FACULTY of SCIENCE and ENGINEERING
Department of Biology

Course: SC/BIOL 4160 3.0 (crosslisted to SC/BCHM 4160 3.0) – **Photosynthesis**

Course Description

A study of the process of photosynthesis at the biochemical, organelle and whole-organism levels, including structure of the photosynthetic apparatus, primary light-harvesting processes, electron transport, photophosphorylation, mechanism of carbon dioxide fixation in higher plants and algae, photorespiration. Two lecture hours, three laboratory hours. One term. Three credits. Prerequisite: One of the following: (1) SC/BIOL 2021 4.00 or SC/BCHM 2021 4.00; (2) SC/BIOL 2021 3.00 or SC/BCHM 2021 3.00; SC/BIOL 2070 3.00.

Course Webpage: http://www.yorku.ca/planters/photosynthesis

Term: Winter Term 2012/2013

Prerequisite / Co-requisite: SC/BIOL 2020 3.0, SC/BIOL 2021 3.0 and SC/BIOL 2070 3.0; or Permission of the Course Director.

Course Instructor: Roger R. Lew
(416) 736-2100 ext 66114
Farquharson 229 (lab)
planters@yorku.ca

Course consultation hours: I am usually in my lab, so please feel free to drop by.

Time and Location

Lectures	MW	8:30	Life Sciences Building 101

The course website is located at http://www.yorku.ca/planters/photosynthesis/

Laboratory	MT	2:30–5:30	Lumbers 106

The lab manual is located at the Bio.Wiki: http://biologywiki.apps01.yorku.ca/index.php?title=Main_Page/BIOL_4160

Expanded Course Description

Photosynthesis - A study of the process of photosynthesis at the biochemical, organelle and whole organism levels, including structure of the photosynthetic apparatus, primary light harvesting processes, electron transport, photophosphorylation, mechanism of carbon dioxide fixation in higher plants and algae, photorespiration. Two lecture hours, three laboratory hours. One term. Three credits.

Overview. The course emphasizes the biochemistry and physiology of photosynthetic processes. Laboratory exercises are integrated with lecture content and introduce the students to the diversity of experimental methods used to explore the mechanisms of photosynthesis.

Organization of the Course. The course involves formal lectures by the lecturer and weekly laboratories. The textbook and lectures are central to the course. Lectures serve to enrich, clarify, and illustrate crucial issues from the textbook used to reveal the diversity of photosynthetic organisms, and the light and dark reactions in the photosynthetic process. Emphasis is on the biochemistry and biotechnological importance of photosynthesis. The physiology of photosynthesis is covered to less extent, as time permits.

The majority of the material presented in laboratory exercises focuses on developing the hands-on experimental skill set of the students. They are provided with the opportunity to work with the instrumental tools common to research on photosynthesis, and to develop independent experiments as they become adept at experimental protocols.

The lecture and laboratory are highly integrated (and usually synchronized). The final grade of the student is compiled from the combination of lecture and laboratory.

Course Learning Objectives. Please note that a detailed syllabus of lecture material and past tests on the course website (www.yorku.ca/planters/photosynthesis) provide a highly detailed and practical presentation of the Learning Objectives.

Brief statement of the purpose:

DIVERSITAS

Students will be able to describe the major characteristics of photosynthetic clades —anoxygenic and oxygenic— and apply and integrate their knowledge to explore and propose novel bioengineering applications, including artificial photosynthesis. Students will be enabled to extend photosynthetic possibilities beyond those that have appeared during evolutionary time (the past 4000 million years). Achievement of the *Diversitas* Learning Objectives is documented by assignments and tests that challenge the student to apply and integrate their knowledge of photosynthetic diversity.

LUCIDA

Students will explore the nature of light, mechanisms of photon energy absorption and outcomes, and the structure and function of major photosynthetic pigments that absorb light. They will be able to explain the nature of exciton transfer to reactions centers, integrating kinetic mechanisms with the known structures of reaction centers. Students will understand in detail the photochemical reactions and role of water to replenish excitons, with especial reference to the most recent results on fast kinetics and quantum entanglement. As well, they will understand the electron transport mechanisms and enzymatic reactions required to synthesize ATP and NADPH. Achievement of the *Lucida* Learning Objectives is documented by assignments and tests that challenge students to apply and integrate their knowledge of the light reactions of photosynthesis, and by their practical experimental outcomes in laboratory exercises.

NOCTIS

Students will explore the nature of carbon dioxide fixation and the production of carbohydrate, utilizing ATP, NADPH and other compounds. Students will be able to describe the complexity of multiple biochemical steps in metabolic pathways that span the cell, the leaf and the whole plant. Achievement of the *Noctis* Learning Objectives is documented by assignments and tests that challenge students to apply and integrate their knowledge of the dark reactions of photosynthesis.

Brief list of specific learning objectives of the course

The specific objectives of the course are that students will be able to:

- critically examine the diversity of major organismal groups that photosynthesize —with especial reference to the differences between anoxygenic and oxygenic forms, and the evolution of oxygenic photosynthesis in evolutionary (geological) time
- understand the key physical events of light absorption and transformation into chemical energy
- obtain a detailed understanding of the biochemical steps of the dark reactions, their regulation and integration into metabolic systems
- develop their *experimental hands* in laboratory exercises in which they become adept at molecular spectroscopy, us of the oxygen electrode, biochemical assays and molecular biological protocols
- develop the flexibility required to apply and integrate fundamental principles and mechanisms in photosynthesis to develop novel mechanisms or processes suitable for bioengineering
- Become familiar with the fundamental physics, biochemistry and physiology necessary to analyze and integrate components of the photosynthetic process
- develop their ability to think and analyze independently to apply their knowledge to new problems and goals

Course Text / Readings

Lawlor, D.W. (2001) Photosynthesis (3d edition). Springer-Verlag

(another good introductory textbook (not required) is: Blankenship, R.E. (2002) Molecular Mechanisms of Photosynthesis. Blackwell Science)

Lew and others. 2013. Laboratory Manual for SC/BIOL 4160 4.0 (Photosynthesis).

The laboratory manual is provided on a Bio.Wiki as part of a Creative Commons Learning Initiative (http://biologywiki.apps01.yorku.ca/index.php?title=Main_Page/BIOL_4160).

Evaluation (Decided on by the students)

- Two term tests and final (highest scoring 25%, middle scoring 20%, lowest scoring 15%)
- Assignment (10%)
- Laboratory exercises (30%: Two lab reports [lowest score 10 %, highest 15%] and participation 5%).

In the event of an absence from a term test, please provide a letter stating that you were absent, and acknowledging that the weight of the missed term test (15%) will be carried over to the final and other term test (lowest score worth 27.5%, highest worth 32.5%).

"Final course grades may be adjusted to conform to Program or Faculty grades distribution profiles."

Grading: The grading scheme for the course conforms to the 9-point grading system used in undergraduate programs at York (e.g., A+ = 9, A = 8, B+ - 7, C+ = 5, etc.). Assignments and tests***** will bear either a letter grade designation or a corresponding number grade (e.g. A+ = 90 to 100, A = 80 to 90, B+ = 75 to 79, etc.). For a full description of York grading system see the York University Undergraduate Calendar - http://calendars.registrar.yorku.ca/2010-2011/academic/index.htm. Students may take a limited number of courses for degree credit on an ungraded (pass/fail) basis. For full information on this option see Alternative Grading Option in the *(Faculty of Science and Engineering)* section of the Undergraduate Calendar: (http://ugbio.apps01.yorku.ca/)

Assignment Submission: Proper academic performance depends on students doing their work not only well, but on time. Accordingly, **lab** assignments for this course must be received on the due date specified for the assignment. Assignments are to be handed in to the TA for your laboratory section per their instructions.

Lateness Penalty: Assignments received later than the due date will be penalized (usually 10% for the first day, 20% for the second, 40% for the third, ad infinitum). Late penalties for lab exercises will be determined by the laboratory coordinator.

Missed Tests: Students with a documented reason for missing a course test, such as illness, compassionate grounds, etc., which is confirmed by supporting documentation (e.g., doctor's letter) will have the weight of the missed term test transferred to the final exam.

IMPORTANT COURSE INFORMATION FOR STUDENTS

All students are expected to familiarize themselves with the following information, available on the Senate Committee on Academic Standards, Curriculum & Pedagogy webpage (see Reports, Initiatives, Documents) - http://www.yorku.ca/secretariat/senate/committees/ascp/index-ascp.html

- Senate Policy on Academic Honesty and the Academic Integrity Website
- Ethics Review Process for research involving human participants
- Course requirement accommodation for students with disabilities, including physical, medical, systemic, learning and psychiatric disabilities
- Student Conduct Standards
- Religious Observance Accommodation

July 2013