



THE UNIVERSITY OF  
**TENNESSEE**  
KNOXVILLE

## **PLSC423/523 Genome Engineering and Gene Editing of Plant Cells, Spring Semester 2025**

University of Tennessee, Knoxville

**Course Section:** PLSC423/523

**Meeting Time and Place:** Monday, Wednesday, and Friday 9:10-10:00 am in MGH-226

**Course Credit Hours:** 1-3 credit hour course

### **Faculty Contact Information**

Dr. Alessandro Occhialini

Assistant Professor

Department of Plant Sciences,

University of Tennessee Institute of Agriculture (UTIA),

Office address: 137 Plant Biotechnology Building (PBB)

2505 E J Chapman Drive, Knoxville, 37996-4500 (USA)

aocchial@utk.edu

Online information about Occhialini's research

Faculty web page: <https://utia.tennessee.edu/person/?id=12681>

Google scholar: <https://scholar.google.com/citations?user=wz-qVU4AAAAJ&hl=en>

ORCID id: <https://orcid.org/0000-0002-1162-798X>

Research Gate: [https://www.researchgate.net/profile/Alessandro\\_Occhialini](https://www.researchgate.net/profile/Alessandro_Occhialini)

LinkedIn: <https://www.linkedin.com/in/alessandro-occhialini-88137050/>

Twitter: [https://twitter.com/Ales\\_Occhialini](https://twitter.com/Ales_Occhialini)

**Course Description/Information:**

This course consists of a comprehensive set of classes focusing on cutting-edge synthetic biology tools for genome engineering of plant cells and organelles. During this course, many examples of potential applications of novel genetic engineering tools for improving crop traits will be provided. The following subjects will be covered during the course: i) fundamentals of plant cellular and molecular biology, including protein trafficking and subcellular localization in plant cell; ii) genetic tools for engineering plant genomes, including plastids (binary vectors, viral vectors, homologous recombination vectors, synthetic genomes); iii) gene editing techniques, where a particular emphasis will be dedicated to CRISPR/Cas tools for gene editing, prime editing, homologous direct repair (HDR) and modulation of gene expression; iv) plant genetic elements, orthogonal systems, genetic switches and tools to control and modulate transgene expression in plant cells; v) advanced cloning techniques; vi) stable and transient transformation of plant cells; vii) fundamentals of confocal and electron microscopy to observe plant cells.

**Value Proposition:**

This course is particularly valuable for those students who want to apply for grad school and to perform research focused on plant cell and molecular biology, synthetic biology, metabolic engineering, and biotechnology.

**Student Learning Outcomes/Objectives:**

After the completion of this course, students will obtain all required knowledge, tools, and skills necessary to start working effectively in a plant molecular and cellular biology laboratory. Students will get a comprehensive understanding of the following subject areas: i) functioning of plant cells at genetic level; ii) functioning of different subcellular compartments of plant cells; ii) knowledge of the most novel techniques for engineering plant genomes (nuclear and plastid genomes); iii) genetic tool to modulate transgene expression; iv) advanced cloning techniques to assemble transformation vectors; v) stable and transient transformation methods for delivery transgenes in plant cells.

**Learning Environment:**

The course consists of in-person lectures that all students are required to attend. In order to facilitate attendance, signatures will be taken at the beginning of each class. Considering the novelty and the rapid expansion of these subjects, relevant teaching material will be distributed to students throughout the duration of the course. All necessary teaching material will be posted on Canvas at UT. Students are also expected to demonstrate interest and actively participate in classes by asking questions and clarification. Key questions will be underlined at the end of each course session, and group discussions will be performed to reinforce important biological concepts covered during the lectures.

**Course Communications:**

I will be available for any questions and clarifications after each Monday, Wednesday, and Friday class, or you can fix an appointment in my office (137 PBB) by sending an email at [aocchial@utk.edu](mailto:aocchial@utk.edu). Depending on my daily schedule, you can also try to check directly with me without any appointment. If I am available in my office (137 PBB) or laboratory (145 PBB) I am always very happy to respond to any questions. I believe in an open-door policy, and in-person communication with my students and colleagues.

**How to Be Successful in This Course:**

Students are expected to actively participate by attending classes in person, staying focused, asking questions, and enjoying the lectures. I fully understand that lectures presented during the course will cover many difficult biological concepts. Therefore, I am very happy to spend extra time if biological concepts are not clear. Students are expected to review teaching materials after each lecture and to be prepared to discuss key concepts (focus questions) during classes. Any suggestions or comments provided by students are very important to improve the course. Students from Plant Sciences that have already taken or are attending the PLSC 452/552 Plant Biotechnology and Genetics, and PLSC 554 Plant Biotechniques courses may be facilitated to understand the subject areas of this course.

**Students' Responsibilities**

- Be prepared for classes.
- Be respectful of others.
- Actively contributes to the learning activities in class.
- Abide by the UT Honor Code.

**Instructor's Responsibility**

- Be prepared for classes.
- Evaluate all fairly and equally.
- Be respectful of all students.
- Create and facilitate meaningful learning activities.
- Behave according to University codes of conduct.

**Texts, Course Resources and Materials:**

Relevant teaching materials will be posted on Canvas after each lecture. Considering that an exhaustive textbook is not available for this course, attending lectures and revising the teaching material provided during the entire course will be fundamental to be successful. Some important information provided during classes can also be found in the textbook: Stewart, C.N., Jr. (Ed.) Plant Biotechnology and Genetics: Principles, Techniques and Applications, John Wiley and Sons, Hoboken, New Jersey, New Third Edition.

**Course Requirements, Assessments, and Evaluations:**

Students are required to attend lectures, and signatures will be taken at the beginning of each lecture. Undergrad and graduate students will take a mid and a final exam in the form of written short answers (10 questions per exam). After the exam, I will be available for a face-to-face meeting with each student for discussion. This meeting will also give students an opportunity to discuss the exam and demonstrate their understanding of fundamental topics of the course. In addition, graduate students are required to write a project white paper (2 pages) on a research topic of interest relevant to the course. Graduate students will also give a short presentation (10-20 minutes) on their research topics to all students. The grade scale will be calculated in points.

**Major Assignments and Exams (names and due dates)**

- Mid-exam (short answer format: 10 questions). Required for both undergrad and graduate students.

- Final exam (short answer format: 10 questions). Required for undergrad and graduate students.
- Project white paper and presentation are required for graduate students.

Mid exam: 40 points

Final exam: 40 points

Attendance: 20 points

Grading in points:

A = 91-100

B = 80-89

C = 70-79

D = 65-69

F = 0-64

**Course Feedback:**

Any suggestions or comments provided by students are very important to improve the course, and they can be provided anytime. An anonymous questionnaire will be made available at the end of the course on Canvas.

**Key Campus Resources for Students:**

- [Center for Career Development and Academic Exploration](#) (Career counseling and resources; Handshake job search system)
- [Course Catalogs](#) (Listing of academic programs, courses, and policies)
- [Hilltopics](#) (Campus and academic policies, procedures, and standards of conduct)
- [OIT HelpDesk](#) (865) 974-9900
- [Schedule of Classes/Timetable](#)
- [Student Health Center](#) (visit the site for a list of services)
- [Academic Success Center](#) (Academic support resources)
- [Undergraduate Academic Advising](#) (Advising resources, course requirements, and major guides)
- [University Libraries](#) (Access to library resources, databases, course reserves, and services)

**Course Outline:**

While the topic areas will be the same, the schedule of lectures may change during the course.

Lecture number	Topic
1	First day (course assessment)
2	Plant biology fundamentals, organelles, and trafficking
3	Plant biology fundamentals, organelles, and trafficking
4	Plant biology fundamentals, organelles, and trafficking
5	Plastid biology and genetics
6	Plastid biology and genetics

7	Plastid biology and genetics
8	Plastid engineering
9	Plastid engineering
10	Plastid engineering
11	Genetic engineering of nuclear genome
12	Genetic engineering of nuclear genome
13	Genetic engineering of nuclear genome
14	Viral vectors/replicons
15	Viral vectors/replicons
16	Viral vectors/replicons
17	Overview and history of gene editing
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18	CRISPR/Cas gene editing tools and techniques
19	CRISPR/Cas gene editing tools and techniques
20	<b>Mid exam (questions)</b>
21	CRISPR/Cas gene editing tools and techniques
22	Synthetic biology tools
23	Synthetic biology tools
24	Synthetic biology tools
25	BMCs and metabolic engineer
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26	BMCs and metabolic engineer
27	BMCs and metabolic engineer
28	Cloning techniques and vector design
29	Cloning techniques and vector design
30	Cloning techniques and vector design
31	Method of transformation of plant cells
32	Method of transformation of plant cells
33	Method of transformation of plant cells
34	Microscopy techniques
35	Microscopy techniques
36	Microscopy techniques
37	Genetic engineering applications
38	Genetic engineering applications
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39	Genetic engineering applications
40	<b>Grad student seminars on research projects and discussion</b>
41	<b>Grad student seminars on research projects and discussion</b>
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	<b>Final exam (questions)</b>
	<b>Final exam (meeting)</b>
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*The instructor reserves the right to revise, alter or amend this syllabus as necessary. Students will be notified in writing / email of any such changes. [Optional section/language]*

## **The Campus Syllabus**

Dear Student,

The purpose of this **Campus Syllabus** is to provide you with important information that applies to all UTK courses. Please observe the following policies and familiarize yourself with the university resources listed below. At UT, we are committed to providing you with a high-quality learning experience. I want to wish you the best for a successful and productive semester.

–Dr. John Zomchick, Provost and Senior Vice Chancellor

### **ACADEMIC INTEGRITY**

Each student is responsible for their personal integrity in academic life and for adhering to UT's Honor Statement. The Honor Statement reads: "An essential feature of the University of Tennessee, Knoxville is a commitment to maintaining an atmosphere of intellectual integrity and academic honesty. As a student of the university, I pledge that I will neither knowingly give nor receive any inappropriate assistance in academic work, thus affirming my own personal commitment to honor and integrity."

### **YOUR ROLE IN IMPROVING THE COURSE THROUGH ASSESSMENT**

At UT, it is our collective responsibility to improve the state of teaching and learning. During the semester you may be requested to assess aspects of this course, either during class or at the completion of the class, and through the TNVoice course evaluation. Please take the few moments needed to respond to these requests as they are used by instructors, department heads, deans and others to improve the quality of your UT learning experience.

### **STUDENTS WITH DISABILITIES** – <http://sds.utk.edu>

The University of Tennessee, Knoxville, is committed to providing an inclusive learning environment for all students. If you anticipate or experience a barrier in this course due to a chronic health condition, a learning, hearing, neurological, mental health, vision, physical, or other kind of disability, or a temporary injury, you are encouraged to contact [Student Disability Services](#) (SDS) at 865-974-6087 or [sds@utk.edu](mailto:sds@utk.edu). An SDS Coordinator will meet with you to develop a plan to ensure you have equitable access to this course. If you are already registered with SDS, please contact your instructor to discuss implementing accommodations included in your course access letter.

## **ACCESSIBILITY POLICY AND TRAINING** – <http://accessibility.utk.edu>

The University of Tennessee, Knoxville, provides reasonable accommodations for individual students with disabilities through its office of [Student Disability Services](#). The university is also committed to making information and materials accessible, when possible. Resources and assistance to support these efforts can be found at <http://accessibility.utk.edu/>.

## **WELLNESS** – <http://wellness.utk.edu/> and <http://counselingcenter.utk.edu/>

The [Center for Health Education and Wellness](#) empowers all Volunteers to thrive by cultivating personal and community well-being. The Center can answer questions about general wellness, substance use, sexual health, healthy relationships, and sexual assault prevention. The [Student Counseling Center](#) is the university's primary facility for personal counseling, psychotherapy, and psychological outreach and consultation services.

Any student who has difficulty affording hygiene products, groceries, or accessing sufficient food to eat every day is urged to contact the [Big Orange Pantry](#) for support. The Big Orange Pantry, located in Greve Hall, is a free resource for all students, faculty, and staff, no matter how great or small their need is. Students who need emergency financial assistance can also request funding from the [Student Emergency Fund](#).

Students who are experiencing non-academic difficulty or distress and need assistance should call 974-HELP or [submit an online referral](#). The 974-HELP team specializes in aligning resources and support to students experiencing mental health distress.

## **EMERGENCY ALERT SYSTEM** – <http://safety.utk.edu/>

The University of Tennessee is committed to providing a safe environment to learn and work. When you are alerted to an emergency, please take appropriate action. Learn more about what to do in an emergency and sign up for [UT Alerts](#). Check the emergency posters near exits and elevators for building specific information. In the event of an emergency, the course schedule and assignments may be subject to change. If changes to graded activities are required, reasonable adjustments will be made, and you will be responsible for meeting revised deadlines.