

NANOTECHNOLOGY IN FOOD, AGRICULTURE AND ENVIRONMENT (AGG 6503)

3 Credits- Every Spring

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CATALOG DESCRIPTION:

Application of nanotechnology in crop production, food processing and preservation, and environmental remediation; behavior of engineered nanoparticles in plant, soil and the environment, and environmental toxicology and regulations of engineered nanoparticles.

PRE-REQUISITES/CO-REQUISITES:

Basic knowledge in soil sciences, soil and water chemistry, environmental sciences or equivalent courses in the related fields; SWS 5050 – Soils for Environmental Professionals

COURSE OBJECTIVES:

This course will cover the fundamentals of nanoscience and nanotechnology, application of nanotechnology in crop production, food processing and preservation, and environmental remediation; behavior of engineered nanoparticles in plant, soil and the environment, and environmental toxicology and regulations of engineered nanoparticles.

- Understand basic concepts, principles, and components of nanotechnology. At the end of the course all students will be able to describe basic theory of nanoscience and nanotechnology.
- Develop skills in the creation and characterization of nanomaterials. At the end of the course all students will be familiar with methods for characterizing important properties of nanomaterials commonly used in agriculture and the environment.
- Gain expertise in application of nanotechnology in agriculture, food, and environment. At the end of the course all students will be able to apply nanotechnology to solve some problems in the fields of food, agriculture, and environment.
- Learn toxicology of engineered nanoparticles (EPs) and current methods of assessment. At the end of the course all students will be able to understand potential impact of EPs and conduct simple environmental risk assessment.

DELIVERY METHOD: Online-Canvas E-Learning System and audio/video lectures (with powerpoint presentations and reading materials)

OFFICE HOURS: Open for e-mail and phone call at any time or chat room by appointment.

FREQUENCY: Spring semester, every year

TARGET STUDENTS: Graduate students who wish to expand their knowledge in emerging sciences and become a specialist in food, agriculture, and environment.

CLASS ATTENDANCE: Attendance of chat sessions is mandatory. There is 5% grade for chat room participation.

CHAT ROOM SESSION: Chat room session is scheduled 5-7 PM every Tuesday except for public holidays.

GRADING:	Homework/Quizzes:	30%
	Chat room attendance	5%
	Mid-term Examination:	20%
	Project	20%
	Final Examination	25%
	Total	100%

Students are responsible for satisfying all academic objectives as defined by the instructor. Absences count from the first class meeting.

A	94 – 100%
A-	90 – 93.9%
B+	87 – 89.9%
B	83 – 86.9%
B-	80 – 82.9%
C+	77 – 79.9%
C	73 – 76.9%
C-	70 – 72.9%
D+	67 – 69.9%
D	63 – 66.9%
D-	60 – 62.9%
E	< 60%

ASSIGNMENTS/ EXAMS/PROJECTS: Nanotechnology is one of the rapidly-developing frontiers with application in many fields including food, agriculture /LECTURES and environment. This course involves new concepts, principles, application, and measurements. It is important that the students have a good understanding of the concepts and principles. Therefore, in addition to lectures, the students will be also provided with supplementary course materials to read and homework to do at the end of each chapter. The students are required to submit homework report timely in order to obtain scores. The mid-term examination is designed to check the study progresses of each student so that some adjustment can be made based on student's performance. In this course, each student is required to conduct an independent nanotechnology project. For this project, students will select one of the nanotechnology application areas (food processing/preservation, agricultural production/nanofertilizers, soil and water quality, and environment-pollution control/toxicology, *etc.*), conduct a literature review based on journal articles, book chapters, and/or proceeding papers, discuss the characteristics of the concept/approach, its limitations, and benefits, submit a report, and present results of their independent study.

TEXTBOOK/REFERENCES:

No textbook is required. Reference books, journal articles, and related information links are provided on course website and in disk. Some examples of general readings that support several topics are listed as follows:

Reference Books:

- Poole Jr., C. A., and F. J. Owens (ed).2003.Introduction to nanotechnology. John Wiley & Sons, Hoboken, NJ, ISBN 0-471-07935-9.
- Sellers, K., C. Mackay, L. L. Bergeson, S. R. Clough, M. Hoyt, J. Chen, K. Henry, and J. Hamblen (eds.). 2009. Nanotechnology and the Environment. CRC Press, Boca Raton, FL.
- Wiesner, M. R. and J. Y. Bottero (ed). 2007. Environmental Nanotechnology: application and impacts of nanomaterials. The McGraw-Hill Co, New York.
- Batley, G. E., J. K. Kirby, and M. J. McLaughlin. 2011. Fate and risks of nanomaterials in aquatic and terrestrial environments. *Accounts of Chemical Research* 46: 854-862.
- Bergeson, L. L. 2013. Sustainable nanomaterials: Emerging governance systems. *ACS Sustainable Chemistry and Engineering* 1: 724-730.
- Rico, C. M., S. Majumdar, M. Duarte-Gardea, J. R. Peralta-Videa, and J. L. Gardea-Teooredy. 2011. Interaction of nanoparticles with edible plants and their possible implications in the food chain. *Journal of Agricultural and Food Chemistry* 59: 3485-3498.
- Weir, A, P. Westerhoff, L. Fabricius, K. Hristovski and N. von Goetz. 2012. Titanium dioxide nanoparticles in food and personal care products. *Environmental Science and Technology* 46: 2242-2250.

Journal Articles:

1. National Science and Technology Council, 2000. National Nanotechnology Initiative: Leading to the next industrial revolution. A report by the Interagency Working Group on Nanoscience, Engineering and Technology. Washington, D.C.
2. ASTM International, 2006. Designation: E 2456-06. Standard Terminology Relating to Nanotechnology.
3. Wang, Z.L., Y. Liu, and Z. Zhang. (Ed.). 2002. Handbook of Nanophase and Nanostructured Materials: Synthesis/ Characterization / Materials Systems and Applications I/Materials Systems and Applications II. Springer Science & Business Media.
4. Bakshi S. et al, 2015. Natural nanoparticles: implications for environment and human health. *Critical Reviews in Environmental Science and Technology* 45:861–904
5. Hartland A. et al, 2013. The Environmental Significance of Natural Nanoparticles. *Nature Education Knowledge* 4(8):7
6. Sharma et al. 2015. Natural inorganic nanoparticles–formation, fate, and toxicity in the environment. *Chemical Society Reviews* 44: 8410-8423.
7. Sekhon, B. S. 2014. Nanotechnology in agri-food production: an overview. *Nanotechnology, Science and Applications* 7, 31.
8. Mousavi, S. R., & Rezaei, M. 2011. Nanotechnology in agriculture and food production. *J Appl Environ Biol Sci*, 1(10), 414-419.

9. Gogos, A., Knauer, K., and Bucheli, T.D. 2012. Nanomaterials in plant protection and fertilization: current state, foreseen applications and research priorities. *J. Agric. Food Chem.* 60: 9871-9792.
10. Weiss J., P. Takhistov, and D. J. McClements. 2006. Functional materials in food nanotechnology. *J. Food Sci.* 71:R107-R116.
11. Habuda-Stanic M. and M. Nujic. 2015. Arsenic removal by nanoparticles: a review. *Environ. Sci. Pollut. Res.* 22: 8094-8123.
12. Kasaraneni V. R., L. A. Schiffman, T. B. Boving, and V. Oyanedel-Craver. 2014. Enhancement of surface runoff quality using modified sorbents. *Sustainable Chem. & Eng.* 2: 1609-1615.
13. Upadhyayula et al. 2009. Application of carbon nanotube technology for removal of contaminants in drinking water: a review. *Science of the Total Environment* 408: 1-13.
14. Klaine, S. J., Alvarez, P. J., Batley, G. E., Fernandes, T. F., Handy, R. D., Lyon, D. Y., & Lead, J. R. 2008. Nanomaterials in the environment: behavior, fate, bioavailability, and effects. *Environmental Toxicology and Chemistry* 27(9), 1825-1851.
15. Lin D et al. 2010. Fate and transport of engineered nanomaterials in the environment. *Journal of Environmental Quality* 39: 1896-1908.
16. Zhu et al. 2012. Effect of surface charge on the uptake and distribution of gold nanoparticles in four plant species. *Environmental Science & Technology* 46: 12391-12398.
17. Bergeson, L. L. 2013. Sustainable nanomaterials: emerging governance systems. *ACS Sustainable Chemistry & Engineering* 1: 724-730.
18. Rico C. M. et al. 2015. Physiological and biochemical response of soil-grown barley (*Hordeum vulgare* L.) to cerium oxide nanoparticles. *Environ Sci Pollut Res* 22:10551–10558.
19. Gonzalez-Melendi, P. et al. 2008. Nanoparticles as smart treatment-delivery systems in plants: assessment of different techniques of microscopy for their visualization in plant tissues. *Annals of Botany* 101: 187–195.
20. TASCIOTTI, E. et al. 2008. Mesoporous silicon particles as a multistage delivery system for imaging and therapeutic applications. *Nature nanotechnology* 3: 151-157.

COURSE CHAPTERS

Nanotechnology in Agriculture, Food and Environment

Module I Basic concepts and principles of nanotechnology

- Chapter 1 Fundamentals of Nanoscience and Nanotechnology
- 2 Nanoscale Materials: Definition and Properties
 - 3 Manufacturing and Characterization of Nanoparticles
 - 4 Natural Nanoparticles and Their Role in Soil and Water Quality

Module II Nanotechnology Applications

- 5 Nanotechnology Application in Agriculture

6	Nanotechnology Application in Food Sciences
7	Nanotechnology Application in the Environment
Module III	Behavior, environmental toxicology and regulations of nanoparticle
8	Environmental Fate and Transport of Engineered Nanoparticles
9	Environmental Toxicology of Engineered Nanoparticles
10	Environmental Regulation of Engineered Nanomaterials
Module IV	Smart nano-delivery systems
11	Smart Nanoscale Systems for Targeted Delivery of Drugs, Nutrients and Pesticides

Teaching schedule*

Week	Topics covered	Lectures/reading materials/assignments
1	Introduction/ historic development and fundamentals of nanoscience and nanotechnology	Lecture 1/Chapter 1 Reading materials Assignment 1
2	Nanoscale materials: definition and properties	Lecture 2/Chapter 2 Reading materials Assignment 2
3	Manufacturing and characterization of nanoparticles	Lecture 3/Chapter 3 Reading materials Assignment 3
4	Natural nanoparticles and their role in soil and water quality	Lecture 4/Chapter 4 Reading materials
5	Nanotechnology application in agriculture I & II	Lectures 5/Chapters 5 Reading materials Assignment 5
6	Nanotechnology application in food sciences	Lecture 6/Chapter 6 Reading materials Assignment 5
7		Spring break
8	Nanotechnology application in the environment	Lecture 7/Chapter 7 Reading materials Assignment 6
9	Course review	Mid-term exam
10	Environmental fate and transport of engineered nanomaterials	Lecture 8/Chapter 8 Reading materials Assignment 7
11	Environmental toxicology of engineered nanoparticles	Lecture 9/Chapter 9 Reading materials Assignment 8
12	Environmental regulation of engineered nanomaterial	Lecture 10/Chapter 10 Reading materials
13	Smart Nanoscale Systems for Targeted Delivery of Drugs, Nutrients and Pesticides	Lecture 11/Chapter 11 Reading materials
14-15	Course review	

* Dates for topics or exams are subject to change.

GRADES AND GRADE POINTS: For information on current UF policies for assigning grade points, see <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

ABSENCES AND MAKE-UP WORK: Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found at: <https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>.

ACADEMIC HONESTY: As a student at the University of Florida, you have committed yourself to uphold the Honor Code, which includes the following pledge: "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity." You are expected to exhibit behavior consistent with this commitment to the UF academic community, and on all work submitted for credit at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment."

It is assumed that you will complete all work independently in each course unless the instructor provides explicit permission for you to collaborate on course tasks (e.g. assignments, papers, quizzes, exams). Furthermore, as part of your obligation to uphold the Honor Code, you should report any condition that facilitates academic misconduct to appropriate personnel. It is your individual responsibility to know and comply with all university policies and procedures regarding academic integrity and the Student Honor Code. Violations of the Honor Code at the University of Florida will not be tolerated. Violations will be reported to the Dean of Students Office for consideration of disciplinary action. For more information regarding the Student Honor Code, please see: <http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code>.

SOFTWARE USE: All faculty, staff, and students of the University of Florida are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

CAMPUS RESOURCES:

Health and Wellness

U Matter, We Care:

If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center:

<http://www.counseling.ufl.edu/cwc/Default.aspx>, 392-1575;

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department, 392-1111 (or 9-1-1 for emergencies).
<http://www.police.ufl.edu/>

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu, <https://lss.at.ufl.edu/help.shtml>.

University Counseling & Wellness Center, 3190 Radio Road, 352-392-1575,

www.counseling.ufl.edu/cwc/

Counseling Services

Groups and Workshops

Outreach and Consultation

Self-Help Library

Wellness Coaching

U Matter We Care, www.umatter.ufl.edu/

Career Resource Center, First Floor JWRU, 392-1601, www.crc.ufl.edu/

Library Support, <http://cms.uflib.ufl.edu/ask> . Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.

<http://teachingcenter.ufl.edu/>

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.

<http://writing.ufl.edu/writing-studio/>

Student Complaints Campus: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>

STUDENTS WITH DISABILITIES: The Disability Resource Center coordinates the needed accommodations of students with disabilities. This includes registering disabilities, recommending academic accommodations within the classroom, accessing special adaptive computer equipment, providing interpretation services and mediating faculty-student disability related issues. Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, www.dso.ufl.edu/drc/) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

ONLINE COURSE EVALUATION: Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

STUDENT COMPLAINTS: Each online distance learning program has a process for, and will make every attempt to resolve, student complaints within its academic and administrative departments at the program level. See <http://distance.ufl.edu/student-complaints> for more details.