

University of Florida
Even years, Summer B semester 2022
Horticultural Sciences Department

HOS 5711 Section 4A94 Phytochemicals in Food & Health

Class Numbers 19380 Section 4A94 (In person); 19947 Section 4A95 (100% online)

Format: Lecture 3 credits
Schedule: MTWRF, Period 2 (9:30 pm to 10:45 AM).
Location: Fifield Hall Room 2316.
Pre-requisite: BCH 4024 or equivalent or instructor consent.

For students joining via Zoom:

Join Zoom Meeting

<https://ufl.zoom.us/j/91657950470?pwd=OXQrVjNkR241aXBYc3p4c3ZXMmdHZz09>

Meeting ID: 916 5795 0470

Passcode: 990940

Course Description:

This applied biotechnology course will examine the nature and properties of phytochemicals in fruits and vegetables including their taxonomic distribution, potential roles in human disease prevention/health promotion, biosynthesis and degradation, enzymes, genes and case studies of select plant breeding or metabolic engineering efforts.

Course Objectives:

At the completion of this course, the students are expected to be able to (a) describe major groups of phytochemicals and their chemical, physical and biological properties, (b) to design plant breeding and genetic engineering strategies to overproduce specific phytochemicals in plants and other organisms, and (c) to interpret and evaluate research on health promoting phytochemicals.

Instructor: Dr. Bala Rathinasabapathi (Dr. Saba)
Room 2247 Building Fifield Hall
Phone 352-273-4847
E-mail brath@ufl.edu
Office Hours: By appointment

Resources:

There is no required textbook for this course. The following are suggested as general guides:

Harborne JB 1998. Phytochemical methods. Chapman and Hall.

Lea PJ, Leegood RC 1993. Plant Biochemistry and molecular biology. Wiley.

Biochemistry & Molecular Biology of Plants, Second edition, print or electronic version, 2015, Wiley Blackwell (Available on Google Play https://play.google.com/store/books/details/Bob_B_Buchanan_Biochemistry_and_Molecular_Biology?id=9YAZCgAAQBAJ for \$93.59)

Heldt, HW. 2005. Plant Biochemistry and Molecular Biology. Oxford University Press, 3rd Ed.

Campbell, TC and Campbell II, TM.. 2006. The China Study: The most comprehensive study of nutrition ever conducted and the startling implications for diet, weight loss and long-term health. Benbella Books, Dallas, TX.

Reading List This tentative reading list of review articles and will be updated during the course:

(1) Methods, ROS, Antioxidant Hypothesis

Ames BN, Shigenaga MK, Hagen TM (1993) Oxidants, antioxidants, and the degenerative diseases of aging. Proc. Natl. Acad. Sci. USA 90: 7915-7922.

Espin JC, Garcia-Conesa MT, Tomas-Barberan FA (2007) Nutraceuticals: Facts and fiction. Phytochemistry 68: 2986 – 3008.

Peram MR, Jalalpure SS, Palkar MB, Diwan PV (2017) Stability studies of pure and mixture form of curcuminoids by reverse phase-HPLC method under various experimental stress conditions. Food Sci. Biotechnol. 26: 591-602.

Wu X., Prior R.L. (2005) Identification and characterization of anthocyanins by High-Performance Liquid Chromatography-Electrospray Ionization-Tandem Mass Spectrophotometry in common foods in the United States: Vegetables, nuts, and grains. J. Agric. Food Chem. 53: 3101-3113.

Kolosova NG, Trofimova NA, Fursova A.Z. (2006) Opposite effects of antioxidants on anxiety in Wistar and OXYS rats. Bulletin of Experimental Biology and Medicine 141: 734-737.

Kolosova NG, Shcheglova TV, Sergeeva SV, Loskutova LV (2006) Long-term antioxidant supplementation attenuates oxidative stress markers and cognitive deficits in senescent-accelerated OXYS rats. Neurobiology of Aging 27: 1289-1297.

Lai D, Huang M, Zhao L, Tian Y, Li Y, Liu D., Wu Y., Deng F (2019) Delphinidin-induced autophagy protects pancreatic beta cells against apoptosis resulting from high-glucose stress via AMPK signaling pathway. Acta Biochim Biophys Sin 51: 1242-1249.

Lin SH, Huang KJ, Weng, CF, Shiuan D (2015) Exploration of natural product ingredients as inhibitors of human HMG-CoA reductase through structure-based virtual screening. *Drug Design, Development and Therapy* 9: 3312-3324.

(2) Sugars, fibers and organic acids

Smirnoff N, Wheeler GL (2000) Ascorbic acid in plants: biosynthesis and function. *Crit Rev Biochem Mol Biol* 35: 291-314.

Debolt S, Melino V, Ford CM (2007) Ascorbate as a biosynthetic precursor in plants. *Annals of Botany* 99: 3-8.

(3) Flavonoids, anthocyanins and polyphenolics

Ross JA, Kasum CM (2002) Dietary flavonoids: Bioavailability, metabolic effects and safety. *Annu. Rev. Nutrition* 22:19-34.

He J, Giusti, M.M. (2010) Anthocyanins: Natural colorants with health-promoting properties. *Annu. Rev. Food Sci. Technol.* 1: 163-187.

Hoek-van den Hil EF, Schothorst EM, Stelt I, Swarts HJM, Vilet M, Amolo T, Vervoort, JJM, Venema D, Hollman, PCH, Rietjens IMCM, Keijer J (2015) Direct comparison of metabolic effects of the flavonoids quercetin, hesperetin, epicatechin, apigenin and anthocyanins in high-fat-fed mice. *Genes Nutr* 10: 23.

Cassidy A, Mukamal KJ, Liu L, Franz M, Eliassen H, Rimm (2013) High anthocyanin intake is associated with a reduced risk of myocardial infarction in young and middle-aged women. *Circulation* 127: 188-196.

Xie D, Dixon RA (2005) Proanthocyanidin biosynthesis – still more questions than answers. *Phytochemistry* 66:2127-2144. [Review]

Lambert JD, Sang S, Yang CS (2007) Biotransformation of green tea polyphenols and the biological activities of those metabolites. *Mol. Pharm.* 4:819-825.

Villasante A, Powell MS, Moutou K, Murdoch GK, Overturf K, Wacyk J, Hardy RW (2016) Effects of anthocyanidins on myogenic differentiation and antioxidant defense in primary myogenic cells isolated from rainbow trout (*Oncorhynchus mykiss*). *Aquaculture* 454: 81-89.

(4) Fats, Oils and Carotenoids

Graham IA (2008) Seed storage oil mobilization. *Annu. Rev. Plant Biol.* 59: 115-142.

Faulks RM, Southon S (2005) Challenges to understanding and measuring carotenoid bioavailability. *Biochim Biophys Acta* 1740: 95-100.

Kim Y, Oh D (2010) Biotransformation of carotenoids to retinal by carotenoid 15, 15'-oxygenase. *Appl Microbiol Biotechnol* 88: 807-816.

Kotake-Nara E, Nagao A (2011) Absorption and metabolism of xanthophylls. *Mar. Drugs* 9: 1024-1037.

Namitha KK, Negi PS (2010) Chemistry and biotechnology of carotenoids. *Critical Rev Food Sci and Nutrition* 50: 728-760.

Das A, Yoon SH, Lee SH, Kim JY, Oh DK, Kim SW (2007) An update on microbial carotenoid production: application of recent metabolic engineering tools. *Appl Microbiol Biotechnol* 77:505-512.

Klein-Marcuschamer D, Ajikumar PK, Stephanopoulos G (2007) Engineering microbial cell factories for biosynthesis of isoprenoid molecules: beyond lycopene. *Trends in Biotechnol.* 25: 417-424.

Kopec RE, Schick J, Tober KL, Riedl KM, Francis DM, Young GS, Schwartz SJ, Oberyszyn TM (2016) Sex differences in skin carotenoid deposition and acute UVB-induced skin damage in SKH-1 hairless mice after consumption of tangerine tomatoes. *Mol Nutrition and Food Research* (in press).

(5) Alkaloids

Facchini PJ, St-Pierre B (2005) Synthesis and trafficking of alkaloid biosynthesis enzymes. *Current Opinion in Plant Biology* 8: 657-666.

Sato F, Hashimoto T, Hachiya A, Tamura K, Choi K, Morishige T, Fujimoto H, Yamada Y (1999) Metabolic engineering of plant alkaloid biosynthesis. *Proc. Natl. Acad. Sci U.S.A.* 98:367-372.

Lopez-Carrillo E, Camargo MC, Schneider BG, Sicinschi LA, Hernandez-Ramirez RU, Correa P, Cebrina ME (2012) Capsaicin consumption, *Helicobacter pylori* CagA status and IL1B-31C>T genotypes: A host and environment interaction in gastric cancer. *Food Chem Toxicol* 50: 2118-2122.

Kobata K, Sugawara M, Mimura M, Yazawa S, Watanabe T (2013) Potent production of Capsaicinoids and Capsinoids by *Capsicum* peppers. *J. Agric. Food Chem.* 61: 11127-11132.

Kim S et al (2014) Genome sequence of the hot pepper provides insights into the evolution of pungency in *Capsicum* species. *Nature Genetics* 46: 270-279.

(6) Seed storage proteins

Galili G, Amir R, Hoefgen R, Hesse H (2005) Improving the levels of essential amino acids and sulfur metabolites in plants. *Biol. Chem.* 386: 817-831.

Shewry PR, Halford NG (2002) Cereal seed storage proteins: structures, properties and role in grain utilization. *J Exp. Bot.* 53: 947-958.

(7) Glucosinolates

Juge N, Mithen RF, Traka M (2007) Molecular basis for chemoprevention by sulforaphane: a comprehensive review. *Cell Mol. Life Sci.* 64:1105-1127.

Fahey JW, Zalemann AT, Talalay P (2001) The chemical diversity and distribution of glucosinolates and isothiocyanates among plants. *Phytochemistry* 56: 5-51.

Internet Homepage for the Course See Canvas

Course Outline:

Nature and properties, distribution, biosynthesis and genetics of pathways for the selected phytochemicals will be discussed. The course will be during a 6-week period each week centering on a theme. The last week is for student presentations.

Week 1: Methods used to study connections between phytochemicals and health.

06-27-22 Mon Introductions, Syllabus & Phytochemistry resources

06-28-22 Tue Introduction to a variety of food plants & health promotion

06-29-22 Wed ROS and Antioxidant hypothesis

06-30-22 Thu Total antioxidant activity assays
07-01-22 Fri Methods to study phytochemicals and health promotion

Week 2: Sugars, soluble fibers and organic acids

07-04-22 Mon No class
07-05-22 Tue Sugars & Soluble fibers
07-06-22 Wed Ascorbic acid
07-07-22 Thu Other organic acids
07-08-22 Fri Amino acids

Week 3: Flavonoids, anthocyanins and polyphenolics

07-11-22 Mon Flavonoid biosynthesis
07-12-22 Tue Anthocyanins
07-13-22 Wed Condensed tannins
07-14-22 Thu Tea polyphenolics
07-15-22 Fri Discussions of specific papers

Week 4: Fats and oils, Carotenoids.

07-18-22 Mon Seed oils
07-19-22 Tue Carotenoids
07-20-22 Wed Terpenoids
07-21-22 Thu No class – Instructor travel to a meeting
07-31-22 Fri No class – Instructor travel to a meeting

Week 5: Alkaloids and Seed storage proteins.

07-25-22 Mon Alkaloids – Capsaicinoids
07-26-22 Tue Alkaloids – Caffeine
07-27-22 Wed Essential amino acids
07-28-22 Thu Seed storage proteins
07-29-22 Fri Plant-Animal interactions. Written proposals are due by 5 pm.

Week 6: Student Presentations.

08-01-22 Mon Student Presentation
08-02-22 Tue Student Presentation
08-03-22 Wed Student Presentation
08-04-22 Thu Student Presentation
08-05-22 Fri Student Presentation

Student Presentation: Students are required to make a 30 minute presentation on their chosen research topic relevant to their written research proposal. Grading will be based on (a) communication of the main idea (b) explanation of the methods used, (c) critical analysis of the research plan and (d) clarity of delivery.

Written Assignment: Students should write a research proposal within 5 pages (double or single-spaced, including references) on any health promoting food phytochemical.

The research could be based on one or many of the following: (a) phytochemical surveys, (b) analytical methods, (c) evidence for health benefits, (d) elucidation of biosynthesis or catabolism, (e) plant breeding to improve nutraceuticals and (f) metabolic engineering. Grading will be based on (a) a building a testable hypothesis from the literature, (b) choosing and describing the appropriate methods that could be used for testing the hypothesis, (c) a discussion on the expected results and their significance and (d) clarity in writing.

Course Evaluation

Attendance & participation	50 points
Written assignment	75 points
Student presentation	75 points
TOTAL	200 points

Letter grades for the course will be assigned according to the chart below:
90-100 = A; 87-89 = A-; 84-86 = B+; 80-83 = B; 77-79 = B-; 74-76 = C+;
70-73 = C; 67-69 = C-; 64-66 = D+; 60-63 = D; 57-59 = D-; 56-below = E.

Course Policies and Procedures

1. Attendance: Attendance at the lectures and active participation in classroom discussions are required (50 points out of 200 total). Two absences will be tolerated, if prior written notification is given to the instructor.
2. Homework Policy: The assignment should be returned to the instructor by 5 p.m. on the specific date announced and late submissions will receive zero points. Classroom presentations should be completed by the specific date announced.
3. Honor Code: By registering for classes, all students agree to abide by and follow the University of Florida Student Honor Code (Rule 6C1-4.017). Visit: <http://regulations.ufl.edu/chapter4/4017.pdf> to read the Student Honor Code. Honor code violations in this course will not be tolerated, and may result in the assignment of a failing grade.
4. UF Counseling Services:
Counseling & Wellness Center, 301 Peabody Hall, 392-1575, personal and career counseling. <http://www.counseling.ufl.edu>
Student Health Care Center, 392-1161, personal counseling. <http://shcc.ufl.edu/>
Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling. <http://www.crc.ufl.edu/>
5. Software Use: Everyone is required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages/criminal penalties for the violator.

6. Electronic Device Policy: The use by students of cellular phones, messaging devices and other electronic devices during lectures is prohibited. In class, the students are asked to put the phones and messaging devices on silent mode and turn off other devices.

7. Students with Disabilities Act. The Dean of Students Office coordinates the needed accommodations of students with disabilities. To register contact: Dean of Students Office, 202 Peabody Hall, 392-7066, www.dso.ufl.edu