5]	Journal Club: Bellharz, et al. (2015). Red Fluorescent Proteins for Gene Expression and Protein Localization Studies in *Streptococcus pneunmoniae* and Efficient Transformation with DNA Assembled via the Gibson Assembly Method. *Applied and Environmental Microbiology* 81: 7244
7	**Recombinant protein expression in yeast** [March 11 or March 12] Opinion paper 3: *Discuss a consequence of not removing the affinity tag from a recombinant protein vaccine.* Suggested Readings: Juturu and Wu (2018). Heterologous Protein Expression in *Pichia pastoris*: Latest Research Progress and Applications. *ChemBioChem* 17: 7 Cregg, *et al.* (2000). Recombinant protein expression in *Pichia pastoris. Molecular Biotechnology* 16: 23	**Recombinant protein expression in yeast** [March 13 or March 14] Journal Club: Thongyoo, et al. (2018). Expression, purification, and biological activity of monomeric insulin precursors from methylotrophic yeasts. *Protein Expression and Purification* 153: 35
8	**No Class – Spring Break** [March 18 or March 19]	**No Class – Spring Break** [March 20 or March 21]
9	**Recombinant protein expression in Baculovirus/insect systems** [March 25 or March 26] Take home exam 2 posted Experimental Design Strategy Intro and outline due Suggested Readings: Kost, *et al.* (2005). Baculovirus as versatile vectors for protein expression in insect and mammalian cells. *Nature Biotechnology* 23: 567 Cox (2012). Recombinant protein vaccines produced in insect cells. *Vaccine* 30: 1759	**Recombinant protein expression in Baculovirus/insect systems** [March 27 or March 28] Journal Club: Minagawa, et al. (2018). Novel recombinant feline interferon carrying N-glycans with reduced allergy risk produced by a transgenic silkworm system. *BMC Veterinary Research* 14: 260

	Opinion paper 4: *What is a concern of the Food and Drug Administration (FDA) when reviewing recombinant protein therapeutics made in insect cells?*	
10	**Recombinant protein expression in plants** [April 1 or April 2] Suggested Reading: Ma, et al. (2003). The production of recombinant pharmaceuticals proteins in plants. *Nature Reviews Genetics* 4: 794	**Recombinant protein expression in plants** [April 3 or April 4] Journal Club: Bordat, et al. (2015). Gibson assembly: an easy way to clone potyviral full-length infectious cDNA clones expressing an ectopic VPg. *Virology Journal* 12: 89
10	Take home exam 2 due In-class exam 2 [April 8 or April 9]	**Recombinant protein expression in mammalian cells** [April 10 or April 11] Suggested reading: Romanova and Noll (2018). Engineered and Natural Promoters and Chromatin Modifying Elements for Recombinant Protein Expression in CHO Cells. *Biotechnology Journal* 13: e1700232 Wurm (2004). Production of recombinant protein therapeutics in cultivated mammalian cells. *Nature Biotechnology* 22: 1393 Journal Club: Zustiak, et al. (2014). Enhanced transient recombinant protein production in CHO cells through the co-transfection of the product gene with Bcl-xL. *Biotechnology Journal* 9: 1164
11	**Recombinant protein expression in mammalian cells** [April 15 or April 16]	**Monoclonal antibodies** [April 17 or April 18] Suggested Readings: Ecker, et al. (2015). The therapeutic monoclonal antibody market. *mAbs* 7: 9 Zhang (2012). Hybridoma technology for the generation of monoclonal antibodies. *Methods in Molecular Biology* 901: 117 (Clifton, NJ) Journal Club: Yang, et al. (2017).

		Production of bFGF monoclonal antibody and its inhibition of metastasis in Lewis lung carcinoma. *Molecular Medicine Reports* 16: 4015
12	**Chimeric proteins; humanized antibodies** [April 22 or April 23] Suggested Reading: Hood, et al. (2002). Monoclonal antibody manufacturing in transgenic plants – myths and realities. *Current Opinion in Biotechnology* 13: 630 Soria-Guerra, et al. (2011). Two decades of plant-based candidate vaccines: a review of the chimeric protein approaches. *Plant Cell Reports* 30: 1367	**Monoclonal antibodies in non-mammalian expression systems** [April 24 or April 25] Journal club: Kim, et al. (2017). Development and characterization of novel chimeric monoclonal antibodies for broad spectrum neutralization of rabies virus. *PLoS One* 12: e0186380
13	**Recombinant protein expression in transgenic animals** [April 29 or April 30] Opinion paper 5: *What are the ethical concerns associated with obtaining recombinant protein therapeutics from the milk of goats?* Suggested Reading: Dyck, et al. (2003). Making recombinant proteins in animals – different systems, different approaches. *Trends in Biotechnology* 21: 394 Monzani, et al. (2016). Transgenic bovine as bioreactors: Challenges and perspectives. *Bioengineered* 7: 123	**Recombinant protein expression in transgenic animals** [May 1 or May 2] Journal Club: Zhang, *et al.* (2018). A novel glycosylated anti-CD20 monoclonal antibody from transgenic cattle. *Scientific Reports* 8: 13208
14	**Engineered cell therapies; CAR-T cells** [May 6 or May 7] Suggested Reading: Labanieh, et al. (2018). Programming CAR-T cells to kill cancer. *Nature Biomedical Engineering* 2: 377	**Vaccine development** [May 8 or May 9] Journal Club: Gomes-Silva, et al. (2017). Chimeric Antigen Receptor (CAR) T Cell Therapy for CD7-Positive Acute Myeloid Leukemia. *Blood* 130: 2642

15	**Good manufacturing practices (GMP) for recombinant proteins** [May 13 or May 14] Experimental Design Strategy due Suggested Reading: Zuck (1995). Current good manufacturing practices. *Transfusion* 35: 955	
16	**Final Exam** [TBA]	

IMPORTANT ACADEMIC POLICIES AND SERVICES

Clickers: Clickers must be purchased in the UMBC bookstore along with a license subscription (*ResponseWare / TurningPoint mobile app will not be allowed*). There are one-year and five-year license subscriptions available for purchase. If you have already purchased a clicker and registered it, then you do not need to purchase another clicker, but you may need to renew your license subscription. Ask your representative in the UMBC bookstore during checkout for more information.

Once you've purchased your clicker and acquired your license subscription, you will need to register your clicker in Blackboard.

Step 1: Create a Turning Account - https://tinyurl.com/krrrrla
Step 2: Register your clicker - https://tinyurl.com/jrvvqlo

When using your clicker in class, be sure that it is set to the correct channel. While polling is open for a clicker question, press the button corresponding to the correct answer; students will get 60 seconds to respond to each clicker question.. If you have any questions or are having trouble registering your clicker, please feel free to submit an RT Ticket.

Useful Clicker Links:

- UMBC Bookstore: http://bookstore.umbc.edu/home.aspx
- How to change the channel on your clicker: https://tinyurl.com/lvgsgql
- Troubleshooting your clicker: https://tinyurl.com/h3kydsy
- Submit an RT Ticket: https://rt.umbc.edu/UMBC/RequestHelp.html

Disability Services: UMBC is committed to eliminating discriminatory obstacles that disadvantage students based on disability. Student Disability Services (SDS) is designated to receive and maintain confidential files of disability-related documentation, certify eligibility for services, and determine reasonable accommodations. If you have a disability and want to request accommodations, contact SDS in Math/Psych Bldg. or call 410-455-2459. If you require accommodations for this class, make an appointment to meet with Dr. Ott to discuss your SDS-approved accommodations or any other concerns that you may have.

Equity, Diversity, Equal Opportunity, and Affirmative Action: UMBC provides equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion,

national origin, gender, age, marital status, disability, public assistance status, veteran status, sexual orientation, gender identify, or gender expression.

Mental Health and Stress Management: As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. University services are available to assist you. You can learn more about the broad range of confidential mental health services available on campus via the Counseling Center at http://counseling.umbc.edu/services/.

Inclement Weather Policy: Students are strongly encouraged to consult the UMBC Student Handbook and Academic Catalog and the University website for detailed information regarding inclement weather announcements. Students are also encouraged to check Blackboard and/or their UMBC emails regularly for any announcements regarding inclement weather from the course instructor.

VALUES STATEMENT

By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are reprehensible. Academic misconduct could result in disciplinary action that may include, but not limited to, suspension or dismissal. To read the full Student Academic Conduct Policy, consult the UMBC Student Handbook, the Faculty Handbook, or the Policies section of the UMBC Director. The UMBC Student Handbook is available at:
www.umbc.edu/saf/policies/pdfs/UMBC_Student_Handbook.pdf.