PBGG 8890 | PLANT CYTOGENETICS

The Behavior & Evolution of the Plant Genome

Spring 2025

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OFFICE HOURS BY APPOINTMENT

Course web site: https://parrottlab.uga.edu/pbgg8890/

For Tifton & Griffin students: https://zoom.us/j/92177449768

- Note, for security reasons, you must be logged on to your Zoom account to log in to the course.

Goal: Familiarize students with the biology, behavior & evolution of the angiosperm genome, enabling the use of this information to facilitate work in plant genetics, marker-assisted selection, and plant breeding.

Outcome: The purpose is not to memorize data, but rather, to use critical thinking skills, including the ability to analyze the available data set and draw inferences, as well as to recognize biological phenomena occurring in different situations or data sets.

Textbook: There is no official text for the course, which instead will use handouts, eLC, and perhaps assigned readings.

Communication: Will be via UGA MyID, with possible migration to eLC during the semester.[1]

Hours: Wednesday 09:30 – 10:45 Room 128 CAGT
Friday: 09:30 – 10:45

Labs: TBD, based on student schedules and room availability

Grading:

Midterm	20%	(Once we have gone through the meiosis section)
Lab project	40%	(Monday, April 28th, no later than 5 pm[2], last day of class)

[1]Hence, if your @uga.edu is not your default email address, set your UGA address to automatically forward mail to your preferred email address.

[2]The only accepted definition of 5:00 pm for this class is the time stamp that email places on a file when it is uploaded. Late papers automatically receive a grade penalty.

Final (comprehensive!) 40% (Friday May 2nd —Will be take-home, due May 6th by noon)

- In the case of borderline grades, class participation will be the deciding factor.

Lab project:

The goals of the lab project are to ensure that students

- Get to develop an understanding of the cytogenetic behavior of a plant species
- Get an opportunity to learn cytogenetic technique
- Get to actually observe chromosomes & cell division

Accordingly, each student will write a literature review of the major cytogenetic work that has been done on a species of the student's choice (and approved by the instructor). The review should pay particular attention to that species' cytogenetic behavior and to the techniques and procedures which have been most successful for that particular species.

The report must include photographs **taken by the student** of either

1) a root-tip or other somatic cell squash of sufficient quality to permit an accurate and unambiguous count of the chromosome number of the student's selected species. In addition, photographs should be included of all the stages of mitosis, OR
2) all of the stages of meiosis (starting with diakinesis), taken from pollen mother cells of the student's particular species, OR, for those with a strong molecular bent,
3) a root-tip or other somatic cell squash of sufficient quality to permit an accurate and unambiguous count of the chromosome number of the student's selected species, + a study using flow cytometry or other cytological technique, or
4) *in situ* hybridization of a DNA onto plant chromosomes (FISH or GISH).

The best study cases have a large amount of DNA and a low chromosome number.

Projects that do not actually visualize chromosomes are not appropriate.

Creativity counts. Try to find some novel twist or question to answer, rather than repeating what has been done before. As a word of caution, pollen mother cells are easier to study than root tips; however, flowering plants are necessary for pollen mother cells. Healthy plants are needed in all cases. If you don't have any available, plant them immediately to ensure that root-tips and flowers will be available at the appropriate time. Both root-tips and PMC's will require time to practice before you get photo-quality material. *Be sure to budget this time into your schedule!*

The lab project must include a **Review of the Literature** (25%). This review should have two parts. The first part should focus on what is known about the cytogenetic behavior of the species. The second part should describe the cytological methods that have been used successfully.

Materials and Methods section with a description of source material and of the procedures used

to prepare tissues and obtain all photographs (15%).

The **Results** section (50%) should meet the goals in one of the 4 options above, and have a discussion on your findings.

Don't forget the **References**! Citation format should be that for *Crop Science* or *Plant Physiology*.

REPORTS ARE TO BE PREPARED AS A WEB PAGE(S), TO BE PLACED ON ELC OR OTHER WEBSITE, AND *ALL OF WHICH WILL BECOME PUBLICLY AVAILABLE FOREVER*.

To get full credit for your final project report, the final write-up should be free of spelling and grammatical errors, and the overall presentation of the photographs should be neat and professional (10%). *Get another person to review your spelling and grammar. This is particularly important for those who are not native speakers*. Because of the web format, attractiveness and simplicity count! Points will be deducted for unnecessary animations, flashing lights, and background music.

AVAILABLE RESOURCES:

- Bass & Birchler 2012 *Plant Cytogenetics: Genome Structure and Chromosome Function*
- Burnham 1962 *Discussions in Cytogenetics* (QH431.B966d)
- Gupta & Tsuchiya 1991 *Chromosome Engineering in Plants: Genetics, Breeding, Evolution*, Part A (QK981.35.C493)
- Jauhar 1996 *Methods of Genome Analysis in Plants (*QK981.45.M48)
- Schulz-Schaeffer 1980 *Cytogenetics, Plants, Animals, Humans (*QH430.S38)
- Singh 2016 *Plant Cytogenetics*, 3rd Ed.
- Swanson et al 1981 *Cytogenetics. The Chromosomes in Division, Inheritance, and Evolution (*QH430.S98)
- Sybenga 1972 *General Cytogenetics (*QH431.S981713)

Topical outline

- I. **Foundations of cytogenetics**
- **II. Chromosome morphology & terminology**
  - Part A: Chromosomes & karyotypes
  - Part B: B chromosomes
  - Part C: Sex chromosomes
    - *For your information only-- not up to date & will not be covered in class*
- **III. Mitosis**
  - Part A: Mitosis & its alterations & role in plant development
  - Part B: Somatic instability & crossing over; c-mitosis
- **IV. Meiosis**
  - Part A: Importance & Stages
  - Part B: Micro & mega sporo & gametogenesis

    - Part C: Chromosome pairing & fundamental concepts
    - Part D: Crossing over & impact on mapping
    - Part E: 2n gametes
    - Part F: Apomixis
    - Part G: Gene drives
    - Part Misc: Achiasmate, inverse & somatic meiosis; sister strand crossovers in inversions
        - *For your information only-- has **not** been updated and will not be covered in class*
- **V. Chromosome reconfigurations**
    - Part A: Deficiencies, duplications & inversions
    - Part B: Translocations
    - Part C: Ring chromosomes & Breakage-fusion-bridge cycles
    - Part Misc: Quantifying interstitial crossovers & *Oenothera* cytogenetics
        - *For your information only-- will not be covered in class*
- **VI. Changes in chromosome number**
    - Part A: Aneuploidy
    - Part B: Haploidy & triploidy
    - Part C: Autotetraploidy
    - Part D: Allopolyploidy 1
    - Part E: Allopolyploidy 2
    - Part F: Wheat cytogenetics
- **VII. Evolution of the karyotype/genome**
    - Part A: Karyotype evolution & diploidization
    - Part B: Repetitive DNA
    - Part C: Changes in DNA amount, chromosome size, & gene number
    - Part D: Adaptive value to DNA content

Additional items:

- **All academic work must meet the standards contained in "*A Culture of Honesty*." Students are responsible for informing themselves about those standards before performing any academic work. http://www.uga.edu/honesty/ for more information**
- The course syllabus is a general plan for the course; deviations announced to the class by the instructor may be necessary.
- As per UGA policy, the following may lead to an instructor-initiated withdrawal of the student
    - Disruptive behavior during class, including cell phone use or laptop/tablet use.
    - Un-excused absences
- Examinations may be made up only if the student has a valid excuse (doctor=s note specifically stating s/he was too ill to take the exam) or has made prior arrangements with the instructor.

Mental Health and Wellness Resources:

- If you or someone you know needs assistance, you are encouraged to contact Student Care and Outreach in the Division of Student Affairs at 706-542-7774 or visit https://sco.uga.edu. They will help you navigate any difficult circumstances you may be facing by connecting you with the appropriate resources or services.
- UGA has several resources for a student seeking mental health services:
    - (https://www.uhs.uga.edu/bewelluga/bewelluga) or crisis support
    - (https://www.uhs.uga.edu/info/emergencies)
- If you need help managing stress anxiety, relationships, etc., please visit BeWellUGA

(https://www.uhs.uga.edu/bewelluga/bewelluga) for a list of FREE workshops, classes, mentoring, and health coaching led by licensed clinicians and health educators in the University Health Center.

- Additional resources can be accessed through the UGA App.