HORT/CROP_SCI 202 **SPRING 2020**

CROP GROWTH AND DEVELOPMENT

Instructor and Teaching Assistants: (Office hours: please communicate before or after class, and by e-mail for an appointment)

Instructor: Michael Pumphrey, Associate Professor, 381 Johnson Hall, (509)-335-0509,
m.pumphrey@wsu.edu

Teaching Assistant [Pullman – Thur (pm) Lab Section]: Ty James,
tymon.james@wsu.edu
Teaching Assistant [Pullman – Tues (am) and Tues(pm) Lab Sections]: Aaron Appleby,
aaron.appleby@wsu.edu
Teaching Assistant [Tri-Cities – Monday (pm)]: Thoa Pham,
thoa.pham@wsu.edu
Teaching Assistant [Everett/Mt. Vernon – Friday (am)]: Cheyenne Sloan,
cheyenne.sloan@wsu.edu

Class Meeting Times:

Lecture: Pullman - MWF 9:10–10:00 am, FSHN T101
Tri-Cities – MWF 9:10-10:00 am, Wine Science 202
Everett/Mt. Vernon – MWF 9:10-10:00 am,

Lab: Pullman – Tue 9:10–11:50 am, Vogel Plant Sciences Bldg. 35
Pullman – Tue 1:25–4:05 pm, Vogel Plant Sciences Bldg. 35
Pullman – Thu 1:25–4:05 pm, Vogel Plant Sciences Bldg. 35
Tri-Cities – Mon 2:10–5:00 pm, arrangement with Thao Pham
Mt. Vernon – Fri 10:30 – 1:00, NW REC, by arrangement

Field Trips – both on and off-campus field trips will occur during the lab period as noted further in the syllabus unless communicated otherwise by the TA.

NOTE: Please thoroughly read this course syllabus and maintain a copy on your laptop or in your notebook to refer to as needed.

Blackboard: You can access the course by logging into https://learn.wsu.edu and then finding the course ID listed under the My Courses module. The course id is:
Crop Growth and Development (2020-SPRI-PULLM-HORT-202-5160-LEC). The video lecture recordings will be available under the Zoom link on the course menu. These are usually posted by AMS a few hours following the lecture. An Adobe Acrobat (.pdf) file of the PowerPoint slides for each lecture will be posted to the Course Content section before or after each lecture.

Instructor Communication: Information regarding exams, assignments, labs, schedule changes, etc. will occasionally be communicated **by e-mail** and may be posted on Blackboard. E-mails will be sent to your @wsu.edu account. **Check your email frequently**. If you are using a different primary email address (e.g., @gmail.com, @yahoo.com, etc.), please be sure that your @wsu.edu messages are successfully **forwarded** to your primary e-mail account. You are responsible to read all e-mail messages related to **HORT/CROP_SCI 202**.

Course Prerequisites: HORT/CROP_SCI 102

Programmatic Advising Note: – both HORT/CROP_SCI 102 and 202 are required for students in the Integrated Plant Sciences majors in CAHNRS (e.g., Agricultural Biotechnology, Field Crop Management, Fruit and Vegetable Management, Landscape, Nursery and Greenhouse Management, Turfgrass Management, and Viticulture and Enology) and the Organic Agriculture Systems major in the AFS program. In the normal course sequence, students take these two introductory courses in the Fall and Spring semesters, respectively, of their freshman year. For various reasons (changing major, articulation from community college, transfer from another university, conflicts with other required courses, etc.), students may take this course out of its' normal sequence. Ideally, with proper advising this should not happen. However, for reasons noted above, sometimes it does happen. I teach this course as an introductory freshman course with the expectation that students were in the HORT/CROP_SCI 102 class the previous semester. If you have already taken plant science courses at the 300 or 400 level (either at WSU or elsewhere), this course may cover content that you have already been taught. Further, both HORT/CROP_SCI 102 and 202 were developed for students in the AFS/IPS program and not for students in other colleges at WSU. BIOL 120 "Introductory Botany", for example, is not a required course for AFS/IPS students but, according to the course catalogue, it can be taken as an elective. If you are an AFS/IPS student taking HORT/CROP_SCI 202 now and you are considering taking BIOL 120 in the future, this would **not** be a good idea due to content overlap. If you have already taken BIOL 120 at WSU, much of the content in the combined HORT/CROP_SCI 102 and 202 classes will be similar. BIOL 120 and HORT/CROP_SCI 102 and 202 were developed for different student audiences and it is assumed that Biology students would not be taking HORT/CROP_SCI 102 and 202 and vice versa. A significant and primary difference between BIOL 120 and HORT/CROP_SCI 202 is the semester-long, team-based student plant research projects in the greenhouse. This is a critical element to this class to prepare students for future research opportunities and higher-level plant science courses in the IPS and Organic Ag. Systems programs in CAHNRS. If you have any questions about whether or not you should be in this class, please see the instructor directly.

Required Reading: Chalker-Scott, L. and C.H. Daniels. 2016. Scientific literacy for the citizen scientist. WSU Extension EM100E. 28 p. (see Blackboard "Content" folder).

Recommended text book:
Hartmann's Plant Science: Growth, Development, and Utilization of Cultivated Plants
by M. McMahon, A. Kofranek, and V. Rubatsky, Pearson Prentice Hall. Fifth edition.
Some of the course content was based on content covered in chapters of this textbook. You are not required to buy the book and are free to use it as a reading supplement if you like. It also provides complementary content to what you may have covered in HORT/CROP_SCI 102 or other plant science courses in the future.

Goals:
Students will be provided with knowledge on basic scientific principles of crop growth and development, including external abiotic influences and their interaction with internal influences from the cellular to the whole plant level. Both agronomic and horticultural crops will be featured as examples to explain various principles. Consideration of how the application of scientific knowledge has and can lead to crop improvement for efficient and sustainable crop production will be emphasized. Skills in quantitative reasoning, scientific teamwork, and research communication (written, visual, and oral) will be introduced and fostered. Students will gain an appreciation of and access to knowledge sources for crop growth and development principles and practice. This includes scientific literature and other sources, WSU faculty and other experts.

Expected student learning outcomes:
Through engagement in class, lab activities, group projects, and field trips, students will:

- Apply basic scientific principles of how crop plants grow and develop to understand factors influencing crop quality and yield.
- Evaluate how scientific knowledge enables improved crop production.
- Investigate areas of interest in crop growth and development for crop improvement, integrating knowledge sources and demonstrating skills in quantitative reasoning, research communication, and teamwork.

Class Holidays: Class will not meet on **Jan. 20** (Martin Luther King Jr. Day), **Feb. 17** (President's Day) or during **March 16-20** (Spring Break).

LECTURE OUTLINE:

1. **Introduction** – syllabus review, overview

2. **Crop Improvement** – definitions, cultural practices, genetic techniques, factors influencing crop growth and development
    a. Crop Domestication
    b. Origins, examples (corn), propagation, changes with domestication (e.g., germination, growth habit, thorniness, reproductive organs, seed dispersal, palatability, biomass allocation),
    c. Germplasm – what is it? Why important? Preservation, introduction, invasive species, gene banks/repositories,
    d. Historical trends (tomato)
    e. Why improve? The Future
    f. Targets for crop improvement (increased productivity, abiotic stress resistance, biotic stress resistance, improved quality, improved energy efficiency, more produced, larger products, larger harvest index)

3. **Patterns of Plant Growth and Development**
    a. Vegetative growth – measuring, stages of development (phenology), avoiding development, how plants grow (basics),
    b. Factors – transcription factors, hormones (just introduce), environmental conditions,
    c. Stages – germination, vegetative, phase change, reproduction, factors affecting germination, germination process, embryo growth, vegetative growth including roots, shoots (determinate/indeterminate),
    d. Annuals and life cycles (e.g., wheat, barley), Biennials and life cycles (foxglove, radish), Perennials and life cycles (clover, herbaceous and woody plants)
    e. Phases of Growth and Development
        i. Embryonic, juvenile, adult, senescence
            1. Harvest Index, Green revolution,
            2. Reproductive growth and development (flower induction, initiation, photoperiodism, vernalization, differentiation, development, pollination, fertilization, fruit set, seed formation, thinning, alternate bearing, fruit/seed growth and development, fruit growth patterns, maturation, climacteric, non-climacteric, aging and senescence)

4. **Plant Hormones and Plant Growth Regulators**
    a. How they work, **auxins** – sources, effects and commercial uses, **gibberellins** – sources, effects and commercial uses, **cytokinins** – sources, effects and commercial

uses, **ethylene** – sources, effects and commercial uses, abscission, management, **abscisic acid** – sources, effects and commercial uses, **brassinosteroids** – sources, effects and commercial uses, **salicylic acid** – sources, effects and commercial uses, systemic acquired resistance, **jasmonic acid** – sources, effects and commercial uses, **systemin** – sources, effects, **florigen**, **strigolactones**

5. **Plant Cell Components**
    a. Overview and then details, cell wall, cell membrane, cytoplasm, nucleus, endoplasmic reticulum, golgi apparatus, plastids, chloroplast, mitochondria, vacuole

6. **Plant Biochemistry**
    a. Photosynthesis – carbon cycle, "light" reactions, "dark" reactions, factors affecting photosynthetic rate, electromagnetic spectrum, light quality, light intensity, light response, CO_2 response, enrichment, temperature response, water – drought/flooding
    b. Transpiration – role of ABA (e.g., bitter pit in 'Honeycrisp' apple)
    c. Different photosynthetic mechanisms – C3, C4, CAM, source-sink relationships
    d. Respiration – glycolysis, TCA cycle, electron transport chain
    e. Light manipulation – quantity, quality, photoperiod duration

7. **Plant Propagation**
    a. Purpose, sexual, asexual, meiosis and mitosis review
    b. Sexual propagation, germination test, seed dormancy, scarification, stratification, factors affecting germination,
    c. Asexual propagation – adventitious shoots and roots, clones, chimeras, cuttings, grafting and budding, top working, cleft grafting, tree repair, whip/tongue, bench grafting, healing, incompatibility, layering, runnering, crowns, specialized roots and stems, tissue culture

COURSE ASSESSMENT

600 pts total
300 pts Lecture – Three exams taken online (each covering 1/3 of course content, see below)
300 pts Lab – Team Projects, team participation, field trip write-ups

Lecture (300 pts total):
100 pts Mid-term exam 1 (Friday, **February 14**- online)
100 pts Mid-term exam 2 (Friday, **March 27** – online)
100 pts Final exam (Mon, May 4, 8 am– online)

Lab (300 pts total):
260 pts Team Research Project (see details later)
20 pts Field trip write-up 1 (due date announced in lab)
20 pts Field trip write-up 2 (due date announced in lab)

Grading scale

100 - 93% = A	86 - 83% = B	76 - 73% = C	65 - 60% = D
92 - 90% = A-	82 - 80% = B-	72 - 70% = C-	≤59% = F
89 - 87% = B+	79 - 77% = C+	69 - 66% = D+	

Exams cannot be made up if missed unless a university approved excused absence is provided beforehand. Failure to complete during the exam period will result in a grade of zero. The three exams have equal weight. Each exam will be open book, but must be done individually, and will

cover approximately 1/3 of the total course content. During the lab periods of the week when exams are scheduled, a brief review of typical exam questions will be provided (e.g., short answer, fill-in-the-blank, True/False). **No study guide will be provided**. The .pdf files for each PowerPoint lecture will provide the basis for all exam questions. The **first** mid-term exam will include any information covered in lecture during **Jan. 13 – Feb. 12**; the **second** mid-term exam will include any information covered in lecture during **Feb. 19 – March 25**. The **final** exam will include any material covered in the lecture during **March 30 –** . If you have any questions about your exam grade, you must first review the exam answer key to see what was expected. If questions remain about how your score was determined or if there was an error in grading, please contact the TA for review.

Lecture Expectations – Before coming to class you are strongly recommended to: (1) review the previous lecture and PowerPoint slides provided on Blackboard; (2) review any additional material that you are directed to by the instructor (e.g., video, on-line resource, etc.). Complementary information in the recommended textbook could also be reviewed but it is not required. Failure to attend any given lecture may put you at a disadvantage when exams are given because there may be occasional tips given to the class about how to study, what a good question might be, etc. As noted elsewhere in the syllabus, the lectures are usually recorded, so that you can review a missed lecture on-line should that be necessary. Occasionally, however, there may be a Blackboard malfunction and a lecture may not be recorded. This has happened at least once each year. The instructor is not responsible for this. In such a case, the lecture PowerPoint will still be uploaded to Blackboard but you will miss the actual instruction associated with it. To ensure that you do not miss any critical lecture instruction, it is advised that you attend all lectures.

Classroom Etiquette - Be respectful of your instructor and fellow classmates by refraining from talking, text messaging, Facebook, other online social media, web browsing, gaming, etc. during class time. Such activities are a distraction to those around you and have no place in a lecture classroom. Please silence and put away your cell phone during class. For note taking purposes in class, you are free to use whatever method you prefer (laptop, tablet, pen/paper, etc.). If you have a question of the instructor, please raise your hand and wait until you are recognized. If you are off-campus, I may not see you adequately on the AMS monitor so feel free to turn on the classroom microphone and interrupt me to get my attention with "Excuse me, Dr. Pumphrey, this is _____ from Tri-Cities…". At any time during the semester, you may set up an appointment with either your instructor or TA outside of class to address any questions that you may have about the course content or activities.

Lab Expectations – Any pertinent lab information will be posted on **Blackboard** so please check this regularly. Occasionally, your TA may have material to directly hand out to you as well. For an excused absence to the lab, see TA in advance only. You will be responsible for any missed work. You are expected to attend all field trips. For Pullman students, if the location is beyond walking distance, please plan to drive yourself or arrange to car pool with a classmate – perhaps one of your project teammates. Directions will be provided but we will be unable to provide transportation. For Tri-Cities students, your TA will direct you regarding field trip travel arrangements.

Attendance – Attendance in lecture and lab sessions is expected. Absences because of illness, personal and/or family crises, mandated court appearances, or similar reasons will be accommodated as long as such absences are not excessive and notification is provided to the instructor or TA in advance. Excused absences should be arranged prior to any known or planned event. Required University activities will be excused absences if an official Class Absence Request form signed by the sponsoring faculty/organization is given to the Instructor (if for lecture) or TA (if for lab) before the event.

TEAM RESEARCH PROJECTS

You will work in 4-5 person team to research, implement, analyze, document, and communicate your findings on a crop growth and development research project. Besides taking theory from the classroom and applying it to your hands-on team project, you will also hone critical thinking, teamwork, and communication skills. This will be useful for higher level plant science courses, possible internships, and even jobs. It might even spark an interest in you for advanced research training in graduate school to become a scientist.

Your experiments will be conducted in the course assigned greenhouses under your own direction. The Pullman Horticulture greenhouses are located between Ferdinands's ice cream shop and the football indoor practice field. The doors are generally unlocked and you can access your plants between 7 am – 4 pm during Monday-Friday. For afterhours access, please contact the lab TA. Past years' team projects, ideas, and guidelines will be provided during the early lab sessions of the semester. You will work in a 4-5 member team on one crop and cultivar of your choice including: **Basil, Eggplant, Lettuce, Pepper, Radish, Tomato, Turf grass, Spring Wheat, and Zinnia.** You will grow your crops from seed. We will help you to decide on the experimental hypothesis to test, the treatments and replication needed so that you can study their influence on growth and development of your crop. Ideally, experimental treatments that are chosen should result in different plant growth responses over a 10-14 week growing timeframe. These could include growing medium, planting density, seed sowing depth, fertility regime, irrigation frequency, soil temperature, soil amendments (e.g., compost, mycorrhizal inoculation, etc.). Other treatments are possible but you will need TA approval to test them.

Your project team will be responsible for routine greenhouse tasks such as plant care (e.g., watering, fertilizing, staking, transplanting, overall maintenance, cleanup), applying experimental treatments, taking growth measurements, analyzing data and preparing a final research poster and delivering an oral presentation to the class. Consider the TA's as mentors who will advise you so that you can successfully conduct your research and present it professionally. However, this is your project and it is your responsibility to complete it as a team.

We will provide you with a standard poster presentation template that you can populate with content as noted below to get feedback from us prior to submitting your final project. We will also provide you feedback ahead of time on your PowerPoint slides for the oral presentation. The **260** points assigned for the research project will be distributed as follows:

Graded Item	**Value (pts)**	**Class Week Due Date**
Initial project plan (team members, crop, experimental treatments, data collection)	5	2
Revised project plan (incorporating TA feedback)	10	3
Annotated bibliography (with at least 5 peer-reviewed citations)	20	4
Poster Part 1 (Title, Authors, Introduction, Hypothesis, Preliminary References from Annotated bibliography)	20	6
Poster Part 2 (Revisions of part 1 plus Materials and Methods)	20	8
Self and Peer Evaluation 1	20	9
Poster Part 3 (Revisions of part 2 plus Results – graphs, tables, photographs)	20	12
Poster Part 4 (Revisions of part 3 plus Discussion and Conclusions)	20	14
Final Complete Poster (Revisions of part 4, Updated References if any)	45	15
PowerPoint presentation slides	20	15
Team oral presentation in lab	40	16
Self and peer evaluation 2	20	16
Total points possible	**260**	

LABORATORY SCHEDULE

Dates below are for Pullman (Tuesday's/Thursdays). Tri-Cities Monday, Mt. Vernon Friday.

Week	Lab Dates	Laboratory Topic	Notes/Deliverables (pt. value)**
1	Jan. 13-17	Introduction, greenhouse visit	Review schedule, discuss research projects & crops, scientific method, show posters, discuss project plan
2	Jan. 20-24	Scientific research review, discuss annotated bibliography preparation	Initial project plan (5 pts)
3	Jan. 27-31	Sow seeds for research project Botany of Desire/discussion	Revised project plan (10 pts)
4	Feb. 3-7	**Tour**: Wheat Breeding Greenhouse ; Discuss data collection/poster	Annotated bibliography (20 pts)
5	Feb. 10-14	**Tour**: Exam review & poster tips	
6	Feb. 17-21	Plant Propagation Lab Botany of Desire/discussion	Poster Part 1 (20 pts)
7	Feb. 24-28	**Tour**: Merry Cellars Winery	
8	Mar. 2-6	Peer evaluation discussion; Student Project work; Botany of Desire discussion	Field Trip Write Up #1 Due (20 pts) Poster Part 2 (20 pts)
9	Mar 9-13	Student project work Botany of Desire/discussion	Self and Peer Evaluation 1 (20 pts)
10	**Mar 16-20**	**SPRING BREAK NO LAB** Make arrangements for plant care	
11	Mar 23-27	**Tour**: Tree Fruit DNA Lab; Discuss results presentation; Exam review; Student project work	
12	Mar 30-Apr 3	Student project work	Poster Part 3 (20 pts)
13	April 6-10	**Tour**: Tukey Orchard; Discuss discussion presentation; Student project work	Field Trip Write Up #2 Due (20 pts)
14	April 13-17	**Tour**: Organic Farm	Poster Part 4 (20 pts)
15	April 20-24	Review posters/PPT's	Final Poster (45 pts); PowerPoint Presentation Slides (20 pts)
16	April 27-May 1	Oral Presentations in Lab	Oral Presentations (40 pts); Self and Peer Evaluation 2 (20 pts)

****NOTE**:** Activities/field trips in Tri-Cities and Mt. Vernon will be communicated by TA. Any spare time during the scheduled lab period can be used to go to the greenhouse to care for plants, collect data, meet with team members to discuss project, analyze data, prepare graphs, work on posters, etc. Note: you will likely need to meet with your team outside of lab to work on various aspects of your project, especially as you prepare your final poster and oral presentation.

Disability Statement

Students with Disabilities: Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center (Washington Building 217; 509-335-3417) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center. For Tri-Cities or Everett students, please visit these links: http://www.tricity.wsu.edu/disability/ https://everett.wsu.edu/disability-resources/

Academic Integrity Statement

Academic integrity is the cornerstone of higher education. As such, all members of the university community share responsibility for maintaining and promoting the principles of integrity in all activities, including academic integrity and honest scholarship. Academic integrity will be strongly enforced in this course. Students who violate WSU's Academic Integrity Policy (identified in Washington Administrative Code (WAC) 504-26-010(3) and -404) **will receive a score of zero** on the exam, assignment, etc., will not have the option to withdraw from the course pending an appeal, and will be reported to the Office of Student Conduct.

Cheating includes, but is not limited to, plagiarism and unauthorized collaboration as defined in the Standards of Conduct for Students, WAC 504-26-010(3). You need to read and understand all of the definitions of cheating: http://app.leg.wa.gov/WAC/default.aspx?cite=504-26-010. If you have any questions about what is and is not allowed in this course, you should ask the instructor or TA's before proceeding. If you wish to appeal a faculty member's decision relating to academic integrity, please use the form available at conduct.wsu.edu.

Commercial Note-Taking In My Classroom

Any course-related materials, presentations, lectures, *etc.* are my intellectual property and may be protected by copyright. Selling class notes through commercial note taking services, without the written advance permission of the course instructor, could be viewed as copyright infringement and/or an academic integrity violation, WAC 504-26-010 (3)(a,b,c,i). Further, the use of University electronic resources (*e.g.,* Blackboard) for commercial purposes, including advertising to other students to buy notes, is a violation of WSU's computer abuses and theft policy (WAC 504-26-218), a violation of WSU's Electronic Communication policy (EP 4), and also violates the terms of use for the Blackboard software program. Another important consideration regarding commercial note-selling is the educational value of such an activity. Notehall.com, for example, assumes zero liability for the content on its site. There is no guarantee the information is factual or even pertains to the class discussion. Purchasers have no assurances of the quality of what they are buying.

Classroom Safety

Classroom and campus safety are of paramount importance at Washington State University, and are the shared responsibility of the entire campus population. WSU urges students to follow the "***Alert, Assess, Act***" protocol for all types of emergencies and the *"Run, Hide, Fight"* response for an active shooter incident. Remain ***ALERT*** (through direct observation or emergency notification), ***ASSESS*** your specific situation, and ***ACT*** in the most appropriate way to assure your own safety (and the safety of others if you are able).

Please sign up for emergency alerts on your account at MyWSU. For more information on this subject, campus safety, and related topics, please view the FBI's *Run, Hide, Fight* video and visit the WSU safety portal.