ENVIRONMENTAL HEALTH SCIENCES

EHS 500a or b / SBS 500a or b, Independent Study in Environmental Health Sciences  Nicole Deziel
Independent study on a specific research topic agreed upon by both faculty and M.P.H. student. Research projects may be "dry" (i.e., statistical or epidemiologic analysis) or "wet" (i.e., laboratory analyses). The student meets with the EHS faculty member at the beginning of the term to discuss goals and expectations and to develop a syllabus. The student becomes familiar with the research models, approaches, and methods utilized by the faculty. The student is expected to spend at least ten hours per week working on their project and to produce a culminating paper at the end of the term.

EHS 502a / CDE 502a, Physiology for Public Health  Catherine Yeckel
The objective of this course is to build a comprehensive working knowledge base for each of the primary physiologic systems that respond to acute and chronic environmental stressors, as well as chronic disease states. The course follows the general framework: (1) examine the structural and functional characteristics of given physiological system; (2) explore how both structure and function (within and between physiological systems) work to promote health; (3) explore how necessary features of each system (or integrated systems) are points of vulnerability that can lead to dysfunction and disease. In addition, this course offers the opportunity to examine each physiological system with respect to influences key to public health interest, e.g., age, race/ethnicity, environmental exposures, chronic disease, microbial disease, and lifestyle, including the protection afforded by healthy lifestyle factors.

EHS 503b, Public Health Toxicology  Vasilis Vasilou
This course is designed to serve as a foundation for understanding public health toxicology in the twenty-first century. Although it includes the basic principles of toxicology such as dose response and mechanisms of toxicity and cellular defense, this course introduces new concepts of toxicology such as lifetime exposures, low-level exposure to mixtures, high-throughput screening and computational toxicology, and green chemistry in order to understand fundamental interactions between chemicals and biological systems and possible health outcomes. Through the use of case studies and up-to-date published research, the course provides insights into prevention of mortality and morbidity resulting from environmental exposure to toxic substances, the next-generation risk assessment and regulatory toxicology, and the causes underlying the variability in susceptibility of people to chemicals.

EHS 507a, Environmental Epidemiology  Yawei Zhang
This course focuses on application of epidemiology principles and methods to the study of environmental exposures and adverse health outcomes. The major focus on environmental exposures includes both physical and chemical exposures, i.e., environmental chemicals and pesticides, air pollution, radiation, etc. Emphasis is placed on designing population-based studies to investigate environmental issues and human health, critically reviewing literatures and interpreting environmental epidemiologic research data, identifying challenges involved in studying environmental exposures and human health, and analyzing data of environmental exposures and human health. Gene-environment interactions, an essential component when studying environmental hazards in relation to human health, are also addressed and discussed. Prerequisites: EPH 508 and BIS 505, or permission of the instructor.

EHS 508b, Environmental and Occupational Exposure Science  Nicole Deziel
This course examines the fundamental and practical aspects of assessing exposures to environmental agents, broadly defined, in the residential, ambient, and workplace environments. The course provides the knowledge and skills to design and conduct exposure assessments, and has a particular focus on applications to environmental epidemiology and risk assessment. Indirect and direct methods of assessing exposures, such as questionnaires, environmental sampling, biological monitoring, and spatial modeling, are reviewed; and case studies and hands-on projects are presented.

EHS 511b, Principles of Risk Assessment  Gary Ginsberg
This course introduces students to the nomenclature, concepts, and basic skills of quantitative risk assessment (QRA). The goal is to provide an understanding necessary to read and critically evaluate and perform QRA. Emphasis is on the intellectual and conceptual basis of risk assessment, particularly its dependence on toxicology, epidemiology, and exposure assessment. Quantitation of exposure and dose response provides practical skills and theoretical background, although not detailed in mathematical and model derivations. Specific cases consider the use of risk assessment for setting occupational exposure limits, establishing community exposure limits, and quantifying the hazards of environmental exposures to chemicals in air, drinking water, consumer products, and the built environment.

EHS 520b / CDE 520b, Case-Based Learning for Genetic and Environmental Diseases  Josephine Hoh
This course is a gateway to several updated as well as landmark public health stories with insights, analysis, and exclusives, including topics such as epigenetics, development of disease prevention, and personalized medicines. Ethical, political, and economic issues involved in the proper handling of genetic information are also discussed. Lectures are delivered using multimedia methods, including illustrations, cartoons, videos, and smart reads. Students take away the latest developments in tackling the causes of both early- and late-onset diseases; a roundup of key challenges; and skills in the appropriate design of a study, analysis, and interpretation that will be crucial for tackling the disease of their own interest in the future. Active participation in quizzes, writing, sharing personal research and opinions, and presentations are the criteria for the final grade. No prerequisites.

EHS 525a and EHS 526b, Seminar and Journal Club in Environmental Health  Ying Chen
Students are introduced to a wide variety of research topics, policy topics, and applications in environmental health science. The course consists of seminar presentations and journal club meetings that alternate weekly. The seminar series includes biweekly presentations by EHS faculty and outside experts, followed by a discussion period. The journal club series includes student presentations and discussion
on one or two scientific literatures related to the seminar topic of the following week. This course is designed to promote critical thinking regarding current topics in environmental health science as well as to help students develop topics for their theses. Although no credit or grade is awarded, satisfactory performance will be noted on the student’s transcript. Course cr per term

**EHS 530a, Air Pollution and Public Health**  
Krystal Pollitt
Exposure to air pollution is a leading contributor to the global disease burden. This course discusses major emission sources, atmospheric transformation and transport, measurement and modeling techniques for human exposure assessment, and the health impacts of air pollutants. Emphasis is placed on students gaining hands-on experience with measurement (e.g., low-cost sensors, passive samplers) and spatial analysis tools (e.g., ArcGIS) for application to research, public health practice, and community engagement. Through a series of laboratory sessions, students quantitatively characterize indoor and outdoor exposure concentrations and learn methods to critically assess data quality. The public health implications of air pollutant exposure are examined through review of recent epidemiological and toxicological research. The course discusses inequitable distribution of air pollutant exposure across the United States in relation to environmental health disparities. The health benefits of air pollutant intervention strategies in developed and developing regions and implications for policy action are also covered.

**EHS 531b, Meta-research: Evaluating and Synthesizing Research**  
Joshua Wallach
Over the past few years, there have been growing concerns about a possible “reproducibility crisis” in research. Every year, several million new research papers are published, and in biomedicine alone, the number has been increasing exponentially. The rapid accumulation of scientific studies provides an opportunity to conduct meta-research, which is the field that focuses on performing research on existing research. Meta-research, which cuts across all disciplines and relies on a wide range of methodological approaches, involves studying the methods, reporting, reproducibility, evaluation, and incentives related to research. While individual meta-analyses, which generally involve combining data from multiple studies for specific exposure-outcome relationships, fall under the umbrella of “meta-research,” this course is focused on the methods used to evaluate multiple studies (or meta-analyses) across multiple topics. The overall goals of meta-research are to assess key research characteristics and to determine how to improve research practices and evidentiary standards. This course covers some meta-analytical methodology, similar to CDE 650. However, unlike a traditional “meta-analysis” course, where students complete a systematic review/meta-analysis, this course is designed to accommodate diverse student projects that deal with research methods, reporting, reproducibility, evaluation, and incentives. Overall, the course provides students with the tools to (1) evaluate the quality, validity, and reproducibility of research; and (2) preregister, design, conduct, and publish a theoretical or empirical meta-research study, following the best open-science practices. Meta-research studies can be conducted across all scientific fields, from preclinical/animal research to the social sciences. Key topics include the philosophy of science; scientific biases and bias assessment; designing and conducting a meta-research project; meta-analytical methodology; database searches; and open-science practices. The class consists of lectures and labs/discussions. Students design a meta-research project in their own field. The goal is to have students work on a project that will be suitable for a thesis and/or eventual publication in a peer-reviewed journal. Prerequisite: one graduate-level biostatistics (e.g., BIS 505) or epidemiology (e.g., EPH 508) course.

**EHS 537a / EMD 537a, Water, Sanitation, and Global Health**  
Ying Chen and Elsio Wunder
Water is essential for life, and yet unsafe water poses threats to human health globally, from the poorest to the wealthiest countries. More than two billion people around the world lack access to clean, safe drinking water, hygiene, and sanitation (WASH). This course focuses on the role of water in human health from a public health perspective. The course provides a broad overview of the important relationships between water quality, human health, and the global burden of waterborne diseases. It discusses the basics of water compartments and the health effects from exposures to pathogenic microbes and toxic chemicals in drinking water. It also covers different sanitation solutions to improve water quality and disease prevention and discusses future challenges and the need for intervention strategies in the new millennium.

**EHS 545b, Molecular Epidemiology**  
Yong Zhu
Many diseases are the outcome of a complex interrelationship between multiple genetic, epigenetic, and environmental factors. This course covers basic concepts of human genetics as well as recent discoveries in the field of epigenetics, which are fundamental to understanding how individuals differ in their susceptibility to environmental agents and how these susceptibilities change over time. Current knowledge of molecular approaches to identifying specific genetic variations and epigenetic alterations associated with human diseases are introduced, and their roles in gene-environment interactions and disease development are discussed. The course includes formal lectures, article discussions, and laboratory components, which provide hands-on experiences of some commonly used molecular techniques for detecting genetic and epigenetic changes.

**EHS 547b, Climate Change and Public Health**  
Robert Dubrow
This course takes an interdisciplinary approach to examining relationships between climate change and public health. After placing climate change in the context of the Anthropocene and planetary health and exploring the fundamentals of climate change science, the course covers impacts of climate change on public health, including heat waves; occupational heat stress; hurricanes and flooding; tropospheric ozone; wildfires; aerosol gerns; vector-borne, foodborne, and waterborne diseases; food insecurity; migration; and violent conflict. The course covers the public health strategies of adaptation (secondary prevention) and mitigation (primary prevention) to reduce adverse health impacts of climate change and discusses the substantial non-climate health benefits of these strategies. Policy, vulnerability, and climate justice considerations are integrated into the course throughout. The course is reading-intensive and makes ample use of case studies. This course should be of interest to students across Yale School of Public Health and the University. Prerequisites: EPH 508 or HLTH 240 or equivalent, and EPH 505 or equivalent.
EHS 560a, Methods in Climate Change and Health Research  Kai Chen
Climate change is recognized as one of the greatest public health challenges of the twenty-first century. This course takes multidisciplinary approaches to identify, assess, quantify, and project public health impacts of climate change and of measures to address climate change. It first introduces the fundamental principles of health impact assessment and gives a brief overview of the public health approaches to address climate change. Then it applies advanced data analysis methodologies in environmental epidemiology, including time-series analysis, spatial epidemiology, and vulnerability assessment, to characterize the present climate-health (exposure-response) relationships and to identify vulnerable populations. This course discusses key concepts of scenario-based climate projections and their applications in projecting future health impacts, evaluating health co-benefits of climate mitigation polices, and assessing climate change adaptation measures. Emphasis is placed on hands-on computer lab exercises with real-data examples and R scripts. Prerequisites: EPH 505 or equivalent; EPH 508 or equivalent; EPH 513; or permission of the instructor.

EHS 562b / CDE 563b, Biomarkers of Exposure, Effect, and Susceptibility in the Epidemiology of Noncommunicable Disease  Caroline Johnson
This course explores how new biomarker approaches can be applied to understanding the health consequences of environmental exposures and other risk factors. We learn how advances in the measurement of environmental exposures, genes, proteins, metabolites, and the microbiome have strengthened epidemiological associations, and narrowed the gap from correlation to causality. Variability in biomarker performance and susceptibility to disease due to ageing, diet, location, and other factors is discussed, along with methods that are used to evaluate biomarker evidence in epidemiology. Lectures describe chronic noncommunicable diseases of immediate concern to public health such as neurodegenerative diseases (Alzheimer’s disease, Parkinson’s disease), cancer, cardiovascular diseases, and asthma. We examine seminal publications and the application of techniques that have transformed the understanding of each disease, resulting in improvements to early detection and treatment approaches for these diseases. We also delve into examples of epidemiologic studies that have been carried out on large prospective cohorts, such as the Framingham Heart Study and Nurses’ Health Study, and compare and critique methods used to identify biomarkers of disease between the cohorts. To evaluate and foster greater understanding of these areas, students critique journal articles for homework assignments.

EHS 566a / CDE 566a, Causal Inference Methods in Public Health Research  Zeyan Liew
This course introduces the theory and applications of causal inference methods for public health research. The rapid development of both the theoretical frameworks and applications of causal inference methods in recent years provides opportunities to improve the rigor of epidemiological research. The course covers topics such as (i) the principles of causal logic including counterfactuals and probability logic, (ii) epidemiological study designs and sources of biases including misinterpretations of statistics, (iii) applications of causal diagrams in epidemiology, (iv) applications of causal modeling techniques in epidemiological research using real-world and simulated data. Students leave the course with a basic knowledge of causal inference methods to apply in their own research projects and the ability to further explore the causal inference literature. This is an introductory-level course for causal inference methods with a focus on epidemiological research using observational data. Students interested in the theoretical and mathematical basis of causal inference methods should consider taking BIS 537. Prerequisites: EPH 508 and either BIS 505 or CDE 534. Other equivalent classes would require the permission of the instructor. Programming experience is also required.

EHS 567b, Fundamentals of Green Engineering and Green Chemistry  Paul Anastas
There is a broad desire to ensure that consumer products, manufacturing processes, and material and energy systems are compatible with public health and environmental sustainability. This course provides fundamental knowledge of the frameworks, methods, tools, and techniques of designing for sustainability. Through an understanding of conceptual contracts and application to real-world case studies, students learn the impacts of design on health (including toxic and ecotoxic effects) and the ways to ensure that new products, processes, and systems can be constructed through the principles of green engineering and green chemistry. This course provides the foundation for more advanced investigations in sustainable design; there are no prerequisites.

EHS 569a or b, Introduction to GIS for Public Health  Jill Kelly
This course teaches the use of Geographic Information Systems (GIS), a collection of hardware and software tools that allow users to acquire, manipulate, analyze, and display geographic data in its spatial configuration. Students learn both the theory of geospatial analysis and practical applications of GIS in a public health context.

EHS 572b, Epidemiological Issues in Occupational and Environmental Medicine  Mark Russi and Martin Slade
This course explores issues around the detection and characterization of health outcomes from environmental and occupational exposures. Case studies include infectious disease outbreaks, cancer clusters in the general environment and within industrial settings, groundwater contaminations and birth defects, lung diseases and cancers following the World Trade Center attacks, health sequelae in military populations, radon exposures and lung cancers in miners and in the general population, and exposures among marginalized populations. The course is taught in discussion format by occupational and environmental medicine faculty. There is a take-home final examination.

EHS 573a, Introduction to Occupational and Environmental Medicine  Carrie Redlich
This course presents a broad overview of the fundamental concepts of occupational and environmental medicine (OEM), including the major workplace and environmental hazards and stressors (chemical, physical, biological, psychosocial), the settings in which they occur, major related illnesses and injuries, and preventive strategies. The key role of exposure assessment, industrial hygiene, ergonomics, epidemiology, toxicology, and regulatory and ethical factors in the recognition and prevention of work and environment-related health
effects is incorporated throughout the course. The course includes lectures, workplace site visits, and article discussions. There are no prerequisites.

**EHS 581b, Public Health Emergencies: Disaster Planning and Response** Yong Zhu
This course focuses on operational aspects of planning and response to domestic and international public health and medical emergencies. Under the National Response Framework, public health and medical components of emergency response are grouped in Emergency Support Function #8 (ESF 8). Many states and local jurisdictions organize their responses similarly. ESF 8 encompasses seventeen core functions. The course primarily emphasizes U.S. domestic scenarios and familiarity with U.S. government guidance documents, but international response analogies and distinctions are included for illustration of some concepts.

**EHS 600a or b, Independent Study or Directed Readings** Staff
Independent study or directed readings on a specific research topic agreed upon by faculty and student. By arrangement with faculty. For PhD Students only.

**EHS 619a and EHS 620b, Research Rotation** Caroline Johnson
This course is required of all EHS Ph.D. students during their first academic year. The research rotations are in EHS laboratories that are able to accommodate students. Research rotations are available for both “dry” (i.e., statistical analysis) and “wet” (i.e., bench) laboratory research groups. The student meets with the EHS graduate faculty member at the beginning of the rotation for an explanation of the goals and expectations of a student in the laboratory. The student becomes familiar with the research models, approaches, and methods utilized by the research group through interactions with other laboratory/research personnel and from laboratory manuscripts. The student is expected to spend at least fifteen hours per week working in the laboratory or research group and to present a rotation seminar at the end of the rotation period.