

ENVS*3300 - Introduction to Controlled Environment Systems

Fall 2024 Course Outline

Section: 01

Credits: 0.50

Calendar Description

Controlled Environment Systems (CES), otherwise known as Controlled Environment Agriculture (CEA), is a rapidly evolving technological framework for producing crops in a stable, controlled and efficient manner. This CES/CEA technological platform is poised to play a significant role in current and emerging social and environmental issues including, but not limited to, climate change adaptation, food insecurity (urban and Northern/remote communities), local food supply, food supply chain stabilization, food safety, medicinal crop production and standardization, biodiversity preservation, functional foods/improved human nutrition, etc. Highly controlled production of plants in CES is even an absolute requirement in the global quest to explore and colonize the moon, Mars and beyond. This course will provide the student with a strong understanding of the principles of CES/CEA and will dig deep into the wide range of commercial, research, and human space exploration applications of CES/CEA. Through numerous guest speakers, students will also develop a sense of the career opportunities in this rapidly growing sector.

Prerequisite(s): BIOL*1050 or BIOL*1070

Department(s): School of Environmental Sciences

Lecture Schedule

TuTh 1pm-2:20pm in GRHM*2310 (9/5 to 12/13)

Instructor Information

Thomas Graham, PhD

Associate Professor

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Office: Boverly 2105

Office Hours:

Open door policy, but appointments are more reliable as Dr. Graham is often in the lab or at other campus facilities.

Office Phone: x54869

Learning Resources

There is no one textbook for the course. Select journal articles, video resources, and book chapters will be assigned via CourseLink to complement the lectures they are associated with.

Required Resources

There will be a repository of learning materials provided on CourseLink, some of which will be assigned as **required**. Samples include short videos, journal articles, and relevant reputable websites.

Course Resources

There is no need or expectation for students to take notes; any material that you will be tested on will be provided. This said, if students feel that taking notes will aid in their learning then please bring to class whatever is needed to allow that.

Campus Resources

If you are concerned about any aspect of your academic program: Make an appointment with a Program Counsellor (<https://www.uoguelph.ca/uaic/programcounsellors/>) in your degree program. If you are struggling to succeed academically: There are numerous academic resources offered by the Learning Commons (<https://www.lib.uoguelph.ca/using-library/spaces/learning-commons/>) including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills.

Course Learning Outcomes

1. Demonstrate an understanding of key environment variables and their basic interactions as they pertain to CES plant production.
2. Define and compare CES plant culture techniques.
3. Describe and appreciate the main economic, environmental, and societal factors driving CES.
4. Compare and contrast various CES based agricultural production technologies.
5. Explain the requirements of bio-regenerative life-support and the role CES plays in human space exploration.
6. Relate current social and environmental challenges, such as food security and climate change adaptation, to CES such that the student can postulate measures to help address these challenges.
7. Critically evaluate literature resources.
8. Consider terrestrial transfer of space inspired technologies.
9. Appreciate the diversity of career opportunities in CES agriculture.

Course Level Learning Outcomes

The overarching objective of this course is to familiarize students with the depth and breadth of Controlled Environment Systems and applications, leading to an appreciation for the role of CES in addressing a wide array of environmental and social issues facing Canada and the world.

By the end of this course, students will be able to:

1. Demonstrate an understanding of key environment variables and their basic interactions as they pertain to CES plant production;
2. Define and compare CES plant culture techniques;
3. Describe and appreciate the main economic, environmental, and societal factors driving CES;
4. Compare and contrast various CES based agricultural production technologies;
5. Explain the requirements of bio-regenerative life-support and the role CES plays in human space exploration;
6. Relate current social and environmental challenges, such as food security and climate change adaptation, to CES such that the student can postulate measures to help address these challenges.
7. Critically evaluate literature resources
8. Consider terrestrial transfer of space inspired technologies
9. Appreciate the diversity of career opportunities in CES agriculture

Teaching and Learning Activities

Weekly Activities

Note: Due to the on-going scheduling of guest speakers, the schedule below is subject to change as the semester develops.

Lectures 01-03

Welcome to ENVS*3300! We will spend a reasonable portion of the first lecture getting to know one another. We will be discussing, in broad strokes, what you can expect from the course and your instructors as well as what is expected of you.

Lecture 02/03 will be an overview of the CESRF Program followed by a tour of the CESRF and the Bovey Research Greenhouse. The class will be split with one half touring the CESRF and the other the greenhouse during Lec 02 and the groups will be flipped for Lec 03.

General Items:

- Introductions and motivations regarding Controlled Environment Systems
 - Details on the course structure and expectations for assigned readings, quizzes, final project/presentation, etc.
 - CourseLink Modules and postings
 - What *are* Controlled Environment Systems (and what they are not) Introduction to the University of Guelph's Controlled Environments Systems Research Facility (CESRF)
 - Virtual Tour of the Controlled Environment Systems Research Facility (CESRF) and Bovey Greenhouse Complex
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Lecture 04/05: The What, Why, & How

We will be going back and taking a high-level look at the concepts introduced during week the first few sessions (esp. the tours).

There will be a lot of new material so ask lots of questions. If some of what you see and hear is totally new that is okay, we will sort it all out, taking a deep dive into these baseline topics.

General Items:

- A high-level crash course on what environmental parameters are important (hint, it is all of them), why we need to control them, and how we can control them
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Lectures 06/07 Controlled Root Environment Systems

This week we will first dive into the various types of production systems used in CEA, with a focus on solution-based systems generically referred to as 'Hydroponics' – but there is much more to it. We will define various systems and compare and contrast them in the context of CEA applications. We will consider things that are happening in and influencing the root zone environment. We will consider different growing substrates, system hygiene (root pathogen prevention) considerations/technologies, and nutrient management in CEA.

Lectures 08/09 Controlled Aerial Environment Systems

Now that we have an appreciation for the trials and tribulations of root zone management, we need to move up in the world and consider all the things that are influencing a plant from above. We will consider how light, CO₂, and water/water vapour influence a plant and how & why we need to manage these parameters.

Lectures 10/11

The remainder of the course will look at the diverse reach of Controlled Environment plant production ranging from greenhouse food & flower production through to molecular farming and human space exploration. Several guest lecturers will be providing commercial and public service perspectives on various CEA industries. Some sample topics (no particular order) are:

- Northern and remote community food insecurity
 - Molecular *Pharming*
 - Phytopharmaceuticals
 - Medicinal crops
 - Urban Agriculture & Vertical Farming
 - Research Applications
 - Space Exploration
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Lecture 12*High Intensity Urban Agriculture*

High intensity urban and peri-urban agriculture, often (mistakenly) colloquially referred to as 'vertical farming' is an emerging segment of the overall agriculture industry. We will be digging into the pros and cons of this industry and address how it is and needs to evolve to realize its full potential. This is a rapidly expanding sector and there is a lot of contradictory and sometimes outright wrong information in the public domain. There is more than we can possibly cover in a few short lectures so there will be several videos that will be required (outside of lecture) viewing – these assigned videos will be the fodder for in class discussions as well as a preparation for a series of guest lectures.

Lectures 13/14

High Intensity Urban Agriculture & Molecular Farming, Phytopharmaceuticals, and Medicinal Crops in CEA

Controlled Environment Agriculture is about far more than food; it is now a significant tool for producing many non-food and medical products. The next few lectures and assigned readings/videos will introduce these applications. Topics to be covered include:

- Molecular Farming/Pharming – What is it and what is the Role of CEA
- Phytopharmaceuticals and Medicinal Crops
- Regulatory issues, safety, biodiversity preservation, global market overview

Note: Several Guest Lecturers are planned but final dates have not been nailed down as of the start of the course.

Lectures 15/16

Medicinal Crops and CEA

The global use and harvest of medicinal crops will be discussed with a focus on environmental impact, product safety, and active compound quality. The current regulations governing medicinal crops and active ingredients will be discussed. The benefits and limitations of adapting medicinal crops to CEA production will be explored in class discussions.

Food Insecurity: A role for CEA to play in reducing it

Food insecurity is a significant issue in many places around the world and Canada is no exception. The general state of Canada's food insecurity will be discussed along with CEA as a contributor to solutions to address this serious issue.

Lectures 17 - 24 Guest Lectures, Assignments, and...

Space, the final *agricultural* frontier

We will introduce the concepts of bioregenerative life-support and its absolutely critical role in supporting human space exploration. Additionally, we will talk big rockets and where life may already be and where we should go as human explorers.

Assessment Breakdown

Students will have received 27.5% of their grade on or before the 40th class day.

| Description | Weighting (%) | Due Date |
|---------------------|---------------|--|
| Perspective One | 5% | September 16th by 23:59 |
| Quiz #1 | 5% | Open from September 20th @ 08:00 to September 23rd @ 23:59 |
| Quiz #2 | 7.5% | Open from October 4th @ 08:00 to October 7th @ 23:59 |
| Quiz #3 | 10% | Open from October 18th @ 08:00 to October 21st @ 23:59 |
| Quiz #4 | 12.5% | Open from November 1st @ 08:00 to November 4th @ 23:59 |
| Quiz #5 | 15% | Open from November 22nd @ 08:00 to November 25th @ 23:59 |
| Critical Assessment | 5% | November 17th by 23:59 |
| Term Assignment | 25% | TBD |

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|-----------------|-----|-----------------------|
| Peer Evaluation | 10% | TBD |
| Perspective Two | 5% | December 1st by 23:59 |

Last Day to Drop Course

The final day to drop Fall 2024 courses without academic penalty is the last day of classes: November 29

After this date, a mark will be recorded, whether course work is completed or not (a zero is assigned for missed tests/assignments). This mark will show on the student's transcript and will be calculated into their average.

Course Grading Policies

Submission of Assignments

Assignments will be submitted via CourseLink unless otherwise indicated. The delivery of quizzes will be reviewed in class.

Late Assignment

Students are expected to submit assignments on the date and time indicated. If this is not possible the student *must discuss alternative arrangements with the instructor well in advance* (1-week minimum) of the due date. It is understood that emergencies do arise. In these cases, please notify your instructor as soon as is feasible, as well as any group members in the case of group assignments.

Quiz Structure

Quizzes will be cumulative (i.e., material from all lectures leading up to a quiz will be eligible for evaluation), but the majority (>60%) of material will be from lectures between the previous quiz and the current quiz.

Course Standard Statements

Course Policies

The course is largely discussion based so attendance is STRONGLY encouraged to get the most out of the course.

Standard Statements for Undergraduate Courses

Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-misconduct/>) is outlined in the Undergraduate Calendar.

Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability. Use of the SAS Exam Centre requires students to make a booking at least 10 days in advance, and no later than the first business day in November, March or July as appropriate for the semester. Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time. For students at the Guelph campus, information can be found on the SAS website. (<https://www.uoguelph.ca/sas/>)

Accommodation of Religious Obligations

If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements.

See the Academic calendar for information on regulations and procedures for Academic Accommodations of Religious Obligations (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-accommodation-religious-obligations/>).

Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all undergraduate students except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in the Undergraduate Calendar - Dropping Courses (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/dropping-courses/>).

Email Communication

As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly. e-mail is the official route of communication between the University and its students.

Health and Wellbeing

The University of Guelph provides a wide range of health and wellbeing services at the Vaccarino Centre for Student Wellness (<https://wellness.uoguelph.ca/>). If you are concerned about your mental health and not sure where to start, connect with a Student Wellness Navigator (<https://wellness.uoguelph.ca/navigators/>) who can help develop a plan to manage and support your mental health or check out our mental wellbeing resources (<https://wellness.uoguelph.ca/shine-this-year/>). The Student Wellness team are here to help and welcome the opportunity to connect with you.

Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g., final exam or major assignment).

Recording of Materials

Presentations that are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Resources

The Academic Calendars (<http://www.uoguelph.ca/registrar/calendars/?index>) are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.

When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. See the Undergraduate Calendar for information on regulations and procedures for Academic Consideration. (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-consideration-appeals-petitions/>)