Departments: Biochemistry and Molecular Biology, Plant Biology and the Molecular Plant Sciences Program

Biotechnology and Plant Biochemistry Spring 2022 Syllabus

BMB/PLB and MPS 864

Credit Hours Total Credits: 3 Lecture/Recitation/Discussion Hours: 3

Course meeting days and time: Tuesdays and Thursdays 1:00-2:20

Course location: Zoom, https://msu.zoom.us/j/5852439276

Course website address: https://d2l.msu.edu/d2l/home/1678111

Course Modality: Online, until further notice

## Instructors

Instructor Information

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| **Instructor(s)**  |
| Names: Björn Hamberger (he/him/his)Rob Last (he/him/his)Cornelius Barry (he/him/his) |
| Office: by ZoomPersonal meeting ID 585 243 9276 https://msu.zoom.us/j/5852439276  |
| Office hours: Please contact Dr. Hamberger by email for arrangements. 24 hours may be needed to respond to student emails.  |
| Office Phone: 517-884-6964  |
| E-mail: hamberge@msu.edu |

Instructor Introduction:

Plant Synthetic Biology approaches offer sustainable production and complementing difficult chemical synthesis or extraction from the often rare, native plant species. Research in the Hamberger lab focuses on pathway discovery of specialized metabolism in plants. Specifically, our team is interested in natural compounds of the terpene class with a broad range of applications, including agrichemicals, cosmetics and therapeutics. With the biobricks (enzymes) in hand, biotechnological production with engineered chassis systems of the often high-value products as well as access to novel chemistries becomes possible. Relevant for this course, our team has extensive experience with Intellectual Property management from the academic perspective, which has enabled several industrial collaborations.

For details please see: Hamberger Lab: https://bmb.natsci.msu.edu/faculty/bjoern-hamberger/

Publications: https://www.ncbi.nlm.nih.gov/myncbi/1b5IZBIHgv25v/bibliography/public/

## Course Information

### Course Description, Objectives and General Course Information

BMB/PLB and MPS 864 is an interdisciplinary course for graduate students with interest in biotechnology applications using Plant Biology, Biochemistry or Synthetic Biology. Despite building on cases from plant biotechnology, this course explicitly invites students with broad interests outside the field of photosynthetic systems. You will be encouraged to think about, and actively develop concepts and ideas that may have the potential for commercialized.

Perspectives of public perception, investor and scientist will be discussed and shape the course. Examples will highlight plant metabolic pathways that impact human health and nutrition, as well as sustainability in the production of therapeutics, food and biomaterials. Case studies will cover expression hosts, strategies and pitfalls such as emerging resistances. Examples are chosen to explain basic metabolic engineering principles, including synthetic biology approaches to generate, analyze, and optimize transgenic platforms. Some cases will examine regulatory and commercial issues related to genetically modified organisms (GMOs) and the ‘share-your-parts’ philosophy, as promoted by the international genetically modified machine (iGEM) initiative. To actively participate in the course, you need to have a basic understanding of molecular biology, genomics, or biochemistry. You are expected to read background and original research papers as assigned, and you should be comfortable giving a summary and express your opinion.

You will be guided to develop a 3-page brochure presenting a scientific idea for your biotechnology-based product or process with a recognized need or a new opportunity. You will need to lay out the idea, present reasonable milestones, be aware of potential technical, commercial, or societal hurdles, and articulate how the proposed technology would address the need or opportunity. The course will provide you with tools, i.e., relevant concepts (technology readiness level, societal acceptance, outreach, IP aspects) will be discussed, and a list of topics will be developed together with the students during the course. The instructors will provide guidance and feedback on an individual base as you develop your project. Individual feedback will also be given for both take home assignments.

During the final sessions of the semester, you will present your idea/spin-out in a 10-min pitch. Feedback will include the perspective of Angel Investors. This may involve the MSU Innovation Center.

The course includes a responsible conduct of research module (RCR). BMB 864 is complementary to BMB 961 and the NIH T32 training program ‘Plant Biotechnology, Health and Sustainability.

### Prerequisite:

### The following is recommended background: Interest in biotechnology applications using Plant Biology, Biochemistry or Synthetic Biology, basic knowledge in molecular biology, genomics, or biochemistry as demonstrated by having completed at least one of the following, or equivalent graduate level classes: BMB801 molecular genetics or BMB961 genomics or BMB865 plant molecular biology. Enrolled in a graduate program related to plant molecular sciences.

### Course Overview and Grading:

The format of this course is online via Zoom, in accordance with MSU regulations. If those regulations are changed, course participants and instructors will discuss how to make appropriate adjustments. This course is a mixture of live lectures, providing background to the individual topics and live discussions of assigned research papers.

The progress will be evaluated and course objectives will be met in equal weight distributed over a mid-term (25%, February 24) and final (25%, April 19) 24-hour take-home assignment (opinion-based essays) as well as a 3-page brochure (25%, May 3) and a 10-minute pitch (25%, May 5) detailing a scientific idea for your biotechnology-based product or process with a recognized need or a new opportunity. Additional credits are awarded for the projects attracting highest capital investments and for the investors with the best sense for innovation.

Scheduling of the take-home assignments can be arranged within a week, if needed and requested by the student, but essays must be submitted a day before the class meets for discussion. All essays will be returned with commentary. No re-writing will be needed, but follow-up questions raised by the student will be accommodated and discussed during office time if needed.

Ethics policy regarding take-home examinations: Take home exams are fully open book and open notes. Take home exams will also permit use of online resources. Exam material may require online resources and an internet connection. As such, these exams require students to abide by academic and scientific ethical standards. All answers for take-home exams must be solely the effort of the individual student. All consulting and collaboration with other members of the class, former students, or scientific colleagues more generally, needs to be clearly marked and referenced. If a student wishes to paraphrase from a published scientific work, the article needs to be properly cited, and the relevant text should be clearly marked for quoted information.

## Course Outline/Schedule

### BMB/PLB/MPS 864 Spring 2022 Biotechnology and Plant Biochemistry

Instructors: Hamberger, Last, Barry

Course meeting days and time: Tuesdays and Thursdays 1:00-2:20

Course location: Zoom, https://msu.zoom.us/j/5852439276

| ***Week*** | ***Date*** | ***Instructor*** | ***Topic/Activities*** |
| --- | --- | --- | --- |
| Week 1 | 11-Jan | Hamberger | Course Introduction, Goals and Expectations; business aspects |
|  | 13-Jan | Hamberger | SynBio: Societal acceptance; Outreach and communication; examples iGEM |
| Week 2 | 18-Jan | Hamberger | Guest Speaker: Susan Kendall; MSU Biology Librarian and Health Sciences Coordinator; hands-on workshop: Research tools to scan Markets, Companies and IP. |
|  | 20-Jan | Hamberger | IP, inventions and industrial commercialization: the scientist’s perspective. Examples Streptomycin and lab notebooks; Warfarin discovery. |
| Week 3 | 25-Jan | Last | Birth of a new discipline, Rod Croteau and molecular biology of early terpene biosynthetic pathways in mint |
|  | 27-Jan | Last | The Avenacin pathway to antimicrobials in oat: developments during the last 15 years. |
| Week 4 | 1-Feb | Last | Glucosinolates/Cyanogenic Glucosides |
|  | 3-Feb | Hamberger | Phenylpropanoids Background, the core pathway to lignin, soluble and wall bound phenolics and flavonoids |
| Week 5 | 8-Feb | Hamberger | The science of targeting the shikimate pathway. Bowman vs. Monsanto; glyphosate Case study: Engineering glyphosate resistance. Naturally occurring resistance in weeds. |
|  | 10-Feb | Hamberger | RCR - Critical reading: the Seralini affair, integrity in science |
| Week 6 | 15-Feb | Hamberger | Flavonid and anthocyanin engineering |
|  | 17-Feb | Hamberger | Brochure brainstorming. Pre-mortem analysis and discussion. |
| Week 7 | 22-Feb | Hamberger | Terpenoids Background |
|  | 24-Feb | Hamberger | SynBio hosts - Is there an ideal chassis organism? |
| Week 8 | 1-Mar | Hamberger | Take-home assignment I, discussions |
|  | 3-Mar | Hamberger | Brochure/Biotech project discussion and feedback |
| Week 10 | 15-Mar | Barry | Alkaloids Background, tropinone alkaloids from the Solanaceae |
|  | 17-Mar | Hamberger | Brewing Bad: Identifying the missing enzymes of morphine biosynthesis and regulatory considerations. Case study for alkaloid drug production. |
| Week 11 | 22-Mar | Hamberger | Biodiversity and Biopirates |
|  | 24-Mar | Hamberger | Is this food good? Golden rice, papaya, artic apple, mushrooms |
| Week 12 | 29-Mar | Hamberger | Clustering: Genomic organization of pathways; Regulation: Dhurrin Metabolon. |
|  | 31-Mar | Hamberger | Lockdown: biological containment from Synthetic Biological Perspective. |
| Week 13 | 5-Apr | Hamberger | Tools for Specialized Metabolism, add promoters and synthetic promoters e.g. Patrick Shikh  |
|  | 7-Apr | Hamberger | MSU Technologies/MTRAC: Guest speaker Tom Herlache |
| Week 14 | 12-Apr | Hamberger | Guest Speaker: Bobbi Bringi, TBC |
|  | 14-Apr | Hamberger | Selectable module, 24-hour take-home assignment II |
| Week 15 | 19-Apr | Hamberger | Selectable module |
|  | 21-Apr | Hamberger | Take-home assignment II, discussions |
| Week 16 | 3-May | Hamberger | Make your pitch! And discussions, feedback for the brochure (where applicable, also from the MSU tech trans office).  |
|  | 5-May | Hamberger | Make your pitch! And discussions, feedback for the brochure (where applicable, also from the MSU tech trans office).  |

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| ***Examples of selectable modules:*** |
| *Molecular warfare: Gene drive* |
| *Is this food good? BT toxin -- benefits and risks; GMO vs. organic; emerging insect resistance* |
| *Is this food good? Virus resistant Papaya in Hawai'i* |
| *GMO or not? The sweet potato genome with transgenic material, focus Tilling and Crispr.* |
| *Emerging themes from Student Projects* |
| *Hot topic of the season (past examples: CRISPR IP fight; deep eutactic solvents; nano-clays in agriculture; commercial bryotechnology (engineered moss)).* |

## Other Course Policies

### Important Dates to Remember:

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| --- | --- |
| **Course/Acad. year Event** | **Date** |
| Classes begin | 10-Jan |
| Lecture 1, introduction | 11-Jan |
| 24-hour take-home assignment I | 24-Feb |
| Latest due date, assignment I | 28-Feb |
| Brief opinion presentations, discussions | 1-Mar |
| Spring Break | 3-Mar to 11-Mar |
| 24-hour take-home assignment II | 14-Apr |
| Latest due date, assignment II | 20-Apr |
| Brief opinion presentations, discussions | 21-Apr |
| Classes end | 24-Apr |
| Final pitches | 3-May and 5-May |

### **Required Course Materials:**

### No specific textbook is assigned. Lecture material will come from reviews and primary literature manuscripts assigned throughout the semester. These will be available online through D2L. For general background you are likely to find a biochemistry textbook useful, for example “Principles of Biochemistry by D.L. Nelson and M. M. Cox, W.H. Freeman and Company”. In addition, there are some books specific to plant biochemistry that you may want to consult for background on specific topics. The following are available through MSU:

### 1. Buchanan BB, Gruissem W, Jones RL (2015) Biochemistry & Molecular Biology of Plants. American Society of Plant Physiologists, Rockville. Second addition.

<https://ebookcentral-proquest-com.proxy1.cl.msu.edu/lib/michstate-ebooks/detail.action?docID=4035886>

### 2. Heldt H-W (2011) Plant Biochemistry. Fourth Edition. Elsevier Academic Press, Burlington MA.

### <http://www.sciencedirect.com.proxy1.cl.msu.edu/science/book/9780123849861>

### Required Technologies:

* The course requires access to "high speed" internet and a webcam.
* Browsers and internet speeds best for working with D2L:

Browser/mobile support for D2L:

<https://documentation.brightspace.com/EN/brightspace/requirements/all/browser_support.htm>

* Information about how students can access internet connections, including those companies offering students free or reduced cost internet: <https://remote.msu.edu/learning/internet.html>
* Please notify the course coordinator within a day by phone or email should students encounter difficulties--including outages--during synchronous sessions, or the final pitch to discuss how to accommodate the student’s needs best.

**MSU Community Compact regarding COVID-19:**

BMB/PLB/MPS 864 is, according to current MSU regulations, held virtually (online). Should regulations change the following guidelines will be followed in case the course is changed to hybrid, or in person format.

**Course platforms/Structure:**

This course will be delivered synchronous ***online*** (Zoom) through the course management system and you will need your MSU NetID to login to the course from the ***D2L homepage* (*http://d2l.msu.edu*).**

In ***D2L***, you will access course materials, and additional resources. Activities may consist of readings, discussion forums, email, and other online activities.

Any adjustment of the course structure to hybrid, or in-person class will follow possible changes of MSU regulations.

**Technical Assistance:**

Information helpful for the use of required software, including D2L: Include information on how to navigate necessary software, expectations, instructions on how to access course material, and where to find technical and online course development assistance. For example: If you need technical assistance at any time during the course or to report a problem you can:

• Visit the MSU Help site at [http://help.msu.edu](http://help.msu.edu/)• Visit the Desire2Learn Help Site at [http://help.d2l.msu.edu](http://help.d2l.msu.edu/)• Call the MSU IT Service Desk at (517)432-6200, (844)678-6200, or e-mail at ithelp@msu.edu• Request assistance navigating and requesting instructional design help: <https://tech.msu.edu/service-catalog/teaching/instructional-design-development/>

Consider including pointers for which browsers and internet speeds are best for working with D2L:

Browser/mobile support for D2L: <https://documentation.brightspace.com/EN/brightspace/requirements/all/browser_support.htm>

Guide for internet speed:  <https://broadbandnow.com/guides/how-much-internet-speed-do-i-need>. For most courses, 25 Mbps should work.

## Additional Optional Information

### **Disability Access:**

Students must inform the instructor of any accommodations needed. Information related to disability access is available on the [Resource Center for Persons with Disabilities (RCPD) website](http://www.rcpd.msu.edu/Awareness/Home). Students: to make an appointment with a specialist, call: (517) 353-9642 Or TTY: (517) 355-1293 or visit the [RCPD website](http://myprofile.rcpd.msu.edu/).

### Americans with Disabilities Act Accommodations:

**“Michigan State University is committed to providing equal opportunity for participation in all programs, services and activities. Requests for accommodations by persons with disabilities may be made by contacting the Resource Center for Persons with Disabilities at 517-884-RCPD or on the web at rcpd.msu.edu. Once your eligibility for an accommodation has been determined, you will be issued a verified individual services accommodation (“VISA”) form. Please present this form to me at the start of the term and/or two weeks prior to the accommodation date (test, project, etc.). Requests received after this date will be honored whenever possible.”**

**MSU Community Compact regarding COVID-19:**

The novel coronavirus, which causes the disease COVID-19, has been declared a worldwide pandemic. The COVID-19 virus is extremely contagious and is believed to spread mainly from person-to-person contact. The COVID-19 pandemic represents an unprecedented public health crisis that has impacted every facet of life, including the classroom environment. As a result, significant changes in how we conduct in-person classes must be made. This section of the syllabus discusses the policies and procedures we will use in class.

This class abides by all principles, guidelines, and requirements detailed in the MSU Community Compact. Specifically, all participants in the class will adhere to the following:

Face coverings. Face coverings must be worn by everyone (including all faculty, staff, students, vendors, and visitors) indoors and outdoors while on property owned or governed by MSU and while participating in MSU-related or MSU-sponsored activities. Thus, unless you are unable to tolerate a face covering for medical reasons you must wear a face covering inside and outside of class. This face covering must cover your mouth and nose.

Physical distancing. We will be practicing physical distancing in the classroom. Thus, all students should maintain at least six feet distance between themselves and others (excluding those with whom they live). This applies to all aspects of the classroom setting, including seating arrangements, informal conversations, and dialogue between faculty and students.

Personal Hygiene. All students must maintain proper hygiene and health practices, including:

• Washing hands frequently with soap and water or, if soap is unavailable, using hand sanitizer with at least 60% alcohol

• Routinely cleaning and sanitizing living spaces and/or workspace

• Using the bend of the elbow or shoulder to shield a cough or sneeze

• Refraining from shaking hands

## Adherence to Signage and Instructions. Students will (a) look for instructional signs posted by MSU or public health authorities, (b) observe instructions from MSU or public health authorities that are emailed to my “msu.edu” account, and (c) follow those instructions.

## Self-Monitoring. Students will self-monitor for flu-like symptoms (for example, cough, shortness of breath, difficulty breathing, fever, sore throat or loss of taste or smell). If a student experiences any flu-like symptoms, they will stay home and contact a health care provider to determine what steps should be taken.

## Exposure to COVID-19. If a student is exposed to someone who is ill or has tested positive for the COVID-19 virus, they will stay home, contact a health care provider and follow all public health recommendations.

## Compliance and reporting. Those who come to MSU facilities must commit to the personal responsibility necessary for us to remain as safe as possible, including following the specific guidelines outlined in this syllabus and provided by MSU more broadly (see below). There may be times when action will be necessary to reinforce expectations. If you do not wear appropriate face coverings (see MSU’s guidelines), do not wear your face covering appropriately (i.e., over your mouth and nose), or do not adhere to physical distancing guidelines (i.e., six feet apart), you will be asked to correct the situation or leave the facility. In addition, MSU will utilize the processes already in place to respond to any issues of noncompliance with standards established for the health and safety of our community. For classroom disruptions or issues, the responses and processes that have been used previously remain the first line of action. If necessary, the student conduct system will be the avenue used to adjudicate student disciplinary situations.

## Additional information. See https://msu.edu/together-we-will/keeping-spartans-safe/ for details about these new policies and procedures and see https://ehs.msu.edu/\_assets/docs/fact-sheets/cloth-face-covering-fact-sheet.pdf for more details about the cloth face coverings guidelines.

## **Learning Continuity Statement:**

## What students should do should they become unable to virtually attend class for an extended period of time.

## Communication with the instructor via phone, or email regarding prolonged absences, and assignments, homework, and groupwork caused by prolonged absences.

## **Course Continuity Statement:**

## All instruction for this course is virtual. Should the instructor be required to be absent for an extended period of time, this will be communicated to the class within 24 hours. The secondary instructor will provide continuity regarding feedback and grading expectations and assessment modifications (if any) surrounding prolonged absences.

## A close up of a sign  Description automatically generatedSyllabus Signature Page

Instructor:

Course:

Semester:

 I \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ do agree that I received a copy of the course syllabus for the class mentioned above. I understand the course requirements and the policies entailed in this document. I further understand that my participation and conduct in this course is a key contributor to my success and the success of this course.

I pledge to come to class prepared and to conduct myself respectfully at all times.

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Print Full Name

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Signature Date