THE OHIO STATE UNIVERSITY
COLLEGE OF PUBLIC HEALTH

PUBHEPI 5420
Modeling Transmission Processes and Control of Infectious Diseases in Humans & Animals
3 credit hours – Fall, 2017

Instructors:

Name	Email	Office Address	Office Hours
Dr. Rebecca Garabed	Garabed.1@osu.edu	A100G Sisson Hall	By appointment
Dr. Laura Pomeroy	Pomeroy.26@osu.edu	380G Cunz Hall	Wednesday 1-2pm
Dr. Andrew Calinger-Yoak	Yoak1@otterbein.edu	Otterbein University	By appointment
Ms. Sarah Mielke	Mielke.153@osu.edu	A100Z Sisson Hall	By appointment

Class Time and Location: Fridays, 2 pm to 5 pm in Wenger Computer Laboratory, 215 Veterinary Medical Academic Building (VMAB)

Course description: This course provides an introduction to applied infectious disease modeling suitable for health professionals and graduate students intending to pursue further study of the use of this research tool.

Class Format: One hour of lecture and discussion followed by two hours of computer laboratory exercises.

Course Objectives

- Derivation and application of basic theories of infectious pathogen dynamics including thresholds for disease, herd immunity, and basic reproduction number.
- Identification and development of simulation models of diseases with different transmission pathways, parameterization of the models using data from field/lab or literature, and assessment of the model validity.
- Employment of models to assess health risks associated with infectious disease in humans/animals and evaluation of different disease control and prevention strategies.
- Employment of models to assess health impacts associated with changes in anthropogenic and environmental factors in the context of infectious diseases.
- Critique of modeling papers on infectious diseases/pathogens.

Core Competencies

Ph.D. STUDENT COMPETENCIES:

1. Explain how the core public health concepts of biostatistics, epidemiology, environmental health, health behavior/health promotion, and health administration relate to the student's area of specialization.
2. Synthesize and critique existing literature in student's area of specialization to identify gaps in the evidence base and justify their importance for public health.
3. Apply relevant theories and conceptual models to inform and ground research design and interpretation.
4. Formulate hypotheses, plan and conduct a research study using appropriate research methods, and ethical approaches.

5. Communicate in writing and orally a research study's purpose, methods, results, limitations, conclusions and public health relevance to both informed and lay audiences.

M.P.H. STUDENT CORE COMPETENCIES:

Integrative and Interdisciplinary:

1. apply appropriate descriptive and inferential statistical techniques to public health data and interpret results of statistical analyses in the context of public health research and evaluation;
2. apply foundational principles of environmental health science to categorize sources and types of contaminants, matrices involved, pathways for and modes of exposure, associated health effects and societal issues, approaches to control, and major regulations;
3. apply epidemiologic principles to investigate the distribution of risk factors and disease in the population to improve public health;
4. apply evidence-based concepts of health behavior and health promotion to the design of public health messages and strategies;
5. demonstrate effective written and oral skills for communicating with different audiences in the context of professional public health activities;
6. collaborate with multidisciplinary groups to recognize and evaluate public health issues and develop strategies for intervention.

M.P.H. STUDENT COMPENTENCIES – EPIDEMIOLOGY SPECIALIZATION

1. Choose the correct analysis for data obtained from an epidemiologic investigation,
2. Analyze and interpret data obtained from an epidemiologic investigation,
3. Demonstrate familiarity with the basic content and issues in infectious disease epidemiology,
4. Identify the natural histories of major types of disease and their relevance to epidemiologic investigations.
5. Use appropriate computer software for the management and analysis of epidemiologic data.

M.P.H. STUDENT COMPENTENCIES – ENVIRONMENTAL HEALTH SCIENCE SPECIALIZATION

1. Outline the health threat that natural and anthropogenic contaminants in the environment and pose to population health.
2. Compare the fate, transport, and human uptake of chemical and biological agents.
3. 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.
4. Define, recognize, and explain environmental justice and its significance as a public health issue.
5. Work with other public health disciplines (e.g. nurses, physicians, veterinarians, epidemiologists, biostatisticians) to address environmental and occupational health concerns.

UNDERGRADUATE COMPENTENCIES:

BSPH Core Competencies:

1. Summarize the historic milestones in public health (infectious disease epidemiology).
2. Compare and contrast examples of major domestic and international public health issues (infectious disease transmission and control strategies).
3. Discuss various approaches/strategies for identification, response and intervention to address and attempt to resolve common public health issues.
4. Identify behavioral, demographic and ethical factors and relationships to domestic and international public health issues and determinants of health.

5. Apply the fundamental principles of the five core disciplines of public health (biostatistics; environmental health; epidemiology) to domestic and international population issues.

Public Health Sociology Specialization:

1. Develop quantitative awareness of the multiple-scale and multiple interactions that characterize public health problems.
2. Summarize major factors that contribute to human disease and compromised quality of life.
3. Apply theory to public health issues identified within contemporary society.
4. Analyze and interpret fundamental statistical and epidemiological data.
5. Communicate ideas and results that solve community-based public health problems.
6. Summarize the intervention and disease prevention strategies to sustain and improve quality of life.
7. Write and communicate applicable case summaries.

Environmental Public Health Specialization:

1. Apply principles of math, chemistry, biology to applied science of environmental public health.
2. Summarize major sources, hazardous agents, conditions, and other exposure factors that contribute to environmentally-related human diseases.
3. Apply theory to environmental public health issues identified within indoor/outdoor and occupational/non-occupational settings.
4. Calculate, analyze and interpret fundamental statistical, epidemiological, and environmental monitoring/surveillance and risk assessment data.
5. Summarize management and technical measures and approaches that control human exposure to environmental contaminants.
6. Write and communicate applicable scientific and technical summaries.

Text/Readings

Textbooks not required; textbooks on reserve at Vet Med Library. Journal articles will be provided to you through Carmen.

- Bansal S, Grenfell BT, Meyers LA (2007) When individual behaviour matters: homogeneous and network models in epidemiology. J R Soc Interface 4: 879-891.
- Daley, D.J. & Gani, J. (2005) Epidemic Modeling: an Introduction. Cambridge University Press. New York, NY. ISBN 978-0-521-01467-0.
- Fisman DN (2007) Seasonality of infectious diseases. Annu Rev Public Health 28: 127-143.
- Keeling, M.J. & Rohani, P. (2008) Modeling Infectious Diseases in Humans and Animals. Princeton University Press. Princeton, NJ. ISBN 978-0-691-11617-4. **(Vet Med Library Reserves)**
- Kopec, J.A., et al. (2010) Validation of population-based disease simulation models: a review of concepts and methods. BMC Public Health 10: 710. http://www.biomedcentral.com/1471-2458/10/710.
- Lloyd-Smith, J.O., et al. (2005) Should we expect population thresholds for wildlife disease? TRENDS in Ecology and Evolution 20(9): 511-519. doi: 10.1016/j.tree.2005.07.004
- McCallum, H., et al. (2001) How should pathogen transmission be modeled? TRENDS in Ecology and Evolution 16(6): 295-300. doi: 10.1016/S0169-5347(01)02144-9
- Vynnycky, E. & White, R.G. (2010) An Introduction to Infectious Disease Modelling. Oxford University Press. New York, NY. ISBN 978-0-19-856-576-5 **(Vet Med Library Reserves)**

- Bjørnstad O.N., et al. (2002). Dynamics of Measles Epidemics: Estimating Scaling of Transmission Rates Using a Time Series SIR Model. Ecological Monographs 72(2): 169-184 doi: 10.1890/0012-9615(2002)072
- Gautam R, Bani-Yaghoub M, Neill WH, Dopfer D, Kaspar C, et al. Modeling the effect of seasonal variation in ambient temperature on the transmission dynamics of a pathogen with a free-living stage: example of Escherichia coli O157:H7 in a dairy herd. Prev Vet Med 102: 10-21.
- Hampson, K., et al. (2009) Transmission dynamics and prospects for the elimination of canine rabies. PLoS Biol 7(3):e1000053. doi:10.1371/journal.pbio.1000053
- Keeling, M.J. & Grenfell, B.T. (1997) Disease Extinction and Community Size: Modeling the Persistence of Measles. Science. 275(5296):65-67 doi: 10.1126/science.275.5296.65
- Klepac, P., et al. (2009) Stage-structured transmission of phocine distempter virus in the Dutch 2002 outbreak. Proceedings of the Royal Society B 276, 2469-2476. doi: 10.1098/rspb.2009.0175
- Kopec et al. (2010) Validation of population-based disease simulation models: a review of concepts and methods. BMC Public Health, 10:710 http://www.biomedcentral.com/1471-2458/10/710
- Mitchell, R.M., et al. (2008) Simulation modeling to evaluate the persistence of Mycobacterium avium subsp. paratuberculosis (MAP) on commercial dairy farms in the United States. Preventive Veterinary Medicine 83, 360-380. doi: 10.1016/j.prevetmed.2007.09.006
- Stoddard, S.T., et al. (2009) The role of human movement in the transmission of vector-borne pathogens. PLoS Negl Trop Dis 3(7): e481. doi:10.1371/journal.pntd.0000481
- Tildesley, M.J., Smith, G. & Keeling, M.J. (2012) Modeling the spread and control of foot-and-mouth disease in Pennsylvania following its discovery and options for control. Preventive Veterinary Medicine 104: 224-239. doi: 10.1016/j.prevetmed.2011.11.007
- Ward, M.P. et al. (2009) Simulation of foot-and-mouth disease spread within an integrated livestock system in Texas, USA. Preventive Veterinary Medicine 88: 286–297. doi:10.1016/j.prevetmed.2008.12.006.

Grading

Grades for graduate and professional students will include three components – lab reports, case studies, and a final project. There are 8 reports based on lab work. Specific modeling exercises will be assigned together with lab tutorial materials and the student is expected to follow the tutorial and finish up the exercises and a report emphasizing the application of the concepts learned in lab. A case study modeling paper will be assigned each class to provide an application of the lecture and lab topics. Each student is required to participate in a discussion of the methods used by the researchers and an assessment of how well the modeling techniques are performed and applied to the topic of investigation. Also, students are required to develop a model, use it to answer a question about the disease or its control, and present the results of the investigation in a group (e.g. 2 persons/group). A final report (10-page limit not including figures, references, and appendices) based on the class project is required and due following the last class. To encourage steady progress in the project throughout the quarter, the final project will include due dates for ungraded parts of the final project. While **lab reports and case studies** may be discussed among students and discussion is encouraged, the final report or online discussion post must be the work of the **individual** submitting the work. The **final project** is a **group project** and represents the work of the entire group. Plagiarism will not be tolerated.

Undergraduate students are required to turn in lab reports and discuss case studies as described above. They are also required to evaluate the group project presentations on the final day of class. If undergraduate students wish, they may write a model of a disease of their choice, and turn in the code and a report of how the code is appropriate for the disease they chose including a figure of the model output. A grade of this report can be substituted for the student's lowest lab grade. All work for

undergraduates is intended to be **individual**. The grade distribution for undergraduate students is lab reports (70%), case study discussions (25%), presentation evaluations (5%).

Grading Scale Used

A = 93.0 - 100	C+ = 77.0 - 79.9
A- = 90.0 - 92.9	C = 73.0 - 76.9
B+ = 87.0 - 89.9	C- = 70.0 - 72.9
B = 83.0 - 86.9	D+ = 67.0 - 69.9
B- = 80.0 - 82.9	D = 60.0 - 66.9
	E = Below 60

Exams
There are no exams in this course.

Assignments

Case study 1; Lab 1	due September 8
Case study 2; Lab 2; Project background	due September 15
Case study 3; Lab 3	due September 22
Case study 4; Lab 4	due September 29
Case study 5; Lab 5	due October 6
Case study 6; Lab 6; Project equations	due October 20
Case study 7; Lab 7	due October 27
Case study 8; Lab 8	due November 3
Presentations; final papers	due December 1

Carmen
There will be a Carmen site for this course where all readings, lecture, and laboratory materials will be posted. Students have the option of turning in their written assignments on this site.

Class Policies
All students are expected to be present for each class. Please contact an instructor in advance if you cannot be present on a particular day. Attendance is not required, but all case study discussions and laboratories must be completed individually and on time whether or not you are present in the class and laboratory sessions. Please be considerate of other group members if you cannot meet with them to discuss your project during regular class times. Attendance is required for the final presentations (December 1st) unless you make other arrangements with the instructors (Skype, for example).

There are a limited number of computers available in Wenger Laboratory. It is recommended that you bring a laptop to class if you have one. Software used in the class may not work on iPads and Android tablets, so a laptop is preferred. Please contact the instructor if you have questions about your device or if you do not have a computer to use.

Office of Student Life: Disability Services
Any student who feels s/he may need an accommodation based on the impact of a disability should contact me privately to discuss your specific needs. Please contact the Office of Student Life: Disability Services at 614-292-3307 in Room 098 Baker Hall 113 W. 12th Ave. to coordinate reasonable accommodations for students with documented disabilities (http://www.ods.ohio-state.edu/).

Mental Health Services

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273-TALK or at suicidepreventionlifeline.org.

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 School'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 Outline

Week	*Class*	*Date*	*Topics*	*Instructor(s)*
1	1	Aug 25	Course Introduction & Tutorial Using R	Garabed & Pomeroy
2	2	Sep 1	The Basic SIR Model	Pomeroy
3	3	Sep 8	Thresholds and R_0	Pomeroy
4	4	Sep 15	Choosing Disease States in Models	Garabed
5	5	Sep 22	Control of Infectious Diseases	Garabed
6	6	Sep 29	Host Heterogenity	Pomeroy
7	7	Oct 6	Environmental Heterogenity	Garabed
8	8	Oct 20	Simulation vs. Data Fitting	Pomeroy

Week	*Class*	*Date*	*Topics*	*Instructor(s)*
9	9	Oct 27	Agent Based Models 1	Calinger-Yoak
10	10	Nov 3	Agent Based Models 2	Calinger-Yoak & Mielke
11	11	Nov 17	Class Project Work	Garabed
12	12	Dec 1	Class Project Presentations	Garabed & Pomeroy