

## Photosynthesis

IB 421, BIOPH 432, CPSC 489

Credit: 3 hrs

607 IGB

Tuesday & Thursday

9:30 – 10:50 AM

Semester Course – Fall 2021

**Instructors:** Don Ort, Carl Bernacchi, Lisa Ainsworth

Don Ort, 1406 IGB, Tel: 333-2093, e-mail: [d-ort@illinois.edu](mailto:d-ort@illinois.edu)

Carl Bernacchi, 196 ERML, Tel: 333-8048, e-mail: [bernacch@illinois.edu](mailto:bernacch@illinois.edu)

Lisa Ainsworth, 147 ERML, Tel: 265-9887, e-mail: [ainswort@illinois.edu](mailto:ainswort@illinois.edu)

**Course Description:** Photosynthesis is the primary source of energy for all of life on Earth and is the process by which plants harvest sunlight energy, convert it to chemical energy, and use it to fix atmospheric carbon dioxide to produce sugars. In doing so, plants emit oxygen and water vapor to the atmosphere. Since the process of photosynthesis evolved over 2000 million years ago, it has shaped the atmospheric composition and climate of the planet, and today photosynthesis is ultimately responsible for the vast majority of humankind's food, feed, fiber, and fuel. This course covers many aspects of the photosynthetic process, including photosynthetic energy transformations; photosynthetic metabolism; measuring, modeling and scaling photosynthesis; the central role of photosynthesis in the global C cycle and the potential for improving photosynthesis to increase crop yields. **Learning outcomes:** Students will gain understanding of the biochemistry, molecular biology, physiology, evolution and ecology of photosynthesis in this course. Students learn hands-on how to measure photosynthesis using infrared gas analysis and how to scale rates of photosynthesis from the leaf to the canopy. Students also gain critical thinking and quantitative reasoning in applying fundamental knowledge of photosynthesis to real world problems.

**Pre-requisites:** It is strongly recommended that students have taken Plant Physiology or Plant Biochemistry before taking IB 421.

**Assigned Reading.** There will be assigned readings and/or a handout for each class with key information. Readings will be posted on course moodle page (<https://learn.illinois.edu>) and students are expected read all assignments and be prepared for discussion sessions.

**Grades.** The course grade will be based on the take-home Final Exam (40%), the Mid-term Exam (35%), homework assignments (10%), and in-class discussions (15%).

**Discussions.** Approximately every 2 weeks, students will lead in class discussions to review key concepts covered in the lectures. Students should come prepared with class notes and readings for these discussions. Along with in class participation, student involvement in discussion accounts for the discussion portion of the grade.

**Background Texts.** Blankenship R.E. (2014) *Molecular Mechanisms of Photosynthesis*. Wiley. Available from UIUC library, <http://onlinelibrary.wiley.com/book/10.1002/9780470758472>.

**Course Attendance Policy.** Regular class attendance is expected of all students. Students should inform instructors in advance of missing class and generally adhere to the guidelines specified in the UIUC Student Code ([http://studentcode.illinois.edu/article1\\_part5\\_1-501.html](http://studentcode.illinois.edu/article1_part5_1-501.html)).

**Academic Integrity.** As specified in the UIUC Student Code, “*It is the responsibility of each student to refrain from infractions of academic integrity, from conduct that may lead to suspicion of such infractions, and from conduct that aids others in such infractions.*” It is our responsibility as instructors to uphold the academic integrity policy of the University (<http://studentcode.illinois.edu/>).

**Accommodations:** If you require special accommodations, please tell instructors within the first two weeks of class. All accommodations will follow the procedures as stated in Article 1-110 of the Student Code (<http://studentcode.illinois.edu>). To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail: [disability@illinois.edu](mailto:disability@illinois.edu) or go to the DRES website. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available on campus that can help diagnosis a previously undiagnosed disability by visiting the DRES website and selecting “Sign-Up for an Academic Screening” at the bottom of that page.

**Inclusivity Statement:** The effectiveness of this course is dependent upon the creation of an encouraging and safe classroom environment. Exclusionary, offensive or harmful speech (such as racism, sexism, homophobia, transphobia, etc.) will not be tolerated and in some cases subject to University harassment procedures. We are all responsible for creating a positive and safe environment that allows all students equal respect and comfort. We expect each of you to help establish and maintain an environment where you and your peers can contribute without fear of ridicule or intolerant or offensive language.

### Course Calendar

Date	Day	Topic	Instructor
Aug 24	Tues	Photosynthesis in a Global & Human Context	Ort

### Photosynthetic Energy Transformations

Aug 26	Thur	Photosynthetic Reaction Centers	Ort
Aug 31	Tues	Electron Transport	Ort

Sep 2	Thur	ATP Synthesis and Regulation	Ort
Sep 7	Tues	Light Harvesting	Ort
Sep 9	Thur	Photoprotection	Ort
Sep 14	Tues	<i>Review/Discussion</i>	
Sep 16	Thur	Chloroplast Development & Division	Ainsworth
Sep 21	Tues	Plastid Evolution	Ainsworth

### Photosynthetic Metabolism

Sep 23	Thur	Rubisco & Rubisco Activase	Bernacchi
Sep 28	Tues	C3 – Photosynthetic Carbon Reduction Cycle	Bernacchi
Sep 30	Thur	C2 – Photosynthetic Carbon Oxidation Pathway	Bernacchi
Oct 5	Tues	Photosynthesis modeling – theory	Bernacchi
Oct 7	Thur	Photosynthesis modeling - practice	Bernacchi
Oct 12	Tues	C4 Photosynthesis – The process and its variants	Ainsworth
Oct 14	Thur	<i>Review/Discussion</i>	

### Oct 19 Tues Midterm Exam

Oct 21	Thur	C4 Photosynthesis – Evolution and environment	Ainsworth
Oct 26	Tues	CAM & other concentrating mechanisms	Ainsworth

### Measuring and Scaling Photosynthesis

Oct 28	Thur	Stomata and Stomatal limitation of photosynthesis	Ainsworth/Leakey
Nov 2	Tues	Gas exchange & Chl fluorescence theory	<i>Boyd/Li</i>
Nov 4	Thur	Gas exchange & Chl fluorescence practice	<i>Boyd/Peterson</i>
Nov 9	Tues	Stable isotope discrimination/mesophyll conductance	<i>Stutz/Boyd</i>
Nov 11	Thur	Scaling photosynthesis	Bernacchi
Nov 16	Tues	<i>Review/Discussion</i>	

### The Future

Nov 18	Thur	Improving Photosynthesis	Long
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### Nov 23 & 25 – Thanksgiving Break

Nov 30	Tues	Photosynthesis & Bioenergy	Long
Dec 2	Thur	Photosynthesis and Global Change	Ainsworth
Dec 7	Tues	<i>Review/Discussion</i>	
Dec 9	Thur	Reading Day	

**Dec 14 Tues FINAL EXAM due by 5:00 pm**