Course Syllabus

Division of Environmental Health Sciences (EHS)
College of Public Health (CPH)
Department of Food Science & Technology (FST)
College of Food, Agriculture & Environmental Sciences (CFAES)
The Ohio State University

WATER CONTAMINATION: SOURCES AND HEALTH IMPACT

PUBHEHS 7360
FDSCTE 7360

Autumn Semester, 3 credit

Instructor: Jiyoung Lee, PhD
Associate Professor
Division of Environmental Health Sciences
Department of Food Science & Technology

Office location: 406 Cunz Hall
1841 Neil Avenue
(phone) 292-5546

E-mail: lee.3598@osu.edu

Class Time and Location: Thur 5:15-8:00 pm at Cunz Hall 180

Instructor's Office Hours: Email or call to schedule an appointment

TA Name, email, and office hours: Igor Mrdjen, PhD student
Office: Cunz Hall 400B
Email: mrdjen.1@osu.edu
Office hours: by appointment

TA responsibilities:
The TA assigned to the course will hold regular office hours and answer questions from students who need help with class material. The TA assists with scoring quiz and uploading course materials; however, final grades will be assigned by the professor. Any questions regarding grading should be directed to the professor and not the TA.

Description:
Water contamination affects our health and daily life in various ways. It has been one of the biggest pollution problems for the past decades and is gaining new attention since we now face and expect extreme weather events more frequently due to climate change and

the water resources are getting limited. The water contaminants include biological infectious agents, chemical pollutants and other toxic agents that are transmitted primarily via water, but also air, soil, food and human activities. The lectures are designed to provide understanding about the sources of contamination, the pathways of transport, public health impacts and interventions. Emerging issues as well as fundamental issues will be discussed.

Class Format:
This course is lecture-based. Small group discussions and brief presentations are incorporated throughout the course.

Course Objectives: After successfully completing the course, students will be able to:

1. Provide an overview of the impact of water pollution on human health.
2. Describe the environmental contaminants and associated diseases.
3. List the common biological and chemical pollutants and federal guidelines about water-related pollution.
4. Describe pathways of pollutant transmission via water and other related matrices.
5. Outline biomonitoring, aquatic toxicity and other emerging contaminant issues.
6. Describe the treatment technology for remediating water contamination.

This course covers following competencies:

MPH Specialization

1. Explain the significance of the community and workplace environment to public health.
2. Outline the health threat that natural and anthropogenic contaminants in the environment can pose to population health.
3. Compare the fate, transport, and human uptake of chemical and biological agents.
4. Explain the physiological factors that influence human exposure and the uptake of chemical and biological environmental agents.
5. Critique and conduct human risk assessments.
6. Identify and explain individual (e.g., genetic, physiologic and psychosocial) and community (social, built, economic, race) susceptibility factors that heighten the risk for populations for adverse health outcomes from environmental hazards.
7. Define, recognize, and explain environmental justice and its significance as a public health issue.
8. Use various risk management and risk communication approaches for environmental hazards.
9. Summarize the underlying mechanisms of toxicity resulting from exposure to environmental agents.
10. Describe federal and state regulatory programs, guidelines and authorities relevant to environmental and occupational health.
11. Access state, federal, and local resources for assessing environmental and occupational health.
12. Work with other public health disciplines (e.g., nurses, physicians, veterinarians, epidemiologists, biostatisticians) to address environmental and occupational health concerns.
13. Compare the principle components and influencing factors in the exposure continuum from source to disease.

14. Determine the role of exposure assessment in environmental and occupational health.

MS Competencies

1. Read the scientific literature in the student's field and critique the methods and results.
2. Conduct literature reviews to evaluate the state of the science regarding specific topics.
3. With input from the student's advisor, identify an unanswered research question, formulate a hypothesis, and design a research study.
4. Write a research proposal.

PhD competencies

1. Conduct thorough literature reviews to summarize and evaluate the state of the science regarding new topics in the student's general area or specialization.
2. Identify gaps in that literature and formulate research questions designed to address those gaps.
3. Formulate hypotheses and design a research study using the appropriate research methods and approaches.
4. Prepare a research proposal to address the research question, with particular attention to study design; subject selection; measurement of variables; methods for sample size determination, data collection, data management and data analysis; and interpretation of results.

Prerequisite: Previous coursework in college level biology and chemistry are required.

Reading Materials: Reading materials covering the lecture topics are specified in the syllabus and will be posted on Carmen.

Grading:

Class attendance and participation	**10 %**
Quiz	**50 %**
Term project	
a. Written paper	**33%**
b. Presentation	**7%**

Course grades are determined by points. The minimum percentage to achieve a given grades are as follows;

grade		87	B+	77	C+	67	D+
93	A	83	B	73	C	63	D
90	A-	80	B-	70	C-	60	D-

Term paper:

Topics should be about 'water contamination' issues that have 'human health impact'. Team effort is highly encouraged (e.g. 2-3 people per team). If you should do in solo, check with the instructor. The format is a research grant proposal. The term paper should include **Cover Page** that has title of the project, the student's name, email address, department, advisor's name and an abstract. The abstract should have 150 words or less describing the summary of your project. Key words should be provided (5 max) at the end of the abstract. **Project Narrative** should contain following components:

1) Introduction that clearly introduces the topic of the project (identify the contaminant(s), sources, transport, how exposure happens, health impact, etc) and why this work is important and how the project will improve water quality and human health. Clearly outline the objectives of the project
2) Significance and Innovation that clearly state why your project is innovative and clarify 'what the problem is', the knowledge gap and significance of the project
3) Approach that define the research questions and describe the activities proposed and methods to be used in carrying out the proposed project, including the feasibility of the methods, expected outcomes, means by which results will be analyzed, how results will be used, pitfalls and limitations of the propose procedures.

Graphical Abstract should summarize the content of your project in a concise, pictorial form designed to capture the main theme and approach of your project. The graphical abstract should fit in a page.

Proper literature review and accurate citations should be included. It should be with 1-inch margins in Microsoft Word and 12-point font size. The Cover Page and Project Narrative has **3-page limit**. Budget is not needed, however, it can be attached and page limit is not applied. Curriculum vitae should be attached (1-page limit per person). The CV and references are not counted toward the 3-page limit. Everything should be in **one Microsoft Word or PDF file** with the following order: Graphical Abstract (1 page max), Cover Page and Project Narrative (3 page max), References, CV, and budget (optional).

Presentation is 20 min per team (15 min for presentation and 5 min for Q and A). The grade of presentation is based on showing full understanding about the chosen topic, critical and logical thinking, answering questions, and effective presenting skills. Powerpoint slides are required and should be uploaded at Carmen Dropbox by 11am on the assigned presentation day. During presentation, entire class should listen carefully and engage in Q and A session. The listeners should provide honest feedback and evaluation for the presenters using the evaluation form.

Quizzes: Closed book. In-class. Multiple choice, True/false, and short answer format. Quizzes will be taken frequently.

Carmen:
Lecture notes and reading materials will be posted on Carmen. All news and instructions for quiz, term paper and other course-related information will be posted on CourseHome of Carmen.

Class Policies:
Any **unexcused absence** will be counted in the Class Attendance grade. Cell phone usage is **not allowed** during the class unless it is cleared earlier for legitimate reasons. Computer can be used only for seeing the lecture notes. Other usages of a computer are not allowed.

Accommodation for special needs:
If you need an accommodation based on the impact of a disability, you should contact me to arrange an appointment as soon as possible. At the appointment we can discuss the course format, anticipate your needs and explore potential accommodations. I rely on the Office for Disability Services for assistance in verifying the need for accommodations and developing accommodation strategies. If you believe you need accommodation and have

not previously contacted the Office for Disability Services, I encourage you to do so (more information available at http://www.ods.ohio-state.edu/).

Academic Integrity:
Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University, the College of Public Health, and the Committee on Academic Misconduct (COAM) expect that all students have read and understood the University's *Code of Student Conduct* and the College's *Student Handbook*, and that all students will complete all academic and scholarly assignments with fairness and honesty. The *Code of Student Conduct* and other information on academic integrity and academic misconduct can be found at the COAM web pages (http://oaa.osu.edu/coam/home.html). Students must recognize that failure to follow the rules and guidelines established in the University's *Code of Student Conduct*, the *Student Handbook*, and in the syllabi for their courses may constitute "Academic Misconduct."

The Ohio State University's *Code of Student Conduct* (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the University, or subvert the educational process." Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Please note that the use of material from the Internet without appropriate acknowledgement and complete citation is plagiarism just as it would be if the source were printed material. Further examples are found in the *Student Handbook*. Ignorance of the *Code of Student Conduct* and the *Student Handbook* is never considered an "excuse" for academic misconduct.

If I suspect a student of academic misconduct in a course, I am obligated by University Rules to report these suspicions to the University's Committee on Academic Misconduct. If COAM determines that the student has violated the University's *Code of Student Conduct* (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in the course and suspension or dismissal from the University. If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.

Course schedule:

1. 8/24/17 Course Overview & Introduction of Water

Readings:

Reynolds, K.A., Mena, K.D. and Gerba, C.P., 2008. Risk of waterborne illness via drinking water in the United States. In *Reviews of environmental contamination and toxicology* (pp. 117-158). Springer New York.

Levin, RB, et al. 2002. U.S. Drinking Water Challenges in the Twenty-First Century. *Environ Health Perspect.* 110 (Suppl.1):43-52.

Ford, T. 2006. Emerging issues in water and health research. *J Wat Health.* 4 (Supp):59-65.

2. 8/31/2017 Water contaminants and problems: US and worldwide

Readings:
National Primary Drinking Water Regulations:

https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

Contaminant Candidate List (CCL):

- Final CCL4 Chemical Contaminants List
  https://www.epa.gov/ccl/chemical-contaminants-ccl-4
- Final CCL4 Microbial Contaminants List
  https://www.epa.gov/ccl/microbial-contaminants-ccl-4

Healy, J, Mouhaman, A, Lee, S, Garabed, R, Moritz, M, Piperata, B, Tien, J, Bisesi, M, Lee, J. 2014. Muddying the Waters: A New Area of Concern for Drinking Water Contamination in Cameroon. *International Journal of Environmental Research and Public Health*. 11:12454-12472.

Schwarzenbach, R. P., Egli, T., Hofstetter, T. B., von Gunten, U. Wehrli, B. (2010). Global Water Pollution and Human Health. Annu. Rev. Environ. Resour. 35:109-136.

Wu, C. et al. 1999. Water pollution and human health in China. *Environmental Health Perspectives*. 107:251-256.

Aldhous P. The world's forgotten crisis. Nature. 422 (20 March 2003):251.

Clarke, T. Delta blues. Nature. 422 (20 March 2003): 254-256.

3. 9/7/17 Agricultural runoff and urban runoff & storm water management (bioretention)

Readings:
Tsihrintzis, V.A. and R. Hamid. 1997. Modeling and management of urban stormwater runoff quality: a review. Water Resources Management 11:137-164

Gaffield, S. J., R. L. Goo, L. A. Richards, and R.J. Jackson. 2003. Public health effects of inadequately managed stormwater runoff. Am J Public Health **93**:1527–1533.

U.S. Geological Survey (USGS) website
- Runoff: http://ga.water.usgs.gov/edu/runoff.html
- Surface runoff: http://ga.water.usgs.gov/edu/watercyclerunoff.html
  - Urban runoff: http://ga.water.usgs.gov/edu/urbanrun.html

Lefevre, G.H., Novak, P.J., Hozalski, R.M., 2012. Fate of naphthalene in laboratory-scale bioretention cells: implications for sustainable stormwater management. Environ. Sci. Technol. 46, 995–1002.

Davis, A.P., Hunt, W.F., Traver, R.G., Clar, M., 2009. Bioretention Technology: Overview of Current Practice and Future Needs. J. Environ. Eng. 135, 109–117.

US EPA, Water: Best Management Practices, Bioretention, http://water.epa.gov/polwaste/npdes/swbmp/Bioretention-Rain-Gardens.cfm

4. 9/14/17 **Issues Related to Drinking Water Distribution System** (Dr. Mark Weir)

Readings:
Ashbolt, N. 2015. Microbial Contamination of Drinking Water and Human Health from Community Water Systems. *Curr Envir Health Rpt.* 2: 95-106.

5. 9/21/17 **Freshwater harmful algal blooms & cyanotoxins: causes, health impact, monitoring, guidelines & mitigation**

Readings:
Harmful algal blooms: Information for public water systems (Ohio EPA) http://epa.ohio.gov/ddagw/HAB.aspx

Public Water System HAB Response Strategy
http://epa.ohio.gov/Portals/28/documents/habs/PWS_HAB_Response_Strategy.pdf

Zhang, F, Lee, J, Liang, S, Shum, CK. 2015. Cyanobacteria Blooms and Non-alcoholic Liver Disease: Evidence from a County Level Ecological Study in the United States. *Environmental Health.* http://www.ehjournal.net/content/14/1/41/abstract

Lee, J, Lee, S, Jiang, X. 2017. Cyanobacterial Toxins in Freshwater and Food: Important Sources of Exposure to Humans. Annual Review of Food Science and Technology. 8:281-304. http://www.annualreviews.org/doi/abs/10.1146/annurev-food-030216-030116

Cheung, MY. Liang, S, Lee, J. 2013. Toxin-producing Cyanobacteria in Freshwater: A Review of their Problems, Impact on Drinking Water Safety, and Efforts for Protecting Public Health. Journal of Microbiology. 51:1:1-10.

Zhang, F, Hu, C, Shum, CK. Liang, S, Lee, J. 2017. Satellite remote sensing of drinking water intakes in Lake Erie for cyanobacteria population using two MODIS-based indicators as a potential tool for toxin tracking. Frontiers in Marine Science. 4:124.

Gorham, T, Jia, Y, Shum, CK, Lee, J. Ten-Year Survey of Cyanobacteria Blooms in Ohio's Waterbodies Using Satellite Remote Sensing. Harmful Algae. 66:13-19.

Marion, J. Lee J, Wilkins J, Lemeshow S, Lee C, Waletzko E, Buckley T. 2012. *In Vivo* Phycocyanin Flourometry as a Rapid Screening Tool for Predicting Elevated Microcystin Concentrations at Inland Beaches. *Environmental Science & Technology.* 46:8:4523-4531.

Carmichael, W. et al. 2016. Health impacts from cyanobacteria harmful algae blooms: Implications for the North American Great Lakes. *Harmful Algae.* 54:194-212.

Ibelings, B. et al. 2014. Current approaches to cyanotoxin risk assessment and risk management around the globe. *Harmful Algae.* 40:63-74. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4587991/

Paerl, H. et al. 2016. Mitigating cyanobacterial HABs in aquatic ecosystems impacted by climate change and anthropogenic nutrients. *Harmful Algae*. 54:213-222.

❖ **9/21/17** **Group Discussion:**
- **US water problems & global water crisis**
- **What concerns do we have?**

6. 9/28/17 **Endocrine disruptors in water** (Dr. Zuzana Bohrerova)

Readings:
Melnick, R. et al. 2002. Summary of the National Toxicology Program's report of the endocrine disruptors low-dose peer review. Environ Health
Perspect. 110: 427–431

World Health Organization. State of the Science of Endocrine Disrupting Chemicals – 2013. Ed. Bergman, A. et al.

❖ **9/28/17 Quiz (Lecture 1- 4)**

7. 10/5/17 Recreational water: contamination sources, pathogens and health impact

Readings:
US Environmental Protection Agency. 2012. Recreational Water Quality criteria. EPA 820-F-12-058, Office of Water, Office of Research and Development. Washington, Washington, D.C.

Marion, J, Lee, C, Lee, CS, Lemeshow, S, Wang, Q, Buckley, T, Saif, L, Lee, J. 2014. Integrating Bacterial and Viral Water Quality Assessment to Predict Swimming-Associated Illness at a Freshwater Beach. *PLoS One.* 9:11:e112029.

Lee, CS, Lee, C, Marion, JW, Wang, Q, Saif, L, Lee, J. 2014. Occurrence of Human Enteric Viruses at Freshwater Beaches during Swimming Season and Its link to Water Inflow. *Science of the Total Environment*. 472:757-766.

OSU's tradition, Mirror Lake Jump as an example of extreme recreational water event: History & diverse perspectives

Readings:
Marion, J, Burrowes, V, Lee, C, Lee, J. 2015. Changes in Microbial Water Quality Associated with an Extreme Recreational Water Event in Ohio, United States. *Water Quality, Exposure, and Health.* (Epub ahead of print) doi: 10.1007/s12403-015-0164-8

Lee, CS, Lee, J. 2010. Evaluation of new *gyrB*-based real-time PCR system for the detection of *B. fragilis* as an indicator of human-specific fecal contamination. *Journal of Microbiological Methods.* 82:3:311-318.

8. 10/12/17 Autumn Break (no class)

9. 10/19/17 Water and agriculture: Lessons learned from Ohio

Ohio Farm Bureau Federation: Water quality issues
- Plan to reduce phosphorus entering Lake Erie
- Erie County Farm Bureau water quality tour
- 4R Technology Review
- Ohio farmers testifies before congress about agriculture community's water quality efforts
- Farmers' efforts having positive impact on state's water quality

https://ofbf.org/tag/clean-water/

❖ **10/19/17 Group Discussion about Term Paper Topics**

10. 10/26/17 Climate Change: impact on water quality & climate-water-food nexus

Readings:
Khan, AE. et al. Drinking water salinity and maternal health in coastal Bangladesh: Implications of climate change. Environ Health Perspect. 119(9):1328-1332.

Patz, JA. et al. 2000. The potential health impacts of climate variability and change for the United States: executive summary of the report of the health sector of the U.S. National Assessment. Environ Health Perspect.108(4):367–376.

Patz JA, Vavrus SJ, Uejio CK, McLellan SL. 2008. Climate change and waterborne disease risk in the Great Lakes region of the U.S. Am J Prev Med. 35(5):451-8.
Ge, C, Lee, C, Lee, J. 2012. The Impact of Extreme Weather Events on Salmonella Internalization in Lettuce and Green Onion. *Food Research International* 45:2:1118-1122.

Ge, C, Lee, C, Nagle, E, Li, J, Kleinhenz, M, Gardner, D, Lee, J. 2014. Impact of phytopathogen infection and extreme weather events on internalization of *Salmonella* Typhimurium in lettuce. *International Journal of Food Microbiology.*168-169:24-31

❖ **10/26/17 Quiz (Lecture 5- 9)**

11. 11/2/17 Lake Erie Critical Issues and the Work being done to address these Concerns

Readings:
Lake Erie Programs. Ohio EPA.
http://www.epa.state.oh.us/dsw/lakeerie/index.aspx

Ohio Lake Erie Phosphorus Task Force II Final Report
http://www.epa.state.oh.us/portals/35/lakeerie/ptaskforce2/Task_Force_Report_October_2013.pdf

12. 11/9/17 Ground Water Issues (Dr. Motomu Ibaraki)

Readings:
US EPA. Ground Water Contamination
https://www.epa.gov/sites/production/files/2015-08/documents/mgwc-gwc1.pdf

Wasserman, Gail A., et al. 2014. A cross-sectional study of well water arsenic and child IQ in Maine schoolchildren. *Environmental Health* 13.1:23.

Well Water Should Be Tested Annually to Reduce Health Risks to Children
https://www.niehs.nih.gov/news/newsroom/releases/2009/may26/index.cfm

13. 11/16/17 Water and Energy: Hydraulic fracturing and its impact on water quality

Readings:
Kerr RA. (2010) Natural Gas From Shale Bursts Onto the Scene. Science 328: 1624-1626.
http://www.sciencemag.org/content/328/5986/1624.full.pdf

Vengosh, A, Warner, N, Jackson, R, Darrah, T. (2013) The effects of shale gas exploration and hydraulic fracturing on the quality of water resources in the United States. Peocedia Earth and Planetary Science 7:863-866.

Gregory,K.B., Vidic,R.D. and Dzombak,D.A. (2011) Water Management Challenges Associated with the Production of Shale Gas by Hydraulic Fracturing. Elements 7, 181-186.

http://wp.cedha.net/wp-content/uploads/2012/11/Water-Management-Challenges-Associated-with-the-Production-of-Shale-Gas-by-Hydraulic-Fracturing.pdf

Ohio Department of Natural Resources. The facts about hydraulic fracturing. http://oilandgas.ohiodnr.gov/portals/oilgas/pdf/Facts-about-HFracturing.pdf

Ohio EPA. 2012. Drilling for natural gas in the Marcellus and Utica Shales: Environmental regulatory basics http://www.epa.ohio.gov/portals/0/general%20pdfs/generalshale711.pdf

Ohio EPA. 2012. Sources of water for hydraulic fracturing fluids http://www.epa.state.oh.us/Portals/0/general%20pdfs/sources%20of%20water%20for%20hydraulic%20fracturing%20fluids.pdf

14. 11/23/17 Thanksgiving (No class)

15. 11/30/17 Term project presentations and discussion

❖ **11/30/17 Quiz (Lecture 10-13)**